Research & Vehicle Technology
"Infotainment Systems Product Development"

Feature – Active Noise Cancellation (Phoenix)

Infotainment Subsystem Part Specific Specification (SPSS)

Version 1.1

UNCONTROLLED COPY IF PRINTED

Version Date: September 23, 2022

FORD CONFIDENTIAL

Revision History

Date	Version	Notes	
March 8, 2022	**1.0**	**Initial Release**	
September 23, 2022	**1.1**		
	ANC-FRD-REQ-433458/B-Active Noise Cancellation SPSS	bganesa7: Added new functional requirement
	STR-936043/A-Overview	<BG> updated for better Clarity
	STR-1104290/A-Library Calibration/Configuration file usage	bganesa7: Added information for more details about Library Calibration
	STR-1114150/A-Feature Considerations	<BG> Added for Clarification
	STR-936048/B-Architectural Design	<BG> Added new Class for Phoenix
	STR-936049/B-Deployment Table	<BG> Added new Class
	ANC-IIR-REQ-433461/B-NVH Event Client Interface	<BG> Added new interfaces
	STR-936050/B-Logical Signal Mapping	<BG> Updated the logical names
	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-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
	STR-936051/B-General Requirements	<BG> Added new requirement for Phoenix
	ANC-SR-REQ-500097/A-Information DID	<BG> Added new requirement
	ANC-SR-REQ-519037/A-Calibration & Configuration Support	<BG> Added new requirement
	STR-936052/B-Functional Definition	<BG> Added new requirements
	STR-1025390/B-Requirements	<BG> Added new requirments
	ANC-SR-REQ-477779/B-Power-up for ANC audio components	bganesa7: Added reference to the timing requirement
	PPS-TMR-REQ-519017/A-T_NVH_Startup_Audio	bganesa7: Added new timming requirement requirement
	STR-936035/B-Requirements	<BG> Added new requirement for Phoenix
	ANC-SR-REQ-502517/A-ANC Audio	<BG> Added new requirement
	ANC-TMR-REQ-484617/B-T_ANC_Disable_time	<BG> Updated the default time
	ANC-TMR-REQ-484618/A-T_ANC_Enable_time	<BG> Added new requirement
	ANC-REQ-433452/A-ANC audio Muting/Unmuting	<BG> Added new requirement
	STR-1093431/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-512637/B-Fault Handling for 'InfotainmentAudio_St'	bganesa7:updated the table for better Clarity
	PPS-SR-REQ-512657/A-Fault Handling for 'InfotainmentAudio_St2'+	bganesa7: New requirement for Phoenix
	PPS-SR-REQ-512657/B-Fault Handling for 'InfotainmentAudio_St2'	bganesa7:updated the table for better Clarity
	PPS-SR-REQ-512777/A-Fault Handling for 'InfotainmentAudio_St3'+	bganesa7: New requirement for Phoenix
	PPS-SR-REQ-512777/B-Fault Handling for 'InfotainmentAudio_St3'	bganesa7:updated the table for better Clarity
	ANC-SR-REQ-433454/A-ANC audio Internal system fault handling	<BG> Added new requirement for Phoenix
	ANC-SR-REQ-433446/A-Missing Message	<BG> Added new requirements for Missing Message
	ANC-SR-REQ-433455/A-Forwarding the signal based on configuration	<BG> Added new requirement for Phoenix
	ANC-SR-REQ-520237/A-Microphone fault detection based on configuration	<BG> Added new requirement for Phoenix
	STR-1036270/B-Use Cases	<BG> Added new use case requirements
	ANC-UC-REQ-519059/A-ANC audio at Startup - PAC, Aux Amp combination	<BG> Added new use case requirements
	ANC-UC-REQ-519060/A-ANC audio at Startup - PAC only	<BG> Added new use case requirements

ANC-UC-REQ-519061/A-ANC audio at Startup - PAC, DSP combination	<BG> Added new use case requirements
ANC-UC-REQ-519062/A-ANC audio playing during Shutdown	<BG> Added new use case requirements
ANC-UC-REQ-519065/A-Reading Calibration Part number	<BG> Added new use case requirements
ANC-UC-REQ-519066/A-Internal system error	<BG> Added new use case requirements
ANC-UC-REQ-519067/A-Amplifier Fault status is received while playing ANC Audio - At least 1 or more channel(s) is used	<BG> Added new use case requirements
ANC-UC-REQ-519068/A-Amplifier Fault status is received while playing ANC Audio - none of the channel(s) is used	<BG> Added new use case requirements
ANC-UC-REQ-519069/A-Channel level fault is detected on one of the unused channels from PAC	<BG> Added new use case requirements
ANC-UC-REQ-519070/A-Channel level fault is detected on one of the used channels from Aux Amplifier	<BG> Added new use case requirements
ANC-ACT-REQ-433443/B-ANC Operation	<BG> Updated the activity diagram
STR-936039/B-Sequence Diagrams	<BG> Added new sequence diagrams
ANC-SD-REQ-519083/A-Startup sequence for ANC Audio components	<BG> Added new requirements
ANC-SD-REQ-519084/A-Shutdown sequence for ANC Audio components	<BG> Added new requirements
ANC-SD-REQ-519079/A-Amplifier Module fault is detected while playing ANC Audio	<BG> Added new requirements
ANC-SD-REQ-519080/A-Amplifier channel Fault is detected while playing ANC audio	<BG> Added new requirements
ANC-SD-REQ-519081/A-PAC fault is detected while playing ANC audio	<BG> Added new requirements
ANC-SD-REQ-519082/A-Aux Amplifier channel fault is detected while playing ANC audio	<BG> Added new requirements
ANC-FUN-REQ-497557/A-NVH Event Client & ANC Generator Interaction	<BG> Added new requirements
STR-1061991/A-Requirements	<BG> Core audio requirements for Phoenix authored by FO
ANC-SR-REQ-497558/A-Input signal translation latency	<BG> Core audio requirements for Phoenix authored by FO
ANC-TMR-REQ-497559/A-T_Max_NVH_ANC_Latency	<BG> Core audio requirements for Phoenix authored by FO
PPS-SR-REQ-433478/A-Master VIN list	<BG> Core audio requirements for Phoenix authored by FO
PPS-SR-REQ-500659/A-Derived VINs	<BG> Core audio requirements for Phoenix authored by FO
ANC-SR-REQ-433471/A-Loss of Communication between NVH Event Client and ANC/PS Generator	bganesa7: Added new requirement for Phoenix
ANC-SR-REQ-433472/A-ANC Divergence	<BG> Core audio requirements for Phoenix authored by FO
ANC-SR-REQ-520257/A-Impact of Door and Window Status signals	<BG> Core audio requirements for Phoenix authored by FO
ANC-SR-REQ-523817/A-EOL Audit Test	<BG> Core audio requirements for Phoenix authored by FO
STR-936053/B-Appendix: Reference Documents	<BG> Added reference for IDS spec

Table of Contents

1 Overview

1.1 Library Calibration/Configuration file usage

ANC Acoustic Calibration File – Configuration Contents per Feature

The acoustic calibration "file" used for ANC 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:

ANC

- Audio anti-noise signal generation parameters.
- Perform appropriate mute/unmute behavior based on Feature Enable and Heartbeat VINs.
- Configuration of relevant speaker fault conditions along with updating the corresponding status VIN.
- Configuration of Door and Window states which affect audio signal generation along with updating the corresponding status VINs.
- Configures ANC Divergence Threshold etc.,
- Configure ANC operation handling based on Window(s) and Door(s) status.

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. 'ANC 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
   ANC Amplifier - ANC/PS Amplifier and
   ANC 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 ANC-CLD-REQ-433459/A-ANC Generator

The ANC Generator is responsible for generating the ANC (active noise cancellation) signal.

2.4 ANC-CLD-REQ-433460/A-ANC Amplifier

The ANC Amplifier is responsible for producing the ANC audio through the vehicle loudspeakers.

2.5 ANC-CLD-REQ-478037/A-ANC Aux Amplifier

The 'ANC Secondary Amplifier' is responsible for producing auxiliary audio amplification for the ANC audio through vehicle loudspeakers.

2.6 Deployment Table

The table below shows how the logical classes may be mapped to physical modules for the ANC 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
ANC Generator	APIM PDC CCPU
ANC Amplifier	PAC, DSP AMP (note applies to whatever module receiving the ANC audio signal)
ANC Aux Amplifier	Sub-Woofer Amplifier
ANC Audio Components	PDC, PAC, DSP Amp, Sub-Woofer Amplifier

Module Present	ANC Generator	ANC Amplifier	ANC 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 ANC-IIR-REQ-433461/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
		Channel23	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-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	

2.7.5 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	

2.7.6 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	

2.7.7 MD-REQ-473387/A-TrnAout_W_ActlUnfilt

Message Type: Status

This method is used to indicate the Transmission Output Shaft Speed given in rad/s.
It is unfiltered or very lightly filtered. Suitable for calculating derivatives.

Signal name	Literals	Values	Description
TrnAout_W_ActlUnfilt	-		
	<Range>	0x0000 - 0x7FFD	0 to 3276.5 Resolution : 0.1 Offset: 0
	NoDataExists	0x7FFE	NoDataExists
	Faulty	0x7FFF	Faulty

2.7.8 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	

2.7.9 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	

2.7.10 MD-REQ-473459/A-DrStatInnrTgate_B_Actl

Message Type: Status

This method is used to indicate the status iof inner tailgate/ liftgate.

Signal name	Literals	Values	Description
DrStatInnrTgate_B_Actl	-	-	-
	Closed	0x0	
	Ajar	0x1	

2.7.11 MD-REQ-473460/A-DrStatDrv_B_Actl

Message Type: Status

This method is used to indicate the status of the driver door.

Signal name	Literals	Values	Description
DrStatDrv_B_Actl	-	-	-
	Closed	0x0	
	Ajar	0x1	

2.7.12 MD-REQ-473461/A-DrStatPsngr_B_Actl

Message Type: Status

This method is used to indicate the status of the passenger door.

Signal name	Literals	Values	Description
DrStatPsngr_B_Actl	-	-	-
	Closed	0x0	
	Ajar	0x1	

2.7.13 MD-REQ-473462/A-DrStatRr_B_Actl

Message Type: Status

This method is used to indicate the status of the rear right door.

Signal name	Literals	Values	Description
DrStatRr_B_Actl	-	-	-
	Closed	0x0	
	Ajar	0x1	

2.7.14 MD-REQ-473463/A-DrStatRl_B_Actl

Message Type: Status

This method is used to indicate the status of the rear left door.

Signal name	Literals	Values	Description
DrStatRl_B_Actl	-	-	-
	Closed	0x0	
	Ajar	0x1	

2.7.15 MD-REQ-473464/A-DriverWindowPosition

Message Type: Status

This method is used to indicate the driver windows status.

Signal name	Literals	Values	Description
DriverWindowPosition	-	-	-
	Undefined_window_position	0x0	
	Fully_closed_position	0x1	
	Between_fully_closed_and_10___op	0x2	
	Between_10___open_and_60___open	0x3	
	Between_60___open_and_fully_open	0x4	
	Fully_open_position"	0x5	

2.7.16 MD-REQ-473465/A-RearDriverWindowPos

Message Type: Status

This method is used to indicate the rear driver windows status.

Signal name	Literals	Values	Description
RearDriverWindowPos	-	-	-
	Undefined_window_position	0x0	
	Fully_closed_position	0x1	
	Between_fully_closed_and_10___op	0x2	
	Between_10___open_and_60___open	0x3	
	Between_60___open_and_fully_open	0x4	
	Fully_open_position"	0x5	

2.7.17 MD-REQ-473466/A-PassWindowPosition

Message Type: Status

This method is used to indicate the passenger windows status.

Signal name	Literals	Values	Description
PassWindowPosition	-	-	-
	Undefined_window_position	0x0	
	Fully_closed_position	0x1	
	Between_fully_closed_and_10___op	0x2	
	Between_10___open_and_60___open	0x3	
	Between_60___open_and_fully_open	0x4	
	Fully_open_position"	0x5	

2.7.18 MD-REQ-473467/A-RearPassWindowPos

Message Type: Status

This method is used to indicate the rear passenger windows status.

Signal name	Literals	Values	Description
RearPassWindowPos	-	-	-
	Undefined_window_position	0x0	
	Fully_closed_position	0x1	
	Between_fully_closed_and_10___op	0x2	
	Between_10___open_and_60___open	0x3	
	Between_60___open_and_fully_open	0x4	
	Fully_open_position"	0x5	

2.7.19 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	

2.7.20 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	

2.7.21 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	
	Null	0x0	

Channel6	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel7	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	
Channel8	Null	0x0	
	NormalOperation	0x1	
	ErrorState_NoAudio	0x2	
	Reserved	0x3	

2.7.22 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	
	Null	0x0	

Channel5	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	
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	

2.7.23 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	

2.7.24 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

2.7.25 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

2.7.26 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.

2.7.27 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	

2.7.28 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 ANC-SR-REQ-481697/A-Feature Configuration

The Infotainment system shall have a configurable parameter/DID to enabled/disable the ANC feature

- When enabled, all the functionality and signals defined in this SPSS shall be supported.
- When disabled, ANC 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 ANC-SR-REQ-500097/A-Information DID

The NVH Event Client shall update the status of ANC Audio Components on the 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.

3.3 ANC-SR-REQ-519037/A-Calibration & Configuration Support

The NVH Event Client shall support calibration/configuration governing the quality and characteristics of audio generation performed by the ANC Generator. This calibration / configuration also contains information that the ANC Generator uses to determine which of the amplifier module speaker channels are relevant and used for ANC 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 ANC-FUN-REQ-477777/A-ANC Power Mode

4.1.1 Requirements

4.1.1.1 Deployment Table

The table below shows how the logical classes may be mapped to physical modules for the ANC 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)
ANC Generator	APIM Phoenix Domain Controller
ANC Amplifier	AHU/PAC, DSP AMP (note applies to whatever module receiving the ANC signal)
ANC Aux Amplifier	Sub-Woofer Amplifier
ANC Audio Components	ANC Generator, ANC Amplifier, ANC Aux Amplifier

4.1.1.2 ANC-SR-REQ-477778/A-ANC/PS power mode state definitions

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

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

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

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

4.1.1.3 ANC-SR-REQ-477779/B-Power-up for ANC audio components

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

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

4.1.1.4 ANC-SR-REQ-477780/A-Power down for ANC audio components

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

4.1.1.5 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 ANC-FUN-REQ-433451/A-ANC Audio Operation

4.2.1 Requirements

4.2.1.1 ANC-SR-REQ-502517/A-ANC Audio

ANC Audio Components shall support to play ANC audio along with the main audio source only when the ANC feature is enabled through Diagnostics.

Note: Refer IDS spec for more details.

4.2.1.2 ANC-TMR-REQ-484617/B-T_ANC_Disable_time

Name	Description	Units	Range	Resolution	Default
T_ANC_Disable_time	Maximum time the NVH Event Client & ANC Generator shall take to stop ANC audio generation so that no abrupt audible changes are perceived by the customer (i.e., no blips or pops) Note: Maximum time defined as the default value	msec	0-100		50

4.2.1.3 ANC-TMR-REQ-484618/A-T_ANC_Enable_time

Name	Description	Units	Range	Resolution	Default
T_ANC_Enable_time	Maximum time NVH Event Client & ANC Generator shall take to unmute the audio channel and to start ANC audio generation. Note: Maximum time defined as the default value	msec	0-100		50

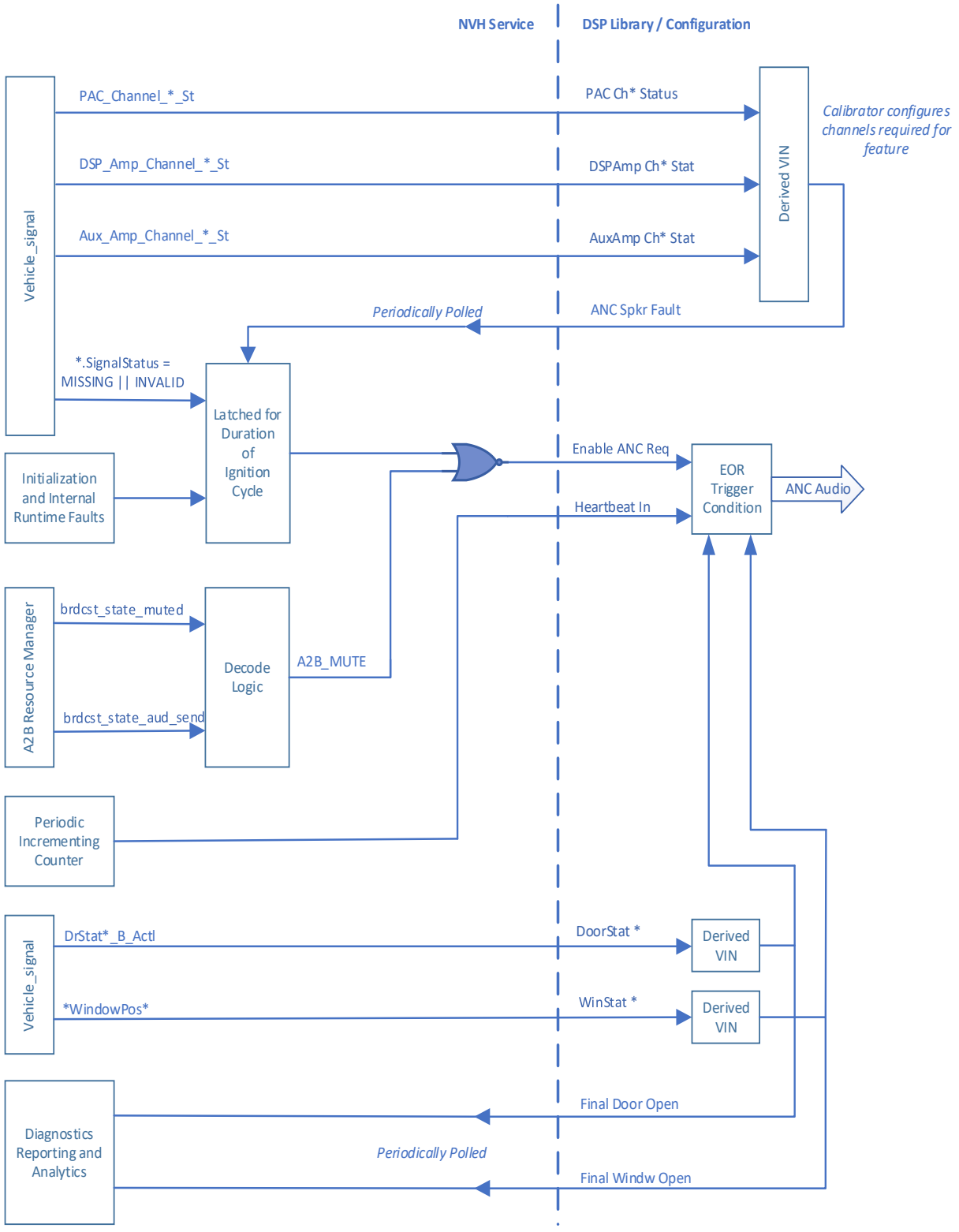
4.2.1.4 ANC-REQ-433452/A-ANC audio Muting/Unmuting

NVH Event Client and ANC Generator shall support to gracefully mute/Unmute the ANC audio within 'T_ANC_Disable_time'/'T_ANC_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 ANC Generator (DSP Library) that would result in enable/disable ANC audio.

Partitioning of Fault / Mute Logic Between NVH Service and DSP Library Configuration for ANC



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/B-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.Channel[n] signal status received	Depending upon 'InfotainmentAudio_St' signal status, the overridden speaker channel(s) status is		
	Null	ErrorState_NoAudio	NormalOperation
Null	Null	UC#1	Null
NormalOperation	NormalOperation	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/B-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	NormalOperation	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/B-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	NormalOperation	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 ANC-SR-REQ-433454/A-ANC audio Internal system fault handling

When NVH Event Client detects a system fault and is not able to play ANC audio, then the NVH Event Client shall interact with ANC Generator to stop on going ANC audio 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. ANC divergence exceeds threshold.
2. Library count threshold failure.
3. Microphone fault (Open/Short Circuit) detected.
4. Configuration mismatch, Incomplete or not loaded.
5. ANC Initialization, Runtime, Internal fault.
6. Communication loss with ANC Generator.

Note1: Refer IDS spec for the list of DTC's associated to these faults.
Note2: Refer Component or Functional specification for applicable internal system faults.

4.2.1.7 ANC-SR-REQ-433446/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 ANC Generator to stop the ANC Audio within T_ANC_Disable_time.

NVH Event Client Rx Signals/Messages	Mute ANC Audio and log Missing Message DTC
EngAout_N_Actl	x
TrnAout_W_ActlUnfilt	x
Eng_D_Stat	x
Ignition_Status	x
TrnRng_D_Rq	x
PwPckTq_D_Stat	x
ActvDrvMde_D2_Stat	x
SelDrvMdeHmi04_D_Rq	x
CnvtTopPos_Dn_Stat	x
CnvtTopPos_Up_Stat	x
EngExhMdeQuiet_D2_Stat	x
DrStatDrv_B_Actl	x
DrStatPsngr_B_Actl	x
DrStatRl_B_Actl	x
DrStatRr_B_Actl	x
DrStatInnrTgate_B_Actl	x
DriverWindowPosition	x
PassWindowPosition	x
RearDriverWindowPos	x
RearPassWindowPos	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 ANC-SR-REQ-433455/A-Forwarding the signal based on configuration

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

Item	Input Signal	When DE bit configuration is Enabled	When DE bit configuration is Disabled
1	AudioAmplifier_Channel_St InfotainmentAudio_St2	1. The NVH Event Client shall pass the signal from vehicle network to 'ANC Generator'. 2. The Infotainment system shall log 'Lost Communication DTC' when any of them is missing.	1. The NVH Event Client **shall not** pass the signals from the vehicle network to 'ANC/PS Generator'. 2. The Infotainment system **shall not** log 'Lost Communication DTC'.
2	TrnAout_W_ActlUnfilt		
3	EngExhMdeQuiet_D2_Stat		
4	1. CnvtTopPos_Dn_Stat 2. CnvtTopPos_Up_Stat		
5	1. SelDrvMdeHmi04_D_Rq 2. ActvDrvMde_D2_Stat		

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

4.2.1.9 ANC-SR-REQ-520237/A-Microphone fault detection based on configuration

For a given vehicle configuration, depending upon the number of ANC microphone(s) supported by the system the NVH Event Client shall decide to pass whether to pass (or) not to pass the microphone audio to 'ANC Generator' as follows

Item	Input Signal	When ANC Fault detection DE bit configuration is Enabled	When ANC Fault detection DE bit configuration is Disabled
1	ANC Mic status	1. The NVH Event Client shall support microphone diagnostics. 2. The Infotainment system shall support to transfer microphone audio data to 'ANC Generator'.	1. The NVH Event Client **shall not** support microphone diagnostics. 2. The Infotainment system **shall not support** to transfer microphone audio to 'ANC Generator'.

Note: Refer Infotainment Diagnostics Specification' for more details on DE bit information and for number of ANC microphone supported for a given vehicle configuration.

4.2.2 Use Cases

4.2.2.1 ANC-UC-REQ-519059/A-ANC audio at 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). 3. ANC Feature is enabled
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 ANC audio within T_NVH_Startup_Audio when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/Aux Amplifier on 'InfotainmentAudio_St*' OR '*Channel_St' signal.
Notes	

4.2.2.2 ANC-UC-REQ-519060/A-ANC audio at 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). 3. ANC Feature is enabled
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 ANC audio within T_NVH_Startup_Audio when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC on 'InfotainmentAudio_St*' OR'*Channel_St' signal.
Notes	

4.2.2.3 ANC-UC-REQ-519061/A-ANC audio at 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). 3. ANC Feature is enabled
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 ANC audio within T_NVH_Startup_Audio when the HMIAudioMode transition is detected.
Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/DSP on 'InfotainmentAudio_St*' OR '*Channel_St' signal.
Notes	

4.2.2.4 ANC-UC-REQ-519062/A-ANC 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. ANC audio is played through vehicle speakers.
Scenario Description	HMIAudioMode transition from ON -> OFF/Load shed.
Post-conditions	1. Infotainment system shall stop playing ANC audio.
List of Exception Use Cases	1. 'ErrorState_NoAudio' status is received from PAC/DSP/Aux Amplifier on 'InfotainmentAudio_St*' OR '*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 ANC-UC-REQ-519065/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

4.2.2.6 ANC-UC-REQ-519066/A-Internal system error

Actors	Vehicle Occupant
Pre-conditions	Infotainment system is ON ANC feature is Enabled, and the ANC audio is played through vehicle speakers
Scenario Description	Internal system error is detected (ex. ANC Divergence exceeds threshold)
Post-conditions	Active ANC 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 ANC audio playing. ‘ANC-SR-REQ-433454’ covers the possible System internal Faults.

4.2.2.7 ANC-UC-REQ-519067/A-Amplifier Fault status is received while playing ANC Audio - At least 1 or more channel(s) is used

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. ANC feature is Enabled, and ANC audio is played through vehicle speakers. 3. Infotainment system comprises PAC, DSP AMP and no Aux Amp. 4. At least one or more channel(s) of DSP Amplifier is used for ANC 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 ‘ANC Generator’. 2. Infotainment system shall stop generating ANC audio and shall remain disabled for the same ignition cycle even when Amplifier recovers from error state.
Exception Use Cases	
Notes	1. For a given Infotainment system combination (PAC only or PAC + Aux Amp), the above use case is 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. For a given Infotainment system combination (PAC + Aux Amp), the above use case is 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'.

4.2.2.8 ANC-UC-REQ-519068/A-Amplifier Fault status is received while playing ANC Audio - none of the channel(s) is used

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. ANC feature is Enabled, and ANC 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 ANC 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 'ANC Generator'. 2. Infotainment system shall continue to play ANC audio even when Amplifier fault status is received.
Exception Use Cases	
Notes	1. For a given Infotainment system combination (PAC only or PAC + Aux Amp), the above use case is 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. For a given Infotainment system combination (PAC + Aux Amp), the above use case is 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'.

4.2.2.9 ANC-UC-REQ-519069/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. ANC feature is Enabled, and the ANC 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 ANC 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 ANC Generator. 2. Infotainment system shall continue to play ANC 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 ANC audio shall not be stopped/interrupted.

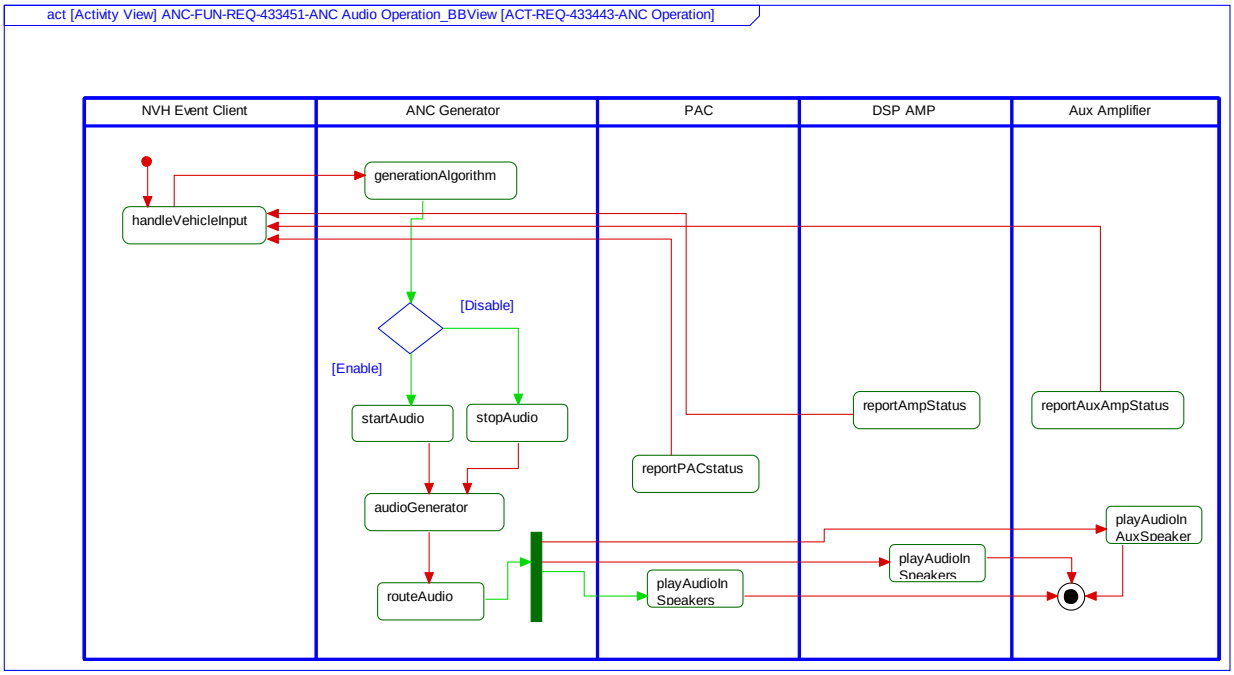
4.2.2.10 ANC-UC-REQ-519070/A-Channel level fault is detected on one of the used channels from Aux Amplifier

Actors	Vehicle User
Pre-conditions	1. Infotainment system is ON 2. ANC feature is Enabled, and the ANC 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 ANC 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 ANC Generator. 2. Infotainment system shall stop playing ANC 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 ANC 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 ANC-ACT-REQ-433443/B-ANC Operation



4.2.3.2 Sequence Diagrams

4.2.3.2.1 ANC-SD-REQ-519083/A-Startup sequence for ANC Audio components

Pre-condition

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

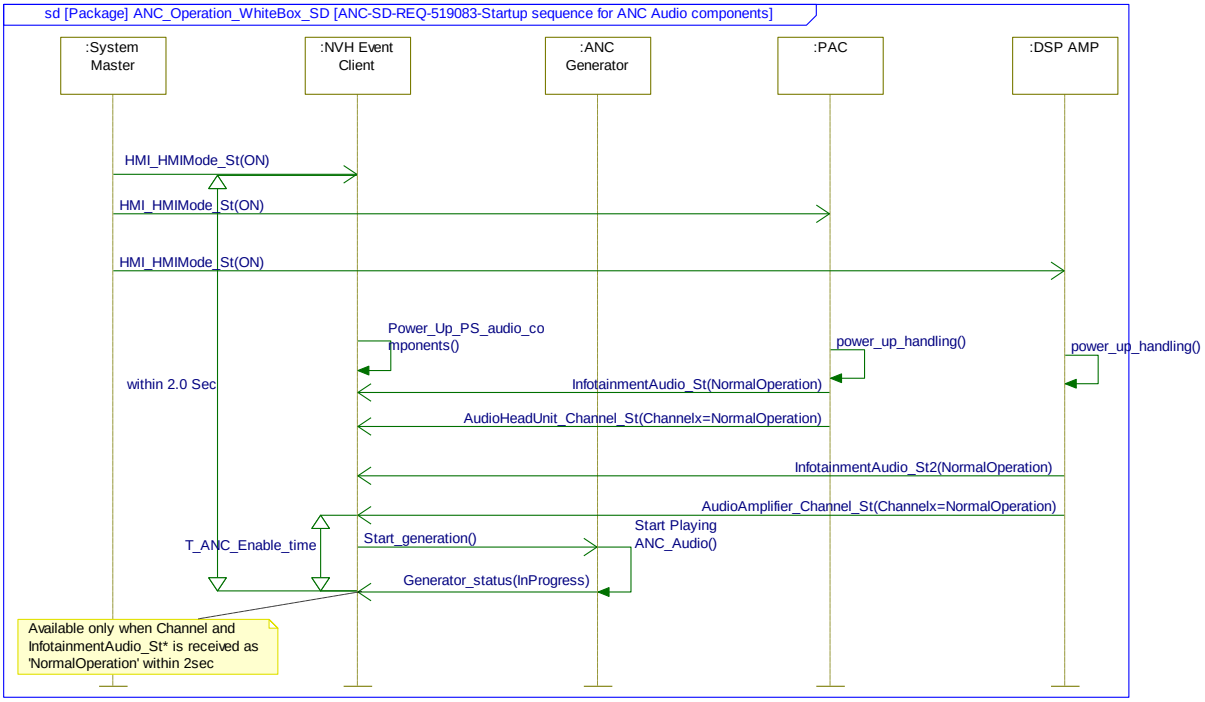
Scenario

1. Infotainment system is ON.

Post-condition

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

Sequence Diagram



4.2.3.2.2 ANC-SD-REQ-519084/A-Shutdown sequence for ANC Audio components

Pre-condition

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

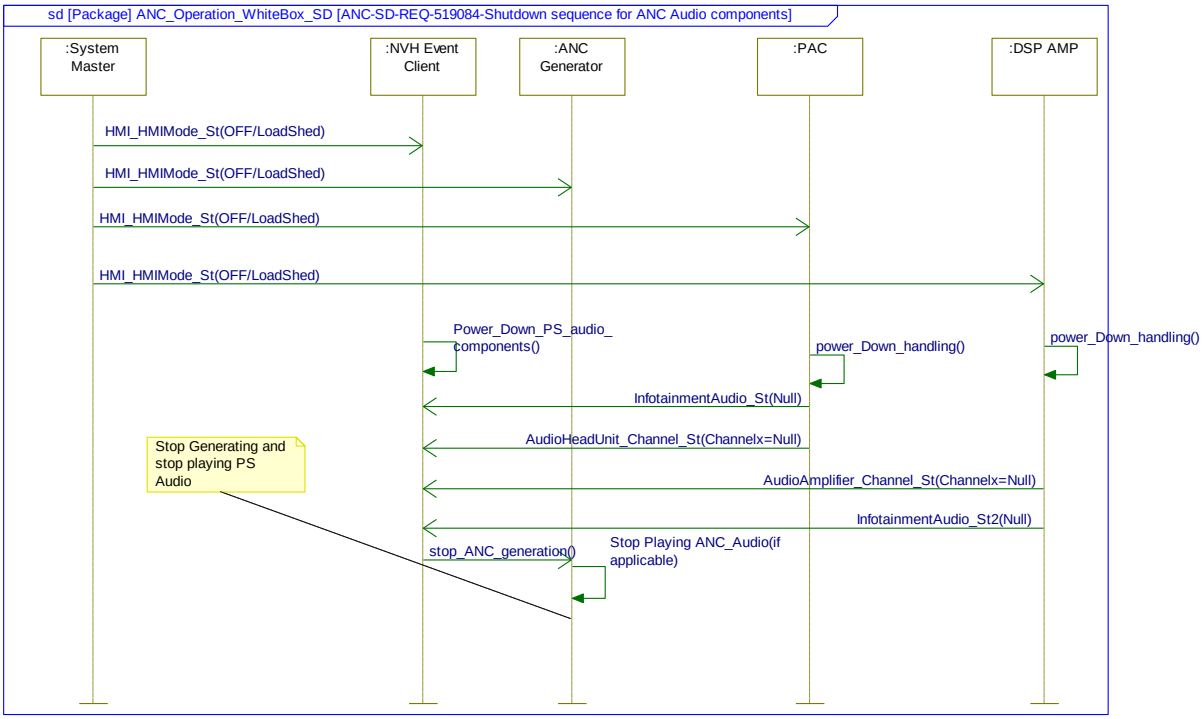
Scenario

1. Infotainment system is turned OFF.

Post-condition

1. ANC audio playing shall be stopped.

Sequence Diagram



4.2.3.2.3 ANC-SD-REQ-519079/A-Amplifier Module fault is detected while playing ANC Audio

Pre-condition

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

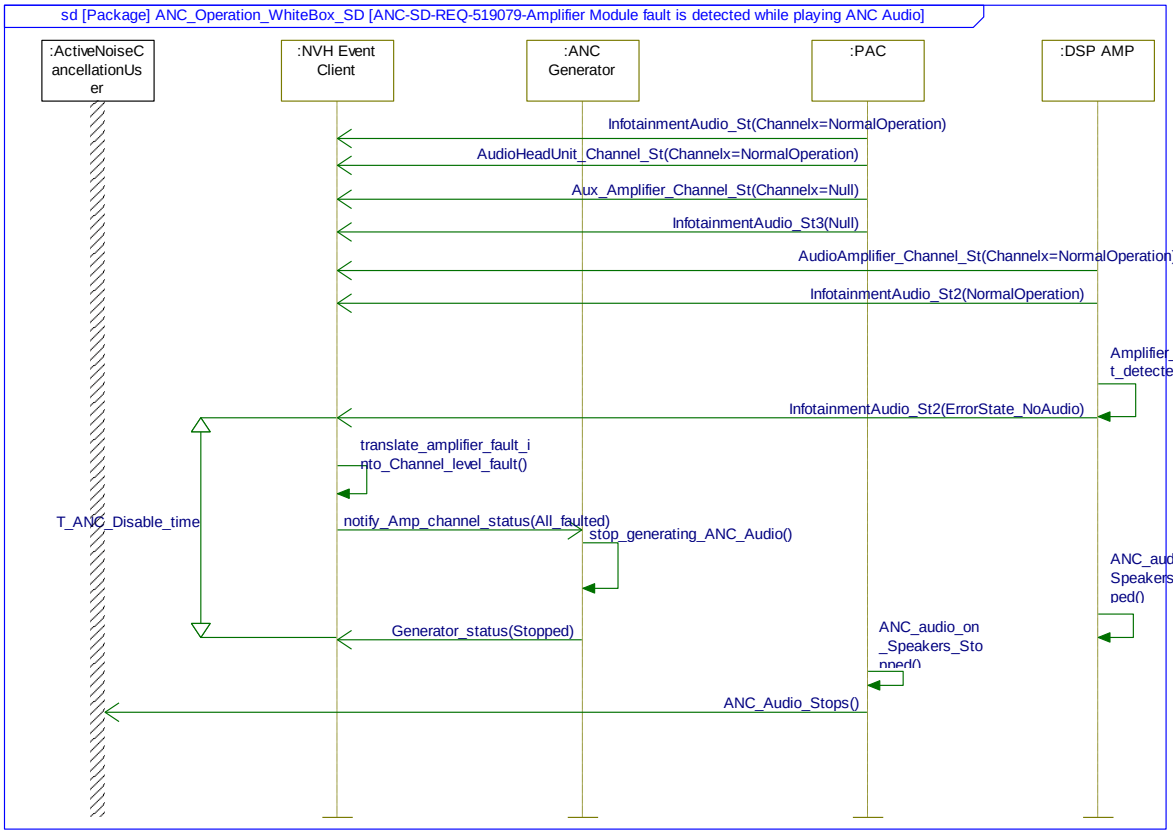
Scenario

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 ANC Generator.
2. Infotainment System shall stop playing ANC audio in the vehicle speakers.

Sequence Diagram



4.2.3.2.4 ANC-SD-REQ-519080/A-Amplifier channel Fault is detected while playing ANC audio

Pre-condition

1. Infotainment system is ON.
2. ANC 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 ANC audio.

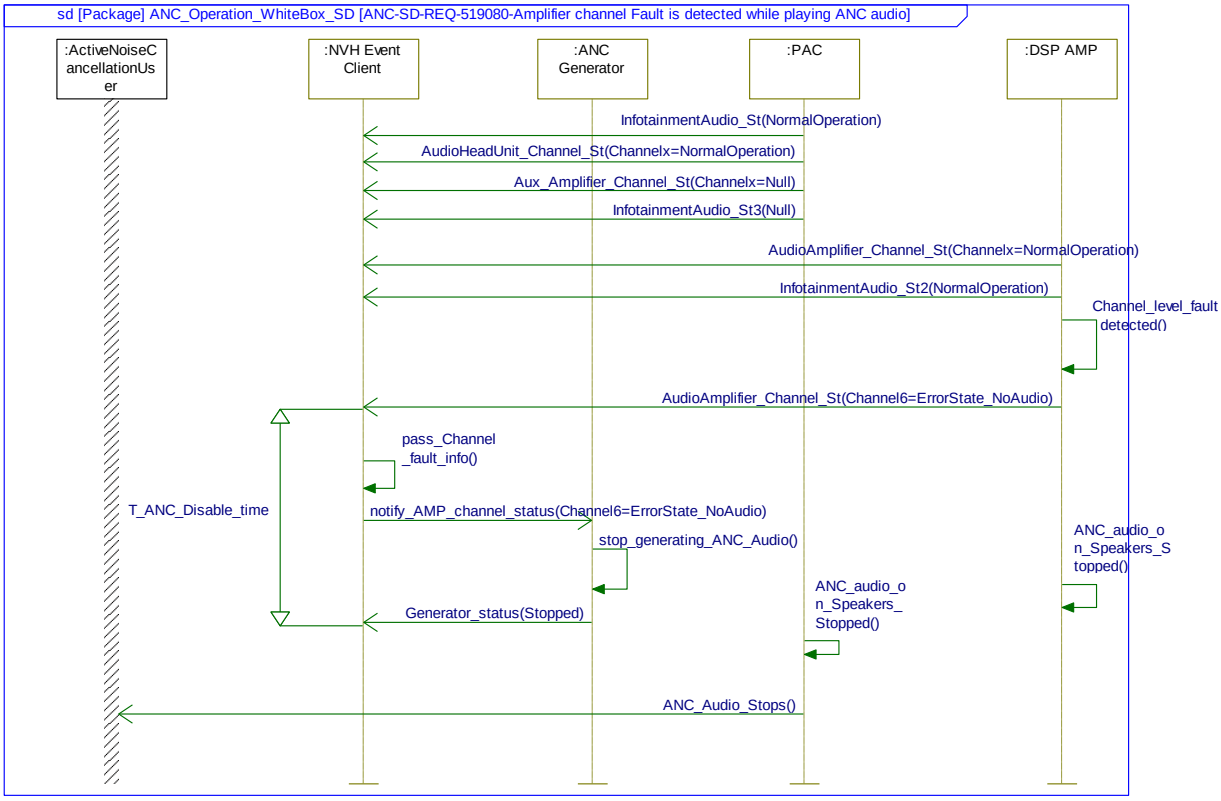
Scenario

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 ANC Generator.
2. Infotainment System shall stop playing ANC audio and remain disabled for the same ignition cycle.

Sequence Diagram



4.2.3.2.5 ANC-SD-REQ-519081/A-PAC fault is detected while playing ANC audio

Pre-condition

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

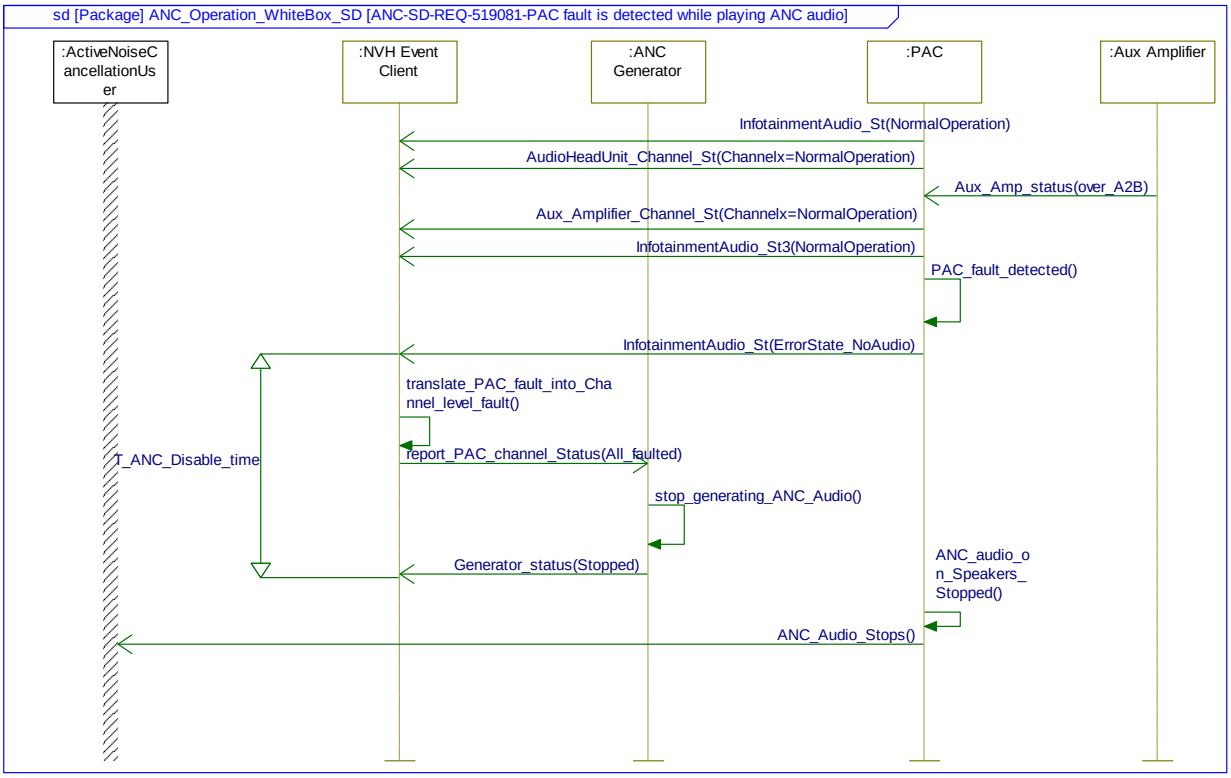
Scenario

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 ANC Generator.
2. Infotainment System shall stop playing ANC audio in the vehicle speakers and remain disabled for the same ignition cycle.

Sequence Diagram



4.2.3.2.6 ANC-SD-REQ-519082/A-Aux Amplifier channel fault is detected while playing ANC audio

Pre-condition

1. Infotainment system is ON.
2. ANC 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 ANC audio.

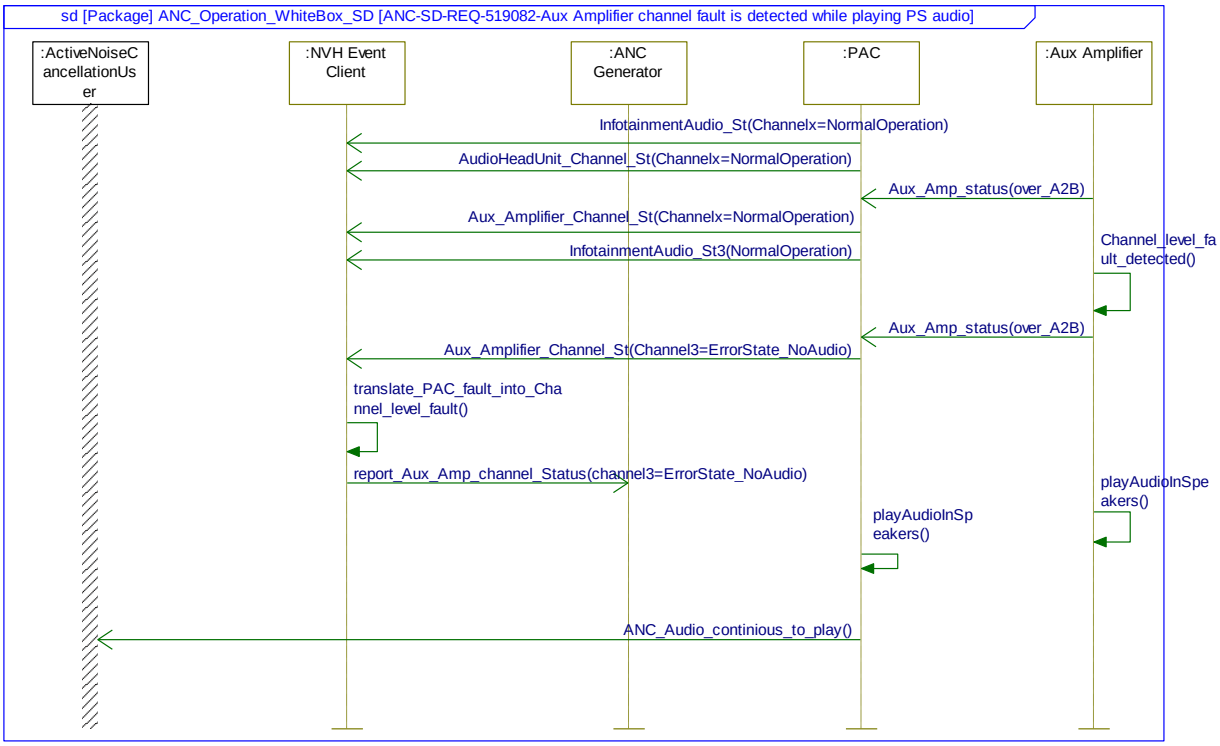
Scenario

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 ANC Generator.
2. The current active ANC audio on the Infotainment System shall not be stopped and continue playing ANC audio. Since the Channel3 in Aux amplifier is not used for ANC audio.

Sequence Diagram



4.3 ANC-FUN-REQ-497557/A-NVH Event Client & ANC Generator Interaction

4.3.1 Requirements

4.3.1.1 ANC-SR-REQ-497558/A-Input signal translation latency

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

4.3.1.2 ANC-TMR-REQ-497559/A-T_Max_NVH_ANC_Latency

Name	Description	Units	Range	Resolution	Default
T_Max_NVH_ANC_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 'ANC 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.

4.3.1.6 ANC-SR-REQ-433472/A-ANC Divergence

Whenever the ANC divergence count exceeds the configurable threshold, the NVH Event Client shall interact with ‘ANC Generator’ and shall stop ongoing ANC audio and shall remain disabled for the entire ignition cycle and the system shall support to log a DTC.

Note1: Refer IDS specification for details about DTC.

4.3.1.7 ANC-SR-REQ-520257/A-Impact of Door and Window Status signals

The NVH Event Client shall pass the Window status and Door status to ‘ANC Generator’ as received from the vehicle network. Based upon the signal status received by the ‘ANC Generator’, the ANC Generator shall decide when to temporarily enable/disable ANC audio based on Calibration/Configuration. The NVH Event Client shall also interact with ‘ANC Generator’ to be aware when the ANC audio generation is available/not available.

The system shall follow the muting and unmuting requirement as mentioned in ‘ANC-REQ-433452’.

4.3.1.8 ANC-SR-REQ-523817/A-EOL Audit Test

NVH Event Client and ANC Generator shall support ANC End of line (EOL) audit testing to verify the input/output audio signals are consistent with the calibration.

Note1: Refer IDS spec for details on ANC EOL testing.

5 Appendix: Reference Documents

Reference #	Document Title
1	Phoenix ANC-PS FS
2	A2B SPSS
3	Infotainment Diagnostics Specification
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
17	