

**Research & Vehicle Technology**

**“Infotainment Systems Product Development”**

**Core Audio Engineering Product Development**

**Phoenix Active Noise Control/ Propulsion Sound Enhancement Functional Specification**

**Version 1.5 Draft**

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# Introduction

This specification defines the functional requirements for the Active Noise Control and Propulsion Sound (ANC/ PS) feature. Propulsion sound is further broken down into two features; Propulsion Sound and Approaching Vehicle Audible System (AVAS). Thus the specification covers the following features:

* Active Noise Control (ANC); used on Hybrid / ICE vehicles.
* Propulsion Sound (PS).
  + ICE Engine Sound Enhancement (ESE).
  + Hybrid / BEV Propulsion Sound Synthesis.
* Approaching Vehicle Audible System (AVAS) used on Hybrid and BEV vehicles.

These audio features are realized on the Phoenix Domain Controller (PDC) across the host application domains running QNX and the MDSP. The audio for these features is generated in real time within the MDSP; specifically by code executing in a vendor provided “Library”.

This specification also provides diagnostic requirements, generic tuning tool interface requirements, and high-level requirements regarding data analytics.

Active Noise Control (ANC), also sometimes referred as “Cancellation" or "Engine Order Reduction" for internal combustion engines. It reduces powertrain noise up to 300 Hz, and up to 5 simultaneous engine orders. Reduction by using the cabin speakers to counteract the noise by generating an corresponding anti-phase signal; thereby reducing the perceived engine noise to the occupants' ears. This design utilizes up to four cabin error detection microphones and six cabin speaker output channels. This feature may be used in conjunction with PS.

ANC is considered narrow-band and does NOT encompass broadband noise reduction/cancellation used to combat road noise or wind noise. ANC is a feed-forward control module that uses the RPM to determine the frequencies of the engine orders to reduce, and the error microphones to monitor noise levels within the cabin and control filter adaptation. The frequencies of the objectionable tones are low frequency and multiples of the engine fundamental frequency, determined from the engine RPM. The feature shall include instability and component failure protection.

Propulsion Sound, also sometimes referred as "Engine Sound Enhancement" or "Electric Vehicle Sound Enhancement", depending upon the application. PS uses parameters such as RPM, throttle position, vehicle speed, etc. as inputs for sound generation and may employ granular/ additive/ wav-based/ noise synthesis.

## Acronyms and Definitions

Table-1 Acronyms and Definitions

|  |  |
| --- | --- |
| Technical Term | Definition and Description |
| A2B | Automotive Audio Bus (Digital audio bus) |
| ADC | Analog to Digital Converter |
| ANC | Active Noise Control |
| ASD | Active Sound Design |
| AVAS | Approaching Vehicle Audible System. Exterior sound generation for electric vehicles, utilizing the same Sound Generation portion of the ASD Library as PS. (Note: AVAS requirements are covered under separate Ford specifications, and references are made to AVAS selectively in this specification as needed.) |
| Branded | As it pertains to audio systems, this refers to high-level audio systems for which Ford Motor Company has partnered with a supplier for delivery of the audio system. "B&O" and "Revel" are current examples of branded audio systems. |
| CAN | Controller Area Network |
| DExx | Data bytes used for the PDC's diagnostic “Method 2” Configuration |
| Diagnostic Tool | Any tool that connects via the vehicle to perform diagnostic functions (ex. dealer service tool, "DET", etc.) |
| DID | Data Identifier |
| DET | Diagnostic Engineering Tool. PC-based software created by Ford, to facilitate CAN-based diagnostics via CAN. |
| DLC | Data Link Connector (i.e. OBD2 Connector) |
| DTC | Diagnostic Trouble Code |
| DSP | Digital Signal Processor |
| DSP amp | Power amplifiers, external from the PDC used for "branded" systems. |
| EMC | Electromagnetic compatibility |
| EOL | End-Of-Line (vehicle manufacturing process for configuration / testing) |
| EP | Event-Periodic (as it pertains to CAN message transmission) |
| ESE | Engine Sound Enhancement |
| EVSE | Electric Vehicle Sound Enhancement |
| FIDL | Franca Interface Definition Language (Franca IDL) – A text based interface definition language used for software interfaces. |
| FP | Fixed-Periodic (as it pertains to CAN message transmission) |
| FNVx | Ford Networked Vehicle (x), representing a version of connected vehicle architecture. |
| HS3-CAN | The High-Speed Controller Area Network #3 that infotainment/ audio components connect to. |
| IDS | Infotainment Diagnostic Specification |
| InfoCAN | Ford Motor Company Infotainment Controller Area Network module-to-module communications bus. Also referred to as “HS3-CAN”, or “High-Speed 3-CAN” bus |
| IVI | Ford Motor Company In-Vehicle Infotainment team |
| Method 2 Configuration | The module-level configuration, consisting of bytes in the range of DExx written to via ISO-14229 Service 0x2E. |
| NVH | Noise, Vibration and Harshness |
| NVM | Non-Volatile Memory |
| PAC | Phoenix Audio Controller |
| PDC | Phoenix Domain Controller |
| PPS | Persistent Publish/Subscribe service which runs under QNX. |
| PS | Interior Propulsion Sound (combination of ESE and EVSE functionality), which utilizes the same Sound Generation portion of the ASD Library as AVAS. |
| PT | Powertrain |
| PT NVH | Ford Motor Company Powertrain Noise Vibration and Harshness team |
| Rx | "Receive" (as it pertains to CAN communications) |
| SED | State Encoded Data (as it pertains to representing data in CAN) |
| Tx | "Transmit" (as it pertains to CAN communications) |
| Unbranded | As it pertains to audio systems, these are mid- to lower-end (base) audio systems that are not "Branded". (Refer to definition of "Branded", above) |
| VBF | Versatile Binary Format (A Ford proprietary file format used to package software and calibration data) |
| VIN | Vehicle Input (as it pertains to data fed to the Library by the NVH Service) |

## Phoenix System Architecture

The Phoenix vehicle architecture (also known as FNV3), audio related hardware modules consist of a Phoenix Domain Controller (PDC) and a Phoenix Audio Controller (PAC). Optional components for higher trim levels may include a Subwoofer Amplifier and DSP Amplifier.

High level key elements of Phoenix:

* The PDC contains a multicore processor SOC which includes DSP cores. Two software domains execute on the PDC; QNX and Android.
* The PAC contains terrestrial and satellite audio tuners, amplification and audio signal processing capability.
* Audio hardware modules are interconnected via A2B which transport multiple bi-directional audio streams, and CAN (HS3) for command/control and diagnostics.
* ANC/PS/AVAS related software components shall reside within the PDC.

Vehicle trim levels will dictate expanded audio channel count and capability:

* PDC and PAC: This architecture would apply for "base" ("unbranded") audio systems. In these systems, the PAC is the sole amplifier used for ANC/ PS signals.
* PDC, PAC, and Subwoofer Amplifier: This architecture would apply for higher-level unbranded audio systems. In these systems, the PAC and Subwoofer Amp may act as the amplifiers for ANC/ PS signals.
* PDC, PAC and DSP Amp: This architecture would apply for high-level "branded" audio systems. In these systems, the DSP Amp is the primary amplifier, with the PAC typically used for "satellite" speakers (such as tweeters, midranges, etc.). Depending upon frequency content, the PAC may be used an amplifier for ANC/ PS signals, whereas the DSP amp would always be used.

Refer to the document "Phoenix Audio System Diagrams - 05-03-21 - DRAFT.pdf" for depictions of these systems.

# PDC External Interfaces

The diagram below illustrates the various PDC interfaces that are related to the ANC/PS feature.

Figure : ANC/ PS-related PDC Interfaces



# PDC Software Components

The ANC/PS feature is realized through software and interface components residing on the PDC and executing within the QNX domain. The following section summarizes these components and their interactions.

## Primary Software Components

### NVH Service

The ANC/PS feature is primarily realized through the “NVH Service” which executes in the QNX domain. This component is interfaces to other PDC software components and is responsible for the initialization and real time control of the ANC/PS feature.

### MDSP Subsystem

The MDSP (Modem Digital Signal Processor) Subsystem consists of dedicated hardware on the PDC SOC and controlling software framework. This subsystem is controlled by the NVH Service and processes / synthesizes the audio.

#### ASD Library

A vendor (QNX/Blackberry) provided signal processing library. The vendor terminology for their library is ASD – Active Sound Design. This library is responsible for generating ANC/PS audio executes within the software framework of the MDSP Subsystem.

#### Acoustic Calibration

The acoustic calibration of ANC/PS consists of one or more files that will be conveyed to the ASD library through the MDSP framework by the NVH Service. These files will reside on a non-volatile filesystem within the QNX domain.

## Interface Software Components

The NVH Service interfaces to various other PDC software components as summarized below.

### vehicle\_signal

This component is responsible for providing a Rx/Tx interface for CAN network messages via UCL Gateway Proxy to the VIP. Its software interface is through FIDL - Franca IDL (Interface Definition Language).

### A2B Resource Manager

This component provides status of the A2B network through a QNX PPS (Persistent Publish & Subscribe) interface.

### Power Manager

Provides suspend and resume events to support suspend-to-RAM and resume-from-suspend.

### Diagnostic Service

Provides an interface to diagnostic facilities; including DID, DTC and Routines; through FIDL.

### DE Configuration Service

Responsible for talking to the PDC VMCU and requesting vehicle configuration information data on startup. This data is stored in a persisted location and made available to the NVH Service for vehicle configuration purposes.

# Acoustic Tuning

The acoustic tuning or calibration will be performed with an external PC based tool; “LiveAMP”. This tool is supplied by the ASD library vendor; QNX/Blackberry. The tuning tool will connect to the library for in vehicle tuning via ethernet.

## Tuning Tool Requirements

The tuning tool will be used by NVH Calibration personnel to tune the acoustic performance of ANC/PS/AVAS features. The Calibrator will have the ability to configure vehicle input (VIN) parameters and how they interact and affect the resulting audio. The tuning tool will run in the Microsoft Windows environment and be compatible with a standard Ford software load; in terms of network and security requirements imposed.

## Tuning Tool VIN Import

The tuning tool shall have the capability of importing a list of VINs and associated parameters; thus providing the Calibrator a consistent starting point from which to develop an acoustic calibration.

## Tuning Tool Communications

The tuning tool shall connect to the library executing on the DSP through the NVH Service; which runs in the QNX domain on the PDC.

The tuning tool shall interface to the PDC via Ethernet (TCP/IP), with full capabilities provided via this means. The tuning tool shall support writing to, and reading from, the Library such that all PT NVH requirements regarding tuning tool functionality is met. Such functionality includes, but is not limited to:

* Tuning functions
* Testing functions (Manual and Automated Test Scenarios)
* Display of real-time vehicle data
* Display of Library status information (Operational states/ error statuses, etc.)
* Display of specified parameters from the calibration file
* Updating calibration files

## Tuning Tool Exported Files

The tuning tool shall have the capability of exporting the acoustic calibration as a group of related files. Each exported file relates to the features and configuration according to the table below.

**Table-2 Ford .vbf Config File Contents**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Associated File** | **Feature Offering** | | | | | | |
| ANC-only | PS-Only | AVAS-only | ANC+PS | ANC+AVAS | PS+AVAS | ANC+PS+AVAS |
|  |  |  |  |  |  |  |  |
| ASD resources file (.json) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ASD Config file (.qcf) | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| ANC Calibration file (.ccf) | 1-2 | 0 | 0 | 1-2 | 1-2 | 0 | 1-2 |
| PS sample files (.bin) | 0 | x | 0 | x | 0 | x | x |
| AVAS sample files (.bin) | 0 | 0 | y | 0 | y | y | y |

### Proposed File Naming Convention

The files exported from the tuning tool will eventually reside on the PDC with identical file names. Their location within the PDC file system will be dictated by the platform team.

#### ASD Resources File

asd\_resources.json

Provides list of files (.qcf, .ccf, .bin) to be loaded. This file will be used by the NVH Service to reference all of the configuration, calibration and samples files that need to be loaded by the DSP library.

#### ASD Configuration File

asd\_configuration\_<index>.qcf

where <index> = 1

Common configuration for ANC, PS and AVAS features.

Estimated size: 3-4 kB.

Note the <index> is fixed at 1 for this specification release. The intent of the <index> is to define the format for a potential future enhancement where the driver would have the capability of selecting between different propulsion sounds.

#### ANC Calibration File(s)

anc\_calibration\_<index>.qcf

where <index> = 1,2

ANC calibration file corresponding to specific acoustic environment. For convertible vehicles additional ANC calibration files may exist corresponding to convertible top/up down acoustic environments.

Index 1 – Default for non-convertible, or convertible top up calibration.

Index 2 – For convertible applications - convertible top down calibration

Estimated size: 30-50 kB.

#### PS Sample Files

asd\_ps\_<name>.bin

Binary audio fragment files used in granular synthesis for propulsion sound. Due to the size of these file they will reside in the file system as part of the software image; rather than then VBF file.

Note that the <name> portion should not contain spaces or special characters.

#### AVAS Sample Files

asd\_avas\_<name>.bin

Binary audio fragment files used in granular synthesis for AVAS. Due to the size of these file they will reside in the file system as part of the software image; rather than then VBF file.

Note that the <name> portion should not contain spaces or special characters.

## ANC/PS/AVAS Acoustic Calibration File (VBF)

A single downloadable file will encapsulate the ANC/PS/AVAS acoustic calibration. This calibration/configuration file will be encoded in VBF (Versatile Binary Format) format. The VBF file format is Ford proprietary, used as a container for downloading software and calibration data to various vehicle ECU’s. A VBF formatted file contains multiple blocks or sections, with the first block being an ASCII encoded header, with all remaining blocks being binary encoded.

The ANC/PS/AVAS configuration VBF file will be written to the PDC at the final vehicle assembly plant. This process is known as “end of line”. It is the assembly plant’s responsibility to ensure the appropriate configuration is written based on the vehicle model and options.

The ANC/ PS/ AVAS Configuration VBF file will be named using FPN (Ford Part Number) nomenclature.

To support cybersecurity requirements, there are two additional mandatory data blocks in the VBF container, Manifest and Manifest.sig.

The VBF file will consist of the following sections/blocks:

1. Header (ASCII encoded)
2. Manifest
3. Manifest.sig
4. Binary payload - Compressed Unix TAR archive (TGZ) of the exported files listed in the previous section.
   1. Note that a header and footer will be pre/post pended to the TGZ file as outlined in the Infotainment Diagnostic Specifications APIM-PDC, SWR-REQ-442377/C-PDC Method 3 Flash.
   2. The header listed above contains the Ford Part Number (FPN); which will be reported by the NVH Service as a query to DID 0xF17D.

The VBF file will be generated and signed using software utilities and processes defined by the Central Software group.

## Acoustic Calibration lifecycle

The ANC/PS/AVAS Ford VBF configuration file, as discussed in the previous, shall be capable of being downloaded to the PDC via the following methods. These methods shall apply to both prototype and production-level vehicles.

### CAN

The calibration files shall be able to be updated over CAN. This update method has typically been used to facilitate software downloads at Ford assembly plant end of line (EOL) testers and at Ford dealerships to load proper calibration files into service replacement parts.

### USB

The calibration file shall be able be updated via USB connection to the PDC.

### Over-The-Air (OTA) Updates

The calibration file shall be able to be updated via OTA.

### Ethernet (via Tuning Tool)

The calibration file shall be able to be updated via the tuning tool via Ethernet (TCP/IP).

# PDC Configuration

To facilitate proper ANC/ PS operation for various vehicle types, the PDC will be configured using "Method 2" / "DExx Block" which are written via CAN-based diagnostic commands. This configuration is typically performed during vehicle manufacturing at EOL.

The sections below detail the feature configuration.

## ANC/ PS PDC DExx Configuration Table

**The table below is extracted from the Infotainment Diagnostic Specification listed in the References section at the end of this specification** and lists all the PDC DExx configurations and the details of each,

**Table-3 ANC/ PS PDC DExx Configurations and Associated Specification Sections**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Description** | **Config Block** | **Byte** | **Bit(s)** | **Operation** |
| Smart DSP | DE00 | 1 | 7 | 0 – Do not log missing DSP Messages  1 – Log missing DSP Messages |
| Propulsion Sound Setting | DE08 | 22 | 6 | 0 = Disable  1 = Enabled |
| Active Noise Cancellation (ANC) | DE0A | 3 | 6 | 0 = Disable  1 = Enabled |
| ANC Mic 1 | 5 | 0 = Disable  1 = Enabled |
| ANC Mic 2 | 4 | 0 = Disable  1 = Enabled |
| ANC Mic 3 | 3 | 0 = Disable  1 = Enabled |
| ANC Mic 4 | 2 | 0 = Disable  1 = Enabled |
| Simulated Sound Request Data | 4 | 4 | 0 – Unavailable  1 – Available |
| Transmission Output Shaft Speed | 3 | 0 – Unavailable  1 – Available |
| Auto Tow/Haul Status | 2 | 0 – Unavailable  1 – Available |
| Active Exhaust Status | 1 | 0 – Not Present  1 – Present |
| Window Status | 0 | 0 – Unavailable  1 – Available |
| Convertible | 5 | 7 | 0 – Non-Convertible  1 – Convertible |
| Selectable Drive Modes (ANC/PS) | 6 | 7-6 | 00 – No SDM 01 - Present SDM 4.0 10 - Present Pre-SDM 4.0 11 - Reserved |

## Common Configuration Actions

Unless otherwise specified, enabling/disabling a specific element will result in the following behavior.

* Enable/disable feature functionality.
* Enable/disable the conveyance of related CAN signals to the library as corresponding VINs, as per NVH Features Master CAN signal and VIN id list.
* Enable/disable missing message fault detection for CAN messages. If a CAN message timeout occurs for a corresponding enabled signal, the corresponding feature will be disabled/muted via Enable VIN.
  + Note the NVH service is not responsible for setting a missing message DTC, as this is the responsibility of the Diagnostic component.
* Subject to misconfiguration detection by the NVH service; which may set a corresponding DTC.

## Active Noise Cancellation (ANC)

Enables/disables ANC feature.

## Propulsion Sound Setting

Enables/disables PS feature.

Enables/disables PS control visibility in the HMI.

## ANC Mic x

Enables/disables individual microphones used for ANC.

* Enable/ disable microphone diagnostics
* Enable/ disable microphone phantom power
  + Phantom power is common to all microphones and can only be disabled if all microphones are disabled.
* Enable/ disable the transfer of the microphone audio data to the Library
  + Microphones will send data via TDM string, disabled microphone will have their TDM output set to zero.

## Vehicle Simulated Sound Request

Enables/disables EV Percent Motor Torque Data signal.

## Transmission Output Shaft Speed

Enables/disables the transmission output shaft speed signal.

## Selectable Drive Modes (ANC/PS) (SDM CAN signal selection)

Enables the reception of one of two signals used to convey vehicle drive mode, or none/disables

Note: The SDM signal selected is dependent upon the generation of Selectable Drive Modes implemented for a given model year/ vehicle line, with the selection "Present Pre-SDM 4.0" offered as protection for "legacy" (pre-SDM 4.0) applications.

## Convertible

Enables/disables signals related to the convertible top.

## Active Exhaust Status

Enables/disables active exhaust valve status signal.

## Auto Tow/Haul Status

Enables/disables auto tow/haul signal.

## Window Status

Enables/disables window status signals.

## Smart DSP

Enabling this configuration bit indicates that a DSP Amplifier is present in the system; thus requiring the conveyance of DSP AMP channel status signals.

# NVH Service

The NVH Service functionality is summarized below.

## Startup/Initialization

The NVH Service shall perform the operations necessary for initialization as listed below.

### Establish connections to related SW components

### Read DE configuration

### Load all files related to Acoustic calibration

### Request configured CAN signals from vehicle\_signal component

Note that the specific list of CAN signals to be requested will depend on the configuration and enabled features in the DE configuration.

### Start Library/MDSP sub-system

### Read Library status / version information

### Set initialization related DTCs

If an error is encountered during initialization, DTC’s will be set to aid in troubleshooting; including :

#### Misconfiguration

#### Error connecting to related software components

#### Errors related to acoustic calibration files

#### Errors related to MDSP framework during library initialization

Note initialization faults, depending on their nature; will generally prevent ANC/PS audio from being generated. The corresponding feature should be disabled through the Enable <feature> Req VIN; latched for the duration of the ignition cycle.

## Time to First Audio

ANC/PS feature support would not need any new power mode requirements for PDC/PAC to support ANC/PS audio on vehicle interior speakers. PDC & PAC are to be readily available and play ANC/PS audio within 2 seconds when 'HMIAudioMode transition from OFF -> ON'

## Runtime

After initialization, the NVH service will be responsible for the following functions.

### Update Vehicle VIN Data

Upon receipt of updated vehicle signal data, the NVH Service shall write the corresponding VIN(s).

* Each signal’s SignalStatus structure member will be evaluated. The NVH Service will only convey updated VIN values when the corresponding SignalStatus element is equal to “OK”.
* The conveyed signal value will be scaled to a format compatible with the library.

#### ~~Handling Quality Factor~~

~~Whenever the accuracy of a CAN signal is represented by its own Quality Factor signal, then the value of the CAN signal shall be considered as accurate only when the Quality factor signal is in “OK” state. The NVH Service will only convey updated VIN values when the corresponding Quality Factor is equal to “OK”. A different state (other than “OK”) shall render the associated CAN signal as being inaccurate; and the NVH Service shall not convey or update the corresponding VIN value; thus the system shall continue to operate on its last known state.~~

~~When the Quality Factor is NOT “OK” for more than 5 seconds, then the system shall consider the CAN signal is missing and shall take the appropriate action. If the Quality Factor changes state back to “OK” within this timeout period, then the system shall continue its normal operation.~~

#### Signal/VIN Latency CAN

The overall latency should not exceed 30ms. Measured from the time that the signal change appears on the CAN bus to the time it is written to the library.

This requirement is based on recommendations from the QNX Active Sound Design documentation; which recommends that this latency be limited to:

* Engine Order Reduction (ANC): Less than 10ms
* PS (Engine Sound Enhancement): Less than 30ms

For ANC, noise reduction performance is characterized against signal latency in the diagram below:

Chart, surface chart

Description automatically generated

### Detect any signal/framework faults and set the corresponding DTC/mute conditions

A signal fault will be latched for the duration of the ignition cycle and will result in the corresponding feature to be disabled through the Enable <feature> Req VIN. Similarly; any DSP framework faults or invalid response from other software components will also be latched and disable the feature for the duration of the ignition cycle.

### Update Heartbeat In value

The NVH service will initialize and maintain a counter which will be conveyed to the corresponding VIN periodically at a rate of 1 Hz. The counter will be initialized with a value of 1, and increment each period. When the counter reaches the maximum positive value of 32767, it will be reset back to 1. This VIN will be read by the configuration of the library. Using the timeout facility, the library will mute the corresponding audio output; as this would indicate a loss of supervisory control by the NVH Service due to a crash or unexpected behavior. As a failure mechanism, muting the feature audio will prevent uncontrolled audio from annoying the driver.

### Convey A2B mute/unmute state

The A2B Resource Manager provides two signals which reflect the state of the A2B bus. These signals are:

* brdcst\_state\_muted
* brdcst\_state\_aud\_send

The combination of states from these signals will be decoded to reflect an overall A2B\_MUTE signal; which will be factored into each feature’s enable VIN. The A2B\_MUTE signal should not be considered a fault; and processed in real-time; not latched.

### Respond to PS HMI enable/disable state changes by conveying corresponding enable VIN

### Read derived VINs periodically and latch fault/mute conditions as appropriate

### Periodically read library operational status

### ANC Divergence status

An ANC divergence event should be latched for the duration of the ignition cycle and cause the ANC feature to mute.

### Library call count

A counter read through the framework to indicate that the DSP library is functioning and processing audio. A timeout on this counter will set an error condition; indicating loss of control/communication with the DSP library.

### Respond to Mic faults

Any enabled microphone fault should be latched for the duration of the ignition cycle and cause the ANC feature to mute.

### Respond to Diagnostic I/O controls/routine requests

### Load/unload configuration as needed

### Respond to Power Manager requests for suspend/shutdown

A Power Manager shutdown request should disable each feature’s enable VIN; thus muting all ANC/PS/AVAS related audio.

## Audio Output Control (PAC/ DSP Amp Unmuting)

The sections below provide details the muting and unmuting of ANC/PS audio during system startup and shutdown.

### Muting/Unmuting ANC/PS Audio Streams at Startup/Shutdown

The coordination of muting/unmuting A2B audio streams is addressed by the A2B SPSS. The A2B resource manager within the PDC provides the following signals through a PPS (Persistent Publish Subscribe) interface.

* Brdcst\_state\_muted
  + which has 2 possible states – muted or unmuted
* Brdcst\_state\_aud\_send
  + which has 2 possible states – audio send or audio not send

The NVH service would unmute/enable the output for each feature for the following conditions and mute/disable for all other states:

* Brdcst\_state\_muted = unmuted
* Brdcst\_state\_aud\_send = audio send

The intended system design is for the PAC and DSP Amp ANC/PS input streams, once unmuted, to remain unmuted for the balance of the ignition cycle until the audio system shuts down but the A2B resource manager states will ultimately dictate the muting/unmuting status of this feature.

#### Library Mute/Unmute Audio Fade-In/Fade out

Any time the ANC/ PS Library unmutes and begins generating audio, the audio output shall have a gradual "fade-in/fade-out" (ramping up of the audio output level) so that no abrupt audible changes are perceived by the customer. It is recommended that a mute/unmute ramp of at least 50ms is maintained to minimize audible artifacts.

#### Muting ANC/PS Audio Streams during Diagnostics

Note: It is possible that diagnostic routines/modes may cause the transition previously mentioned, however this is a scenario in which case any pops heard would be acceptable.

## Partitioning of Fault/Mute Logic for ANC

The following diagram illustrates the interaction between the NVH Service and the Library/Configuration for ANC.



## Partitioning of Fault/Mute Logic for PS

The following diagram illustrates the interaction between the NVH Service and the Library/Configuration for PS.



## Partitioning of Fault/Mute Logic for AVAS

The following diagram illustrates the interaction between the NVH Service and the Library/Configuration for AVAS.



## Common Library Muting By Feature

The NVH Service will use an feature specific enable VIN to convey a request to enable/unmute the library. The corresponding library configuration is to use the corresponding Enable <feature> Req VIN in a trigger condition / mute block as appropriate. Each feature will also use the Heartbeat In signal; detailed earlier for failsafe muting.

The NVH Service will consider various input signals to generate the Enable <feature> Req VIN; as detailed in the earlier partitioning logic diagrams. The library configuration will need to adhere to this logic; and thus it is recommended that the NVH team generate a configuration template for consistency.

The NVH Service will maintain variables that reflect the current state of feature enabled conditions which can be queried via diagnostics for troubleshooting, debugging and analytic purposes.

Features which are disabled via DE Configuration will have their corresponding Enable <feature> Req VIN set to disable.

## Convertibles - ANC

The NVH Service will need to convey the Cnvt Top Pos VIN only if the convertible feature is enabled in DE configuration.

Additionally, the NVH Service will need to manage convertible related calibration files only if the ANC feature is also enabled in DE configuration.

For convertible applications where ANC will require two separate calibrations (top up, and top down, to address the differences in transfer functions between the states). The NVH Service needs to manage the ANC calibration files based upon the convertible top status.

The NVH service will need to manage ANC calibration files as follows; upon detecting a transition of the convertible top:

1. Retain the Top Up or Top Down state that was active immediately prior to the transition occurring.
2. Mute ANC via Enable ANC Req VIN
3. Wait for the convertible top status to be reported as either Top Up or Top Down.
4. Manage the ANC calibration by either:
   1. switching the ANC calibrations (if the state in step 3 is different than the state retained in step 1) OR
   2. retaining the same ANC calibration (if the top state in step 3 is the same as step 1)
5. Unmute ANC via Enable ANC Req VIN

## Convertibles - PS

The NVH Service shall not mute PS during the transition state of the convertible top. The calibrator may decide to use the Cnvt Top Pos VIN to affect the feature as desired as part of the configuration.

## AVAS Two Speaker Switching

For a two speaker AVAS system, one speaker is used when the vehicle is moving in the forward direction, and a different speaker is used when the vehicle is moving in the reverse direction. The AVAS speakers are connected to the PAC module; and the audio signal itself is carried on a single A2B stream. The PAC will perform switching between the front and rear speaker based on various vehicle signal conditions including the reverse gear. The PDC will also need to be aware of a gear change and coordinate a mute of AVAS audio during the period of time that the front/rear AVAS speaker is being switched. The details of the speaker switching is documented in the AVAS SPSS v 1.2

The NVH Service will use the calibration value; Transition Delay Config (0xEE0A) to mute the AVAS output during the transition period from forward to reverse gear and vice versa. During a transition from forward sound/audio to reverse sound/audio or vice versa, the AVAS audio shall mute during the transition and unmute once the transition is complete unless AVAS enters a state where no sound should be played.

# NVH Service Shutdown

Upon a commanded shutdown, the NVH service will be responsible for the following functions

* Mute all outputs
* Ensure NVH service is in a graceful shutdown state

# Audio Signal Requirements

## Allowable PDC Audio Path Latency

The allowable audio system latency, measured from microphone input to amplifier output shall be no greater than 3ms.

## Audio Inputs - Microphones

The PDC and ANC/ PS Library shall support 4 ANC microphone inputs. As the number of microphones used may vary based upon vehicle line, and possibly within a vehicle line (based on different roof types, etc.), each PDC microphone input shall be able to be individually configured as enabled/ disabled.

### PDC Microphone Input Relationship to Microphone Placement

While most vehicles equipped with ANC are expected to use the full capability of four microphones, some vehicles may not be able to due to packaging constraints or other factors. In an attempt to create common, fixed usage patterns for the PDC microphone inputs, the following guidelines have been established. These guidelines facilitate vehicles with varying placement and numbers of ANC microphones.

**Table-4 Relationship of PDC Microphone Inputs to In-vehicle Microphone Usage**

|  |  |  |
| --- | --- | --- |
| **PDC ANC Mic Input** | **Primary Usage** | **Secondary Usage(s)** |
| 1 | Left Front (LF) | Center Front |
| Left Center |
| 2 | Right Front (RF) | Right Center |
| 3 | Right Rear | Center Rear (CR) |
| 4 | Left Rear | - |

The intention of this scheme is to traverse the vehicle in a clockwise direction (when looking down from top of vehicle), starting with the left front microphone as being the first ANC microphone. When a center front mic is used in place of the left/ right mic combination for the front row, the first mic for that row will act as the center mic as there is no left front mic. (Thus, Mic 1 would be used as a CF mic, Mic 3 used as the CR mic.)

To better illustrate this, table-5 and Figure 2 are provided below. Table-5 includes a label for mic placement (ex. "1A") related to the arrangements shown in Figure 2, as well as the microphone inputs used for each arrangement and the associated PDC DExx microphone configuration information for each microphone arrangement.

**Table-5 Relationship of PDC Microphone Inputs to In-vehicle Microphone Placement**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Mic Placement (See Figure 2)** | **PDC Mic Input** | | | | | | | | **PDC DExx configuration**  (Bits of DE0A, Byte 3 = ) |
| **Mic 1** | | | **Mic 2** | | **Mic 3** | | **Mic 4** |
| LF | CF | LC | RF | RC | RR | CR | LR |
| 1A | X |  |  |  |  |  |  |  | xx1000xx |
| 2A |  | X |  |  |  |  | X |  | xx1010xx |
| 2B | X |  |  | X |  |  |  |  | xx1100xx |
| 2C |  |  | X |  | X |  |  |  | xx1100xx |
| 2D |  |  |  |  |  | X |  | X | xx0011xx |
| 3A | X |  |  | X |  |  | X |  | xx1110xx |
| 3B |  | X |  |  |  | X |  | X | xx1011xx |
| 4A | X |  |  | X |  | X |  | X | xx1111xx |

**Figure 2: PDC Microphone Input to In-Vehicle Placement Diagrams**

**Per file “ANC Mic input Config-location info – 11-30-21”**



### PDC Mic Input/ Library Mic Input Relationship

**Table-6 PDC Mic Input/ Library Mic Input Relationship**

|  |  |
| --- | --- |
| **PDC ANC Mic Input** | **Library Mic Input** |
| 1 | mic\_0 |
| 2 | mic\_1 |
| 3 | mic\_2 |
| 4 | mic\_3 |

## Audio Outputs

### Characteristics

* Number of channels: 6 (independently controlled). (Outputs are shared between ANC and PS whenever the features are offered together.
* ANC Bandwidth: 20 - 300Hz
* PS Bandwidth: 20 - 6kHz

### Library/ A2B Stream/ Speaker Channel Relationships

The PDC and ANC/ PS Library shall support 6 ANC independently-controlled outputs, provided as A2B streams to the PAC for unbranded systems, or DSP Amp for branded systems, with the routings fixed in the following manner:

**Table-7 Library/ A2B Stream/ Channel Routing Relationship**

|  |  |  |
| --- | --- | --- |
| **Library Output** | **ANC/ PS A2B Stream** | **Speaker**  **Channel Routing** |
| ctrl\_0 | 62 | Left Front |
| ctrl\_1 | 63 | Right Front |
| ctrl\_2 | 64 | Right Rear |
| ctrl\_3 | 65 | Left Rear |
| ctrl\_4 | 66 | Center Front |
| ctrl\_5 | 67 | Subwoofer |

Similar to the microphone placement discussed in section 8.2.1, the intention of this channel routing scheme is to traverse the vehicle's main speakers in a clockwise fashion (when looking down from top of vehicle), then center front speaker and subwoofer.

The output streams shall be mixed, post-EQ (i.e. EQ does NOT affect the ANC/ PS signals) with other audio sources and routed to the appropriate speakers per the aforementioned generic routings.

Specific details about the routing of each stream, per vehicle line/ audio system are captured in the document "Phoenix Audio Channel Usage Summary… " Excel file. This file indicates such things as which components are used as audio amplifiers (PAC, DSP Amp, auxiliary amps), what speaker(s) each channel powers, and also which ANC/ PS streams are routed to each channel.

Higher frequency content of PS signals shall be provided through

* Passive crossover networks in the woofers (applies to tweeters in unbranded audio systems)
* Active crossover networks in the DSP amp (applies to branded audio systems)

# Master VIN List/ CAN Signal Relationship Table

The relationship between vehicle signals and the associated VINs are captured in a reference document “NVH Features Master CAN signal and VIN id list” excel spreadsheet.

The spreadsheet is organized in the following tabs:

* ANC-PS CAN signals
  + This table captures the vehicle CAN signals required for the feature to function.
  + Each signal is associated with a specific DE configuration which corresponds to a specific sub feature ANC/PS/AVAS.
  + The NVH Service will subscribe to the corresponding enabled vehicle signals from vehicle\_signal component.
  + Missing message DTC(s) should be set for enabled signals which exceed message timeout condition.
* Master VIN list
  + This table captures the VIN ID for each CAN signal and it’s corresponding LiveAMP name.
  + The relationship between the VIN ID and the corresponding CAN signal(s).
  + Feature fault response on a per signal basis.
  + Derived VINs within the LiveAMP configuration to be read by the NVH service.
  + VINs related to Diagnostic modes
  + Reserved VINs for potential future changes
* Logical Variables
  + This table captures the logical relationship for NVH Service generated VINs.

# Vehicle Signal - VIN - Tuning Tool Signal Relationship

The following subsections will detail the relationship between a CAN signal notified by vehicle\_signal component, scaling to VIN value and interactions with the tuning tool.

The vehicle signal VINs are conveyed to the library by the NVH Service. This occurs when the corresponding CAN signal value changes, as notified by the vehicle\_signal component. These signal values are represented in engineering units where applicable.

All values written to the vehicle signal VINs shall be represented as 16-bit signed integers (S16). For each vehicle signal conveyed, the NVH Service needs to coerce the values within the specified range as well as apply the specified multiplier and finally write to the corresponding VIN. The ranges and multipliers are detailed in the subsections below.

The Tuning Tool internally also uses the S16 format, but will convert these back to engineering units through a scale factor for all user interactions. This multiplier is also detailed in the following subsections.

## Limit and Scaling Tables

The Vehicle signals/VINs in this subsection are listed with the following information:

* The minimum and maximum values for the data passed to the NVH Service.
* The multiplier the NVH Service is to apply to the data passed to the NVH Service
* The data written to the VIN by the NVH Service
* The multiplier that the tuning tool applies to the value written to the VIN data. (This multiplier is applied for unit conversion or to make the data more intelligible to the NVH tuning engineer.)
* The resulting value for the tuning tool after the tuning tool multiplier has been applied.

Within these subsections are tables that provide the characteristics for each base VIN, including:

Other applicable rules for the NVH Service's handling of each VIN are also specified, including any additional logic, fault detection requirements, etc..

Throughout this subsections VIN IDs are underlined and associated CAN signals are in italics.

### ~~Accel PdlPos (%) (Accelerator pedal position)~~

~~The NVH Service shall update the corresponding VIN only when the Quality Factor signal “~~*~~ApedPosPcActl\_D\_Qf”~~* ~~has a value of “OK”.~~

**~~Table-8~~ *~~ApedPos\_Pc\_ActlArb~~* ~~/ Accel PdlPos (%) Relationship~~**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **~~Value passed to NVH Service~~** | **~~NVH Service Multiplier~~** | **~~VIN Data~~** | **~~Tuning Tool Multiplier~~** | **~~Displayed Value~~** |
| **~~Min~~** | ~~0~~ | ~~10~~ | ~~0~~ | ~~0.1~~ | ~~0~~ |
| **~~Max~~** | ~~102.3~~ | ~~1023~~ | ~~102.3~~ |

### ~~Engine Spd (RPM)~~

**~~Table-9~~ *~~EngAout\_N\_Actl~~* ~~/ Engine Spd (RPM) Relationship~~**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **~~Value passed to NVH Service~~** | **~~NVH Service Multiplier~~** | **~~VIN Data~~** | **~~Tuning Tool Multiplier~~** | **~~Displayed Value~~** |
| **~~Min~~** | ~~0~~ | ~~1~~ | ~~0~~ | ~~1~~ | ~~0~~ |
| **~~Max~~** | ~~16382~~ | ~~16382~~ | ~~16382~~ |

~~The NVH Service shall update the corresponding VIN only when the Quality Factor signal “EngAoutNActl\_D\_Qf” has a value of “OK”.~~

### ~~Engine Trq (Nm) (Engine Torque Output)~~

~~The NVH Service shall update the corresponding VIN only when the Quality Factor signal “TrnAinTq\_D\_Qf~~*~~”~~* ~~has a value of “OK”.~~

**~~Table-10~~ *~~TrnAin\_Tq\_Actl~~* ~~/ Engine Trq (Nm) Relationship~~**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **~~Value passed to NVH Service~~** | **~~NVH Service Multiplier~~** | **~~VIN Data~~** | **~~Tuning Tool Multiplier~~** | **~~Displayed Value~~** |
| **~~Min~~** | ~~-500~~ | ~~1~~ | ~~-500~~ | ~~1~~ | ~~-500~~ |
| **~~Max~~** | ~~1547~~ | ~~1547~~ | ~~1547~~ |

### ~~Veh Spd (kph) (Vehicle Speed)~~

~~The NVH Service shall update the corresponding VIN only when the Quality Factor signal “VehVActlEng\_D\_Qf~~*~~”~~* ~~has a value of “OK”.~~

**~~Table-11~~ *~~Veh\_V\_ActlEng~~* ~~/ Veh Spd (kph) Relationship~~**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **~~Value passed to NVH Service~~** | **~~NVH Service Multiplier~~** | **~~VIN Data~~** | **~~Tuning Tool Multiplier~~** | **~~Displayed Value~~** |
| **~~Min~~** | ~~0~~ | ~~100~~ | ~~0~~ | ~~0.01~~ | ~~0~~ |
| **~~Max~~** | ~~327.67~~ | ~~32767~~ | ~~327.67~~ |

### DLine Spd (RPM) (Transmission output shaft/ Driveline speed)

Before writing the *TrnAout\_W\_ActlUnfilt* data to the VIN, the NVH Service shall verify the value is neither 0x7FFE ("Unknown") nor 0x7FFF ("Fault"). Upon confirmation, the NVH Service shall multiply the value of *TrnAout\_W\_ActlUnfilt* by the value shown for the "NVH Service Multiplier", and write this information to the DLine Spd (RPM) VIN.

For any cases where the value of *TrnAout\_W\_ActlUnfilt* is either 0x7FFE ("Unknown") or 0x7FFF ("Fault"), the NVH Service shall withhold writing any data to the VIN until the next transmission of valid data (where the data is not indicating "Unknown"/ "Fault").

**Table-12 *TrnAout\_W\_ActlUnfilt* / DLine Spd (RPM) Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Displayed Value** |
| **Min** | 0 | 9.5492965855137 | 0 | 1 | 0 |
| **Max** | 3276.5 | 31288 | 31288 |

The NVH Service Multiplier shown above performs the conversion from radians/ second to revolutions per minute. (RPM = (60 / 2π) \* x rad/ s).

### Pct Mtr Trq (%) (Percentage of motor torque)

**Table-13 *VehSimSnd\_Pc\_Rq* / Pct Mtr Trq (%) Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Displayed Value** |
| **Min** | -102.2 | 5 | -511 | 0.2 | -102.2 |
| **Max** | 102.4 | 512 | 102.4 |

### IC Engine Status

**Table-14 *Eng\_D\_Stat* / IC Engine Status Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 3 | 3 | 3 |

### Ignition status

**Table-15 *Ignition\_Status* / Ignition status Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 15 | 15 | 15 |

### Sound State

The NVH service shall evaluate the statuses of the following CAN signals and write the combined data to the Sound state VIN. The relationship between the input and output signals are detailed in the logical variables tab in the NVH features Master CAN signal and VIN id list, which is summarized below.

*Ignition\_Status*

*PwPckTq\_D\_Stat*

*TrnRng\_D\_R*

The NVH Service will only convey the updated Sound state VIN value when all the corresponding SignalStatus elements are equal to “OK”.

**Table-16 *CAN Signals/* Sound State Relationship**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Values Passed to NVH Service and Evaluation Logic** | | | | | | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** | **State** |
|  | **Ignition\_Status** |  | **PwPckTq\_D\_Stat** |  | **TrnRng\_D\_Rq** |  |  |  |  |
| IF | = 0x4 (Run) | AND | = 0x3 (PwPckOn\_TqAvailable) | AND | = 0x0 (Park) | 1 | 1 | 1 | Ready in Park |
| ELSEIF | = 0x4 (Run) | AND | = 0x3 (PwPckOn\_TqAvailable) | AND | = 0x1 (Reverse) | 2 | 2 | Ready in Reverse |
| ELSEIF | = 0x4 (Run) | AND | = 0x3 (PwPckOn\_TqAvailable) | AND | = 0x2 (Neutral) | 3 | 3 | Ready in Neutral |
| ELSEIF | = 0x4 (Run) | AND | = 0x3 (PwPckOn\_TqAvailable) | AND | = 0x3 (Drive) | 4 | 4 | Ready in Drive |
| ELSEIF | = 0xF (Invalid) | OR |  |  | = 0xF (Fault) | 5 | 5 | Fault |
| ELSE | (All other state combinations) | | | | | 0 | 0 | Not Ready |

### Trq Avail (Y/N) (Torque Available Status)

**Table-17 *PwPckTq\_D\_Stat* / Trq Avail (Y/N) Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 3 | 3 | 3 |

### Trans Gear Pos

**Table-18 *GearPos\_D\_Actl* / Trans Gear Pos Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 15 | 15 | 15 |

### Trans Range

**Table-19 *TrnRng\_D\_Rq* / Trans Range Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 15 | 15 | 15 |

### Veh Drive Mode

The NVH service shall write the data from either the *SelDrvMdeHmi04\_D\_Rq* or *ActvDrvMde\_D2\_Stat* to the Veh Drive Mode VIN. The selection of which source signal to use depends on the DE configuration as specified in the NVH Features Master CAN signal and VIN id list.

**Table-20 *SelDrvMdeHmi04\_D\_Rq* or *ActvDrvMde\_D2\_Stat* / Veh Drive Mode Relationship**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** |  | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 |  | 0 | 1 | 0 |
| **Max** | 31 |  | 31 | 31 |

### Cnvt Top Pos (Convertible Top Position)

The NVH service shall evaluate the statuses of both the *CnvtTopPos\_Dn\_Stat* and *CnvtTopPos\_Up\_Stat* CAN signals and write the data to the Cnvt Top Pos VIN as per table below.

**Table-21 *CnvtTopPos\_Dn\_Stat* and *CnvtTopPos\_Up\_Stat* / Cnvt Top Pos Relationship**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** | **Conv Top State** |
|  | **CnvtTopPos\_Dn\_Stat** | **CnvtTopPos\_Up\_Stat** |  |  |  |  |
| **Min** | 0 (Not Down) | 1 (Up) | 0 | 1 | 0 | Top Up |
|  | 1 (Down) | 0 (Not Up) | 1 | 1 | Top Down |
|  | 0 (Not Down) | 0 (Not Up) | 2 | 2 | Transition |
| **Max** | 1 (Down) | 1 (Up) | 3 | 3 | Error |

The NVH Service will only convey the updated Cnvt Top Pos VIN value when all the corresponding SignalStatus elements are equal to “OK”.

### Auto Tow-Haul

The NVH service shall write the associated *AutoTowActv\_B\_Stat* CAN signal based-data to the VIN

**Table-22 *AutoTowActv\_B\_Stat* / Auto Tow / Haul Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 1 | 1 | 1 |

### Exh Valve Stat (Active exhaust valve status)

The NVH service shall write the associated *EngExhMdeQuiet\_D2\_Stat* CAN signal based-data to the VIN

**Table-23 *EngExhMdeQuiet\_D2\_Stat* / Exh Valve Stat Relationship**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 7 | 7 | 7 |

### DoorStat x (Door/ Liftgate statuses)

The NVH service shall write the associated *DrStatx\_B\_Actl* CAN signal based-data to the VINs.

**Table-24 *DrStatx\_B\_Actl* / DoorStat x Relationships**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 1 | 1 | 1 |

### WinStat x (Window statuses)

The NVH service shall write the associated *xWindowPosition* CAN signal based-data to the VIN(s)

**Table-25 *xWindowPosition* / WinStat x Relationships**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **Value passed to NVH Service** | **NVH Service Multiplier** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | 0 | 1 | 0 | 1 | 0 |
| **Max** | 7 | 7 | 7 |

### PAC Chx Status (PAC Channel Fault Statuses)

When the PDC DExx configuration(s) matches the "Applicable DExx Configuration(s)" for the PAC Chx Status VINs, the NVH service shall write the associated *PAC\_Channel\_x\_St* CAN signal based-data. The relationship of the CAN signals to the eight PAC Chx Status VINs

### AuxAmp CHx Stat (Aux Amp Channel Fault Statuses)

When the PDC DExx configuration(s) matches the "Applicable DExx Configuration(s)" for the AuxAmp CHx Stat VINs, the NVH service shall write the associated *Aux\_Amp\_Channel\_x\_St* CAN signal based-data

### DSPAmp Chx Stat (DSP AMP Amp Fault Statuses)

When the PDC DExx configuration(s) matches the "Applicable DExx Configuration(s)" for the DSPAmp Chx Stat VINs, the NVH service shall write the associated *DSP\_Amp\_Channel\_x\_St* CAN signal based-data

# NVH Service - Generated VINs/Parameters

The NVH Service is responsible for conveying internally generated VINs to the library on a periodic or event basis. The processing logic for the enable VINs are detailed in the NVH Service Runtime section. Only VINs associated with enabled features will be conveyed.

## Enable ANC Req (Enable ANC)

**Table-26 Enable ANC Req VIN Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **State Definition** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | Mute ANC | 0 | 1 | 0 |
| **Max** | Unmute/Enable ANC | 1 | 1 |

## Enable PS Req (Enable Propulsion Sound)

**Table-27 Enable PS Req VIN Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **State Definition** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | Mute Propulsion Sound | 0 | 1 | 0 |
| **Max** | Unmute/Enable Propulsion Sound | 1 | 1 |

## Enable AVAS Req (Enable AVAS)

**Table-28 Enable AVAS Req VIN Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **State Definition** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | Mute AVAS | 0 | 1 | 0 |
| **Max** | Unmute/Enable AVAS | 1 | 1 |

### AVAS Fault Notification to (HMI) Driver

The state of the Enable AVAS Req VIN reflects the ability of the AVAS to produce audio; through a chain of internal conditions. Thus if the PDC has AVAS enabled and the Enable AVAS Req VIN is in a Mute AVAS state continually for a period of time exceeding 5 seconds; then the HMI Service will signal the HMI to display an AVAS Fault message to the driver.

## Heartbeat In

The NVH Service shall generate a 15-bit counter (range of decimal 1-32,767) for use as a "heartbeat" signal provided to the Library via the Heartbeat In VIN. By monitoring this VIN, the Library may determine if the NVH Service/ DSP framework has "crashed" and thus not properly updating the data the Library requires for proper operation.

The NVH Service shall initialize the counter value to 1 (decimal) during library initialization and write this value to the Heartbeat In VIN. The counter value and corresponding Heartbeat In VIN value shall be incremented by 1 every 1000ms, to provide a continuously-changing/ fixed-period input to the Library.

The counter shall be continuously updated while the Library is running and shall not stop in the event the counter has reached its maximum value of 32,767. In such a case, the counter shall "rollover" back to a value of 1 and continue counting at its periodic rate with no pauses or delays incurred before, during, or after the rollover.

The LiveAMP configuration will use the Heartbeat In VIN with the following parameters:

**Table-29 Heartbeat In VIN Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **State Definition** | **VIN Data** | **Tuning Tool Multiplier** | **Tool SED Value** |
| **Min** | NVH Service Fault - Mute | 0 | 1 | 0 |
| **Max** | Normal Operation | 1-32767 | 1-32767 |

The VIN will be configured in LiveAMP with the following parameters:

* Default value: 0
* Minimum value: 0
* Maximum value: 32,767
* Timeout (ms): 5000

Within the LiveAMP configuration, the final mute block shall consider the Heartbeat In VIN value for muting the feature. If the Heartbeat In VIN equals zero then the feature will be muted. This will cause the resulting audio to mute in the event that the NVH Service is unable to refresh the Heartbeat In VIN value. This failsafe mechanism will prevent unintended audio from being generated and annoying the user/customer.

## Diagnostics – Tones Test

For diagnostic purposes; to support the generation of an arbitrary tone on a specified channel; the NVH Service will write the corresponding parameters directly to the library via CAPI V2 interface. The library will supports this mode of operation via:

* Diagnostics mode (QWA\_ASD\_DIAG\_TONE)

Where the frequency, output channel and amplitude is set via:

* qwaAsdDiagFreq
* qwaAsdDiagOutChan
* qwaAsdDiagGain

## Diagnostics – Microphone Passthrough

To support microphone passthrough diagnostics, the NVH service will need to load a specific configuration file which will be present as part of the software load:

* asd\_diag\_mic\_configuration.qcf

This library configuration will use a different set of VIN identifiers; specifically to control this diagnostic feature and to prevent the possibility of audio artifacts in the event the configuration is erroneously loaded. These VINs are listed in the following subsection.

### UnMute DIAG In

Unmutes all of the output channels. Intended as a failsafe to enforce that the NVH Service is controlling the library. Thus a value of 1 will unmute and pass the configured microphone audio to the output channel(s), and a value of 0 (default) will mute all output channels. The configuration also makes use of Heartbeat In as an additional failsafe.

### ChX Amplitude

Specifies the output signal amplitude for each output channel.

### ChX Source

Specifies microphone (1,2,3,4) as a signal source for each output channel. A value of zero will mute the channel.

Note that the microphone passthrough configuration uses the Heartbeat In VIN, and therefore this signal needs to be conveyed to the library during this diagnostic mode.

## Diagnostics – ANC EOL Routine Control

The control of the library to support ANC EOL testing is detailed in the ASD Developers Guide. This will involve the NVH Service writing and reading the corresponding parameters directly to the library via CAPI V2 interface.

Entering EOL mode is performed by setting the library mode (qwaAsdMode) to QWA\_ASD\_MODE\_EOL.

Exiting or aborting EOL mode is performed by setting the library mode (qwaAsdMode) to QWA\_ASD\_MODE\_PROCESS.

The NVH Service will need to coordinate the execution of the EOL routine and manage the appropriate entry and abort conditions.

# NVH Service - Library Reads

During initialization and subsequent continued operation, the NVH Service will read status and derived VINs from the library on a periodic and event basis. It is proposed that the periodic reads be performed at a rate of 1 Hz. Only status / VINs that are relevant to enabled features will be read. These elements are listed in the subsection below.

## Library Version (optional)

The Library Version shall be read during initialization. The NVH Service shall facilitate reporting the Library's Version Number via Diagnostics.

## CAPI V2 Module Version (optional)

The CAPI V2 Module Version shall be read during initialization. The NVH Service shall facilitate reporting the Module Version Number via Diagnostics.

## Library Status

The library status will be periodically polled. The NVH Service shall facilitate reporting of these status elements via Diagnostic DID(s). The NVH Service shall latch status conditions which indicate failure conditions for the duration of the ignition cycle; and use this latched value for disabling the affected features. Status conditions read shall include those listed in the following subsections.

### ANC Divergence (EOR Exception)

The NVH Service will periodically read ANC Divergence status (EOR Exception) via qwaAsdEorExceptionStatus. The library maintains a EOR exception count, and if the configurable threshold (qwaAsdEorExceptionCntMax) is crossed; the library will disable EOR (ANC) for the remainder of the ignition cycle. Since this response in inherent to the library; the periodic polling rate by the NVH service is not critical. If qwaAsdEorExceptionStatus returns QWA\_ASD\_EXCEPT\_MAX\_CNT\_EXCEEDED; indicating the exception count threshold has been crossed, the NVH Service shall:

* Latch and disable/mute ANC via Enable ANC Req VIN.
* Set corresponding DTC.
* Request the exception diagnostics array from the library qwaAsdEorExceptionDiag; whose result should be written to NVM and made available to the corresponding DID.

### Operational Status

If the status of an NVH Service operation results in an error, the status will be latched for the duration of the ignition cycle. And the latched status will be considered when setting the Enable \* Req VIN. The value of latched status shall be available via Diagnostic DID.

### Library Call Count

This value shall be incremented by the library / CAPI V2 wrapper to provide a heartbeat signal back to the NVH Service. If the NVH Service detects that a timeout condition has occurred; it will be deemed that it has lost communication with the DSP/library, responding by disabling all feature VINs and setting the corresponding DTC.

## PS Spkr Fault VIN

This is a VIN set by the library configuration and represents the summation of all speaker faults that the configuration considers to disable PS.

A value of 0 indicates that the feature should not be disabled. A value of 1 indicates that the feature should be disabled.

The NVH Service will read this value periodically, and will latch a fault condition for the duration of the power cycle. Its latched status will be considered when setting the Enable PS Req VIN; as depicted in the Partitioning of Fault/Mute Logic diagram in the NVH Runtime section.

The status of this value will be available via Diagnostics.

## ANC Spkr Fault VIN

This is a VIN set by the library configuration and represents the summation of all speaker faults that the configuration considers to disable ANC.

A value of 0 indicates that the feature should not be disabled. A value of 1 indicates that the feature should be disabled.

The NVH Service will read this value periodically, and will latch a fault condition for the duration of the power cycle. Its latched status will be considered when setting the Enable ANC Req VIN; as depicted in the Partitioning of Fault/Mute Logic diagram in the NVH Runtime section.

The status of this value will be available via Diagnostics.

## Final Windw Open VIN

This is a VIN set by the library configuration and represents the summation of all window positions that the configuration considers to disable ANC/PS.

A value of 0 indicates that the feature is not muted by the window position. A value of 1 indicates that the feature has been muted by the window position.

The NVH Service will read this value periodically.

The status of this value will be available via Diagnostics.

## Final Door Open VIN

This is a VIN set by the library configuration and represents the summation of all door open statuses that the configuration considers to disable ANC/PS.

A value of 0 indicates that the feature is not muted by the window position. A value of 1 indicates that the feature has been muted by the door status.

The NVH Service will read this value periodically.

The status of this value will be available via Diagnostics.

## Diagnostics – ANC EOL Routine Control

The control of the library to support ANC EOL testing is detailed in the ASD Developers Guide. This will involve the NVH Service writing and reading the corresponding parameters directly to the library via CAPI V2 interface.

The NVH Service will need to coordinate the execution of the EOL routine and read the results for reporting via routine result data. The awqAsdEorEolTestResult calibration confidence matrix will be read when the routine has successfully completed.

# HMI Interactions

The ANC/ PS features shall have the following interactions with the PDC associated HMI.

## Enable/Disable PS via HMI Selection

To adjust to individual customer preferences the system shall provide a means for the user to enable/disable PS functionality via HMI.

### Dependence Upon PS DExx Config

HMI control of PS (i.e. menu options) shall only be available when the PS feature has been enabled via DExx configuration (per section 5). (This necessitates the HMI receiving the PS DExx enabled/disabled status.)

As captured in section 5, the HMI selection shall not have any impact on the DExx configuration. The DExx configuration shall be set by the appropriate diagnostic tools (ex. EOL tester/ dealer service tools) and remain static regardless of the customer selection (i.e. will not toggle between enabled/ disabled based upon customer selection).

#### Default Customer Setting

Upon the aforementioned DExx configuration being set to "enabled", the initial/ default setting for the customer setting(s) is "enabled".

### Storage of Customer Selection/Personalization

The customer selection of the enabled/ disabled status of PS shall be stored in non-volatile memory such that the setting is not altered between key cycles or due to system reinitialization (including after battery disconnect/ reconnect).

For vehicles supporting "personalization" where feature settings are based upon the driver of the vehicle (via keyfob in use, etc.), the PS enabled/ disabled setting shall be stored as one of the personalized settings, allowing each user's preference to be maintained separately and selected based upon the current user of the vehicle.

The PS settings shall abide by Ford Motor Company requirements regarding "global" reset of customer selections/ personalization settings.

The selection, storage and management of PS enabled/disabled status shall be handled within the HMI component.

### Dependence Upon PS Fault Status

In the event the PS system is disabled due to fault conditions, the customer HMI controls of the PS enable/disable shall be disabled. The method in which this is accomplished shall abide by Ford Motor Company HMI practices (ex. graying out HMI selections, providing an indication the feature is faulted/ unavailable, etc.).

### Method of Enabling/ Disabling PS

The customer enabling/disabling of PS via HMI acts as a condition for muting/unmuting PS. Upon the customer making an HMI selection regarding the enabled/ disabled status of PS, the HMI shall generate a request that triggers the NVH Service to utilize the Enable PS Req VIN to effectively enable/ disable the PS feature.

The NVH Service/ Host shall provide the PS enabled/disabled status to the HMI so as to provide driver feedback.

### Startup sequence for Enabling/Disabling PS

During the startup of NVH Service, it shall request the current Enable/Disable status.

## Bezel Diagnostics

Select information shall be accessible via "bezel diagnostics" which allows for the user to access such information via the vehicle's HMI instead of via a CAN-connected diagnostic tool. The following items shall be available via bezel diagnostics.:

### Ford .vbf File Part Number

Upon bezel diagnostics being invoked, the Host shall acquire the Ford config part number and transfer this data to the PDC HMI to facilitate viewing.

# Diagnostics (CAN)

The following sections detail ISO-14229 over CAN based diagnostic services supported. The context of use is typically during manufacturing and dealer / garage repair.

The scope of diagnostics services will be restricted to the ANC/PS/AVAS features; implemented by the NVH Service in the QNX domain. It will not detail diagnostics from related or dependent components; as they fall outside of the scope of this document.

The following sections are grouped by supported diagnostic services.

## Data Identifiers (DID)

Supported services:

* ReadDataByIdentifier (0x22)
* WriteDataByIdentifier (0x2E)

Unless otherwise specified, Data Identifiers can be read in default Session (0x01) and extended Diagnostic Session (0x03). Where applicable, writing of Data Identifiers can occur only during extended Diagnostic Session (0x03).

Details for supported Data Identifiers are contained in the following subsections.

### DID 0xEE0A – AVAS Sound Transition Delay

|  |  |
| --- | --- |
| Value | 0xEE0A |
| Name | AVAS Sound Transition Delay |
| Size (Bytes) | 2 |
| Type | Unsigned |
| Services | ReadDataByIdentifier WriteDataByIdentifier |
| Audience | End\_Of\_Line Development |
| Comments | Delay time for transitioning between front and rear speakers for a two speaker AVAS configuration.  NVH Service responsible for maintaining value in non-volatile calibration memory. Units: milliseconds Range: 0-65535 Resolution: 1 millisecond Default: 10 milliseconds |

### DID 0xF17D – ANC/PS/AVAS Acoustic Calibration File Part Number

|  |  |
| --- | --- |
| Value | 0xF17D |
| Name | AVAS/PS/ANC Acoustic Calibration File Number |
| Size (Bytes) | 24 |
| Type | ASCII |
| Services | ReadDataByIdentifier |
| Audience | Technician Special\_Apps End\_Of\_Line Development Analytics |
| Comments | Ford Part Number (FPN) An error detected related to this file and its components will set DTC E02951. |































































































































### DID 0xFD72 – ANC/PS/AVAS Status Summary

|  |  |
| --- | --- |
| Value | 0xFD72 |
| Name | ANC/PS/AVAS Status Summary |
| Size (Bytes) | 3 |
| Type | Packeted |
| Services | ReadDataByIdentifier |
| Audience | Technician Special\_Apps Development Analytics |
| Comments | Returns ANC/PS/AVAS summary status information |

Parameter 1

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 1 | ANC Status  Enumerated value:  0 – Not initialized / not ready / muted  1 – Normal / not faulted / enabled and ready to produce audio  2 – Temporarily disabled due to transient conditions  3 – Faulted / disabled / muted |

Parameter 2

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 1 | PS Status  Enumerated value:  0 – Not initialized / not ready / muted  1 – Normal / not faulted / enabled and ready to produce audio  2 – Temporarily disabled due to transient conditions  3 – Faulted / disabled / muted |

Parameter 3

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 1 | AVAS Status  Enumerated value:  0 – Not initialized / not ready / muted  1 – Normal / not faulted / enabled and ready to produce audio  2 – Temporarily disabled due to transient conditions  3 – Faulted / disabled / muted  0 – 未初始化/未准备好/静音  1 – 正常/无故障/启用并准备好产生音频  2 – 由于瞬态条件暂时禁用  3 – 故障/禁用/静音 |



































































































### DID 0xFD70 – ANC Exception Diagnostics Status

|  |  |
| --- | --- |
| Value | 0xFD70 |
| Name | ANC Exception Diagnostics Status |
| Size (Bytes) | 12 |
| Type | Packeted |
| Services | ReadDataByIdentifier |
| Audience | Technician Special\_Apps Development Analytics |
| Comments | Returns detailed ANC exception status information.  Corresponds to retrieving the exception diagnostics array for EOR (qwaAsdEorExceptionDiag). This is an array of values that provides information about the conditions that resulted in the most recent exception. This can be useful in recreating the driving scenario to understand the underlying issue. For example, the issue might be caused by control limiter thresholds being hit, a difference between the acoustics of the vehicle and the calibration data, a microphone being faulty, or a system delay, polarity or gain change. |

Parameter 1

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | The engine mode when the exception was detected. |

Parameter 2

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | Flag indicating whether the primary RPM (0) or secondary RPM (1) resulted in the exception, or (2)  if the exception was caused by low microphone energy |

Parameter 3

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | If the exception was caused by low microphone energy then:   * The primary RPM when the exception occurred.   Otherwise:   * The value of the primary or secondary RPM, depending on element 1. |

Parameter 4

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | If the exception was caused by low microphone energy then:   * The channel index of the microphone with low energy.   Otherwise:   * The index of the engine order that resulted in the exception. |

Parameter 5

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | If the exception was caused by low microphone energy then:   * N/A.   Otherwise:   * The value of the engine order above (see qwaAsdEorOrders) in 1/100ths of an order. |

Parameter 6

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 2 | If the exception was caused by low microphone energy then:   * N/A.   Otherwise:   * The frequency of the engine order above in 1/100ths of a Hz. |

Note:

If an exception has not occurred, the values of all elements returned will be zero

## Diagnostic Trouble Codes (DTC)

The Diagnostic Trouble Codes (DTC) which are set by the NVH Service are listed below. As noted elsewhere; other dependent software components will also report their own DTCs which are outside the scope of this document.

The Diagnostic software component will be responsible for managing DTC aging, Reading (Service 0x19) and Clearing (Service 0x14).

### DTC E02951 – ANC/PS/AVAS Acoustic Calibration File

Failure to load Acoustic calibration file (VBF) for ANC/PS/AVAS (0xF17D)

Read ANC/PS/AVAS Acoustic Calibration file name error detail DID and NVH Service Status DID to assess reason for DTC being set.

The ANC/PS/AVAS feature will be non-functional/muted when this fault is active.

4.2.1. DTC E02951 – ANC/PS/AVAS 声学校准文件

无法为 ANC/PS/AVAS (0xF17D) 加载声学校准文件 (VBF)

读取 ANC/PS/AVAS 声学校准文件名错误详细信息 DID 和 NVH 服务状态 DID 以评估设置 DTC 的原因。

当此故障激活时，ANC/PS/AVAS 功能将不起作用/静音。

### DTC F00093 - ANC/PS/AVAS Initialization Fault

Fault indicates failure to initialize NVH Service. This includes:

* Failure to initialize dependent software components.
* Failure to load acoustic calibration.
* Failure to initialize DSP framework or library communication.

Detailed cause can be determined by reading NVH Service Status DID.

The ANC/PS/AVAS feature will be non-functional/muted when this fault is active.

14.2.2. DTC F00093 - ANC/PS/AVAS 初始化故障

故障表示初始化 NVH 服务失败。这包括：

- 未能初始化相关软件组件。

- 未能加载声学校准。

- 未能初始化 DSP 框架或库通信。

详细原因可以通过读取 NVH Service Status DID 来确定。

当此故障激活时，ANC/PS/AVAS 功能将不起作用/静音。

### DTC F00092 - ANC/PS/AVAS Runtime Fault

Fault indicates failure to continually communicate and exchange data with the DSP library. These classes of faults include:

* Communication timeout.
* Memory exception.
* Buffer over/under run conditions
* Microphone fault(s)

Detailed cause can be determined by reading NVH Service Status DID.

The ANC/PS/AVAS feature will be non-functional/muted when this fault is active.

14.2.3. DTC F00092 - ANC/PS/AVAS 运行时故障

故障表示无法与 DSP 库持续通信和交换数据。这些故障类别包括：

- 通讯超时。

- 内存异常。

- 缓冲过度/不足运行条件

- 麦克风故障

详细原因可以通过读取 NVH Service Status DID 来确定。

当此故障处于活动状态时，ANC/PS/AVAS 功能将不起作用/静音

### DTC F00005 - ANC EOL Audit Test Failure

Will be set by the ANC EOL Audit Test routine upon completion; if the secondary path confidence is below a fault threshold. This indicates that ANC is unstable; and could be due to one or more of the following conditions:

* Incorrect or invalid acoustic calibration file (e.g. incorrect vehicle type).
* Incorrect microphone configuration (e.g. all expected microphones are not enabled).
* ANC EOL Audit Test performed in excessively noisy environment.
* Microphone defect or blockage.
* Speaker blockage.
* Speaker / PAC / Amplifier defect.

### DTC F00094 - ANC Divergence Count Threshold Failure

Set when the EOR exception count exceeds the configured threshold. When active during the ignition cycle; the ANC feature will remain muted for the duration of the ignition cycle. Further analysis of the failure can be obtained by reading the ANC Exception Diagnostics Status DID.

The ANC feature will be non-functional/muted when this fault is active.

### DTC E10100 – ANC/PS Misconfiguration [Optional – if not performed by VMCU]

The NVH Service upon initialization will examine the following misconfiguration patterns and set this DTC if any are encountered.

The ANC/PS feature will be non-functional/muted when this fault is active.

* Active Noise Cancellation (ANC)" PDC DExx configuration set to "Enabled" while all ANC Mics are set to "Disabled".
* Selectable Drive Modes (ANC/PS)" PDC DExx configuration set to "Reserved".
* "Auto Tow/Haul Status" PDC DExx configuration set to "Available" AND "Selectable Drive Modes (ANC/PS)" PDC DExx configuration is NOT set to "Present Pre-SDM 4.0". (If Auto Tow/Haul is selected it should ONLY be coupled with "pre-SDM 4.0" SDM signal.)

## Routines

Supported services

Routine Control (0x31)

Unless otherwise specified, the routines are classified as Type 2 and executable during extendedDiagnosticSession (0x03).

Details for supported routines are contained in the following subsections.

### Routine – ANC EOL Audit Test# 6035

|  |  |
| --- | --- |
| Routine | Test# 6035 |
| Name | ANC EOL Audit Test |
| Description | Trigger ANC test which verifies secondary transfer path confidence values to determine if microphones, speakers and calibration are correct  If one or more entry conditions are not met, then a NRC response of 0x22 ConditionsNotCorrect will be returned. |
| Entry Conditions | * Ignition is in the Run or Accessory State. * Battery voltage is between 10-16 volts. * Extended diagnostic session. * On demand test is requested by tester. * ANC is activated. * Calibration has been successfully loaded. * A2B has been initialized and unmuted. * No speaker faults for the loaded configuration exist. * The vehicle is stationary. * All windows and doors are closed. |
| Exit Conditions | * Change in the value of the entry conditions. * A stop routine command is issued * Tester does not communicate for more than five (5) seconds. * Test is complete |
| Maximum Routine Run Time | 30000 (ms) |
| Can Restart While Running | No |
| Supported Sub Functions | 0x01 – Start Routine  0x02 – Stop Routine  0x03 – Request Results |
| Audience | Technician End\_Of\_Line Development |
| Comments | Route selected microphone signal to output channel/level specified.  Does not require configuration to be loaded in order to function. Upon returnControlToECU, operation will return to normal. |

Parameter 1

|  |  |
| --- | --- |
| Size (bytes) | Parameter Info |
| 52 | (2 bytes - U16 per element)  The first two elements of the array are the number of control output signals and microphone inputs to EOR,  respectively. The remaining (number control outputs ∗ number mic inputs) elements give the percentage confidence  with which the secondary path from each control output to each microphone input is estimated, where 100 percent is  ideal performance and zero indicates no confidence whatsoever. |

Notes:

Upon successful completion; the secondary path confidence values will be thresholded and the ANC EOL Audit Test Failure DTC will be set if the confidence falls below the threshold level.

# Diagnostics (non-CAN)

The following sections detail non-CAN based diagnostic capabilities. The context of use is geared towards personnel with deeper technical knowledge; performing software development, debugging, validation, tuning, troubleshooting, etc.

Access to these diagnostic capabilities may be restricted by cybersecurity protocols.

## Log Files

Log file records should be written as appropriate to help determine the state of the system in the event of a failure through a series of status records.

Log file verbosity and contents will be left up to the software development team; intended to trace the state of the system in the event of a functional issue.

Software documentation / release notes should document the usage for viewing / filtering log files.

A typical use case would be to understand what files might be missing when loading the calibration file (0xF17D), and the corresponding DTC E02951 is set. This DTC could be due to a missing or corrupted file of any type; manifest, configuration, calibration, audio fragment, etc. The contents of the log files need to provide insight to troubleshoot such an issue.

## Resource Manager Interface

It is proposed that the NVH Service create a QNX device debug interface via device node created during system startup. Both read and write operations should be supported. Software documentation / release notes should document the usage of this interface.

The following subsection names are intended as a guide. Implementation details will be left up to the software development team.

### Tones Test (read/write)

* Audience: Technician, Development
* Purpose: Using the ANC/PS/AVAS DSP library to generate a sinusoidal test tone at specified frequency / channel.
* Parameter: Diagnostic Tone Frequency (Hz) 20-20000.
* Parameter: Diagnostic Tone Output Channel (0-7).
  + Diagnostic Output channel 0-6
  + A value of 7 will play the test tone on all available output channels simultaneously.
* Parameter: Output amplitude. A value of 0 = muted, through 0xFF = Maximum level 0dBFS (peak)

Notes:

* ASD Library qwaAsdDiagGain is specified in mB with a range of -6000 to 0 mB (-60dB to 0dB). This will be mapped to the output amplitude parameter linearly such that setting a value of 0 (muted), will correspond to -6000mB as the parameter is set in the library. Similarly an output amplitude parameter of 0xFF will be mapped to 0mB.
* The presence of an acoustic tuning file (VBF) should not be a prerequisite to perform this test.
* When stopped, the system operation will return to normal.

### ANC Microphone Passthrough Test (read/write)

* Audience: Technician, Development
* Purpose: Route selected microphone signal to output channel/level specified with an audio path through the ANC/PS/AVAS library. Used to measure the end to end audio signal latency and microphone gain / frequency response.
* Parameter: Output channel 0 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 1 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 2 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 3 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 4 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 5 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 6 source. A value of 0 = muted, 1=mic1, 2=mic2, 3=mic3, 4=mic4
* Parameter: Output channel 0 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 1 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 2 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 3 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 4 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 5 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation
* Parameter: Output channel 6 amplitude. A value of 0 = maximum attenuation, through 0xFF = 0dB attenuation

Notes:

* If a microphone(s) is not enabled through DE configuration, the corresponding input will be muted.
* The presence of an acoustic tuning file (VBF) should not be a prerequisite to perform this test.
* When stopped, the system operation will return to normal.

### NVH Service Status (read)

* Audience: Technician, Development
* Purpose: Returns current NVH Service status information
* Recommended parameters to include (for ANC/PS/AVAS as applicable):
  + Initialization status.
  + Library status / info.
  + Value of enable VINs.
  + Value of derived VINs read.
  + Value of calculated VINs such as Sound State.
  + Fault / exception status.
  + Status of dependent services (as applicable).
  + Heartbeat counter(s) value.
  + Additional information which would be useful in troubleshooting issues.

Notes:

* The contents returned will be of vital importance to aid in troubleshooting defects; and thus the software team is encouraged to add parameters as needed.
* Analytic diagnostic log worthy events should include this status.

# Data Analytics

For continuous improvement purposes and to better understand the behavior of the features in normal customer usage, specific data about ANC/ PS shall be collected and made available for data analytics purposes.

Data analytics are made available through an internal portal; diagnostics.ford.com. There are additional dashboards which the analytics team can generate to track specific features or report contents.

The type of information conveyed to Analytics falls into categories:

* Analytics

Operational state changes which are of interest; and may represent user or system interactions. Additional attributes conveyed as key-value pairs will also be stored with the event.

* Diagnostics

Log worthy events which indicate abnormal behavior. Additional attributes conveyed as key-value pairs will also be stored with the event.

* DTC’s

The existing data analytics infrastructure will automatically poll all ECU’s for DTC’s at a period of approximately 30s.

## Analytics Dashboard for NVH Features

The data analytics team provides a dashboard through their portal: reports.diagnostics.ford.com, which allows one to view a summary of specific analytics data. For insight into the usage and effectiveness of ANC/PS features; it is proposed that the following data be made available; with the ability to filter the results based on:

* Vehicle program
* Body style / trim level
* ANC/PS/AVAS feature
* Model Year
* Date Range
* Software Release Version/PN
* Acoustic Calibration FPN

### Propulsion Sound – User Enable/Disable

To provide insight into the customer enabling/disabling Propulsion Sound. Data of interest would include frequency of adjustment and duration ratio of the feature being enabled/disabled.

### ANC Divergence Exceptions

To provide insight into the performance of ANC; by tracking the occurrences and frequency of ANC Divergence. Since each vehicle trim level and body style variation will be individually tuned, it is important to classify these exceptions to determine if they are ANC algorithm / library systemic; or specific to a vehicle / trim level; suggesting an issue with the acoustic calibration.

### ANC/PS/AVAS Exceptions

To provide insight into the performance of ANC/PS/AVAS features; by tracking the frequency of initialization and runtime exceptions. The goal is to forecast and troubleshoot potential systemic issues related to the audio DSP / NVH service subsystems.

## Software Interface

The software interface to Analytics from the NVH Service will be through libAnalytics; whose usage is defined by the Analytics team. The types of events reported fall into two categories as detailed in the following sections.

## Analytic Events

Analytics events are used to instrument applications for the purpose of generating usage data; to gather information about how these features are being used. Analytics events are primarily comprised of key-value attributes, with some additional supporting fields.

### onPSEnabledChanged

Event notification will occur when driver changes the setting to enable/disable propulsion sound.

* Status = enabled/disabled

### onANCDivergenceEvent

Placeholder for the software development team to decide if an ANC divergence event should be handled as an analytic or diagnostic event. An advantage of a diagnostic event includes the additional vehicle collected for context; though this comes at the cost of data bandwidth.

## Diagnostic (Log worthy) Events

Diagnostics events are used primary to collect debug information for software / system failures. Diagnostics events are much heavier than analytics events. When triggered various log files are collected to include in the payload for the event. The goal is to provide a snapshot of the system at the time of invocation to facilitate debugging. Virtually all diagnostics events will result in the system log (in the case of Phoenix logcat) to be dumped. Diagnostics events should never be sent in a loop. Some throttling mechanisms are in place to attempt to mitigate events that are sent too often.

Since the intent of such events are to aid in identifying root cause for potentially rare and high visibility/priority defects; the software development team should have discretion over the triggers and additional content of logworthy events. The following list is intended as a starting point.

It is worth assuming that the context for analyzing such events would be:

* Customer vehicle.
* No physical access.
* Debug token not loaded.
* Goal is to triage issue to likely root cause; which may not be within the PDC.
  + PAC and/or DSP Amplifier involvement.
    - Evidence needed to involve supplier(s).

Upon the occurrence of a log worthy event; it would be desirable to include the output of the NVH Service Status resource manager interface output to aid in analysis and root cause determination.

### LW\_EVENT\_PDC\_NVH\_EVENT\_INIT\_FAILURE

Event notification will occur when NVH Service fails to initialize normally. A corresponding DTC should also be set. Due to the severity of this type of failure; it would not be expected that any audio features would be available (ANC/PS/AVAS). Triggers to this event include:

* Attempt to load an invalid or incomplete acoustic calibration VBF.
  + Since the likelihood of occurrence is high during the NVH tuning process or software validation; it would be beneficial to provide details; e.g. list of missing files.
* Software dependency failure.
  + What? Retries? Timeout? Etc.

### LW\_EVENT\_PDC\_NVH\_EVENT\_RUNTIME\_FAILURE

Event notification will occur when NVH Service encounters a runtime error which is common to all audio features (ANC/PS/AVAS); thus audio from either of these features is not expected after this event. A corresponding DTC should also be set. Triggers to this event include:

* DSP heartbeat timeout.
* Set/Read parameter fault.
* DSP overflow/underflow.
* Software dependency failure (if detectable).
* AMS framework fault.

### LW\_EVENT\_PDC\_NVH\_EVENT\_ANC\_FAILURE

Event notification will occur when NVH Service encounters a runtime error which is unique to the ANC feature (if enabled via DE config). Audio may continue to be generated for other features. A corresponding DTC should also be set; as applicable. Triggers to this event include:

* Enable timeout failure. Triggered when “Enable ANC Req” VIN remains disabled beyond a timeout period (5-10 seconds proposed). Should ignore causes such as open door/window.
* ANC – Microphone fault(s).
* Exception count exceeded (divergence fault)

### LW\_EVENT\_PDC\_NVH\_EVENT\_PS\_FAILURE

Event notification will occur when NVH Service encounters a runtime error which is unique to the PS feature (if enabled via DE config). Audio may continue to be generated for other features. A corresponding DTC should also be set; as applicable. Triggers to this event include:

* Enable timeout failure. Triggered when “Enable PS Req” VIN remains disabled beyond a timeout period (5-10 seconds proposed).

### LW\_EVENT\_PDC\_NVH\_EVENT\_AVAS\_FAILURE

Event notification will occur when NVH Service encounters a runtime error which is unique to the AVAS feature (if enabled via DE config). Audio may continue to be generated for other features. A corresponding DTC should also be set; as applicable. Triggers to this event include:

* Enable timeout failure. Triggered when “Enable AVAS Req” VIN remains disabled beyond a timeout period (5-10 seconds proposed).

# References

The following Ford specifications mentioned in this specification are listed below.

|  |  |  |
| --- | --- | --- |
| **Specification** | **Version** | **Author** |
| **Active Noise Control for Vehicle Interior Application for ICE-Powertrains (ANC)**  Phoenix\_IVI\_ANC\_NVH\_Specification\_Draft\_Version\_1.4.pdf | Draft 1.4 | C. Störig, Z. Rubin, S. Ackers  NVH-Development Engineers Ford NVH-Team |
| **Interior Propulsion Sound Enhancement**  Phoenix\_IVI\_PS\_NVH\_Specification\_Draft\_Version\_1.3.pdf | Draft 1.3 | C. Störig, Z. Rubin, S. Ackers  NVH-Development Engineers Ford NVH-Team |
| **MY24 Phoenix ANC/ PS/ AVAS-Centric Audio System Block Diagrams**  Phoenix Audio System Diagrams - 05-03-21 - DRAFT.pdf | Draft 1.0 | Jim Hartman  Ford IVI Team |
| **Infotainment Diagnostics Specification - APIM Phoenix Domain Controller**  Infotainment Diagnostics Specification\_9-7-0-APIM-PDC.docx | 9.10.0 | John VanHouten  Ford IVI Team |
| **Versatile Binary Format Specification 3.1**  VBF-00.06.15.004-008.pdf | 8 | Bill Waldeck  Ford Netcom Team |
| **NVH Features Master CAN signal and VIN id list** | 1.0 | A. Saminathan |
| Phoenix Audio Channel Usage Summary… | Latest | D. Walus, et al. |
| CAN database CMDB file version | 22.02 W1+2 | Leandro Sakamoto |
| Subsystem part specific specification for DSP Amp  [[SPSS-1099] Propulsion Sound DSP AMP SPSS v1.0 - FORD JIRA](https://www.jira.ford.com/browse/SPSS-1099) | 1.0 | Balakrishnan Ganesan |
| Power Management Subsystem part specific specification |  |  |
| HMI Subsystem part specific specification |  |  |
| Subsystem part specific specification for PS  [[SPSS-1098] Propulsion Sound PAC SPSS v1.0 - FORD JIRA](https://www.jira.ford.com/browse/SPSS-1098) | 1.0 | Balakrishnan Ganesan |
| Subsystem part specific specification for ANC  [[SPSS-1100] Active Noise Cancellation PAC SPSS v1.0 - FORD JIRA](https://www.jira.ford.com/browse/SPSS-1100) | 1.0 | Balakrishnan Ganesan |

# Revision History

|  |  |
| --- | --- |
| **Requirements Changed** | **Details** |
|  | |
| **1.0 Draft** (Released 05/03/2021) | |
| All | Initial Draft |
|  | |
| **1.1 Draft** (Released 12/13/21) | |
| All | Major draft revision |
|  | |
| **1.2 Draft** (Released 01/21/22) | |
| Spec updates per latest updates to summary Excel file: | |
| Reorder/ Shift VINs | |
| 9 (Table 9‑1) | Update table per latest updates to summary Excel file:  - Reorder/ shift most VINs (moving VINs to new VIN IDs) to PT NVH-preferred ordering and to add reserved space for future expansion)  - Add VIN for "Trans Gear Pos" VIN (associated w/ CAN signal GearPos\_D\_Actl) |
| 10.3  10.4 | Reorder CAN signals to match order shown in **Error! Reference source not found.** |
| 12.4  12.5 | Reorder VINs to match order shown in **Error! Reference source not found.** |
| Renamed VINs | |
| 9 (Table 9‑1)  12.5.6  **Error! Reference source not found.** | Rename "Gear Position" VIN (associated w/ CAN signal GearLvrPos\_D\_Actl) to "Gear Lever Pos" |
| 9 (Table 9‑1)  12.5.4  1.1.1.1.1.3 | Rename "Torque Avail" VIN to "Trq Avail (Y/N)" |
| Add new Transmission Gear Position CAN Signal/ VIN | |
| 10.4.4 | Add new section for new Transmission Gear Position (GearPos\_D\_Actl) CAN signal and its characteristics |
| 12.5.5 | Add new section to provide details for how CAN data is written to new Gear Position VIN |
| 1.1.1.1.1.4 | Add new section to address missing message handling for message 0x176 (message containing GearPos\_D\_Actl) |
| Add new GearRvrse\_D\_Actl CAN Signal | |
| 0 | Add new section for new Reverse Gear Status (GearRvrse\_D\_Actl) CAN signal and its characteristics |
| **OTHER** | |
| 12.5.3 | Add new section to provide details for how CAN data is mapped to states of Sound State VIN |
| 6.2 | Update section to elaborate further on usage of A2B status as control for unmuting ANC/ PS |
| 14.1 | Updated entire section for requirements re: disable/ enable PS via HMI |
|  | |
| **1.3 Draft** (Released 2/1422) | |
| Deleted all sections and references to monitoring high-rate CAN signals within the NVH Service for "timeouts". (Replace w/ monitoring for missing messages) | |
| 12.4.1  12.4.2  12.4.2  12.4.3  12.4.6  12.4.4 | Changed all references to signal timeouts in section 12.4 to missing messages (similar as 12.5). |
| Old 16.3.6.1 | Deleted "Timeouts of High Priority Signals/ VINS" section. |
| Old 16.4.12 | Deleted "CAN Signal Timeout Decoder" section |
|  |  |
|  |  |
| 17.1.3.6 | Updated summary to remove requirements regarding monitoring high-rate CAN signals for timeout |
| 17.1.2 | Update Table 17‑1  - For missing messages/ quality factors. (Moved CAN signals out of prior Table 17-2, and captured how signal loss will impact ANC/ PS to match Excel file.) |
| 17.1.3.6 | Updated prior Table 17-2 (ANC/ PS Missing Message Summary Table)  - Remove the and add references to new sections for missing message monitoring.  - Shift CAN message/ signal information from Table 17-2 to Table 17‑1  - Modify prior Table 17-2 (remove CAN signals, "Signal Timeout"/ missing message columns, add DTC display # info), and move to section 23.1. |
| 17.1.3.6.1 | - Add new sections to address missing messages 0x14A, 0x202, 0x204, and 0x410 (that were previously checked for signal timeouts)  - Rearrange section to order based upon CAN arbitration ID |
| Change from reading VIN list from .qcf to reading DExx configurations for the purpose of determining the CAN signal information needed by Library (per request from M. Podhorsky) | |
| 5 | Update all sections (except 5.1/ 5.4) to indicate the configurations all relate to the passing of CAN signal information to the Library. |
| 9 | Table 9‑1: Update table to add ANC/ PS columns and column where applicable DExx configurations are provided (related to each VIN). |
| 12.1  12.4  12.5 | Update all sections to remove comments about reading the VIN list from the Library (to determine which information is to be written to VINs). Instead, replaced with using DExx configurations, referring to the DExx configuration information captured in Table 9‑1. |
| 12.3.2 | Remove " Determine what data to pass to the Library…" comment, |
| 17.1.3.5 | Need to deal with all the areas that call out reading VIN list |
| Change CAN signal for transmission gear position from GearLvrPos\_D\_Actl (0x230) to the signal TrnRng\_D\_Rq (0x176), and rename VIN to Trans Range. (Per 2/8/22 email from B. Schabel) | |
| 9 | Table 9‑1: Update VIN name and signal name in table |
| **Error! Reference source not found.** | Update VIN name and signal name |
| 12.5.6 | - Update VIN name and signal name  - Change reference section for missing message handling (from 0x230 to 0x176). |
| 12.5.3 | Update VIN name and signal name |
| Prior 16.3.6.3.4 (Removed) | Removed. (Missing message monitoring will no longer apply to 0x230.) |
| Addition of Heartbeat VINs | |
| 9 (Table 9‑1) | 9 (Table 9‑1): Add heartbeat VINs. Add references to sections 12.5.12 and 0. |
| 12.5.12 | Added requirements around new Heartbeat In VIN. (i.e. Counter updated by NVH Service and written to VIN at periodic rate) |
| 0 | Added requirements around new Heartbeat Out VIN. (i.e. Library echoes back value received via Heartbeat In VIN at same periodic rate) |
| 17.1.3.7 | Added requirements re: fault detection/ handling for Heartbeat In VIN. (Library monitors for timeout, mutes itself when timeout is detected.) |
| 17.1.4.4 | Added requirements re: fault detection/ handling for Heartbeat Out VIN. (NVH Service monitors for timeout, disables ANC/ PS.) |
| 9  (9.2 in Draft v1.2) | Moved prior section 9.3 (including prior Table 9-2) to new section 9 (still Table 9‑1). (Moving this section was done as the VIN list includes VINs other than CAN inputs, as well as derived VINs which are Library outputs.) |
| 9 | Updated wording in section to better summarize the current status of the VIN list. |
| 9 | Updated Table 9-2 to add a "Read/ Write" column, as the VINs are now bi-directional. (Prior, all VINs were only being written to Library.) |
| 9 | Updated Table 9-2 to add "User Dfnd Gain x" VINs |
| 8.3.2  References | Added reference to the Excel file "Phoenix Audio Channel Usage Summary… " |
| 10.2 | Updated wording to reflect that every CAN signal used for ANC/ PS has an associated configuration them, as well as stating that the configurations are used to determine which CAN signals the NVH service is to acquire. |
| 10.3.1.1  10.3.3.1  10.3.4.1 | Add references to where the usage of the quality factor signals is defined. |
| 10.3.5.1 | Added reference to following section 12.4.2 when the CAN signal indicates "unknown" or "faulty" values. |
| 10.4 | Remove duplicate sections/ Fix tables that have accidental built-in hyperlinks |
| 10.4.10 | Typo fix: Add liftgate ajar to list within section |
| 12.5.3 | Update to add sections for missing message monitoring |
| 12.5.3 | Update logic of Table 12‑10 |
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| **1.3.1 Draft** (Released 2/22/22) | |
| 9 | Table 9‑1: Update table based on "ANC-PS CAN Signal and Missing Msg Info - 11-22-21" (as of dated 2/22/22) |
| 10.3  10.4  12.4  12.5 | Reordered subsections of listed sections to match VIN list (changed order of the VINs, and thus respective CAN signals) |
| 0 | Added note to indicate Engine RPM CAN signal is not applicable to BEV powertrains. |
| 0  Table 9‑1  12.5.3  Table 17‑1 | Remove "Reverse Gear Status" CAN signal, and its usage in Sound State VIN |
| Add ability to read Library door ajar status | |
| 9 | Table 9‑1: Add VIN for reading Library-derived door ajar status |
| 13.9 | Add requirements for NVH Service to read Library-derived door ajar status VIN |
| 17.2.12 | Add requirement placeholders for providing Library-derived door ajar status via DID. Needs further updates. |
| Add ability to read Library window status | |
| 9 | Table 9‑1: Add VIN for reading Library-derived window status |
| 13.9 | Add requirements for NVH Service to read Library-derived window status VIN |
| 17.2.12 | Add requirement placeholders for providing Library-derived window status via DID. Needs further updates. |
| Tones Test | |
| 17.4.1 | Added placeholder sections for Tones Test. Needs further updates. |
| Microphone Pass-through Test | |
| 17.4.2 | Added placeholder sections for mic pass-through test. Needs further updates. |
| 24 | Updated Questions/ Issues sections to highlight known work or questionable items regarding the functional spec, SPSS, CAN database, PDC IDS, PAC/ DSP Amp IDSs, and to capture higher-level process/ Applications engineering items. |
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| **1.4 Draft** | |
| 2 | Updated/simplified Diagram of ANC/ PS-related PDC Interfaces |
| 4.1 | Ford ANC/PS/AVAS configuration file section reworded  Captured the estimated max file size |
| 5.4 | Reworded section ANC Mic x (Enable/ Disable ANC Microphones) |
| 6.2.2.2 |  |
| 8.1 | Updated the allowable PDC audio path latency |
| 8.2 | Added reference to ANC Mic Input Config |
| 9 | Removed table 9 and added reference to the Master VIN list that captures all relevant information |
| 11.1.1 | CAN signal/VIN latency – updated the overall allowable end to end latency should not exceed 20ms |
| 12 | Added information “Periodic reads of all of the derived VINs that are part of the Master VIN list” |
| 12.1 | Updated section configuration impact on host reads of library |
| 12.3 | Updated section ANC enable/disable status |
| 12.4 | Updated section PS enable/disable status |
| 13.1 | Updated section enable/disable PS via HMI selection |
| 13.1.2 | SPSS would need to cover |
| 13.1.3 | SPSS would need to cover |
| 13.2.2 | SPSS would need to cover |
|  |  |
| **1.5 Draft** |  |
| 14.1 | Updated DID #s and DTC #s for all parameters |
| 6.2 | Reworded Time to first audio section |
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