### CAN-Based Passenger Airbag Deactivation Indicator (PADI) Functional Requirements for Host ECUs

**Requirements (R2.5.3 – x)**

**Functional Classification –** Class B (R2.5.3 - 1)

Note: PADI graphics requirements can be found in RQT-012006-016461 PADI Feature Specification.

**Feature Overview**

The restraint's Passenger Airbag Deactivation Indicator (PADI) is a visual indicator used to inform the driver and passengers of the passenger airbag deactivation state. A PADI provides indication of airbag ON of OFF state for the associated seating position. Generally, the PADI is only associated with the front outboard passenger seating position. With the introduction of Autonomous Vehicles (AV), a PADI may be associated with more than one seating position. In particular, a PADI may be used to indicate status of the 1st row, former driver, seating position in an AV.

1. The PADI Control, internal to the RCM, will define the logical state of the PADI as depicted below.

Note: Given the introduction of a second PADI and second OCS, they are differentiated in this specification by “A” and “B” suffixes.

“Passenger A” refers to the traditional first row, outboard passenger position, in a vehicle with a steering wheel. “Passenger B” refers to the first row position historically occupied by the driver.

“PADI\_A” refers to the PADI associated with the traditional first row, outboard passenger position, in a vehicle with a steering wheel. “PADI\_B” refers to the PADI associate with the first row position historically occupied by the driver.

Passenger A Occupant Classification Control

(optional)

Passenger A's Airbag Deactivation Indicator Control (PADICONTROL=On/Off, DUALPADICONTROL=On/Off)

Passenger A Airbag Cutoff Switch Control

(optional)

RCM

Passenger A's Airbag Deactivation Indicator Function

Figure 2.5‑5: PAD Indicator Control, Non-AV Applications

Passenger A Occupant Classification Control

Passenger A's Airbag Deactivation Indicator Control (PADICONTROL=On/Off, DUALPADICONTROL=On/Off)

RCM

Passenger A's Airbag Deactivation Indicator Function

Passenger B Occupant Classification Control

Passenger B's Airbag Deactivation Indicator Control (PADICONTROL=On/Off, DUALPADICONTROL=On/Off)

RCM

Passenger B's Airbag Deactivation Indicator Function

Figure 2.5‑6: PAD Indicator Control, AV Applications

RCM

Hardwire

Single PADI

RCM

CAN

Dual PADI

ACS

OCS\_A

OR\*

ACS

OCS\_A

OR\*

RCM

CAN

Dual PADI\_B

OCS\_A

OCS\_B

Dual PADI\_A

Non-AV Applications

\*Note: ACS and OCS are mutally exclusive

AV Applications

Host ECU

Host ECU

Figure 2.5‑7: PADI Architectures

The following sections describe requirements applicable to all instances of a PADI. Note, however, AV applications will only use CAN controlled Dual PADIs.

**CAN Controlled PADI Prove-Out Requirements (Both non-AV and AV applications)**

1. Given the introduction of a second PADI in AV application, these requirements apply to both PADI\_A and PADI\_B.
2. At key-on the RCM will request illumination of both the 'Airbag On' indicator and the 'Airbag Off' indicator for a period of 4.0 seconds.
3. After 4.0 seconds, the RCM will continue to simultaneously illuminate the ‘Airbag On' indicator and the 'Airbag Off' indicators until the RCM receives an OCS classification other than indeterminate OR a period of 8.0 seconds passes from key-on without receipt of a non-indeterminate OCS classification.
4. Upon receipt of a non-indeterminate OCS classification the RCM will request illumination of the indicator which reflects correct PADI status.
5. At key-on, the RCM will transmit CAN signal *PassRstrnInd\_Req* requesting both indicators to be illuminated within 250ms of key-on, to begin the proveout period of a CAN controlled PADI.
6. The PADI, or its host ECU, shall be capable of illuminating both the ‘Airbag On’ and ‘Airbag Off’ indicators simultaneously, per the examples shown below. Note: Refer to the PADI Feature Specification, for a full description of PADI graphics requirements.

Proveout state of a Dual PADI:



Proveout state of a Dual PADI in AV vehicles with more than one PADI:

 

**CAN Controlled PADI Functional Requirements (Both non-AV and AV applications)**

“PADI\_A” refers to the PADI associated with the traditional first row, outboard passenger position, in a vehicle with a steering wheel. “PADI\_B” refers to the PADI associate with the first row position historically occupied by the driver.

**CAN Controlled Dual PADI Functional Topology**

RCM

Hardwire

Single PADI

RCM

CAN

Dual PADI\_A

ACS

OCS\_A

OR\*

ACS

OCS\_A

OR\*

RCM

CAN

Dual PADI\_B

OCS\_A

OCS\_B

Dual PADI\_A

Non-AV Applications

\*Note: ACS and OCS are mutally exclusive

AV Applications

Host ECU

Host ECU

PADI Architectures

1. In non-AV applications, the PADI, or its host ECU, shall be capable of hosting one instance of a Dual PADI. (Refer to the PADI Feature Specification)
2. In AV applications, the PADI, or its host ECUS, shall be capable of hosting two instances of a Dual PADI. (Refer to the PADI Feature Specification)
3. The PADI shall only be displayed when the key is in the Run/Start position, unless the Restraint Control Module has a different powering scheme and in that case shall be powered in the same ignition modes as the RCM.

**PADI Control Signals for CAN based PADI(s)**

|  |  |
| --- | --- |
| RCM Tx Signals for PADI\_A | |
| PassRstrnInd\_Req | 0x0 - 'Airbag On' illuminated, 'Airbag Off' illuminated  0x1 - 'Airbag On' illuminated, 'Airbag Off' not illuminated  0x2 - 'Airbag On' not illuminated, 'Airbag Off' illuminated  0x3 – ABOnNotIllum\_ABOffNotIllum |
| RCM Rx Signals for PADI\_A (transmitted by the PADI or its host ECU) | |
| PassRstrnInd\_Stat | 0x0 - Not\_Supported  0x1 - Normal  0x2 - AirbagOn\_indicator\_fault  0x3 - AirbagOff'\_indicator\_faulted  0x4 - Both indicators faulted  0x5 - Unused  0x6 - Unused  0x7 – Invalid |
| RCM Tx Signals for PADI\_B | |
| PassRstrnIndB\_Req | 0x0 - 'Airbag On' illuminated, 'Airbag Off' illuminated  0x1 - 'Airbag On' illuminated, 'Airbag Off' not illuminated  0x2 - 'Airbag On' not illuminated, 'Airbag Off' illuminated  0x3 – ABOnNotIllum\_ABOffNotIllum |
| RCM Rx Signals for PADI\_B (transmitted by the PADI or its host ECU) | |
| PassRstrnInd**B**\_Stat | 0x0 - Not\_Supported  0x1 - Normal  0x2 - AirbagOn\_indicator\_fault  0x3 - AirbagOff'\_indicator\_faulted  0x4 - Both indicators faulted  0x5 - Unused  0x6 - Unused  0x7 – Invalid |
|  |  |

**CAN Controlled PADI Functional Requirements (Both non-AV and AV applications)**

1. For applications with a single instance of a PADI (i.e. non-AV applications which have only a PADI\_A), the PADI, or its host ECU, shall illuminate the PADI\_A indicators per Table 1: PADI\_A Control and Status Signals.
2. For applications with two instances of a PADI (i.e. AV applications which have a PADI\_A and a PADI\_B), the PADI, or its host ECU, shall illuminate the PADI\_A indicators per Table 1: PADI\_A Control and Status Signals and shall additionally illuminate the PADI\_B indicators per Table 1: PADI\_B Control and Status Signals.
3. In AV applications, the PADI, or its host ECU, shall determine whether the vehicle is in Autonomous Mode or Manual Mode per requirement RQT-003801-706864. Note: This requirement is released in FEDE.
4. In AV applications, PADI\_A and PADI\_B shall be displayed when the vehicle is in Autonomous Mode. When the vehicle is in Manual Mode, only PADI\_A shall be displayed.

CAN Controlled PADI Fault Detection

1. For each instance of a PADI, the PADI, or its host ECU, shall be capable of diagnosing open circuit, short to ground, or short to battery conditions which result in incorrect illumination of each indicator. *Note: Not applicable to PADI implementations using a display instead of discrete LEDs.*
2. PADI faults which may result in incorrect illumination of either ON of OFF indicator shall be detected within 4 seconds of first occurrence. *Note: This is due to minimum indicator illuminated time of 4 seconds at key-on.*
3. The PADI, or its host ECU, shall default to the PADI ‘Airbag On’ indicator not being illuminated and the ‘Airbag Off’ indicator not being illuminated if there are any faults detected within the corresponding indicator or control functions.
4. Diagnostic strategies may vary by implementation, but, in general, diagnosis of open/short fault conditions will depend on the control state of the indicator. For example, in a low-side drive topology, detection of a short to a voltage should occur when an indicator is intended to be illuminated and diagnosis of an open circuit or a short to ground should occur when an indicator is not illuminated. *Note: Not applicable to PADI implementations using a display instead of discrete LEDs.*
5. PADI diagnostics shall not cause either indicator to have a perceivable glow when the indicator is not intended to be illuminated. *Note: Not applicable to PADI implementations using a display instead of discrete LEDs.*
6. PADI implementations which are integrated into a, instead of discrete LEDs, can utilize status of the overall display as a surrogate for diagnostics on a discrete indicator. i.e. if the display fails, it should be considered a PADI failure.
7. The PADI, or its host ECU, shall qualify faults such as missing messages or invalid signals from the RCM, within 6 seconds.
8. PADI\_A faults shall be communicated via CAN signal PassRstrnInd\_Stat per Table 1: PADI\_A Control and Status Signals within 200ms of qualification.
9. PADI\_B faults shall be communicated via CAN signal PassRstrnIndB\_Stat per Table 2: PADI\_B Control and Status Signals within 200ms of qualification.

CAN Controlled PADI Fault Recovery

1. The PADI, or its host ECU, shall continue to diagnose and report the status of each indicator, after qualification of a fault, and allow dequalification of a fault, if the condition is resolved and update PassRstrnInd\_Stat and PassRstrnIndB\_Stat accordingly.
2. After receipt of CAN signal PassRstrnInd\_Stat state other than ‘Normal’ for greater than 6 continuous seconds, the RCM shall illuminate the RIL and log the appropriate DTC(s), as defined in the Part II specification. *Note: this requirement is applicable to the RCM.*
3. After receipt of CAN signal PassRstrnInd\_Stat -Normal, the RCM shall turn off the RIL, if it had previously been illuminated solely due to a PADI fault. *Note: this requirement is applicable to the RCM.*
4. In all applications, the PADI, or its host ECU, shall an instance of a PADI and illuminate the PADI\_A indicators per the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| RCM Request | Indicator Status | | CAN PADI Host ECU Response |
| *PassRstrnInd\_Req* | On Indicator | Off Indicator | *PassRstrnInd\_Stat* |
| 0x0 – ‘Airbag On’ illuminated, ‘Airbag Off’ illuminated | Illuminated (fault free) | Illuminated (fault free) | 0x1 - Normal |
|  | Faulted | Illuminated | 0x2 – AirbagOn\_indicator\_fault |
|  | Illuminated | Faulted | 0x3 – AirbagOff’\_indicator\_faulted |
|  | Faulted | Faulted | 0x4 – Both indicators faulted |
|  |  |  |  |
| 0x1 – ‘Airbag On’ illuminated, ‘Airbag Off’ not illuminated | Illuminated (fault free) | Not Illuminated | PassRstrnInd\_Stat = 0x1 – Normal |
|  | Faulted | Illuminated (fault free) | 0x2 – AirbagOn\_indicator\_fault |
|  | Illuminated | Faulted | 0x3 – AirbagOff’\_indicator\_faulted |
|  | Faulted | Faulted | 0x4 – Both indicators faulted |
|  |  |  |  |
| 0x2 – ‘Airbag On’ not illuminated, ‘Airbag Off’ illuminated | Not Illuminated | Illuminated (fault free) | PassRstrnInd\_Stat = 0x1 – Normal |
| 0x3 – ABOnNotIllum\_ABOffNotIllum | Not Illuminated | Not Illuminated | PassRstrnInd\_Stat = 0x1 – Normal |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table 1: PADI\_A Control and Status Signals

1. In AV applications, the PADI, or its host ECU, shall additionally support a second instance of a PADI and illuminate the PADI\_B indicators per the table below:

|  |  |  |  |
| --- | --- | --- | --- |
| RCM Request | Indicator Status | | CAN PADI Host ECU Response |
| *PassRstrnInd****B****\_Req* | On Indicator | Off Indicator | *PassRstrnInd****B****\_Stat* |
| 0x0 - 'Airbag On' illuminated, 'Airbag Off' illuminated | Illuminated (fault free) | Illuminated (fault free) | 0x1 – Normal |
|  | Faulted | Illuminated | 0x2 - AirbagOn\_indicator\_fault |
|  | Illuminated | Faulted | 0x3 - AirbagOff'\_indicator\_faulted |
|  | Faulted | Faulted | 0x4 - Both indicators faulted |
|  |  |  |  |
| 0x1 - 'Airbag On' illuminated, 'Airbag Off' not illuminated | Illuminated (fault free) | Not Illuminated | PassRstrnIndB\_Stat = 0x1 – Normal |
|  | Faulted | Illuminated (fault free) | 0x2 - AirbagOn\_indicator\_fault |
|  | Illuminated | Faulted | 0x3 - AirbagOff'\_indicator\_faulted |
|  | Faulted | Faulted | 0x4 - Both indicators faulted |
|  |  |  |  |
| 0x2 - 'Airbag On' not illuminated, 'Airbag Off' illuminated | Not Illuminated | Illuminated (fault free) | PassRstrnIndB\_Stat = 0x1 – Normal |
| 0x3 – ABOnNotIllum\_ABOffNotIllum | Not Illuminated | Not Illuminated | PassRstrnIndB\_Stat = 0x1 - Normal |
|  |  |  |  |
|  |  |  |  |
|  |  |  |  |

Table 2: PADI\_B Control and Status Signals

**CAN Controlled PADI Brightness Control**

1. In CAN controlled dual PADI applications, brightness control for each indicator, if implemented, shall be performed by the PADI itself or its host ECU.

**CAN Controlled PADI Optionality**

1. The PADI, or its host ECU, shall be able to be disabled in markets where PADI is not implemented.
2. In applications where PADI\_A is not present or the PADI\_A is hardwire controlled by the RCM, the PADI, or its host ECU, shall set CAN signal PassRstrnInd\_Stat – Not\_Supported.
3. In applications where PADI\_B is not present but common software of the PADI host ECU generically supports a PADI\_B, the PADI host ECU shall set CAN signal PassRstrnInd**B**\_Stat – Not\_Supported.