Research & Vehicle Technology
"Infotainment Systems Product Development"

Feature – Propulsion Sound (Phoenix)

Infotainment Subsystem Part Specific Specification (SPSS)

Version 1.1

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FORD CONFIDENTIAL

Revision History

Date	Version	Notes	
March 9, 2022	**1.0**	**Initial Release**	
August 22, 2022	**1.1**		
	PPS-FRD-REQ-433483/B-Propulsion Sound SPSS	bganesa7: Added new Functional requirements	
	STR-936074/A-Overview	bganesa7: Added new Calibration and feature consideration	
	STR-1104291/A-Library Calibration/Configuration file usage	bganesa7: Added for Clarification	
	STR-936076/B-Feature Considerations	bganesa7: Added for Clarification	
	STR-936079/B-Architectural Design	bganesa7: Added new Class descriptions	
	STR-936080/B-Deployment Table	bganesa7: Updated the Class information	
	PPS-IIR-REQ-433486/B-NVH Event Client Interface	bganesa7: Added new signals and removed Quality factor signals	
	STR-936081/B-Logical Signal Mapping	bganesa7: Updated the mapping table	
	MD-REQ-483898/B-Veh_V_ActlEng	bganesa7: Updated the description	
	MD-REQ-479457/B-AudioHeadUnit_Channel_St	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-473397/B-AudioAmplifier_Channel_St	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-473396/B-Aux_Amplifier Channel_St	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-483968/B-VehSimSnd_Pc_Rq	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-483908/B-InfotainmentAudio_St	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-483909/B-InfotainmentAudio_St2	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-473402/B-InfotainmentAudio_St3	bganesa7: Updated signal definition for better Clarity	
	MD-REQ-502457/A-PrplWhlTot2_Tq_Actl	bganesa7: Added new requirements	
	MD-REQ-519317/A-GearPos_D_Actl	bganesa7: New req.	
	STR-936082/B-General Requirements	bganesa7: Added new requirements	
	PPS-SR-REQ-500117/A-Information DID	<BG> Added new requirement	
	PPS-SR-REQ-500138/A-Calibration & Configuration Support	<BG> Added new requirement	
	STR-936083/B-Functional Definition	bganesa7: Added new functional requirements	
	PPS-FUN-REQ-478849/B-PS Power Mode	bganesa7: Added new timing requirement	
	PPS-SR-REQ-478856/B-Power-up for PS audio components	<BG> rephrased the timming requirement	
	PPS-TMR-REQ-519017/A-T_NVH_Startup_Audio	bganesa7: Added new timming requirement requirement	
	STR-936066/B-Requirements	<BG> Added new requirements	
	PPS-SR-REQ-433480/B-PS Audio Enable/Disable	bganesa7: Updated the requirement for better Clarity	
	PPS-TMR-REQ-481117/B-T_PS_Disable_time	bganesa7: Updated the requirement for better Clarity	
	PPS-TMR-REQ-481097/B-T_PS_Enable_time	bganesa7: Updated the requirement for better Clarity	
	PPS-SR-REQ-501657/A-PS audio Muting/Unmuting	<BG> Added new requirement	
	STR-1093410/A-Speaker faults and Channel Faults handling	<BG> Added new requirement	
	PPS-SR-REQ-483910/B-Audio Head Unit error state handling	bganesa7: Added new timing requirement	
	PPS-SR-REQ-483911/B-Audio Amplifier error state handling	bganesa7: Added new timing requirement	
	PPS-SR-REQ-473718/B-Aux Amplifier error state handling	bganesa7: Added new timing requirement	
	ANC-SR-REQ-433470/A-Channel Status Signal usage	<BG> Added new requirement for Phoenix	
	PPS-SR-REQ-479458/B-Error Handling when any of the Audio Head Unit channel(s) are faulted	bganesa7: Added new timing requirement	
	PPS-SR-REQ-473860/B-Error Handling when any of the Amplifier audio channel(s) are faulted	bganesa7: Added new timing requirement	
	PPS-SR-REQ-473877/B-Error Handling when Aux Amplifier audio channel(s) are faulted	bganesa7: Added new timing requirement	
	PPS-SR-REQ-512617/A-Speaker channel Fault latching	bganesa7: New requirement for Phoenix	
	PPS-SR-REQ-512637/A-Fault Handling for 'InfotainmentAudio_St'	bganesa7: New requirement for Phoenix	
	PPS-SR-REQ-512657/A-Fault Handling for 'InfotainmentAudio_St2'	bganesa7: New requirement for Phoenix	

PPS-SR-REQ-512777/A-Fault Handling for 'InfotainmentAudio_St3'	bganesa7: New requirement for Phoenix
PPS-SR-REQ-502537/A-PS audio Internal system fault handling	<BG> Added new requirement for Phoenix
PPS-SR-REQ-486280/A-Missing Message	<BG> Added new requirements for Missing Message
PPS-SR-REQ-502997/A-Fault detection configuration	<BG> Added new requirement for Phoenix
STR-936067/B-Use Cases	bganesa7: Added new usecases
PPS-UC-REQ-515157/A-PS audio on Startup - PAC,Aux Amp combination	bganesa7: Added new usecases
PPS-UC-REQ-518101/A-PS audio on Startup - PAC only	bganesa7: Added new usecases
PPS-UC-REQ-518100/A-PS audio on Startup - PAC,DSP combination	bganesa7: Added new usecases
PPS-UC-REQ-515207/A-PS audio playing during Shutdown	bganesa7: Added new usecases
PPS-UC-REQ-433449/A-Reading Calibration Part number	bganesa7: Added new usecases
PPS-UC-REQ-502797/A-Internal system error	bganesa7: Added new usecases
PPS-UC-REQ-433481/B-Amplifier Fault status is received while playing PS Audio - Atleast 1 or more channel(s) is used	bganesa7: Updated for better Clarity
PPS-UC-REQ-518257/A-Amplifier Fault status is received while playing PS Audio - none of the channel(s) is used	bganesa7: Added new requirement for Phoenix
PPS-UC-REQ-515001/A-Channel level fault is detected on one of the unused channels from PAC	bganesa7: Added new requirement for Phoenix
PPS-UC-REQ-515137/A-Channel level fault is detected on one of the used channels from Aux Amplifier	bganesa7: Added new requirement for Phoenix
PPS-ACT-REQ-433468/B-Propulsion Sound Operation	bganesa7: Updated for better Clarity
STR-936070/B-Sequence Diagrams	bganesa7: Added new requirement for Phoenix
PPS-SD-REQ-481538/B-Propulsion Sound Enable & Disabled by the user	bganesa7: Updated the requirement for better Clarity
PPS-SD-REQ-481537/B-Amplifier Module fault is detected while playing PS Audio	bganesa7: Added new requirement for Phoenix
PPS-SD-REQ-514178/A-Amplifier channel Fault is detected while playing PS audio	bganesa7: Added new requirement for Phoenix
PPS-SD-REQ-514179/A-PAC fault is detected while playing PS audio	bganesa7: Added new requirement for Phoenix
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PPS-FUN-REQ-492557/A-NVH Event Client & PS Generator Interaction	bganesa7: Added new requirement for Phoenix
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PPS-SR-REQ-486278/A-Input signal translation latency	<BG> Core audio requirements for Phoenix authored by FO
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1 Overview

1.1 Library Calibration/Configuration file usage

PS Acoustic Calibration File – Configuration Contents per Feature

The acoustic calibration "file" used for PS audio feature is unique to a specific vehicle model / trim / feature combination and is generated as part of the vehicle acoustic tuning process. It encapsulates the following configurable behaviors for each feature as follows:

PS

- Audio signal generation parameters and vehicle inputs affecting modulation.
- Perform appropriate mute/unmute behavior based on Feature Enable and Heartbeat VINs.
- Audio signal generation conditions, e.g., ignition, speed, direction, etc.
- Configuration of relevant speaker fault conditions along with updating the corresponding status VIN.

1.2 Feature Considerations

1. Logical design around speaker channel fault handling between 'NVH Event Client' and ANC Generator/PS Generator may be different. Since the speaker channel usage for ANC/PS feature may be different and is governed by individual Calibration/Configuration file to the ANC/PS Generator.
2. 'PS Generator' is also synonymously referred as 'ANC/PS Generator' throughout this specification since there are re-usable requirements between ANC and PS features. Similar consideration applies to
   PS Amplifier - ANC/PS Amplifier and
   PS Aux Amplifier - ANC/PS Aux Amplifier.

2 Architectural Design

2.1 PPS-CLD-REQ-483953/A-NVH Event Server

The 'NVH Event Server' is responsible to notify the change in vehicle status.

2.2 PPS-CLD-REQ-483952/A-NVH Event Client

The 'NVH Event Client' is the master that tells the ANC/PS Audio Components (i.e., ANC/PS Generator, Amplifier and Aux Amplifier Source Server) when to play the sound. It also receives the vehicle status from 'NVH Event Server' and controls the ANC/PS sound based on the status received.

2.3 PPS-CLD-REQ-433484/A-PS Generator

The 'PS Generator' is responsible for generating the propulsion sound signal.

2.4 PPS-CLD-REQ-433485/A-PS Amplifier

The PS Amplifier is responsible for producing the Propulsion Sound audio through the vehicle loudspeakers.

2.5 PPS-CLD-REQ-473738/A-PS Aux Amplifier

The 'PS Aux Amplifier' is responsible for producing auxiliary audio amplification for the propulsion sound audio through vehicle loudspeakers.

2.6 Deployment Table

The table below shows how the logical classes may be mapped to physical modules for the 'Propulsion Sound' feature/function. The table below covers the lead program.

At the time the specification was written the below table was the latest. If there are additional modules deployed to the class descriptions or the vehicle architecture changed since the spec was written and released, then the applicable implementation guide class description would cover those modules. If there is a conflict between the implementation guide and the table below the implementation guide takes precedent.

Logical Class	**Physical Module (ECU)**
NVH Event Server	BCM, PCM, ABS
NVH Event Client	APIM PDC CCPU
PS Generator	APIM PDC CCPU
PS Amplifier	PAC, DSP AMP (note applies to whatever module receiving the PS audio signal)
PS Aux Amplifier	Sub-Woofer Amplifier
PS Audio Components	PDC, PAC, DSP Amp, Sub-Woofer Amplifier

Module Present	PS Generator	PS Amplifier	PS Aux Amplifier	Notes
PDC, PAC	APIM PDC	PAC	-	-
PDC, PAC, Sub-Woofer Amp	APIM PDC	PAC	Sub-Woofer Amp	-
PDC, PAC, DSP Amp	APIM PDC	DSP AMP, PAC	-	PAC takes the responsibility of Secondary amplification.

2.7 PPS-IIR-REQ-433486/B-NVH Event Client Interface

2.7.1 Logical Signal Mapping

The CAN signals mentioned throughout this document shall refer to the CAN signal's logical name. The logical names shall be mapped to their actual CAN signal names. Please use the table below to perform the mapping. The InfoCAN database file is the master file for the actual CAN signal names. Note: There may be cases where the actual CAN signal name is used in this documentation.

Logical Message Name	CAN Message Name	Logical Signal Name	CAN signal name
AudioHeadUnit_Channel_St		Channel1	AudioCtlChnl1_D_Stat
		Channel2	AudioCtlChnl2_D_Stat
		Channel3	AudioCtlChnl3_D_Stat
		Channel4	AudioCtlChnl4_D_Stat
		Channel5	AudioCtlChnl5_D_Stat
		Channel6	AudioCtlChnl6_D_Stat
		Channel7	AudioCtlChnl7_D_Stat
		Channel8	AudioCtlChnl8_D_Stat
Audio_Amplifier_Channel_St		Channel1	AudioAmpfyChnl1_D_Stat
		Channel2	AudioAmpfyChnl2_D_Stat
		Channel3	AudioAmpfyChnl3_D_Stat
		Channel4	AudioAmpfyChnl4_D_Stat
		Channel5	AudioAmpfyChnl5_D_Stat
		Channel6	AudioAmpfyChnl6_D_Stat
		Channel7	AudioAmpfyChnl7_D_Stat
		Channel8	AudioAmpfyChnl8_D_Stat
		Channel9	AudioAmpfyChnl9_D_Stat
		Channel10	AudioAmpfyChnl10_D_St
		Channel11	AudioAmpfyChnl11_D_St
		Channel12	AudioAmpfyChnl12_D_St
		Channel13	AudioAmpfyChnl13_D_St
		Channel14	AudioAmpfyChnl14_D_St
		Channel15	AudioAmpfyChnl15_D_St
		Channel16	AudioAmpfyChnl16_D_St
		Channel17	AudioAmpfyChnl17_D_St
		Channel18	AudioAmpfyChnl18_D_St
		Channel19	AudioAmpfyChnl19_D_St
		Channel20	AudioAmpfyChnl20_D_St
		Channel21	AudioAmpfyChnl21_D_St
		Channel22	AudioAmpfyChnl22_D_St
		Channel23	AudioAmpfyChnl23_D_St
		Channel24	AudioAmpfyChnl24_D_St
Aux_Amplifier Channel_St		Channel1	AuxAmpfyChnl1_D_Stat
		Channel2	AuxAmpfyChnl2_D_Stat
		Channel3	AuxAmpfyChnl3_D_Stat
		Channel4	AuxAmpfyChnl4_D_Stat
-	-	InfotainmentAudio_St3	AuxAmpfy_D_Stat

Table: Logical name/CAN signal mapping

2.7.2 MD-REQ-473378/A-EngExhMdeQuiet_D2_Stat

Message Type: Status

This method is used to indicate the exhaust status.

Signal name	Literals	Values	Description
EngExhMdeQuiet_D2_Stat	-	-	-
	Null	0x0	
	Stealth	0x1	
	Normal	0x2	
	Sport	0x3	
	Track	0x4	
	NotUsed_1	0x5	
	NotUsed_2	0x6	
	Faulty	0x7	

2.7.3 MD-REQ-473380/A-EngAout_N_Actl

Message Type: Status

This method is used to indicate engine speed in rotations per minute (RPM).

Signal name	Literals	Values	Description
EngAout_N_Actl	-		
	<Range>	0x000 - 0x1FFF	0 to 16382 Resolution: 2 Offset: 0

2.7.4 MD-REQ-473381/A-ApedPos_Pc_ActlArb

Message Type: Status

This method is used to indicate the accelerator pedal position, given in %.

Signal name	Literals	Values	Description
ApedPos_Pc_ActlArb	<Range>	0x000 – 0x3FF	0 to 102.3 Offset: 0 Resolution: 0.1

2.7.5 MD-REQ-473383/A-TrnAin_Tq_Actl

Message Type: Status

This method is used to indicate engine torque, in Nm.

Signal name	Literals	Values	Description
TrnAin_Tq_Actl	-		
	<Range>	0x000 - 0x7FF	-500 to 1547 Offset: -500 Resolution: 1

2.7.6 MD-REQ-473385/A-PwPckTq_D_Stat

Message Type: Status

This method is used to indicate the Power Pack Status.

Signal name	Literals	Values	Description
PwPckTq_D_Stat	-	-	-
	Off Tq Not Available	0x0	
	On Tq Not Available	0x1	
	Strt In Prg No Tq	0x2	
	On Tq Available	0x3	

2.7.7 MD-REQ-473386/A-Eng_D_Stat

Message Type: Status

This method is used to indicate the Engine Status.

Signal name	Literals	Values	Description
Eng_D_Stat	-	-	-
	EngOff	0x0	
	EngOn	0x1	
	EngAutoStopped	0x2	
	NotUsed	0x3	

2.7.8 MD-REQ-473390/A-AutoTowActv_B_Stat

Message Type: Status

Status signal to indicate Auto tow activation status.

Signal Name	Literals	Value	Description
AutoTowActv_B_Stat	No	0x0	
	Yes	0x1	

2.7.9 MD-REQ-483898/B-Veh_V_ActlEng

Message Type: Status

This signal is used to represent the vehicle speed.

Signal Name	Literals	Value	Description
Veh_V_ActlEng	-	-	Indicates vehicle speed.
	<Range>	0x0 – 0xFFFF	0 to 655.35 kilometers / hour. Unit: kph Resolution:0.01 Offset:0

2.7.10 MD-REQ-473391/A-SelDrvMdeHmi04_D_Rq

Message Type: Status

Request signal to select drive mode

Logical Signal Name	Literals	Value	Description
SelDrvMdeHmi04_D_Rq	SelDrvMde01	0x0	
	SelDrvMde02	0x1	
	SelDrvMde03	0x2	
	SelDrvMde04	0x3	
	SelDrvMde05	0x4	
	SelDrvMde06	0x5	
	SelDrvMde07	0x6	
	SelDrvMde08	0x7	
	SelDrvMde09	0x8	
	SelDrvMde10	0x9	
	SelDrvMde11	0xA	
	SelDrvMde12	0xB	
	SelDrvMde13	0xC	
	SelDrvMde14	0xD	
	SelDrvMde15	0xE	
	SelDrvMde16	0xF	
	SelDrvMde17	0x10	
	SelDrvMde18	0x11	
	SelDrvMde19	0x12	
	SelDrvMde20	0x13	
	SelDrvMde21	0x14	
	SelDrvMde22	0x15	
	SelDrvMde23	0x16	
	SelDrvMde24	0x17	
	SelDrvMde25	0x18	
	SelDrvMde26	0x19	
	SelDrvMde27	0x1A	
	SelDrvMde28	0x1B	
	SelDrvMde29	0x1C	
	SelDrvMde30	0x1D	
	SelDrvMde31	0x1E	
	Faulty	0x1F	

2.7.11 MD-REQ-473392/A-ActvDrvMde_D2_Stat

Message Type: Status

Status signal to indicate active drive mode

Logical Signal Name	Literals	Value	Description
ActvDrvMde_D2_Stat	SelDrvMde01	0x0	
	SelDrvMde02	0x1	
	SelDrvMde03	0x2	
	SelDrvMde04	0x3	
	SelDrvMde05	0x4	
	SelDrvMde06	0x5	
	SelDrvMde07	0x6	
	SelDrvMde08	0x7	
	SelDrvMde09	0x8	
	SelDrvMde10	0x9	
	SelDrvMde11	0xA	
	SelDrvMde12	0xB	
	SelDrvMde13	0xC	
	SelDrvMde14	0xD	
	SelDrvMde15	0xE	
	SelDrvMde16	0xF	
	SelDrvMde17	0x10	
	SelDrvMde18	0x11	
	SelDrvMde19	0x12	
	SelDrvMde20	0x13	
	SelDrvMde21	0x14	
	SelDrvMde22	0x15	
	SelDrvMde23	0x16	
	SelDrvMde24	0x17	
	SelDrvMde25	0x18	
	SelDrvMde26	0x19	
	SelDrvMde27	0x1A	
	SelDrvMde28	0x1B	
	SelDrvMde29	0x1C	
	SelDrvMde30	0x1D	
	SelDrvMde31	0x1E	
	Faulty	0x1F	

2.7.12 MD-REQ-273750/A-Ignition_Status

Message Type: Status

Signal sent to the infotainment system indicating the ignition status of the vehicle

Logical Signal Name	Literals	Value	Description
Ignition_Status	Unknown	0x0	
	OFF	0x1	
	Accessory	0x2	

	Run	0x4	
	Start	0x8	
	Invalid	0xF	

2.7.13 MD-REQ-482277/A-TrnRng_D_Rq

Message Type: Status

This signal is used to indicate the actual state of the shift lever or other device (and incorporates transmission state requests from outside functions such as FAPA).

Name	Literals	Value	Description
TrnRng_D_Rq	-	-	
	Park	0x0	
	Reverse	0x1	
	Neutral	0x2	
	Drive	0x3	
	Sport_DriveSport_Mposition	0x4	
	Low	0x5	
	Range1_M1_L1	0x6	
	Range2_M2_L2	0x7	
	Range3_M3_L3	0x8	
	Range4	0x9	
	Range5	0xA	
	Range6	0xB	
	NotUsed_1	0xC	
	NotUsed_2	0xD	
	Unknown_Position	0xE	
	Fault	0xF	

2.7.14 MD-REQ-473394/A-CnvtTopPos_Dn_Stat

Message Type: Status

Status signal to indicate convertible top position.

Signal Name	Literals	Value	Description
CnvtTopPos_Dn_Stat	Not_Down	0x0	
	Down	0x1	

2.7.15 MD-REQ-473395/A-CnvtTopPos_Up_Stat

Message Type: Status

Status signal to indicate convertible top position.

Signal Name	Literals	Value	Description
CnvtTopPos_Up_Stat	Not_Up	0x0	
	Up	0x1	

2.7.16 MD-REQ-479457/B-AudioHeadUnit_Channel_St

Message Type: Status

Signal used to indicate the status of the Audio Head Unit channel(s).

Note: For CAN all these signals need to be in the same message

Logical Signal Name	Literals	Value	Description
Channel1	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel2	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel3	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel4	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel5	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel6	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel7	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
	Null	0x0	

Channel8	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	

2.7.17 MD-REQ-473397/B-AudioAmplifier_Channel_St

Message Type: Status

Signal used to indicate the status of the channel(s) used by DSP AMP.

Note: For CAN all these signals need to be in the same message.

Logical Signal Name	Literals	Value	Description
Channel1	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel2	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel3	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel4	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel5	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel6	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
	Null	0x0	

Channel7	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel8	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel9	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel10	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel11	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel12	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel13	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel14	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel15	Null	0x0	
	NormalOperation	0x1	

	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel16	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel17	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel18	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel19	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel20	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel21	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel22	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel23	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	

	Reserved	0x3	
Channel24	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	

2.7.18 MD-REQ-473396/B-Aux_Amplifier Channel_St

Message Type: Status

Signal used to indicate the status of the Aux Amplifier channel(s).

Note: For CAN all these signals need to be in the same message

Logical Signal Name	Literals	Value	Description
Channel1	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel2	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel3	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel4	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	

2.7.19 MD-REQ-483968/B-VehSimSnd_Pc_Rq

Message Type: Status

This signal is to request a level of simulated vehicle acceleration/deceleration sound according to driving characteristics, e.g. full, moderate or low vehicle acceleration/deceleration.

Name	Literals	Values	Description
VehSimSnd_Pc_Rq			-
	<Range>	-102.2 to 102.4	Min: -102.2 Max: 102.4 Resolution: 0.2 Offset: -102.2 Unit : %

2.7.20 MD-REQ-483908/B-InfotainmentAudio_St

Message Type: Status

Signal sent by the PAC indicating there is no infotainment audio because of an error condition when the infotainment system is powered ON.

Logical Signal Name	Literals	Value	Description
InfotainmentAudio_St	Null / Inactive	0x0	Default State
	NormalOperation	0x1	Able to produce audio
	ErrorState_NoAudio	0x2	Unable to produce audio
	Reserved	0x3	'Place Holder' – Reserved state

2.7.21 MD-REQ-483909/B-InfotainmentAudio_St2

Message Type: Status

Signal sent by the DSP AMP indicating there is no infotainment audio because of an error condition when the infotainment system is powered ON.

Logical Signal Name	Literals	Value	Description
InfotainmentAudio_St2	Null / Inactive	0x0	Default State
	NormalOperation	0x1	Able to produce audio
	ErrorState_NoAudio	0x2	Unable to produce audio
	Reserved	0x3	'Place Holder' – Reserved state

2.7.22 MD-REQ-473402/B-InfotainmentAudio_St3

Message Type: Status

Signal sent by the Aux amplifier to indicate the status when the infotainment system is powered ON (ex. non-channel-specific faults).

Logical Signal Name	Literals	Value	Description
InfotainmentAudio_St3	Null / Inactive	0x0	Default State
	NormalOperation	0x1	Able to produce audio
	ErrorState_NoAudio	0x2	Unable to produce audio
	Reserved	0x3	'Place Holder' – Reserved state

Note: This signal is reported by the PAC, based on diagnostic status information provided by the Aux Amplifier to the PAC via the A2B bus.

2.7.23 MD-REQ-502457/A-PrplWhlTot2_Tq_Actl

Message Type: Status

This signal is used to represent the calculated torque currently being delivered to all the axles at wheel level

Signal Name	Literals	Value	Description
PrplWhlTot2_Tq_Actl	-	-	-
	<Range>	0x0 – 0xFFFF	-131060 to 131060 newton*meter Resolution:4 Offset:-131072

2.7.24 MD-REQ-519317/A-GearPos_D_Actl

Message Type: Status
Signal used to indicate actual gear from automatic transmission. During a shift, the value does not change until the gear ratio change is complete.

Name	Literals	Value	Description
Type	-	-	Actual gear from automatic transmission
	Neutral	0x0	
	First	0x1	
	Second	0x2	
	Third	0x3	
	Fourth	0x4	
	Fifth	0x5	
	Sixth	0x6	
	Seventh	0x7	
	Eighth	0x8	
	Ninth	0x9	
	Tenth	0xA	
	Undefined	0xB	
	Undefined	0xC	
	Undefined	0xD	
	Reverse	0xE	
	Unknown	0xF	

2.7.25 MD-REQ-273358/D-HMIAudioMode

Message Type: Status

Signal sent by the System Master to the Infotainment modules to indicate the power mode status of the infotainment system.

Logical Signal Name	Literals	Value	Description
HMIAudioMode / HMI_HMIMode_St	Inactive	0x0	
	OFF	0x1	
	ON	0x2	
	Reserved	0x3	N/A to Global Infotainment
	Reserved	0x4	N/A to Global Infotainment
	Load Shed Active	0x5	

3 General Requirements

3.1 PPS-SR-REQ-433479/A-Feature Configuration

The Infotainment system shall have a configurable parameter/DID to allow the Propulsion sound feature to be enabled/disabled.

- When enabled, all the functionality and signals defined in this SPSS shall be supported.
- When disabled, PS functionality shall not be available, and the functionality defined in this SPSS shall not be supported.

Refer to the Infotainment Diagnostic Specification for the details on the configuration.

3.2 PPS-SR-REQ-477739/A-PS Settings Preference

If Enhanced Memory is supported, then the 'NVH Event Client' shall support to persist the current PS settings (i.e., Enabled/Disabled) for each personality profile between power mode changes, bus asleep/awake and between battery resets.

If Enhanced memory is not supported, then the 'NVH Event Client' shall persist the current PS settings for the guest vehicle profile between power mode changes, bus asleep/awake and between battery resets.

Note: Refer 'Enhanced Memory InterfaceClient SPSS' to understand 'NVH Event Client' role in persisting PS settings.

3.3 PPS-SR-REQ-500117/A-Information DID

The NVH Event Client shall update the status of PS Audio Components on an information DID as follows

- Not initialized/Not Ready
- Normal/Not Faulted/ready to Produce audio
- Temporarily disabled/ Cannot produce audio
- Faulted /disabled/Muted.

Refer to IDS specification for details on this DID.

3.4 PPS-SR-REQ-500138/A-Calibration & Configuration Support

The NVH Event Client shall support calibration/configuration governing the quality and characteristics of audio generation performed by the PS Generator. This calibration / configuration also contains information that the PS Generator uses to determine which of the amplifier module speaker channels are relevant and used for PS audio output. When the calibration/configuration are not available then the NVH Event Client shall support to log appropriate DTC.

Note 1: Refer IDS specification for more detail on the DTC.

4 Functional Definition

4.1 PPS-FUN-REQ-478849/B-PS Power Mode

4.1.1 Requirements

4.1.1.1 PPS-SR-REQ-478854/A-ANC/PS power mode state definitions

PS Sleep:
PS Sleep State is defined as the state where the CAN bus is asleep and PS functionality is powered down.

PS Standby:
PS Standby State is defined as the state where the CAN bus is active, but PS functionality is not active and is powered down if possible.

- Note this can be a low power state if the PS Amplifier is not powered up for other non-PS features.

PS Functional:
PS Functional State is defined as the state where the CAN bus is active and PS functionality is powered up.

4.1.1.2 PPS-SR-REQ-478856/B-Power-up for PS audio components

PS Audio Components shall transition from PS Standby/Sleep state to PS Functional state within T_NVH_Startup_Audio of HMIAudioMode=OFF -> ON.

Only when the PS audio components DE bits are configured as enabled then the PS Amplifier, PS Generator shall support the requirements covered in this spec (refer IDS spec for details of DE bits).

4.1.1.3 PPS-SR-REQ-478858/A-Power down for PS audio components

PS Audio Components shall transition from Functional to Sleep/Standby when the 'HMIAudioMode = ON -> OFF/Load Shed'.

4.1.2 PPS-TMR-REQ-519017/A-T_NVH_Startup_Audio

Name	Description	Units	Range	Resolution	Default
T_NVH_Startup_Audio	Maximum time for the system to play ANC/PS audio on the vehicle speakers upon system startup. Note: Maximum time defined as the default value	msec	0-3000		2000

4.2 PPS-FUN-REQ-433476/A-Propulsion Sound Audio - Operation

4.2.1 Requirements

4.2.1.1 PPS-SR-REQ-433480/B-PS Audio Enable/Disable

PS Audio Components shall support to play PS audio along with the main audio source only when the PS audio is enabled through Infotainment Screen.

PS Audio components shall support to gracefully mute the PS audio generation within 'T_PS_Disable_time' so that no audio blips or pop is heard, when the PS audio is disabled through Infotainment Screen.

4.2.1.2 PPS-TMR-REQ-481117/B-T_PS_Disable_time

Name	Description	Units	Range	Resolution	Default

T_PS_Disable_time	Maximum time for PS Generator to stop PS audio generation so that no abrupt audible changes are perceived by the customer. Note: Maximum time defined as the default value	msec			50

4.2.1.3 PPS-TMR-REQ-481097/B-T_PS_Enable_time

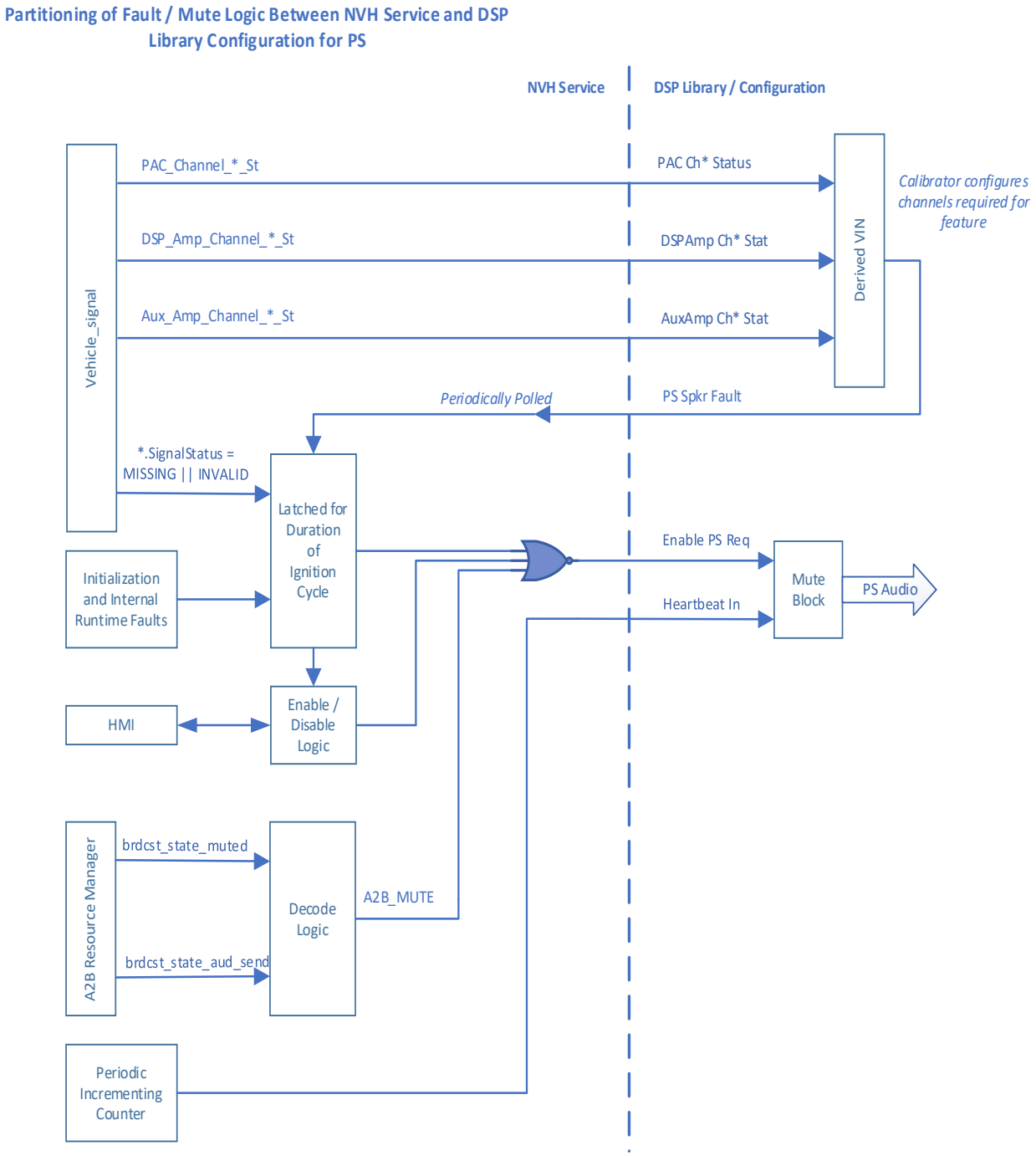
Name	Description	Units	Range	Resolution	Default
T_PS_Enable_time	Maximum time for the PS Generator shall take to unmute the audio channel and to start PS audio generation so that no abrupt audible changes are perceived by the customer. Note: Maximum time defined as the default value	msec			50

4.2.1.4 PPS-SR-REQ-501657/A-PS audio Muting/Unmuting

PS Audio components shall support to gracefully mute/Unmute the PS audio generation within 'T_PS_Disable_time'/ 'T_PS_Enable_time' respectively so that no audio blips or pop is heard.

4.2.1.5 Speaker faults and Channel Faults handling

The below diagram illustrates the interaction between NVH EVENT Client (NVH Service) and PS Generator (DSP Library) that would result in enable/disable PS audio.



4.2.1.5.1 PPS-SR-REQ-483910/B-Audio Head Unit error state handling

On system startup, PAC shall support to report the status on 'InfotainmentAudio_St' within T_NVH_Startup_Audio. Whenever 'NVH Event Client' receives 'InfotainmentAudio_St = ErrorState_NoAudio' that means the PAC cannot produce audio through any of the available vehicle speakers (ex. A2B link error, LVI/OVI Protection Active) and fault handling should be taken by the 'NVH Event Client' as needed (ex HMI updates if needed). If the PAC recovers and can produce audio again, then the signal 'InfotainmentAudio_St' shall change to 'NormalOperation'.

The 'NVH Event Client' shall take appropriate fault handling when it receives 'InfotainmentAudio_St= ErrorState_NoAudio'.

4.2.1.5.2 PPS-SR-REQ-483911/B-Audio Amplifier error state handling

On system startup, DSP Amp shall support to report the status on 'InfotainmentAudio_St2' within T_NVH_Startup_Audio. Whenever 'NVH Event Client' receives 'InfotainmentAudio_St2 = ErrorState_NoAudio' that means the DSP amplifier cannot produce audio through any of the available vehicle speakers (ex. A2B link error, LVI/OVI Protection Active) and fault handling should be taken by the 'NVH Event Client' as needed (ex. HMI updates if needed). If the DSP amplifier recovers and can produce audio again, then the signal 'InfotainmentAudio_St2' shall change to 'NormalOperation'.

The 'NVH Event Client' shall take appropriate fault handling when it receives 'InfotainmentAudio_St2 = ErrorState_NoAudio'.

Note: For a given vehicle configuration when DSP AMP is not in the vehicle network, then the 'InfotainmentAudio_St2' shall remain 'Null'.

4.2.1.5.3 PPS-SR-REQ-473718/B-Aux Amplifier error state handling

On system startup, Aux Amplifier shall support to report the status on 'InfotainmentAudio_St3' within T_NVH_Startup_Audio. Whenever 'NVH Event Client' receives 'InfotainmentAudio_St3 = ErrorState_NoAudio' that means the 'ANC/PS Aux Amplifier' cannot produce audio through any of the available vehicle speakers (ex. A2B link error, LVI/OVI Protection Active) and fault handling should be taken by the 'NVH Event Client' as needed (ex HMI updates if need). If the 'ANC/PS Aux Amplifier' recovers and can produce audio again, then the signal 'InfotainmentAudio_St3' shall change to 'NormalOperation'.

The 'NVH Event Client' shall take appropriate fault handling when it receives 'InfotainmentAudio_St3 = ErrorState_NoAudio'.

Note1: This signal is reported by the PAC, based on diagnostic status information provided by the Aux Amplifier to PAC via the A2B bus.
Note2: For a given vehicle configuration when Aux Amplifier is not in the vehicle network, then the InfotainmentAudio_St3 shall remain 'Null'.

4.2.1.5.4 ANC-SR-REQ-433470/A-Channel Status Signal usage

The 'ANC/PS Audio Components' shall set the status of individual channel(s) to appropriate state as follows on 'AudioHeadUnit_Channel_St/AudioAmplifier_Channel_St/Aux_Amplifier Channel_St' message.

Signal State	Description
Null	Default State of the signal. For any unused channel it shall remain in default state.
NormalOperation	When No channel fault(s) are detected and can produce audio through that channel.
ErrorState_NoAudio	When a channel fault is detected and is not able to produce audio through that channel.

Note: Whenever 'NVH Event Client' receives channel status as 'Reserved' on any of the ''AudioHeadUnit_Channel_St', 'AudioAmplifier_Channel_St', 'Aux_Amplifier Channel_St' signal, then NVH Event Client shall treat it as 'Null'.

4.2.1.5.5 PPS-SR-REQ-479458/B-Error Handling when any of the Audio Head Unit channel(s) are faulted

On system Startup, PAC shall report the status of all its channel(s) on 'AudioHeadUnit_Channel_St.Channel [n]' within T_NVH_Startup_Audio.
Whenever PAC detects 1 or more of its audio channel(s) are faulted then the Audio Head Unit shall set the corresponding signal in the 'AudioHeadUnit_Channel_St.Channel [n] = ErrorState_NoAudio'. When the 'NVH Event Client' receives 'ErrorState_NoAudio' that means the corresponding audio channel on the 'Audio Head Unit' is faulted. The 'NVH Event Client' shall take necessary fault handling as needed.

In the same ignition cycle, if the PAC audio channel recovers from error then the corresponding 'AudioHeadUnit_Channel_St.Channel [n]' signal shall change to 'NormalOperation'.

Note: For a given vehicle configuration when there are unused audio channels with the PAC, the corresponding 'AudioHeadUnit_Channel_St.Channel [n]' shall remain 'Null'.
'n' represents the possible channels it can support.

4.2.1.5.6 PPS-SR-REQ-473860/B-Error Handling when any of the Amplifier audio channel(s) are faulted

On system Startup, 'ANC/PS Amplifier' shall report the status of all its channel(s) on 'AudioAmplifier_Channel_St.Channel [n]' within T_NVH_Startup_Audio.
Whenever DSP AMP detects 1 or more of its audio channel(s) are faulted then the 'ANC/PS Amplifier' shall set the corresponding signal in the 'AudioAmplifier_Channel_St.Channel [n] = ErrorState_NoAudio'. When the 'NVH Event Client' receives 'ErrorState_NoAudio' that means the corresponding audio channel on the 'ANC/PS Amplifier' is faulted. The 'NVH Event Client' shall take necessary fault handling as needed

In the same ignition cycle, if the 'DSP Amplifier' audio channel recovers from error then the corresponding 'AudioAmplifier_Channel_St.Channel [n]' signal shall change to NormalOperation.

Note: For a given vehicle configuration when there are unused audio channels in the 'ANC/PS Amplifier', the corresponding 'AudioAmplifier Channel_St.Channel [n]' shall remain 'Null'. 'n' represents the possible channels the 'ANC/PS Amplifier' can support.

4.2.1.5.7 PPS-SR-REQ-473877/B-Error Handling when Aux Amplifier audio channel(s) are faulted

On system Startup, 'ANC/PS Aux Amplifier' shall report the status of all its channel(s) on 'Aux_Amplifier_Channel_St.Channel [n]' within T_NVH_Startup_Audio.
Whenever 'Aux Amplifier' detects 1 or more of its audio channel(s) is faulted then it shall set the corresponding signal in the 'Aux_Amplifier_Channel_St.Channel [n] = ErrorState_NoAudio'. When the 'NVH Event Client' receives 'ErrorState_NoAudio' that means the corresponding audio channel on the 'ANC/PS Amplifier' is faulted. The 'NVH Event Client' shall take necessary fault handling as needed

In the same ignition cycle, if the 'Aux Amplifier' audio channel recovers from error then the corresponding 'Aux_Amplifier_Channel_St.Channel [n]' signal shall change to NormalOperation.

Note1: This signal is reported by the PAC, based on diagnostic status information provided by the Aux Amplifier to the PAC via the A2B bus.
Note2: For a given vehicle configuration when there are unused audio channels in the 'ANC/PS Aux Amplifier', then the respective 'Aux_Amplifier_Channel_St.Channel [n]' signals shall remain 'Null'.
Note3: 'n' represents the possible channels the 'ANC/PS Aux Amplifier'.

4.2.1.5.8 PPS-SR-REQ-512617/A-Speaker channel Fault latching

Whenever 'NVH Event Client' receives channel status on any of the signals 'AudioHeadUnit_Channel_St.Channel [n] / AudioAmplifier Channel_St.Channel [n] / Aux_Amplifier_Channel_St.Channel[n]', the NVH Event Client shall support to pass the channel(s) status to 'ANC/PS Generator'.

In the same ignition cycle, when any of the speaker channel(s) is received as 'ErrorState_NoAudio', then the NVH Event Client' shall latch on to the fault state (i.e., last aggregated fault status *_Spkr_Fault as received from ANC/PS Generator) even when the channel(s) status transition from 'ErrorState_NoAudio -> NormalOperation'.

Note1: Exceptions shall apply when the Channel status need to override based on 'InfotainmentAudio_St*' signal as mentioned in this specification.
Note2: For a given vehicle configuration (Aux Amp/DSP Amp available or not) NVH Event Client shall pass only the signal(s) that are available in the Vehicle network.

4.2.1.5.9 PPS-SR-REQ-512637/A-Fault Handling for 'InfotainmentAudio_St'

Depending upon the status received on 'InfotainmentAudio_St', the 'NVH Event Client' shall pass the overridden speaker channel(s) status to 'ANC/PS Generator' as follows.

On the same ignition cycle, when the status of 'InfotainmentAudio_St' changes from 'ErrorState_NoAudio -> NormalOperation', the NVH Event Client shall latch on to the last error state and shall send the 'ANC/PS Generator' with 'ErrorState_NoAudio' for all the channel(s).

Possible AudioHeadUnit_Channel_St.	Depending upon 'InfotainmentAudio_St' signal status, the overridden speaker channel(s) status is

Channel[n] signal status received	Null	ErrorState_NoAudio	NormalOperation
Null	Null	UC#1	Null
NormalOperation	Null	UC#1	NormalOperation
ErrorState_NoAudio	ErrorState_NoAudio	UC#1	ErrorState_NoAudio
Reserved	Reserved	Reserved	Reserved

UC#1: NVH Event Client shall pass 'AudioHeadUnit_Channel_St.Channel[n]' status as all faulted (i.e., ErrorState_NoAudio) to 'ANC/PS Generator'.

4.2.1.5.10 PPS-SR-REQ-512657/A-Fault Handling for 'InfotainmentAudio_St2'

Depending upon the status received on 'InfotainmentAudio_St2', the 'NVH Event Client' shall pass the overridden speaker channel(s) status to 'ANC/PS Generator' as follows.

On the same ignition cycle, when the status of 'InfotainmentAudio_St2' changes from 'ErrorState_NoAudio -> NormalOperation', the NVH Event Client shall latch on to the last error state and shall send the 'ANC/PS Generator' with 'ErrorState_NoAudio' for all the channel(s).

Possible AudioAmplifier_Channel_St.Channel[n] signal status received	Depending upon 'InfotainmentAudio_St2' signal status, the overridden speaker channel(s) status is		
	Null	ErrorState_NoAudio	NormalOperation
Null	Null	UC#1	Null
NormalOperation	Null	UC#1	NormalOperation
ErrorState_NoAudio	ErrorState_NoAudio	UC#1	ErrorState_NoAudio
Reserved	Reserved	Reserved	Reserved

UC#1: NVH Event Client shall pass 'AudioAmplifier_Channel_St.Channel[n]' status as all faulted (i.e., ErrorState_NoAudio).

4.2.1.5.11 PPS-SR-REQ-512777/A-Fault Handling for 'InfotainmentAudio_St3'

Depending upon the status received on 'InfotainmentAudio_St3', the 'NVH Event Client' shall pass the overridden speaker channel(s) status to 'ANC/PS Generator' as follows.

On the same ignition cycle, when the status of 'InfotainmentAudio_St3' changes from 'ErrorState_NoAudio -> NormalOperation', the NVH Event Client shall latch on to the last error state and shall send the 'ANC/PS Generator' with 'ErrorState_NoAudio' for all the channel(s).

Possible Aux_Amplifier Channel_St.Channel[n] signal status received	Depending upon 'InfotainmentAudio_St3' signal status, the overridden speaker channel(s) status is		
	Null	ErrorState_NoAudio	NormalOperation
Null	Null	UC#1	Null
NormalOperation	Null	UC#1	NormalOperation
ErrorState_NoAudio	ErrorState_NoAudio	UC#1	ErrorState_NoAudio
Reserved	Reserved	Reserved	Reserved

UC#1: NVH Event Client shall pass 'Aux_Amplifier Channel_St.Channel[n]' status as all faulted (i.e., ErrorState_NoAudio).

4.2.1.6 PPS-SR-REQ-502537/A-PS audio Internal system fault handling

When never 'NVH Event Client' detects a system fault and is not able to play PS audio, then the NVH Event Client shall interact with PS Generator to stop on going PS audio (if any) and remain disabled for the entire ignition cycle. The NVH Event Client shall also support to log DTC when it run into any system faults

Possible System faults are (while not limited only to this)

1. Library count threshold failure.
2. Configuration mismatch, Incomplete or not loaded.
3. PS Initialization, Runtime, Internal fault.
4. Communication loss with the PS Generator.

Refer IDS spec for the list of DTC's associated to these faults.

4.2.1.7 PPS-SR-REQ-486280/A-Missing Message

The Infotainment system shall set 'lost Communication' DTC when any of the below signal is not received (i.e., signal lost) for 5 Sec and the NVH Event Client shall also interact with PS Generator to stop the PS Audio within T_PS_Disable_time.

NVH Event Client Rx Signals/Messages	Mute PS Audio and log Missing Message DTC
ApedPos_Pc_ActlArb	x
EngAout_N_Actl	x
TrnAin_Tq_Actl	x
Veh_V_ActlEng	x
VehSimSnd_Pc_Rq	x
PrplWhlTot2_Tq_Actl	x
Eng_D_Stat	x
Ignition_Status	x
TrnRng_D_Rq	x
PwPckTq_D_Stat	x
GearPos_D_Actl	x
ActvDrvMde_D2_Stat	x
SelDrvMdeHmi04_D_Rq	x
CnvtTopPos_Dn_Stat	x
CnvtTopPos_Up_Stat	x
AutoTowActv_B_Stat	x
EngExhMdeQuiet_D2_Stat	x
AudioHeadUnit_Channel_St	x
Aux_Amplifier Channel_St	x
AudioAmplifier_Channel_St	x
InfotainmentAudio_St	x
InfotainmentAudio_St2	x
InfotainmentAudio_St3	x

Note1: For few inputs CAN signal depending upon configuration, NVH Event Client shall decide whether to log or not to log missing message DTC. Detailed in their individual specification.
Note2: Refer Infotainment Diagnostics Specification' for more details on 'lost communication' DTC.

4.2.1.8 PPS-SR-REQ-502997/A-Fault detection configuration

Based upon the Diagnostics DE configuration, the NVH Event Client shall support to pass (or) not to pass the below signal information to 'PS Generator' as follows

Item	Input Signal	When DE bit configuration is Enabled	When DE bit configuration is Disabled
1	1. AudioAmplifier_Channel_St 2. InfotainmentAudio_St2	1. The NVH Event Client shall pass the signal from vehicle network to 'PS Generator'.	1. The NVH Event Client **shall not** pass the signals from the vehicle network to 'PS Generator'.
2	EngExhMdeQuiet_D2_Stat		
3	1. CnvtTopPos_Dn_Stat 2. CnvtTopPos_Up_Stat		

4	1. SelDrvMdeHmi04_D_Rq 2. ActvDrvMde_D2_Stat	2. The Infotainment system shall log 'Lost Communication DTC' when any of them is missing.	2. The Infotainment system **shall not** log 'Lost Communication DTC'.
5	VehSimSnd_Pc_Rq		
6	AutoTowActv_B_Stat		

Note: Refer Infotainment Diagnostics Specification' for more details on DE bit information

4.2.2 Use Cases

4.2.2.1 PPS-UC-REQ-515157/A-PS audio on Startup - PAC,Aux Amp combination

Actors	Vehicle User
Pre-conditions	1. HMIAudioMode is in OFF state. 2. Infotainment System comprises PAC and Aux Amplifier (No DSP).
Scenario Description	1. HMIAudioMode transition from OFF -> ON state. 2. NVH Event Client receives module status and channel status from PAC and Aux Amplifier on InfotainmentAudio_St/InfotainmentAudio_St3 and AudioHeadUnit_Channel_St/Aux_Amplifier Channel_St as 'NormalOperation' respectively.
Post-conditions	1. Infotainment system shall be able to play PS audio within 2 Sec when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/Aux Amplifier on 'InfotainmentAudio_St*' and '*Channel_St' signal.
Notes	

4.2.2.2 PPS-UC-REQ-518101/A-PS audio on Startup - PAC only

Actors	Vehicle User
Pre-conditions	1. HMIAudioMode is in OFF state. 2. Infotainment System comprises PAC only (No Aux Amplifier and DSP).
Scenario Description	1. HMIAudioMode transition from OFF -> ON state. 2. NVH Event Client receives the module status and channel status from PAC on 'InfotainmentAudio_St' and 'AudioHeadUnit_Channel_St' as 'NormalOperation'
Post-conditions	1. Infotainment system shall be able to play PS audio within 2 Sec when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC on 'InfotainmentAudio_St*' and '*Channel_St' signal.
Notes	

4.2.2.3 PPS-UC-REQ-518100/A-PS audio on Startup - PAC,DSP combination

Actors	Vehicle User
Pre-conditions	1. HMIAudioMode is in OFF state. 2. Infotainment System comprises PAC and DSP Amp (No Aux Amplifier).
Scenario Description	1. HMIAudioMode transition from OFF -> ON state. 2. NVH Event Client shall receive the module status and channel status from PAC and DSP Amp on InfotainmentAudio_St/InfotainmentAudio_St2 and

	AudioHeadUnit_Channel_St/AudioAmplifier_Channel_St as 'NormalOperation' respectively.
Post-conditions	1. Infotainment system shall be able to play PS audio within 2 Sec when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/DSP on 'InfotainmentAudio_St*' and '*Channel_St' signal.
Notes	

4.2.2.4 PPS-UC-REQ-515207/A-PS audio playing during Shutdown

Actors	Vehicle User
Pre-conditions	1. HMIAudioMode is in ON state. 2. Infotainment System comprises PAC and Aux Amplifier (No DSP). 3. PS audio is played through vehicle speakers.
Scenario Description	HMIAudioMode transition from ON -> OFF/Load shed.
Post-conditions	1. Infotainment system shall stop playing PS audio.
List of Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/DSP/Aux Amplifier on 'InfotainmentAudio_St*' and '*Channel_St' signal when the HMIAudioMode is in ON state.
Notes	The above use case is also applicable when the Infotainment system comprises either a. PAC and DSP Amplifier. b. PAC only

4.2.2.5 PPS-UC-REQ-481077/A-User Enables Propulsion Sound Setting

Actors	Vehicle front seat Occupant
Pre-conditions	Infotainment system is ON Propulsion Sound is Disabled (user HMI)
Scenario Description	User change propulsion sound setting to enabled
Post-conditions	Propulsion sound is enabled Propulsion sound HMI is shown set to enabled.
Exception Use Cases	1. Amplifier/Aux Amplifier Fault is detected. 2. Channel Faults detected in the Amplifier/Aux Amplifier. 3. PS Feature is disabled through DE bit configuration.
Notes	Propulsion sound is just referring to propulsion sound interior to vehicle

4.2.2.6 PPS-UC-REQ-481078/A-User Disables Propulsion Sound Setting

Actors	Vehicle front seat occupant
Pre-conditions	Infotainment System is ON Propulsion Sound is Enabled (user HMI)
Scenario Description	User changes propulsion sound setting to disabled
Post-conditions	Propulsion sound is disabled

	Propulsion sound HMI is shown set to disabled
Exception Use Cases	1. Amplifier/Aux Amplifier Fault is detected. 2. Channel Faults detected in the Amplifier/Aux Amplifier. 3. PS Feature is disabled through DE bit configuration.
Notes	Propulsion sound is just referring to propulsion sound interior to vehicle

4.2.2.7 PPS-UC-REQ-433449/A-Reading Calibration Part number

Actors	Vehicle Occupant
Pre-conditions	Infotainment system is ON ANC/PS audio is played through vehicle speakers
Scenario Description	User reads the Calibration Part number from the infotainment screen
Post-conditions	Infotainment system shall display the Calibration file part number.
Exception Use Cases	
Interfaces	Infotainment UI

4.2.2.8 PPS-UC-REQ-502797/A-Internal system error

Actors	Vehicle Occupant
Pre-conditions	Infotainment system is ON PS is Enabled, and the PS audio is played through vehicle speakers
Scenario Description	Internal system error is detected (ex. Communication loss with PS Generator)
Post-conditions	Active PS audio shall be stopped and shall remain disabled for the entire ignition cycle.
Exception Use Cases	
Notes	The same use case is applicable to Other internal system faults that affects PS audio playing. ‘ANC-SR-REQ-502537’ covers the possible System internal Faults.

4.2.2.9 PPS-UC-REQ-433481/B-Amplifier Fault status is received while playing PS Audio - Atleast 1 or more channel(s) is used

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. Propulsion Sound is Enabled, and PS audio is played through vehicle speakers. 3. Infotainment system comprises PAC, DSP AMP and no Aux Amp. 4. Atleast one or more channel(s) of DSP Amplifier is used for PS Audio.
Scenario Description	Amplifier fault status is received on (InfotainmentAudio_St2=ErrorState_NoAudio).

Post-conditions	1. 'NVH Event Client' shall translate Amplifier Fault status into Amplifier Channel level faults as mentioned in 'PPS-SR-REQ-512657' and shall send the updated status to 'PS Generator'. 2. Infotainment system shall stop generating propulsion sound audio and shall remain disabled for the same ignition cycle even when Amplifier recovers from error state.
Exception Use Cases	
Notes	1. The above use case is also applicable when PAC detects a fault and reports the error state on 'InfotainmentAudio_St' signal. 'NVH Event Client' shall translate PAC Fault status into Channel level faults as mentioned in 'PPS-SR-REQ-512657'. 2. The above use case is also applicable when Aux Amplifier detects a fault and reports the error state on 'InfotainmentAudio_St3' signal. 'NVH Event Client' shall translate Aux Amp Fault status into Channel level faults as mentioned in 'PPS-SR-REQ-512777'.

4.2.2.10 PPS-UC-REQ-518257/A-Amplifier Fault status is received while playing PS Audio - none of the channel(s) is used

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. Propulsion Sound is Enabled, and PS audio is played through vehicle speakers. 3. Infotainment system comprises PAC, DSP AMP and no Aux Amp. 4. None of the channel(s) of DSP Amplifier is used for PS Audio.
Scenario Description	Amplifier fault status is received on (InfotainmentAudio_St2=ErrorState_NoAudio).
Post-conditions	1. 'NVH Event Client' shall translate Amplifier Fault status into Amplifier Channel level faults as mentioned in 'PPS-SR-REQ-512657' and shall send the updated status to 'PS Generator'. 2. Infotainment system shall continue to play propulsion sound audio even when Amplifier fault status is received.
Exception Use Cases	
Notes	1. The above use case is also applicable when PAC detects a fault and reports the error state on 'InfotainmentAudio_St' signal. 'NVH Event Client' shall translate PAC Fault status into Channel level faults as mentioned in 'PPS-SR-REQ-512657'. None of the channel(s) of PAC is used for PS Audio. 2. The above use case is also applicable when Aux Amplifier detects a fault and reports the error state on 'InfotainmentAudio_St3' signal. 'NVH Event Client' shall translate Aux Amp Fault status into Channel level faults as mentioned in 'PPS-SR-REQ-512777'. None of the channel(s) of Aux Amp is used for PS Audio.

4.2.2.11 PPS-UC-REQ-515001/A-Channel level fault is detected on one of the unused channels from PAC

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON

	2. Propulsion Sound is Enabled, and the PS audio is played through vehicle speakers 3. Infotainment System comprises PAC only (No DSP, No Aux-Amp). 4. PAC Channel2 is configured as unused channel for PS audio.
Scenario Description	Channel level fault is detected on PAC channel2.
Post-conditions	1. Upon receiving the channel fault from PAC, the NVH Event Client shall pass the fault information to the PS Generator. 2. Infotainment system shall continue to play Propulsion audio through available speakers.
Exception Use Cases	
Notes	1. The above use case is also applicable to other unused channel(s) reported by DSP Amp, Aux amplifier and PAC. 2. When any of the **un-used** channel(s) status for PAC/DSP/Aux Amp is received as 'ErrorState_NoAudio', then the current active PS audio shall not be stopped/interrupted.

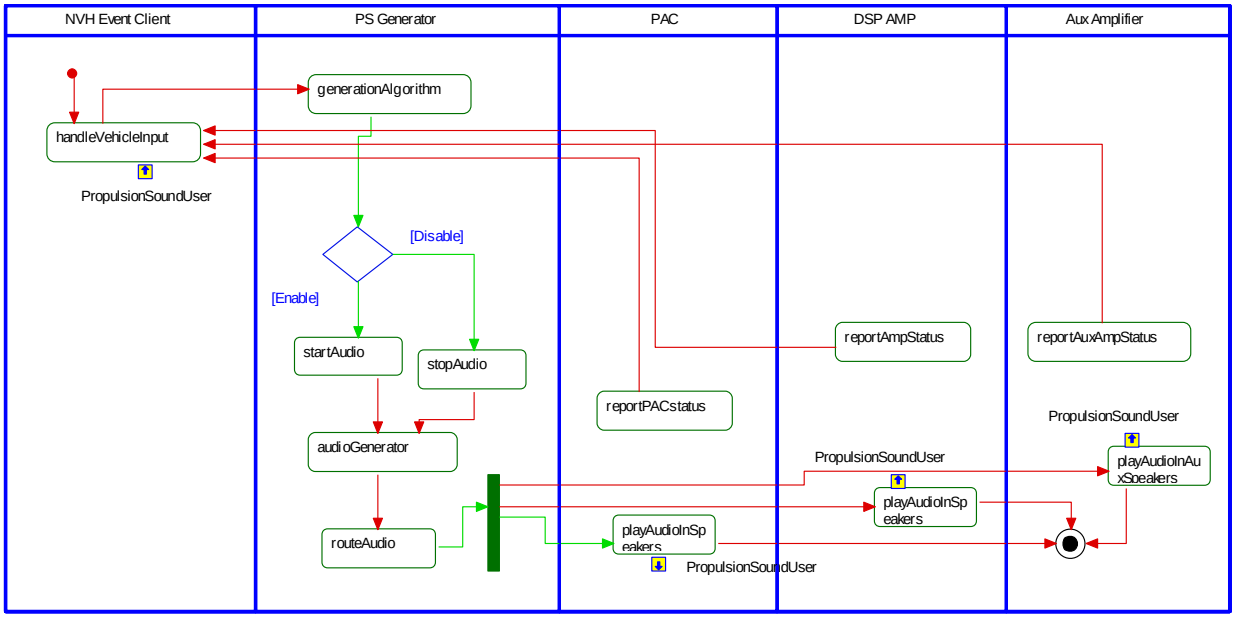
4.2.2.12 PPS-UC-REQ-515137/A-Channel level fault is detected on one of the used channels from Aux Amplifier

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. Propulsion Sound is Enabled, and the PS audio is played through vehicle speakers 3. Infotainment System comprises PAC and Aux Amplifier (No DSP). 4. Aux Amplifier Channel3 is configured as used channel for PS audio.
Scenario Description	Channel level fault is detected on Aux Amplifier channel3.
Post-conditions	1. Upon receiving the channel fault from Aux Amplifier, the NVH Event Client shall pass the fault information to the PS Generator. 2. Infotainment system shall stop playing Propulsion audio and shall remain disabled for the entire ignition cycle, even when the channel recovers from error state.
Exception Use Cases	
Notes	1. The above use case is also applicable to other used channel(s) reported by DSP Amp, Aux amplifier and PAC. 2. When any of the **used** channel(s) from PAC/DSP/Aux Amp is received as 'ErrorState_NoAudio', then the current active PS audio shall be stopped and remain disabled for the same ignition cycle.

4.2.3 White Box View

4.2.3.1 Activity Diagrams

4.2.3.1.1 PPS-ACT-REQ-433468/B-Propulsion Sound Operation



4.2.3.2 Sequence Diagrams

4.2.3.2.1 PPS-SD-REQ-481538/B-Propulsion Sound Enable & Disabled by the user

Pre-condition

1. Infotainment system is ON.
2. PS audio is not active in the Vehicle speakers. Infotainment system components comprises (PAC, DSP AMP, and no AUX Amp) in the vehicle.

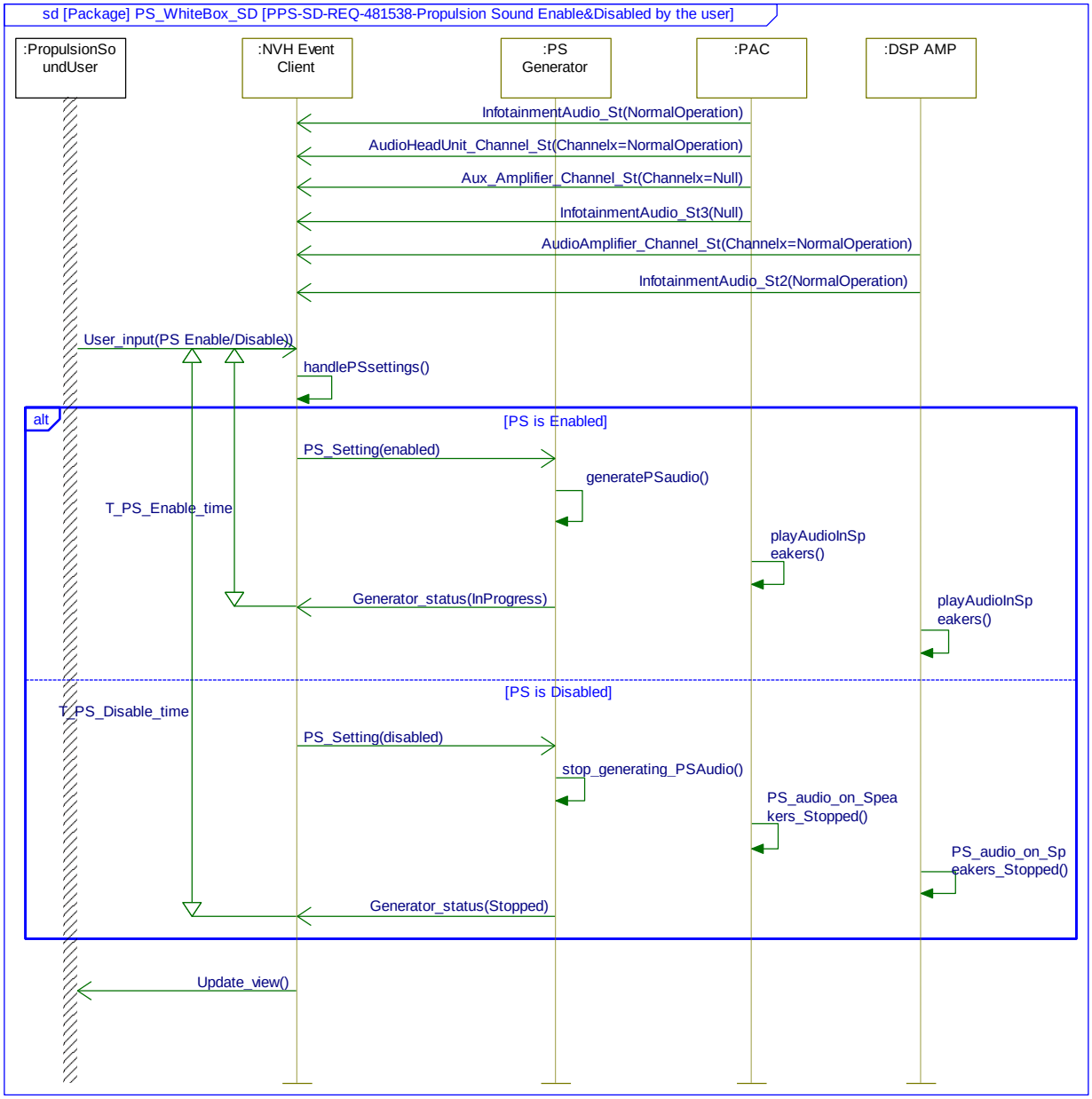
Scenario

1. Vehicle user Enables Propulsion Sound Generation from the Infotainment Screen.

Post-condition

1. Propulsion Sound audio shall be played on the vehicle speakers.

Sequence Diagram



4.2.3.2.2 PPS-SD-REQ-481537/B-Amplifier Module fault is detected while playing PS Audio

Pre-condition

1. Infotainment system in ON.
2. PS audio is played in the Vehicle speakers. Infotainment system components comprises (PAC, DSP AMP, and no AUX Amp) in the vehicle.

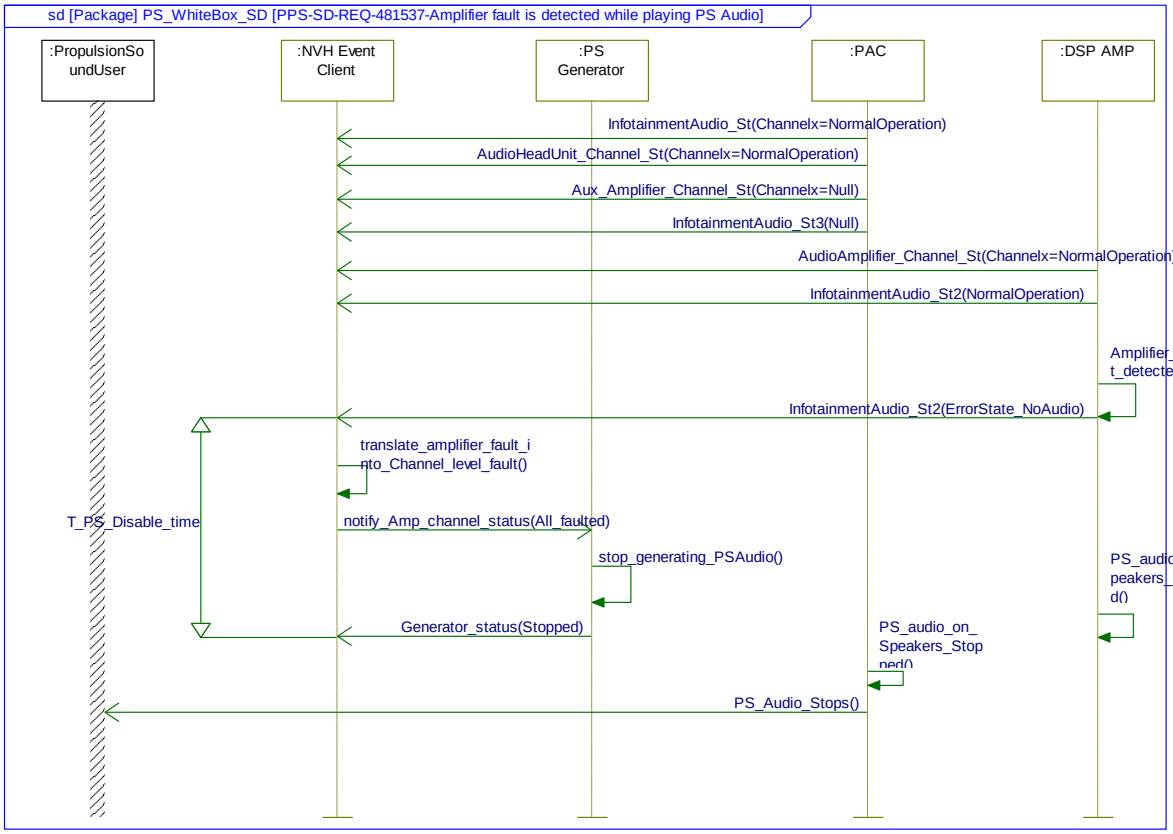
Scenario

1. Amplifier Fault is detected (ex. AMP detects LVI/Over temperature).

Post-condition

1. Upon receiving Amplifier Fault status, the NVH Event client shall translate amplifier fault into equivalent amplifier channel faults as mentioned in 'PPS-SR-REQ-512657' and pass it to the PS Generator.
2. Infotainment System shall stop playing PS audio in the vehicle speakers.

Sequence Diagram



4.2.3.2.3 PPS-SD-REQ-514178/A-Amplifier channel Fault is detected while playing PS audio

Pre-condition

1. Infotainment system is ON.
2. PS audio is played in the Vehicle speakers. Infotainment system components comprises (PAC, DSP AMP, No AUX Amp) in the vehicle.
3. Channel6 on DSP amplifier is configured as used channel for PS audio.

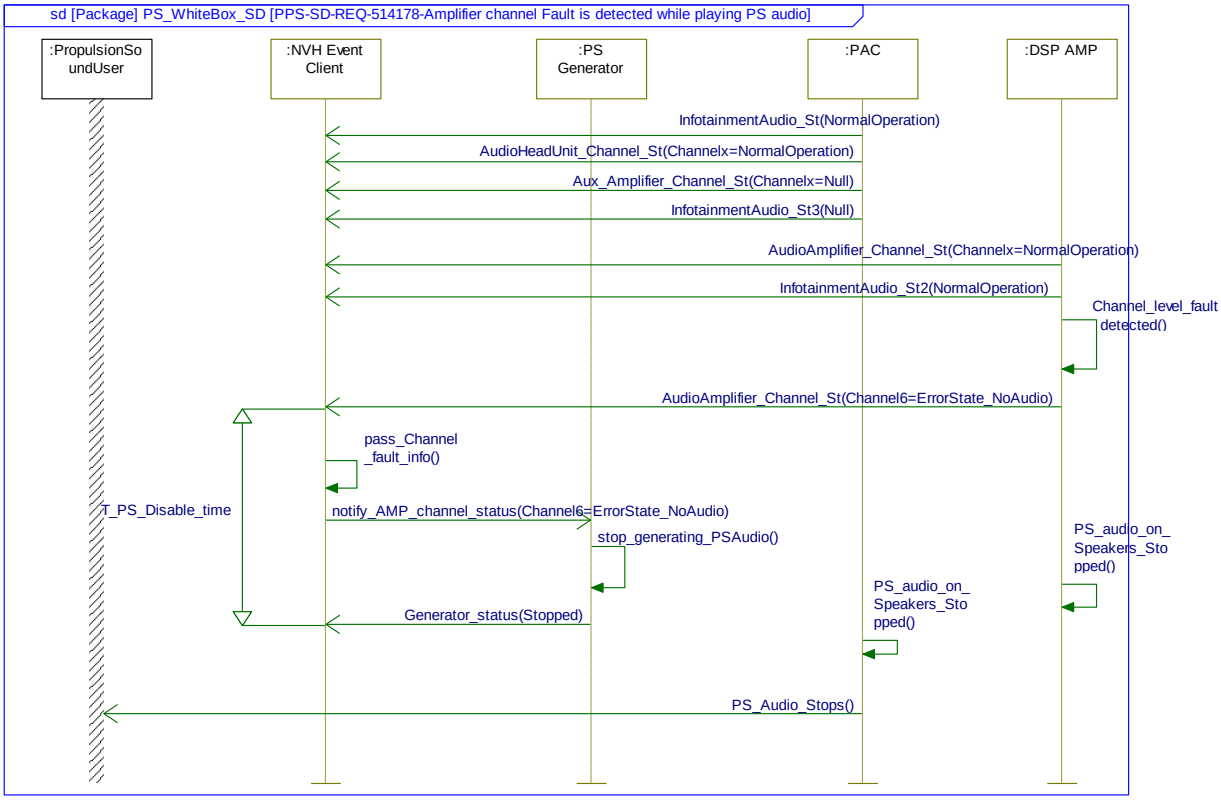
Scenario

1. Channel level fault is detected by the Amplifier on channel6.

Post-condition

1. The NVH Event Client shall pass the channel level fault information to the PS Generator.
2. Infotainment System shall stop playing PS audio and remain disabled for the same ignition cycle.

Sequence Diagram



4.2.3.2.4 PPS-SD-REQ-514179/A-PAC fault is detected while playing PS audio

Pre-condition

1. Infotainment system in ON.
2. PS audio is played in the Vehicle speakers. Infotainment system components comprises PAC, AUX Amp in the vehicle.

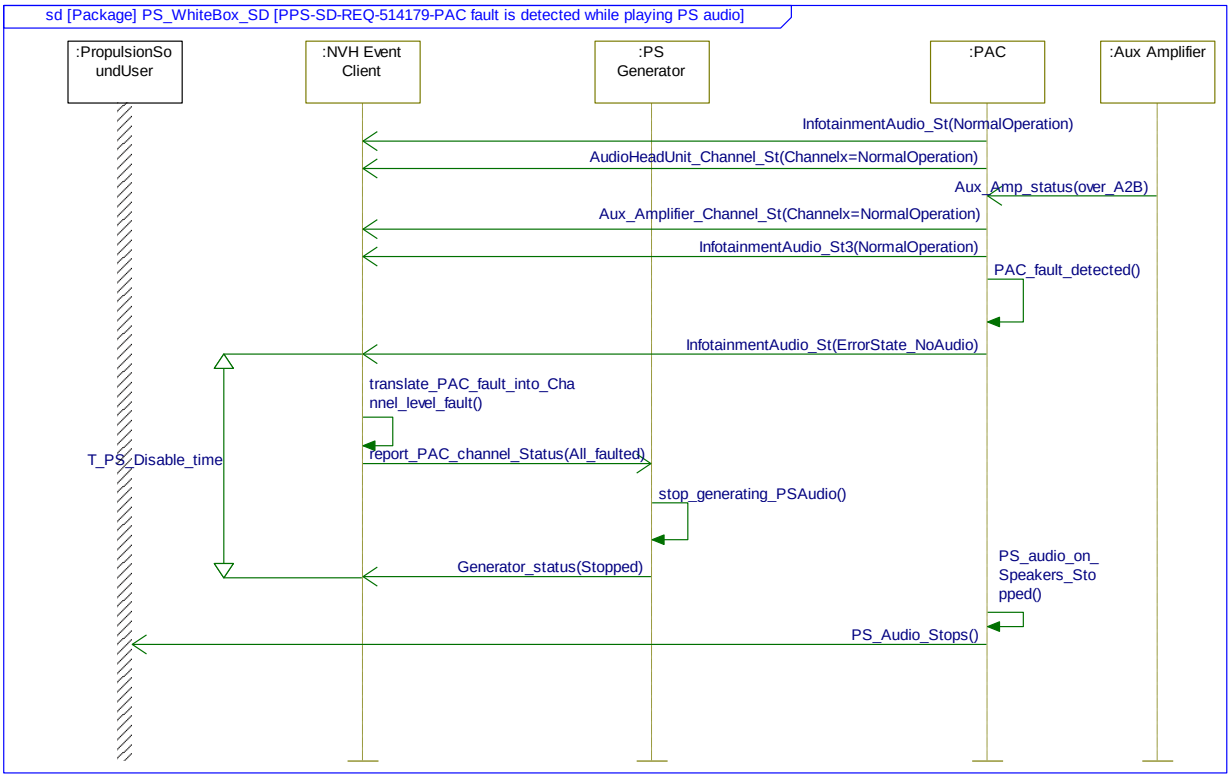
Scenario

1. PAC Fault is detected (ex. PAC detects LVI/Over temperature).

Post-condition

1. Upon receiving PAC Fault status, the NVH Event client shall translate PAC fault into equivalent channel faults as mentioned in ‘PPS-SR-REQ-512637’ and pass it to the PS Generator.
2. Infotainment System shall stop playing PS audio in the vehicle speakers and remain disabled for the same ignition cycle.

Sequence Diagram



4.2.3.2.5 PPS-SD-REQ-514778/A-Aux Amplifier channel fault is detected while playing PS audio

Pre-condition

1. Infotainment system is ON.
2. PS audio is played in the Vehicle speakers. Infotainment system components comprises (PAC, Aux Amplifier, No DSP AMP) in the vehicle.
3. Channel3 on Aux amplifier is configured as un-used channel for PS audio.

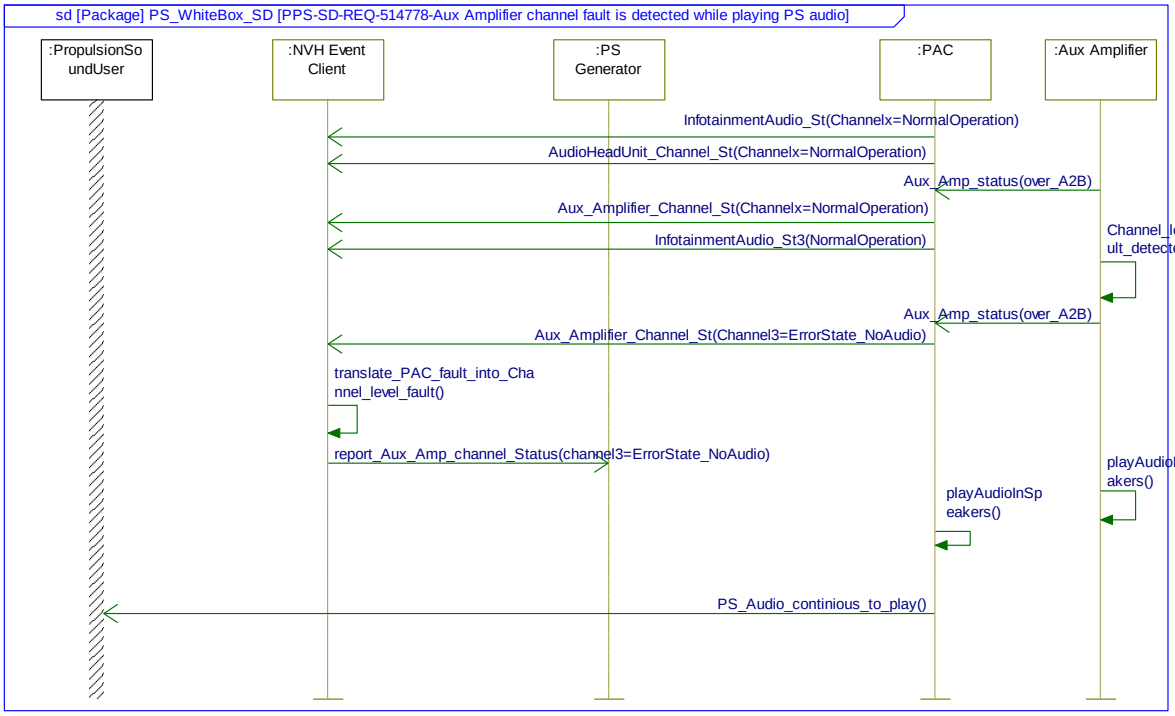
Scenario

1. Channel level fault is detected on channel3 of Aux Amplifier.

Post-condition

1. Upon receiving channel level fault status, the NVH Event client shall pass the channel fault status to PS Generator.
2. The current active PS audio on the Infotainment System shall not be stopped and continue playing PS audio. Since the Channel3 in Aux amplifier is not used for PS audio.

Sequence Diagram



4.2.3.2.6 PPS-SD-REQ-514875/A-Startup sequence for PS Audio components

Pre-condition

1. Infotainment system components comprises (PAC, DSP AMP) in the vehicle.

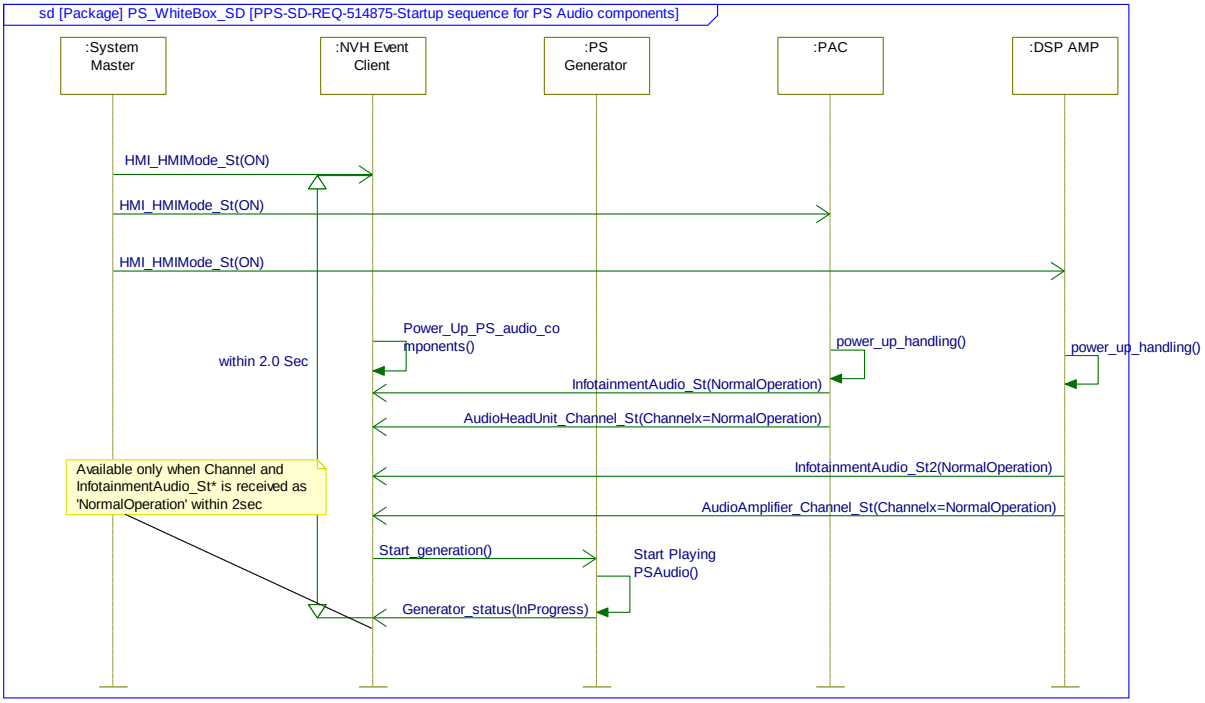
Scenario

1. Infotainment system is ON.

Post-condition

1. Speaker Channel Status and Module level status is received as ‘NormalOperation’
2. PS Audio is played in the Infotainment speaker within 2 .0 seconds

Sequence Diagram



4.2.3.2.7 PPS-SD-REQ-518239/A-Shutdown sequence for PS Audio components

Pre-condition

1. Infotainment system is ON.
2. PS Audio is played through Infotainment speaker. Infotainment system components comprises (PAC, DSP AMP) in the vehicle.

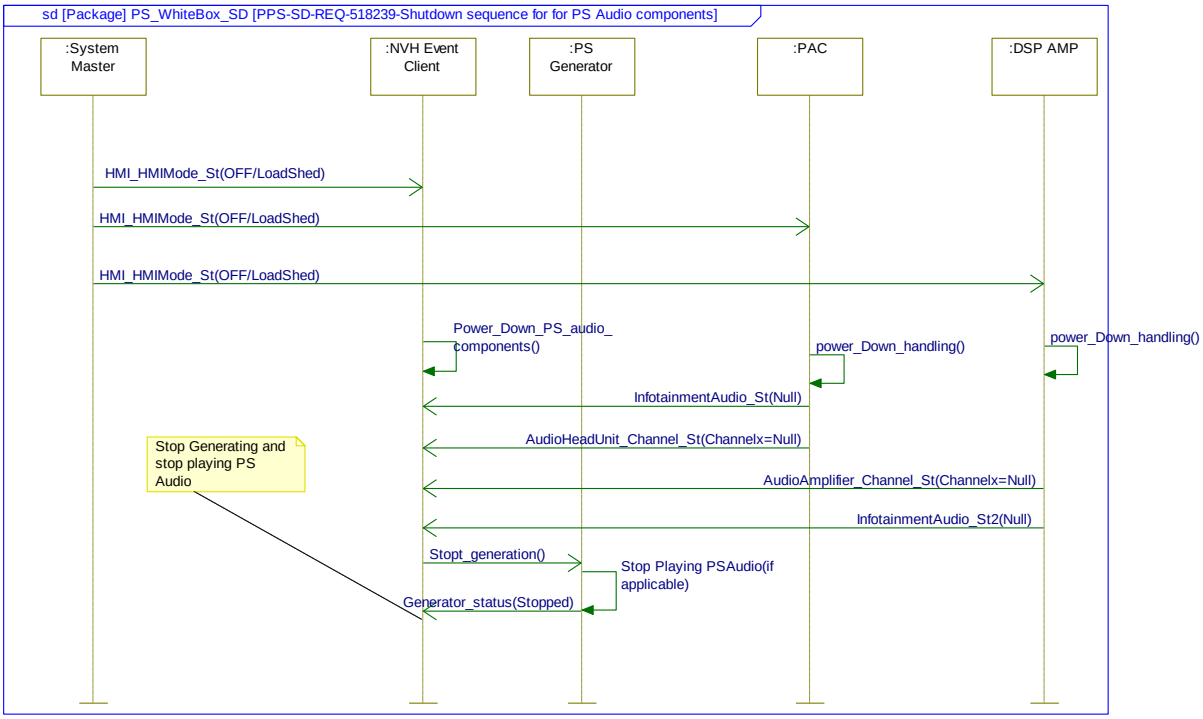
Scenario

1. Infotainment system is turned OFF.

Post-condition

1. PS audio playing shall be stopped.

Sequence Diagram



4.3 PPS-FUN-REQ-492557/A-NVH Event Client & PS Generator Interaction

4.3.1 Requirements

4.3.1.1 PPS-SR-REQ-486278/A-Input signal translation latency

The 'NVH Event Client' shall support to pass the input signals received from the vehicle network to the 'PS Generator' as translated 'VIN' values within 'T_Max_NVH_PS_Latency'. Non-time-critical signals shall be delivered to the PS Generator within a time limit that is implementation dependent.

4.3.1.2 PPS-TMR-REQ-486279/A-T_Max_NVH_PS_Latency

Name	Description	Units	Range	Resolution	Default
T_Max_NVH_PS_Latency	Maximum time taken by 'NVH Event Client' to translate the input signal change appears on the CAN bus and to the time when change in values is passed to 'PS Generator' as 'VIN'. Note: Maximum time defined as the default value	msec			30

4.3.1.3 PPS-SR-REQ-433478/A-Master VIN list

'NVH Event Client' shall support to pass input signals received from the vehicle network to the 'ANC/PS Generator' for use in generating propulsion sound or ANC audio and for use in calculating control logic functions. Signals may need to undergo translation from vehicle network signal identifiers and values to ANC/PS Generator specific identifiers and values known as vehicle information (VINs). The translation consists of a signal name / identifier mapping, a numerical scaling, and an offset.

In addition, signals shall be classified as time-critical versus non-time-critical, roughly delineated by the criticality of the signal to the audio generation process. The classification of vehicle signals as time-critical versus non-time-critical, along with any

required signal translation, is implementation dependent and shall be captured as a "Master VIN List" provided with the feature or component specification.

4.3.1.4 PPS-SR-REQ-500659/A-Derived VINs

Some input signals delivered by the 'NVH Event Client' to the 'ANC/PS Generator' are used to calculate control logic functions, the output of which are of interest to the 'NVH Event Client'. These are represented VIN identifier / values unique to the 'ANC/PS Generator' and shall be periodically read by the 'NVH Event Client'.

The list of derived VINs, and the periodicity at which they're read by the 'NVH Event Client', are implementation dependent shall be captured as part of the "Master VIN List" provided as part of the feature or component specification.

4.3.1.5 ANC-SR-REQ-433471/A-Loss of Communication between NVH Event Client and ANC/PS Generator

Whenever communication is lost between the 'NVH Event Client' and 'ANC/PS Generator', then such a failure shall be treated as a system-level fault and handled accordingly by the ANC/PS components as mentioned in ‘ANC-SR-REQ-502537’. For example, components shall work to disable the ANC/PS audio generation for that ignition cycle and shall log any applicable DTCs called out in this specification.

Note: Refer IDS specification for more details.

5 Appendix: Reference Documents

Reference #	Document Title
1	Phoenix ANC-PS FS
2	A2B SPSS
3	Enhanced Memory InterfaceClient SPSS
4	Infotainment Diagnostics Spec
5	
6	
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