# Ford Performance Exhaust Modes Control Function for Raptor



## Functional Description

### This functional spec describes the process that allows the user to customize the loudness of the exhaust via the instrument cluster, APIM, ECG, SCCM, ABS (SDM) and PCM. The user can select one of the 4 available exhaust modes based on loudness: Stealth / Quiet, Normal, Sport, and Track / Baja.

### The Exhaust mode can be selected via the dedicated Exhaust switch on the Steering Wheel. Additionally, the user will be able to enable a “Quiet Mode” thru the Sync settings menu. Once enabled, the user shall be directed to a screen where s/he can customize the start and end times in increments of 1 hour.

### If the vehicle starts the Ignition Cycle in Quiet Time, the vehicle stays in Quiet Time for the remainder of the Ignition Cycle, even if the time transitions out of the Quiet Time period.

### When using the Steering Wheel Switch to select the modes for tunable exhausts, the Instrument Cluster will send out a request signal to the PCM which in return will send an acknowledgment message back to the cluster with proper status confirming the mode request.

### When the PCM gets the command to change the Engine Exhaust Mode, it shall send the appropriate commands to the Exhaust valves. See PCM Functional Description.

### My Mode arbitration occurs in the PCM. See the PCM Functional Description.

1.1.7 SDM arbitration?

## Interfaces

### SCCM

#### Inputs

##### Hardwired Engine Exhaust Mode Switch from Steering Wheel Mounted Switches to SCCM

#### Outputs

1. EngExhMdeQuiet\_B\_RqDrv2 Signal

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Default** | **Min** | **Max** |
| EngExhMdeQuiet\_B\_RqDrv2 | 1 |  | SED | 1 | 0 |  |  | 0 (0x0) | 1 (0x1) |
|  |  | NotPressed |  |  |  | 0x0 | Yes |  |  |
|  |  | Pressed |  |  |  | 0x1 | No |  |  |

#### SCCM Functional Requirements

###### The SCCM shall read the exhaust mode switch from the steering wheel mounted switch pod on the right side of the steering wheel when the Ignition is Run (Engine Running or Engine Not Running).

###### The SCCM shall filter the switch input and generate the appropriate EngExhMdeQuiet\_B\_RqDrv2 signal.

###### The SCCM shall send EngExhMdeQuiet\_B\_RqDrv2 to the Instrument Cluster over CAN.

###### The possible values for EngExhMdeQuiet\_B\_RqDrv2 are:

###### Pressed

###### Not Pressed

###### The default value for EngExhMdeQuiet\_B\_RqDrv2 is Not Pressed.

### Instrument Cluster

+

#### Inputs

* MUX message on the CAN Bus

1. EngExhMdeQuiet\_D2\_Stat Signal

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** |  | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| EngExhMdeQuiet\_D2\_Stat | 2 |  |  | SED | 1 | 0 |  | 0 (0x0) | 7 (0x7) |
|  |  |  | Null |  |  |  | 0x0 |  |  |
|  |  |  | Stealth |  |  |  | 0x1 |  |  |
|  |  |  | Normal |  |  |  | 0x2 |  |  |
|  |  |  | Sport |  |  |  | 0x3 |  |  |
|  |  |  | Track / Baja |  |  |  | 0x4 |  |  |
|  |  |  | NotUsed |  |  |  | 0x5 |  |  |
|  |  |  | NotUsed |  |  |  | 0x6 |  |  |
|  |  |  | Faulty |  |  |  | 0x7 |  |  |

1. EngExhMdeQuiet\_B\_RqDrv2 Signal

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Default** | **Min** | **Max** |
| EngExhMdeQuiet\_B\_RqDrv2 | 1 |  | SED | 1 | 0 |  |  | 0 (0x0) | 1 (0x1) |
|  |  | NotPressed |  |  |  | 0x0 | Yes |  |  |
|  |  | Pressed |  |  |  | 0x1 | No |  |  |



#### Outputs

* MUX message on the CAN Bus

1. EngExhMdeQuiet\_D2\_Rq Signal

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| EngExhMdeQuiet\_D2\_Rq | 2 |  | SED | 1 | 0 |  | 0 (0x0) | 7 (0x7) |
|  |  | Null |  |  |  | 0x0 |  |  |
|  |  | Stealth |  |  |  | 0x1 |  |  |
|  |  | Normal |  |  |  | 0x2 |  |  |
|  |  | Sport |  |  |  | 0x3 |  |  |
|  |  | Track / Baja |  |  |  | 0x4 |  |  |
|  |  | NotUsed |  |  |  | 0x5 |  |  |
|  |  | NotUsed |  |  |  | 0x6 |  |  |
|  |  | NotUsed |  |  |  | 0x7 |  |  |

Note: The Cluster shall use 0x4 for Baja.

#### Cluster Function/Performance

Within a 100msec of receiving a message that results in a change of state the cluster will update the display to the proper status.

#### Operation: Performance and Functional

###### When EngExhQuiet\_B\_RqDrv2 Becomes Pressed while the Exhaust Mode PopUp Menu is not displayed and EngExhMdeQuiet\_D2\_Stat <> Faulty or NULL, the Exhaust Mode PopUp Menu shall be displayed.

###### Each Time the EngExhQuiet\_B\_RqDrv2 becomes Pressed, while the Exhaust Mode PopUp Menu is visible, the Exhaust Valve State shall move to the next state according to the Exhaust Valve Steering Wheel Switch Diagram below.

###### When four seconds elapses (consistent with other PopUp Based Menus) without EngExhQuiet\_B\_RqDrv2 becoming Pressed, the Exhaust Mode PopUp Menu shall deactivate.

###### When the EngExhMdeQuiet\_D2\_Stat = Faulty**, Null,** or is not available, the Cluster shall send EngExhMdeQuiet\_D2\_Rq = NULL and the Engine Exhaust RTT shall not be displayed.

###### The Cluster shall display a “Engine Exhaust Mode Not Available” when EngExhMdeQuiet\_D2\_Stat = Faulty or Null and the EngExhQuiet\_B\_Rq**Drv**2 becomes Pressed.

###### The cluster will send out a request to the PCM for a state change, via EngExhMdeQuiet\_D2\_Rq but only changes the indication if it gets a matching status back from the PCM via EngExhMdeQuiet\_D2\_Stat.



**Figure 6: Tunable Exhaust Mode State Diagram for ExhEngMdeQuiet\_B\_RqDrv2**

**(for use with Dedicated Exhaust Steering Wheel button)**

#### Operation Description

#### The cluster does not control the Exhaust modes. It simply allows the user to request a select one of the available modes. The PCM is the controlling module, and the cluster shall confirm the mode based on the status received over the EngExhMdeQuiet\_D2\_Stat signal.

#### When equipped and enabled via EOL configuration, the user shall have the ability to change the Exhaust mode thru the cluster pop-up menu using the switch on the steering wheel.

#### When menu is disabled via EOL the cluster shall send a value of NULL on EngExhMdeQuiet\_D2\_Rq.

##### Reconfigurable Telltale

###### There shall be an RTT in the Instrument Cluster to display the current state of the exhaust valve.

###### The Cluster shall display the RTT while the exhaust valve status (EngExhMdeQuiet\_D2\_Stat) is in any state other than Normal.

###### The Cluster shall display the RTT for 2 seconds after becoming EngExhMdeQuiet\_D2\_Stat=Normal.

###### The Cluster shall display on transition to Ignition Run after EngExhMdeQuiet\_D2\_Stat)=Normal.

###### If EngExhMdeQuiet\_D2\_Stat is Faulty or NULL, the cluster shall not display the Exhaust Mode RTT*.*

### Sync Module (APIM)

#### Inputs

* MUX message on the CAN Bus



Table 1.3 EngExhMdeHrEnbl\_D\_Stat

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnbl\_D\_Stat | Null | 0x0 | HMI setting treated as unknown (ex HMI greyed out, setting not shown as selected…) |
| Disabled | 0x1 |  |
| Enabled | 0x2 |  |

**EngExhMdeHrStrt\_D\_Stat**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrStrt\_D\_Stat | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

**EngExhMdeHrEnd\_D\_Stat**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnd\_D\_Stat | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

#### Outputs

* MUX message on the CAN Bus

Table 1.3 EngExhMdeHrEnbl\_D\_Rq

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnbl\_D\_Rq | Null | 0x0 |  |
| Disabled | 0x1 |  |
| Enabled | 0x2 |  |
| Menu Not Configured | 0x3 | No support in APIM, PCM shall treat as “Disabled” |

**EngExhMdeHrStrt\_D\_Rq**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrStrt\_D\_Rq | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

**EngExhMdeHrEnd\_D\_Rq**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnd\_D\_Rq | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

#### Operational Description

#### In addition to the available Exhaust modes, there is also an additional setting that allows the user to customize a time frame when the vehicle will start in “Quiet” exhaust mode. The Quiet time does not change the Exhaust mode setting saved by the user, it simply acts as a stand-alone setting.

#### The Quiet Start is setup using the menu and is saved in the PCM memory. It is then compared to the real time clock (GlblClkHr\_No\_Actl) to determine if the vehicle should start in Quiet Exhaust mode.

#### Quiet Time Setup and Activation

#### Apart from the available exhaust modes, there is an additional “Quiet Start” available for selection. This is so that the loud exhaust does not cause any noise disturbance to anybody. Once enabled, the user is prompted to schedule a Start time and an End time. The PCM then compares the Start and End times with the real time clock. If the time of day falls in the Quiet Start range when the vehicle is started, the PCM initializes the Exhaust mode to “Quiet”. If the vehicle is started while in the Quiet Start period, it shall continue to operate in Quiet exhaust mode until the user manually changes it. If the vehicle is started outside of the “Quiet Start” period, it shall continue to operate it in the selected mode until the user changes it.

#### The vehicle must be stationary to define the Quiet Time. The APIM will implement the common lockout while vehicle moving.

###### The APIM shall send EngExhMdeHrEnbl\_D\_Rq = “Menu Not Configured” if the menu is configured not to be available.

Sample graphic of the Quiet Start feature on the Center Stack



Figure 7: Quiet Time Selection Function for LX (12.4”) cluster HMI

### ABS (SDM)

This portion of the spec defines the Default Exhaust Valve settings for each Drive Mode.

Inputs

Outputs

Table 1.3 SelDrvMdePt\_D\_Rq

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| SelDrvMdePt\_D\_Rq | 1 |  | SED | 1 | 0 |  | 0 (0x0) | 15 (0xF) |
|  |  | Unknown |  |  |  | 0x0 |  |  |
|  |  | Normal |  |  |  | 0x1 |  |  |
|  |  | Sport |  |  |  | 0x2 |  |  |
|  |  | Slippery |  |  |  | 0x3 |  |  |
|  |  | Deep Snow / Sand |  |  |  | 0x4 |  |  |
|  |  | Baja |  |  |  | 0x5 |  |  |
|  |  | Rock Crawl |  |  |  | 0x6 |  |  |
|  |  | Tow Haul |  |  |  | 0x7 |  |  |
|  |  | Unused |  |  |  | 0x8 |  |  |
|  |  | Unused |  |  |  | 0x9 |  |  |
|  |  | Unused |  |  |  | 0xA |  |  |
|  |  | Unused |  |  |  | 0xB |  |  |
|  |  | Unused |  |  |  | 0xC |  |  |
|  |  | Unused |  |  |  | 0xD |  |  |
|  |  | Unused |  |  |  | 0xE |  |  |
|  |  | Faulty |  |  |  | 0xF |  |  |



### ECG

Inputs

**EngExhMdeQuiet\_D2\_Stat:**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size**  **(bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| **EngExhMdeQuiet\_D2\_Stat** | **3** |  | **SED** | **1** | **0** |  | **0(0x0)** | **1(0x7)** |
|  |  | **Null** |  |  |  | **0x0** |  |  |
|  |  | **Stealth** |  |  |  | **0x1** |  |  |
|  |  | **Normal** |  |  |  | **0x2** |  |  |
|  |  | **Sport** |  |  |  | **0x3** |  |  |
|  |  | **Track / Baja** |  |  |  | **0x4** |  |  |
|  |  | **Not used** |  |  |  | **0x5** |  |  |
|  |  | **Not used** |  |  |  | **0x6** |  |  |
|  |  | **Faulty** |  |  |  | **0x7** |  |  |

Table 1.3 SelDrvMdePt\_D\_Rq

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| SelDrvMdePt\_D\_Rq | 1 |  | SED | 1 | 0 |  | 0 (0x0) | 15 (0xF) |
|  |  | Unknown |  |  |  | 0x0 |  |  |
|  |  | Normal |  |  |  | 0x1 |  |  |
|  |  | Sport |  |  |  | 0x2 |  |  |
|  |  | Slippery |  |  |  | 0x3 |  |  |
|  |  | Deep Snow / Sand |  |  |  | 0x4 |  |  |
|  |  | Baja |  |  |  | 0x5 |  |  |
|  |  | Rock Crawl |  |  |  | 0x6 |  |  |
|  |  | Tow Haul |  |  |  | 0x7 |  |  |
|  |  | Unused |  |  |  | 0x8 |  |  |
|  |  | Unused |  |  |  | 0x9 |  |  |
|  |  | Unused |  |  |  | 0xA |  |  |
|  |  | Unused |  |  |  | 0xB |  |  |
|  |  | Unused |  |  |  | 0xC |  |  |
|  |  | Unused |  |  |  | 0xD |  |  |
|  |  | Unused |  |  |  | 0xE |  |  |
|  |  | Faulty |  |  |  | 0xF |  |  |

### PCM

#### Inputs

CAN

1. EngExhMdeQuiet\_D2\_Rq Signal

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| EngExhMdeQuiet\_D2\_Rq | 2 |  | SED | 1 | 0 |  | 0 (0x0) | 7 (0x7) |
|  |  | Null |  |  |  | 0x0 |  |  |
|  |  | Stealth |  |  |  | 0x1 |  |  |
|  |  | Normal |  |  |  | 0x2 |  |  |
|  |  | Sport |  |  |  | 0x3 |  |  |
|  |  | Track/Baja |  |  |  | 0x4 |  |  |
|  |  | NotUsed |  |  |  | 0x5 |  |  |
|  |  | NotUsed |  |  |  | 0x6 |  |  |
|  |  | NotUsed |  |  |  | 0x7 |  |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| EngExhMdeQuietCstm\_D\_Rq | 2 |  | SED | 1 | 0 |  | 0 (0x0) | 7 (0x7) |
|  |  | Null |  |  |  | 0x0 |  |  |
|  |  | Stealth |  |  |  | 0x1 |  |  |
|  |  | Normal |  |  |  | 0x2 |  |  |
|  |  | Sport |  |  |  | 0x3 |  |  |
|  |  | Track/Baja |  |  |  | 0x4 |  |  |
|  |  | NotUsed |  |  |  | 0x5 |  |  |
|  |  | NotUsed |  |  |  | 0x6 |  |  |
|  |  | Faulty |  |  |  | 0x7 |  |  |

Table 1.3 EngExhMdeHrEnbl\_D\_Rq

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnbl\_D\_Rq | Null | 0x0 |  |
| Disabled | 0x1 |  |
| Enabled | 0x2 |  |
| Menu Not Configured | 0x3 | No support in APIM, PCM shall treat as “Disabled” |



**EngExhMdeHrStrt\_D\_Rq**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrStrt\_D\_Rq | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

**EngExhMdeHrEnd\_D\_Rq**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnd\_D\_Rq | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |

#### Outputs

CAN

Table 1.3 EngExhMdeHrEnbl\_D\_Stat

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnbl\_D\_Stat | Null | 0x0 | HMI setting treated as unknown (ex HMI greyed out, setting not shown as selected…) |
| Disabled | 0x1 |  |
| Enabled | 0x2 |  |

**EngExhMdeHrStrt\_D\_Stat**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrStrt\_D\_Stat | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

**EngExhMdeHrEnd\_D\_Stat**

|  |  |  |  |
| --- | --- | --- | --- |
| **Logical Signal Name** | **Literals** | **Value** | **Description** |
| EngExhMdeHrEnd\_D\_Stat | Null | 0x0 |  |
| Hour 0 (12 am) | 0x1 |  |
| Hour 1 (1 am) | 0x2 |  |
| Hour 2 (2 am) | 0x3 |  |
| Hour 3 (3 am) | 0x4 |  |
| … | … |  |
| Hour 21 (9 pm) | 0x16 |  |
| Hour 22 (10 pm) | 0x17 |  |
| Hour 23 (11 pm) | 0x18 |  |

HW Engine Exhaust Valve DT-MB3G-5A216-BX.xlsx



CAN

1. EngExhMdeQuiet\_D2\_Stat Signal

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Signal Name** | **Size (bits)** | **Detail** | **Units** | **Res.** | **Offset** | **State Encoded** | **Min** | **Max** |
| EngExhMdeQuiet\_D2\_Stat | 2 |  | SED | 1 | 0 |  | 0 (0x0) | 7 (0x7) |
|  |  | Null |  |  |  | 0x0 |  |  |
|  |  | Stealth |  |  |  | 0x1 |  |  |
|  |  | Normal |  |  |  | 0x2 |  |  |
|  |  | Sport |  |  |  | 0x3 |  |  |
|  |  | Track / Baja |  |  |  | 0x4 |  |  |
|  |  | NotUsed |  |  |  | 0x5 |  |  |
|  |  | NotUsed |  |  |  | 0x6 |  |  |
|  |  | Faulty |  |  |  | 0x7 |  |  |

**PURPOSE OF FEATURE**:

Exhaust modes enable the use of the active exhaust valves.  The active exhaust valves are used to provide variable acoustic tuning of the exhaust system.  The tuning allows for wide acoustic control, which enables the best balance between sound level, exhaust character, NVH error states and backpressure.

**System Implementation:**



###### Quiet Time Setup and Activation

#### Apart from the available exhaust modes, there is an additional “Quiet Start” available for selection. This is so that the loud exhaust does not cause any noise disturbance to anybody. Once enabled, the PCM shall compare the Start and End times with the real time clock.

#### If the real time clock falls in the Quiet Start range when ignition key transitions to “Run”, and Quiet time is enabled, the PCM initializes the Exhaust mode to “Quiet”.

#### If the ignition key transitions to “Run”, while in the Quiet Start period and the Quiet time is enabled, it shall continue to operate in Quiet exhaust mode until the user manually changes it, and shall not be affected by customer changes in the menu, or by the real time clock no longer falling within the Quiet Start range.

#### If the ignition key transitions to “Run”, outside of the “Quiet Start” period, or Quiet time is disabled, it shall continue to operate in Normal exhaust mode until the user manually changes it, and shall not be affected by customer changes in the menu, or by the real time clock falling within the Quiet Start range.

#### When the “Start/Begin” time is the same as the “End” time, a duration of 24 hours shall be implemented for the Quiet Start range.

#### When EngExhMdeHrEnbl\_D\_Rq = “Menu Not Configured” then EngExhMdeHrEnbl\_D\_Stat shall be set to “Disabled”.

###### The PCM shall store the state of the Quiet Time Enable, Start, and End Times over the key cycle, and only update these signals based on a change of state in the APIM’s requested Enable, Start, or End times. The PCM shall never store “NULL” as sent by the APIM. If the APIM changes state to “NULL”, the PCM shall maintain it’s previous state.

###### The PCM shall default the Quiet Time Stat values to a calibratable default on first initialization in the plant, or on a memory storage failure, where it is unable to retrieve the last stored value over the key cycle. The calibration default values are assumed to be:

EngExhMdeHrEnbl\_D\_Stat = “Disabled”

EngExhMdeHrStrt\_D\_Stat = 10 PM

EngExhMdeHrEnd\_D\_Stat = 8 AM

###### ???? Currently there are no failure mode requirements related to the Quiet Time Signals, are we okay with maintaining the last state if we’ve lost comm with APIM? (I am). What about if the global clock is not set (defaults to 12 pm), are we okay just trusting that? What if we lost comm with the BCM? This might result in us defaulting to assume 12am, and nominally enabling quiet time. Are we okay with that? (I am). Ideally whatever we decide, we should capture the requirement and rationale. Dave Schmitt to raise question with Exhaust Valve Team.

###### When the Drive Mode input changes, the EngExhMdeQuiet\_D2\_Stat shall be sent according to the following unless this transition occurs during a request to enter “My Mode”, in which case the “My Mode” transition must take priority, and the Drive Mode transition ignored.

###### Table based on the Drive Mode Matrix:

|  |  |
| --- | --- |
| SelDrvMdePt\_D\_Rq | Exhaust Mode |
| Normal | Normal |
| Sport | Sport |
| Slippery | Normal |
| Deep Snow / Sand | Sport |
| Baja | Track / Baja |
| Rock Crawl | Normal |
| Tow / Haul | Normal |

###### When My Mode is activated the EngExhMdeQuiet\_D2\_Stat shall be set to the My Mode Active Exhaust state (CAN INPUT EngExhMdeQuietCstm\_D\_Rq)

###### When My Mode transitions from Active to not Active, the PCM shall treat this as if a transition to a new drive mode has occurred, and shall set EngExhMdeQuiet\_D2\_Stat to the Exhaust mode state as specified in the Drive Mode Matrix.

###### When the cluster command via the switch (EngExhMdeQuiet\_D2\_Rq) transitions to new a Non-NULL value the PCM shall set EngExhMdeQuiet\_D2\_Stat = EngExhMdeQuiet\_D2\_Rq. Transitions to NULL shall be ignored, and the last state maintained.

###### Multiple exhaust modes /states are used to tie together different desired driving experiences:

###### 

1.  Sleeper Mode (Quiet) – Customer desires low sound levels, primarily as courtesy to their local environment (example:  neighborhood at early or late hours of the day).

2.  Normal Mode – Ties to “Normal” SDM mode, delivers substantial increase in exhaust sound on vehicle start-up, revving in neutral, and a moderate increase in sound while driving

3.  Sport Mode – Ties to “Sport” SDM mode, delivers increased sound levels and rate of exposure while driving (louder, more often).  You will notice a difference in sound when switching from Normal to Sport SDM, reinforcing that the car is ready for an increased level of driving performance

4.  Track / Baja Mode – Ties to “Track” or “Baja” SDM mode, loudest sound levels delivered full time, lowest exhaust back-pressure condition, with some NVH error state trade-offs to deliver most exciting performance.

###### The Powertrain system transmits the EngExhMdeQuiet\_D2\_Stat based on the initial value determined based on Quiet Time, in response to changes in the EngExhMdeQuiet\_D2\_Rq message and when the exhaust valves get updated based on Drive Mode or MyMode. This signal should be a state encoded via a 3 bit signal, and follows the values defined in EngExhMdeQuiet\_D2\_Rq.  See Input section

**PCM Output**

Startup value – (default) – the default values correspond to state encoded value of normal provided it’s not being set to quiet state.

## Revision History

**Functional Spec Revision History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Level** | **Name** | **Change Description** | **Date** |
| P702 | T. Wroblewski | Replaced Track with Baja, Eliminated references to ECP switch, 4.2 HMI, added Steering Wheel Switch signal from SCCM. | 5/29/2019 |
|  | T. Wroblewski | Added PCM section, clarified that this is a vehicle level spec for Engine Exhaust Mode Individual Setting and is not meant to replace the respective STSS written by Drive Information | 6/2/2019 |
|  | T. Wroblewski | Deleted reference to Visual in Human Machine Interface section of Cluster Functional Description | 7/8/2019 |
|  | T. Wroblewski | Ver 10 Incorporated references to Sync (APIM) and Enhanced Central Gateway | 8/9/2019 |
|  | T. Wroblewski | Ver 12a Updated Signal Flow and clarified functionality in each module | 9/27/2019 |
| 12e | T. Wroblewski | Replaced TBD exhaust mode signal with EngExhMdeQuietCstm\_D\_Rq | 9/1/2020 |