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IMPORTANT PART SYMBOL
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Signature (Renault approver)	Signature (Nissan approver)
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Revisions

Version	Date	Author	Revision History
5.0	2021-10-31	T.MOGARI I. ORBECI	Change FIFO Buffer clear specification
4.0	2020-09-01	T.MOGARI Y.BENAOUDA	New template

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FOREWORD

This document re-uses paragraph(s) of RENAULT document Draft Renault Gateway & Switching features.
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Contents

Foreword 4
Introduction 6
1 Scope 7
2 Normative references 7
3 Terms and definition 7
4 Symbols and abbreviated terms 10
5 General requierement 11
6 Frame handling specification 13
6.1. RECEPTION PROCESS 13
6.2. FRAME PROCESSING CAN TO CAN-FD 13
6.3. FRAME PROCESSING CAN-FD TO CAN 14
6.4. TRANSMISSION PROCESS 16
7 Annex A 19
8 Annex B 20

INTRODUCTION

The embedded CAN to CAN-FD and CAN-FD to CAN Functional Gateway is a function integrated into an ECU. Its purpose is to connect plural channel CAN and CAN-FD buses, as shown on Figure 0-1, and to manage “frame handling” between CAN and CAN-FD busses.

Note:. For other CAN/CAN FD specification (including HW, Software,…) please refer to [REF1], [REF2] and [REF3].

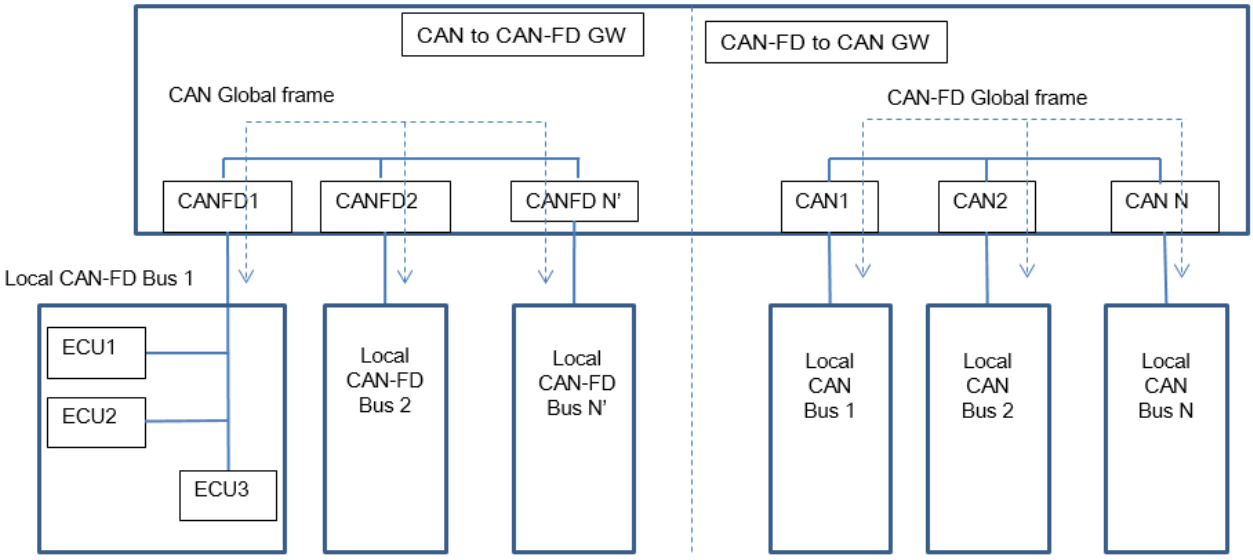


Figure 0-1 Example of the CAN to CAN-FD and CAN-FD to CAN GW implementation

PRODUCT SPECIFICATION

1 SCOPE

This document describes functional and electrical requirements of an embedded CAN to CAN-FD and CAN-FD to CAN Gateway, also called “GW” in the document.

Each requirement is described with a requirement number and a description in a chart such as presented below:

[CANGWXXXy]: description of the requirement; where XXX represents the requirement number for the whole document, and y represents the revision information of the requirement.

Proofs of the respect of all requirements are requested. A validation test plan for all requirements is available in [REF4].

The following terminology is used to define the applicability of each requirement in this document.

- The word **Shall** in the text means a mandatory requirement.

- The word **Should** in the text means a recommendation or advice on implementing a requirement. Such recommendations or advice are expected to be followed; unless justified reasons are stated for not doing so.

2 NORMATIVE REFERENCES

These normative references apply the latest version.
[REF1] RNDS for CAN High-Speed and CAN-FD Hardware
Ref.Renault: 36- 02- 026 / RNDS-B-00008
[REF2] RNDS for CAN high speed and CAN-FD communication software
Ref.Renault: 36-02-030 / RNDS-B-00010
[REF3] Specific Requirement
Renault/Nissan : Communication Requirement Specification of the EUT.
Nissan : CAN and CAN-FD specification result report.
Renault/Nissan : ECU Specific Requirement for the CAN/CAN-FD Bridge.
[REF4] RNDS Validation Test Plan for CAN to CAN-FD and CAN-FD to CAN Functional Gateway
Ref.Renault: 36-02-028 / RNDS-B-00017
[REF5] Message Set Specification for the Gateway
[REF6] AUTOSAR IPDU multiplexer specification v4.2.2 (or later)
[REF7] ISO 11898-1:Road Vehicle Controller Area Network. FDIS Version of 2015 or later.

3 TERMS AND DEFINITION

For the purpose of this standard, the following terms and definitions apply:

- CAN-FD Frames : CAN Frames in Flexible Datarate Format according to [REF7]

- HS-CAN Frames: CAN Frames in Classical High-Speed CAN Format according to [REF7]. Also referred as CAN Frames in this document.
- Source bus: generic name used for the CAN or CAN-FD bus on which a frame is by the GW.
- Destination bus: generic name used for the CAN or CAN-FD bus on which a frame needs to be re-emitted by the Functional Gateway.
- Frame: generic name for both data frames. Some frames need to be queued: refer to “buffered transferred frame” definition.
- MPFO transferred frame: frame transferred through the GW with Most Priority First Out. (Figure 6-6)
- FIFO transferred frame: frame transferred through the GW with First In First Out. (Figure 6-7)
- Frame handling: generic name defining the reception of a frame and its re-emission on the destination bus.
- Global-Fr: All the frames emitted by the ECUs connected on Source bus and containing at least one data or PDU and consumed by at least one ECU connected on Destination buses.
- Local-Fr: All the frames emitted by the ECUs connected on Source bus and not containing data or PDU consumed by any ECU connected on Destination buses: the GW shall not handle them.
- Global ID table : List of ID of frames and contained-IPDU handled by the Functional GW between source and destination buses.
- MPFO_NB_F_Max : The maximum number of MPFO transferred frames.
- FIFO_BUFFER_SIZE_CAN n : The buffer size of FIFO transferred frames per CAN/CAN-FD bus.
- Failure mode: This mode corresponds to a problem of transmission on the CAN/CAN-FD bus: any emission/reception problem can be considered as a part of the failure mode (mute state, bus-off state).
- Reset phase: Initialization of part related to CAN/CAN-FD. Refer to [1] for details.
- Nominal mode: operating mode during which the GW is not in the failure mode and in not in reset phase.
- Total Processing time (Figure **3-1**): delay between the end of a frame received by the GW and the beginning of its retransmission on each channel (by assuming a bus load null on the destination bus and assuming Transmission Buffer are empty)
- Latency time (Figure **3-1**): delay between the end of a frame received by the GW and the end of its retransmission (depending on the destination bus load).
- Separation time (Figure **3-1**): delay between two consecutive frames emitted by the Functional GW, by assuming that these frames were buffered because of activity on the destination bus. Separation time includes inter-frame space.
- Reception processing Time (Figure **3-1**): delay time between following Start timing and End timing.
  Start timing: Reception of the EOF of the frame.
  End timing: Completion to store the frame to all MPFO/FIFO buffers (all destination ports)
- Frame duration (Figure **3-1**): duration of a complete frame (including Start Of Frame, arbitration field, control field, data field, CRC sequence, acknowledgement field, End Of Frame, the Inter-Frame Space and stuff bits).

- The number of stuff bits cannot be known a-priori because of the data values and the CRC: however, the number of stuff bits can be approximated (worst case) by dividing the message length by a factor 5.
- PDU : Protocol Data Unit according to [REF6]
- I-PDU : Interaction Layer Protocol Data Unit according to [REF6]
- Regular Type Frame : HS-CAN frame or CAN-FD frame with only data coded in the data field.
- Container Type Frame : CAN-FD frame with one or several contained I-PDUs in the data field according to [REF6]
- MAC : Message Authentication Code
- A/R : Antireplay

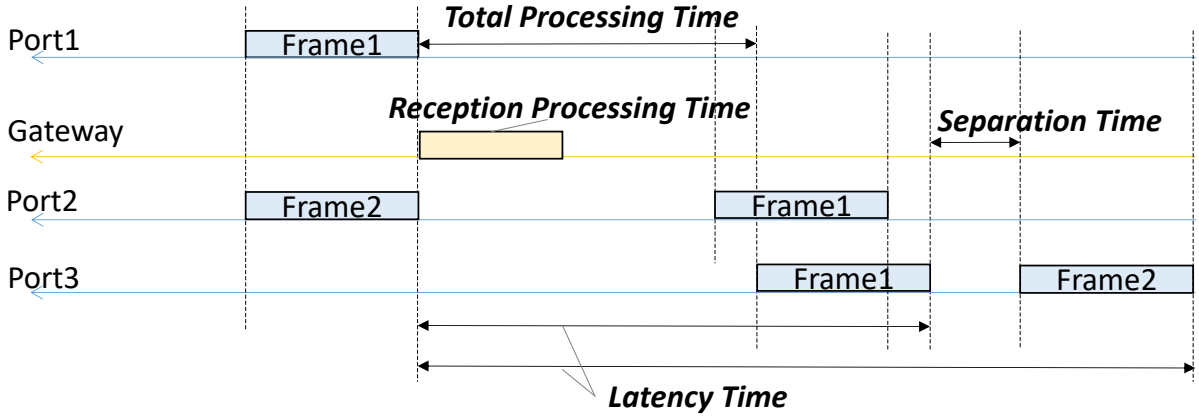


Figure 3-1 Timing definitions

4 SYMBOLS AND ABBREVIATED TERMS

For the purpose of this standard, the following symbols and abbreviated terms apply.

Acronym/Other	Meaning
CAN	**C**ontroller **A**rea **N**etwork
CAN-FD	**C**AN with **F**lexible **D**ata rate
CAN/CAN-FD Bridge	CAN to CAN bridge or CAN-FD to CAN-FD bridge
OSI	**O**pen **S**ystems **I**nterconnection
ECU	**E**lectronic **C**ontrol **U**nit
Tp	Processing Time
Tl	Latency Time

5 GENERAL REQUIEREMENT

Gateway handling is divided in three processes: Reception, Frame Processing, and Transmission as depicted in Figure 5-1

- The goal of reception process is to receive frames from any channel, compare with global ID table and if matching, process to Frame Handling
- The goal of Frame Processing is to handle the frame to proceed into the right format (CAN or CAN-FD) and send to transmission buffer of destination bus.
- The goal of transmission process is to manage frame in specific order, and to put them in HW Tx buffer, ready to be sent when destination bus is available.

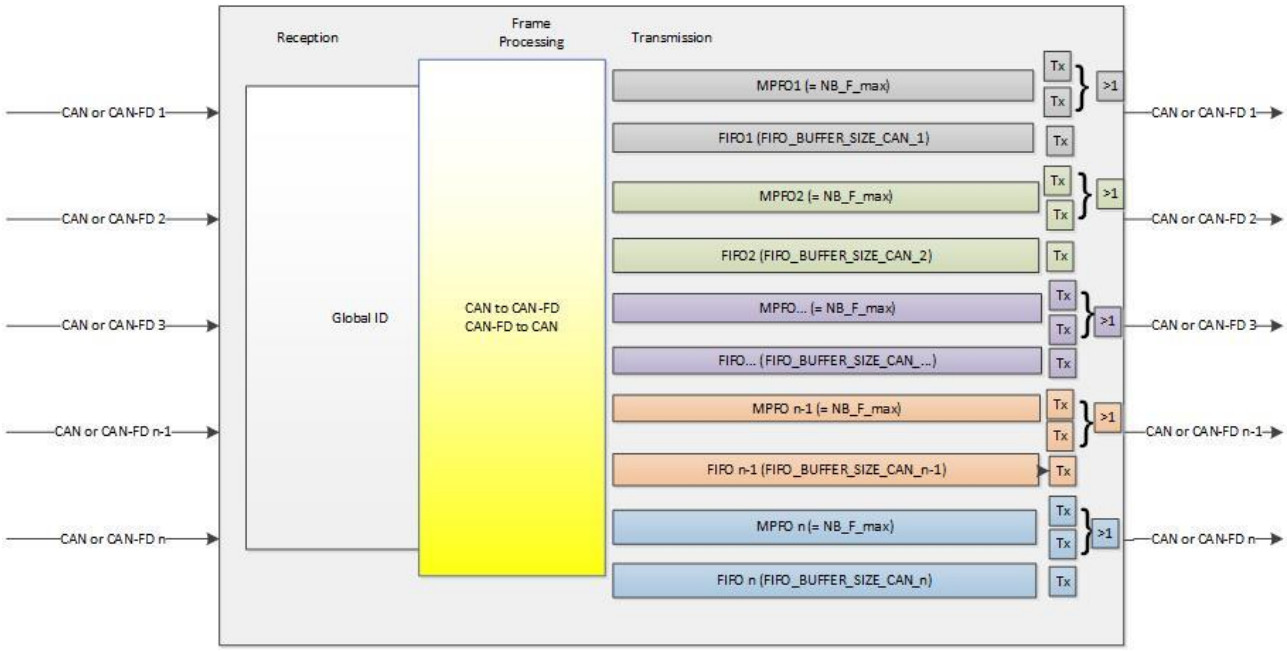


Figure 5-1 : Processes of Gateway

[CANGW_GEN_01.0a] All CAN/CAN-FD buses shall be electrically independent.

Note: This electrical isolation shall keep Source bus functional when one or some of Destination buses down (due to short-circuit between CAN/CAN-FD lines…) and vice versa.

[CANGW_GEN_02.0a] Each CAN/CAN-FD interface between Source bus and Destination buses shall work independently.

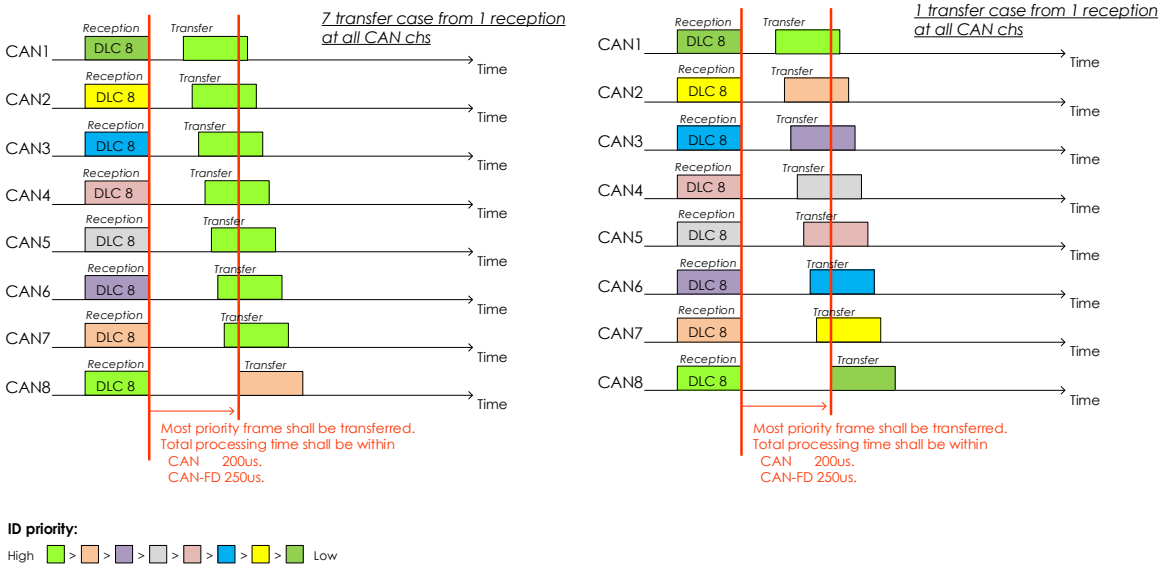
[CANGW_GEN_03.0a] The GW shall be able to handle Gateway frames within 10ms, when a software reset occurs during running.

[CANGW_GEN_04.0a] After hardware or software reset of the CAN/CAN-FD GW, the CAN/CAN-FD transmission buffers (for Source bus and Destination buses) including MPFO and FIFO, shall be cleared.

[CANGW_GEN_05.0a] Even if the GW is receiving any Global frames from any source buses at the same time, it shall handle Global frames within processing time.

[CANGW_GEN_06.0a] The total processing time of the GW shall be below 250µs in all cases.

Example:



[CANGW_GEN_07.0a] The GW shall not respond to a remote frame.

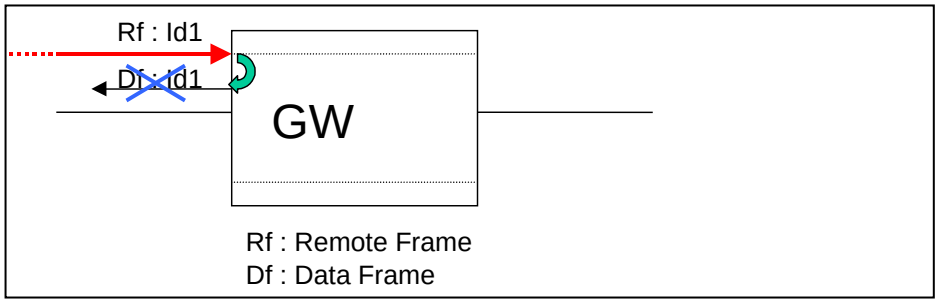


Figure 5-2 – Remote Frames Handling

6 FRAME HANDLING SPECIFICATION

6.1. RECEPTION PROCESS

As defined in general requirement

- The goal of reception process is to receive frames from any channel, compare with global ID table and if matching, transmit to frame processing.

[CANGW_Rx_08.0a] The GW will be frame filtering between Source bus and Destination buses. It shall handle only Global-Fr as defined in global ID table and not transfer Local-Fr. Reception process shall not miss any frames In particular

[CANGW_Rx_09.0a] A transmission process on the destination buses shall not disturb the receiving process on the source bus. A frame present on the source bus shall not be missed by the CAN/CAN-FD Gateway.

[CANGW_Rx_10.0a] The GW shall be able to receive consecutive frames whatever the Data Length from all source buses delayed of inter-frame space without frame lost.(inter-frame space is defined in ISO 11898-1)

[CANGW_Rx_CAN11.0a] Even if the GW is receiving any Global frames from any CAN-HS source buses at the same time, received frame shall be stored in all transmission buffers of all destination busses within reception Processing Time of 100µs.

[CANGW_Rx_CANFD12.0a] Even if the GW is receiving any Global frames from any CAN-FD source buses at the same time, received frame shall be stored in all transmission buffers of all destination busses within reception Processing Time of 75µs.

Note : In case of **[CANGW_Rx_CANFD120a]** cannot be fulfilled, then the supplier shall demonstrate that the proposed implementation (Timing, Reception management, Buffer sizing…) complies with **[CANGW_Rx_100a].**

[CANGW_Rx_CAN880a] The CAN/CAN-FD Gateway shall **not** perform consistency checks for Global-Fr.

Note : For Consistency checks specification on the frame consumed by the CAN/CAN-FD Gateway oneself, please refer to [REF2].

6.2. FRAME PROCESSING CAN TO CAN-FD

As defined in general requirement

- The goal of frame processing CAN to CAN-FD is to convert the received HS-CAN frames into right CAN-FD format and store them in transmission buffer of destination buses. It is used also to route each frame to correct destination bus according to Global ID table.

  Cases 1_a and 2_a describe the different CAN to CAN-FD frame processing the GW shall implement. Please refer to [REF5] to know which case shall be applied for each Identifier.

6.2.1. Case 1_a : Regular Type Frame

[CANGW_Fpr_13.0a] No Processing of the frame shall be done.

[CANGW_Fpr_14.0a] It shall be possible to change the Id of the frame if required in [REF5],

[CANGW_Fpr_15.0a] Frame shall be stored in CAN-FD format in transmission buffer of destination bus according to Figure 6-1 and Chapter 6.4.

Figure 6-1 : CAN to CAN-FD. Case 1_a

6.2.2. Case 2_a : Container Type Frame

[CANGW_Fpr_16.0a] A Container type frame with one PDU shall be built from the original HS-CAN Frame as defined in [REF5] and depicted in Figure 6-2.

[CANGW_Fpr_17.0a] Original HS-CAN frame PDU shal be transferred in the CAN-FD frame together with a header.

Note: The header is defined by a 24 bits Identifier followed by a 8 bits Data Length Code built from original HS-CAN frame Identifier and Data Length Code. Detailed definition is given in [REF5].

[CANGW_Fpr_18.0a] CAN-FD Frame Identifier shall be fixed as defined in [REF5].

[CANGW_Fpr_19.0a] CAN-FD I-PDU Header shall be fixed as defined in [REF5] and depicted in Figure 6-2.

[CANGW_Fpr_20.0a] CAN-FD Data Bytes shall be copied from original HS-CAN Frame as depicted in Figure 6-2.

[CANGW_Fpr_21.0a] If requested, MAC and A/R calculated by the GW shall be added in the CAN-FD frame at a fix position as defined in [REF5] and depicted in Figure 6-2. 0x00 padding shall be made up to closest authorized value of CAN-FD Data Length.

[CANGW_Fpr_22.0a] Frame shall be stored in CAN-FD format in transmission buffer of destination bus according to Figure 6-2 and Chapter 6.4.

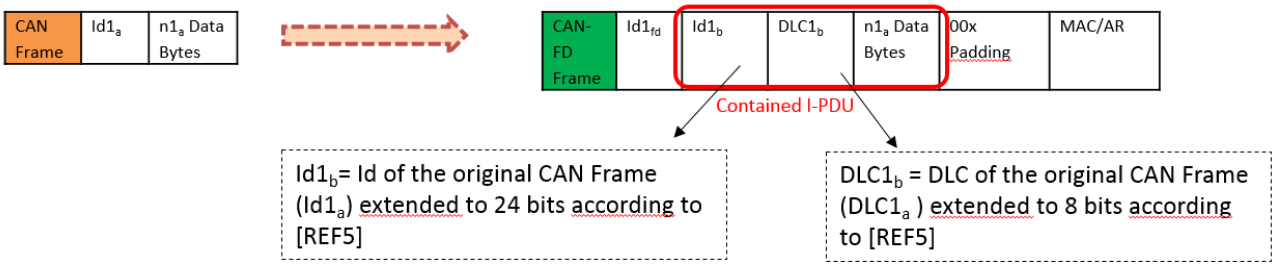


Figure 6-2 : CAN to CAN-FD. Case 2_a

[CANGW_Fpr_23.0a] (Requirement left Intentionnaly Blank)

6.3. FRAME PROCESSING CAN-FD TO CAN

As defined in general requirement

- The goal of frame processing CAN-FD to CAN is to convert the received CAN-FD frames into right HS-CAN format and store them in transmission buffer of destination buses. It is used also to route each frame to correct destination bus according to Global ID table.

Cases 1_b, 2_b, and 3_b describe the different CAN-FD to CAN frame processing the GW shall implement. Please refer to [REF5] to know which case shall be applied for each Identifier.

6.3.1. Case 1_b : Regular Type Frame - DLC ≤ 8

[CANGW_Fpr_24.0a] No Processing of the frame shall be done. (240a)

[CANGW_Fpr_25.0a It shall be possible to change the Id of the frame if required in [REF5].

[CANGW_Fpr_26.0a] Frame shall be stored in HS-CAN format in transmission buffer of destination bus according to Figure 6-3 and Chapter 6.4.

Figure 6-3 : CAN-FD to CAN. Case 1_b

6.3.2. Case 2_b : Container Type Frame

[CANGW_Fpr_27.0a] When receiving container type frame, the GW shall extract the individual PDU's from the CAN-FD Frame as depicted in Figure 6-4.

The detailed content of the CAN-FD frame is defined in [REF5]

[CANGW_Fpr_28.0a] The GW shall constitute one HS-CAN Frame for each contained I-PDU as depicted in Figure 6-4.

[CANGW_Fpr_29.0a] CAN Frame Identifier on 11 bits shall be built using the 11 LSB bits of the 24 bits extended Identifier as defined in [REF5].

[CANGW_Fpr_30.0a] HS-CAN Frame Data Length Code on 4 bits shall be built using the 4 LSB bits of the 8 bits extended PDU Data Length Code extended on 8 bits as defined in [REF5].

[CANGW_Fpr_31.0a] Other data and end of frame 0x00 padding shall be discarded by the GW.

[CANGW_Fpr_32.0a] Frames shall be stored in HS-CAN format in transmission buffer of destination bus according to Chapter 6.4.

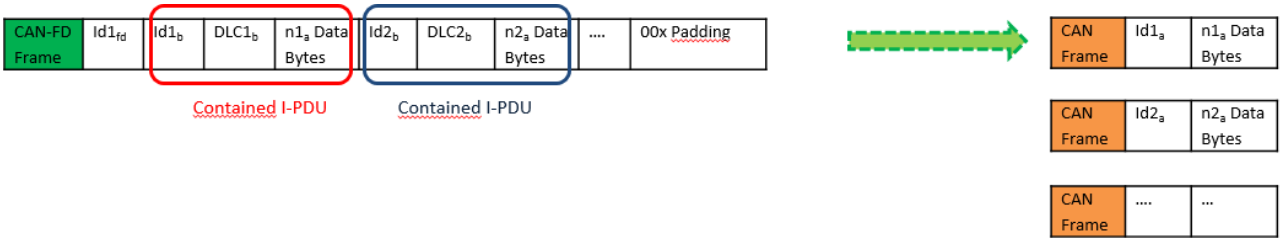


Figure 6-4 : CAN-FD to CAN. Case 2_b

6.3.3. Case 3_b : Container Type Frame

Following requirements will be applied to the frames that have to be handled:

[CANGW_Fpr_33.0a] When receiving container type frame, the GW shall extract the individual PDU's from the CAN-FD Frame as depicted in Figure 6-5.

The detailed content of the CAN-FD frame is defined in [REF5]

[CANGW_Fpr_34.0a] The GW shall constitute one HS-CAN Frame for each contained I-PDU as depicted in Figure 6-5.

[CANGW_Fpr_35.0a] HS-CAN Frame Identifier on 11 bits shall be built using the 11 LSB bits of the 24 bits extended Identifier as defined in [REF5].

[CANGW_Fpr_36.0a] HS-CAN Frame Data Length Code on 4 bits shall be built using the 4 LSB bits of the 8 bits extended PDU Data Length Code extended on 8 bits as defined in [REF5].

[CANGW_Fpr_37.0a] Other data and end of frame 0x00 padding shall be discarded by the GW.

[CANGW_Fpr_38.0a] Frames shall be stored in HS-CAN format in transmission buffer of destination bus according to Chapter 6.4.

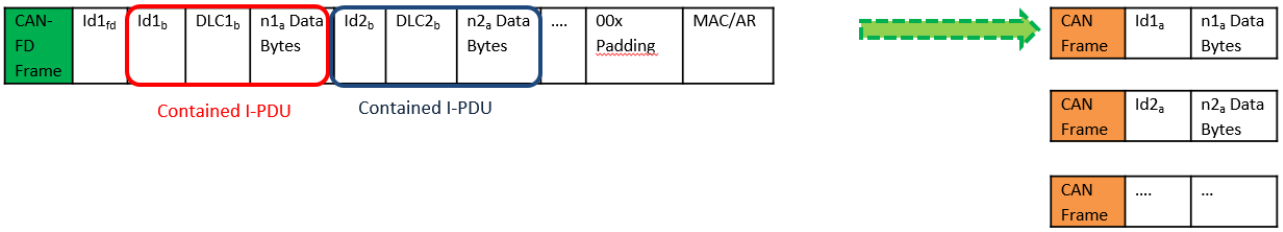


Figure 6-5 : CAN-FD to CAN. Case 3_b

6.4. TRANSMISSION PROCESS

As defined in general requirement

The goal of transmission process is to manage frame in specific order, and to put them in HW Tx buffer, ready to be sent when destination bus is available.

[CANGW_Tx_39.0a] After a BusOff recovery performed as specified in [REF2], the CAN/CAN-FD transmission buffers including MPFO and FIFO, of the CAN/CAN-FD interface which was detected in a BusOff state shall be cleared.

[CANGW_Tx_ 40. 0a] After a BusOff recovery on CAN/CAN-FD interface, the CAN/CAN-FD transmission buffers of the other interfaces (not in a BusOff before), shall not be cleared.

[CANGW_Tx_41.0a] MPFO transferred frames shall be handled by the GW function.

[CANGW_Tx_42.0a] FIFO transferred frames shall be handled by the GW function.

Note: Applicability and Frames Id will be defined in specific software document for the GW in [REF3].

[CANGW_Tx_43.0a] If transmission buffer is empty, the filtered frame shall be stored in HW Tx buffer directly. Else the filtered frame shall be buffered.

[CANGW_Tx_44.0a] The GW shall buffer MPFO frame and FIFO frame separately. Transmission of MPFO frame shall not be delayed due to FIFO.

[CANGW_Tx_441a] When storing more than 2 frames in transmission buffer of one CAN-FD destination bus, If this destination becomes available, the CAN/CAN-FD Gateway shall send frames within separation time of 75µs.

[CANGW_Tx_45.0a] When storing more than 2 frames in transmission buffer of one CAN destination bus, if this destination becomes available, the CAN/CAN-FD Gateway shall send frames within separation time of 100µs.

6.4.1. MPFO transferred frame

[CANGW_MPFO_46.0a] If several frames (with different IDs) are buffered, the first frame to be transmitted is the frame with the highest priority (Most Priority First Out).

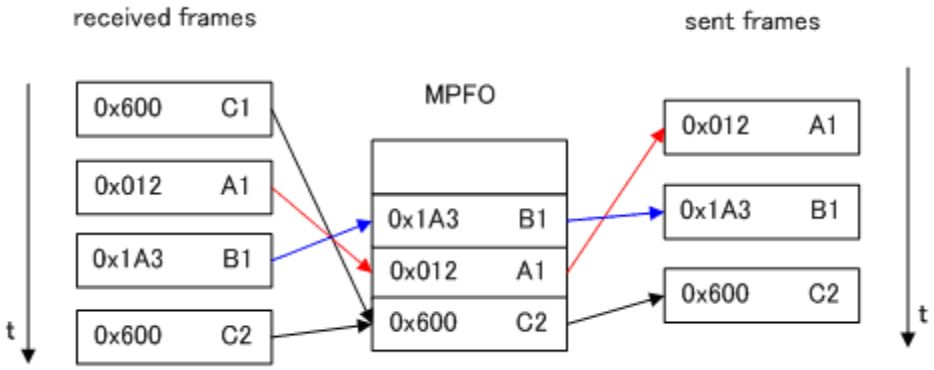


Figure 6-6 MPFO transferred frames. (Example for test cases 1_a and 1_b.)

[CANGW_MPFO_ 47. 0a] The GW shall be able to handle MPFO_NB_F_Max different MPFO transferred frames.

Note: MPFO_NB_F_Max shall be defined per the CAN/CAN-FD networks in the specific software document for the GW in [REF3].

[CANGW_MPFO_48.0a] If several frames (with same IDs) need to be handled at the same time by the GW (for example, frame reception without having successfully re-emitted the preceding one), the previous message shall be overwritten by the later one.

[CANGW_MPFO_49.0a] The GW should implement a minimum of 7 Tx buffers.
Note: These Tx buffers will manage range of ID for priority. The number and arrangement of Tx buffers will be discussed during the project development between supplier and Renault/Nissan according to GW definition.

6.4.2. FIFO transferred frame

[CANGW_FIFO_50.0a] FIFO transferred frame only applies for test cases 1_a and 1_b according to Chapters 6.2.1 and 6.3.1.

[CANGW_FIFO_51.0a] If several frames (with same or different ID) are received by the CAN/CAN-FD GW, then GW shall transmit all frames in respect with reception order (First In First Out).

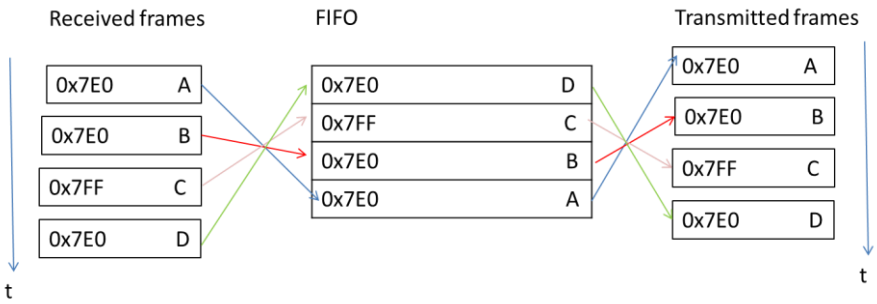


Figure 6-7 FIFO transferred frames

[CANGW_FIFO_52.0a] The GW shall be able to handle different FIFO transferred frames

[CANGW_FIFO_53.0a] Each CAN/CAN-FD interface will have a buffer dimension: FIFO_BUFFER_SIZE_CAN n.

Note: The number of FIFO buffer and dimension of each FIFO buffer shall be defined in the specific software document for the GW in [REF3].

[CANGW_FIFO_54.0a] In case where FIFO buffers are fulfilled, if a new FIFO transferred frame is received, it shall be stored after FIFO buffers are cleared.

Annex A

(Normative)

Revisions before RNDS-B-00016 v4.0 are described below;

S. LOUVART / T. MATSUMOTO	V. BIDAULT / T. MOGARI	DEA-SIA / XX2	2018/03/30	DLC filtering for CAN/CANFD GW forbidden.	3.0	--B	2
S. LOUVART / T. MATSUMOTO	V. BIDAULT / T. MOGARI	DEA-SIA / XX2	2017/03/31	Clarification of Requirements. Typography Mistake Corrections.	2.0	--A	1
S. LOUVART / T. MATSUMOTO	V. BIDAULT / T. MOGARI	DEA-SIA / XX2	2016/03/31	Newly established	1.0	---	N
APPROVED BY	SIGN	SECT	APPROVED DATE	ALTERATION	CHG RNDS	Ver GDNormes	CHG NES

Annex B

(Informative)