REQUIREMENT REPORT

FILTERS
SOIL:

REQUIREMENTS SUMMARY						
FEDE ID (SETK Legacy)	**RQT Version**	**Requirement Title**	**Publish Date**	**Priority Level**	**Attachment ID(s)**	**Associated Test Methods / Evaluation Methods**
RQT-060904-721800 (AN-0531)	1	Trailer Sway Control Feature Specification	21-Oct-2021	Secondary	•TSC Specification Rev2	TM-06.09-L-12303/2 TM-06.09-R-10962/1

REQUIREMENT		
ID: RQT-060904-721800	**Rev:** 1	**Title:** Trailer Sway Control Feature Specification

Legacy ID: AN-0531　　**Author:** Suter,Greg-GSUTER (gsuter) **Primary Contact:**　　　　**Priority Level:** Secondary　　　　**GAP Flag:** No

Other Contacts:

State: Released　　　　**Rqmt Published Date:** 21-Oct-2021　　**Obsolete Date:**　　　　**Superseded Date:**

Interface CPSCs:
060904

Requirement Collection:

Rqmt Sources(s):

Related Requirements:

Markets:
GLOBAL

Vehicle Types:
GLOBAL:All,,

Revision Summary & Rationale:
RQT is moved by IT from 060900 to 060904 CPSC. RQT-060900-020525 is the old RQT#

Core Parameter(s):

Analysis/Discussion:

Explanation:

Requirement Description:

RQT-060900-020525

See attached TSC Specification document.

Attachment

Dataset Name:TSC Specification Rev2   **Dataset Description:**TSC Specification Rev2.docx   **Dataset Attachment File Name:**TSC Specification Rev2.docx

RQT-060900-020525

1.   Purpose of Specification

The purpose of this specification is to define the performance requirements for the Trailer Sway Control (TSC) software function contained in the Electronic Stability Control (ESC) module.

2.   Scope of Specification

This specification only describes the performance specification for TSC, and does not define software or hardware interfaces regarding ESC or other interfaces. NOTE: These signals described in this specification may be placed in different messages based upon the program message list, therefore this specification only focuses on the signals and does not declare the messages in which they are contained. The TSC and ESC shall meet all other requirements defined by the vehicle program Engineering Statement of Work.

3.   Definitions

3.1.   Lateral Acceleration

For purposes of this specification the lateral acceleration is Vx * YawRate. (m/s^2)

3.2.   AyPeak

50 ms average centered around a local peak in Lateral Acceleration. (m/s^2)

3.3. $TSHalfPeriod_N$

The Trailer Sway Half Period, equaling the time between between two AyPeaks. (s)
$TSHalfPeriod_N$ = (Time at $AyPeak_N$) – (Time at $AyPeak_{N-1}$)

3.4. $AyPeak_1$

The first $|AyPeak|>0.5 m/s^2$ that is preceded by a time of 25 ms where LatAcc is not >0.5 m/s^2.

3.5. $AyPeak_2$

An AyPeak of the opposite sign of $AyPeak_1$ and occurring within a window of time TSHalfPeriod±15% after the $AyPeak_1$.

3.6. $AyPeak_N$

An AyPeak of the opposite sign of $AyPeak_{N-1}$ and occurring within a window of time TSHalfPeriod±15% after $AyPeak_{N-1}$.

3.7. ΔAy_N

The difference in amplitude between successive Lat Acc peaks (AyPeak): ΔAy_N = $|AyPeak_{N-1}|$ - $|AyPeak_N|$
A trailer sway event with positive damping has positive values of ΔAy_N (m/s^2).

3.8.   AyPeakSum

The sum of the 5 most recent AyPeak values over 0.5 m/s^2. (m/s^2)

3.9.   Vx

Longitudinal velocity as defined by the reference velocity of the stability control system. (m/s)

3.10. Vcrit
Critical speed of the vehicle and trailer ("train") configuration. This is the speed at which sway will occur with zero damping. (m/s)

3.11. V_Reduction_Start
Scaling factor for Vx Reduction requirement for maneuvers starting at speeds much higher than Vcrit. (m/s)

3.12. SteadyStateAccelerator
Accelerator pedal position that keeps vehicle train at a constant speed when no trailer sway exists.

3.13. Intervention
The brake control system, *for purpose of this document*, is considered to be in an "intervention" whenever commanded brake pressures are greater than 8 bar. Therefore an intervention has ended when the final commanded brake pressures have fallen below 8 bar.

4.   Trailer Sway Control Availability

Vehicle programs with an available trailer tow rating exceeding 2000 lb (907 kg), shall include the Trailer Sway Control feature, and meet the performance requirements in Section 5.

When Trailer Sway Control is included on a program, it shall be functional for all vehicles of that program, even if they do not include a factory installed hitch or do not have a trailer tow rating exceeding 2000 lb for that variant.

Rationale: Trailers weighing less than 2000 lb are unlikely to result in sway. Further, any resulting sway will consist more of trailer yaw motion, with less vehicle yaw motion making it difficult to detect and control with the vehicle brakes. This requirement does not prohibit including TSC for vehicles with tow ratings less than 2000 lb, if the system is deemed beneficial.

Note: Trailer Sway Control may be disabled through driver selection or disabled in certain selectable drive modes.

5.   Performance Requirements

For specification purposes, if multiple interventions occur within an interval of ≤ 5 seconds, those interventions will be combined for evaluating system performance versus specification requirements. If the 5 second interval ends in the middle of an intervention, the interval shall be extended until all measured brake pressures from that intervention are less than 1 bar (and connected to atmospheric pressure), plus an additional 2 seconds. All individual interventions in the 5 second interval are also required to meet SPECIFICATION level for these requirements.

For the Amplitude Reduction and TSC Efficiency requirements, the metric starting and ending points are determined according to the following:

The lateral acceleration sway peaks will be summed continuously for all peaks greater than 0.5 m/s^2. The starting peak for the metric begins at the peak where the AyPeakSum is greater than $3 * 1.5$ m/s^2. The ending point for the metric is determined by two factors:

1. The time when all brake pressures (measured) are less than 8 bar, but reducing to 1 bar [and connected to atmospheric] or below within 500 ms.
2. The time of the last lateral acceleration peak above 0.5 m/s^2.
If the pressure based time is greater than the peak based time, then the metric ending point is set to the pressure based time and an amplitude of 0.5 m/s^2, opposite in sign of the last peak above 0.5 m/s^2. If the pressure based time is less than the peak based time, then the metric endpoint is set at the time and value of the last peak above 0.5 m/s^2.

5.1. TSC Amplitude Reduction

Purpose: Ensure that the TSC system effectively reduces the amplitude of trailer sway events.

Plot the delta lateral acceleration that occurs in the following half-cycle against its lateral acceleration peak. The locus of points shall remain in the "Acceptable" region of the following figure:
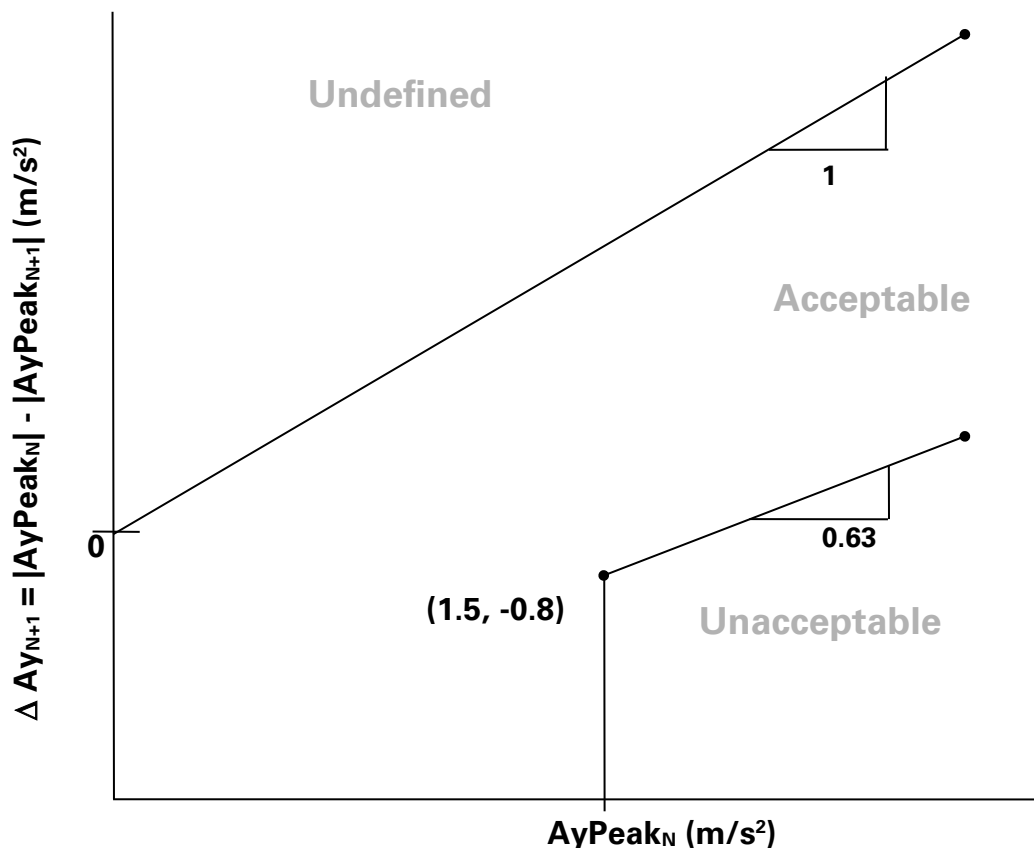
5.2. TSC Efficiency

Purpose: to ensure that the TSC system does not generate excessive deceleration for a given amount of trailer sway amplitude reduction.

Plot the reduction in Vx against the reduction in lateral acceleration. The locus of the points shall remain in the "Acceptable" area of the following figure:

Reduction in AyPeak = |AyPeak$_1$| - |AyPeak$_N$| (m/s^2)
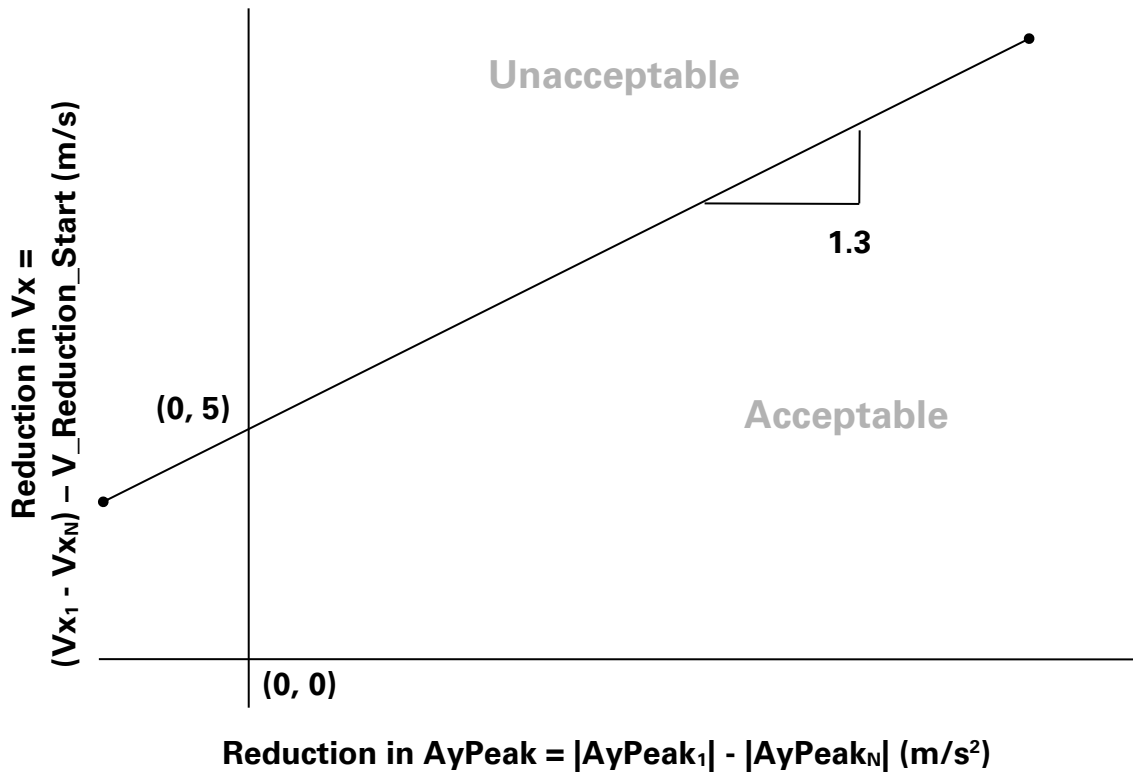
The starting y-axis value for the reduction in Vx is based upon the critical speed of the train. This point is equivalent to the minimum between zero and V_Reduction_Start = 1.15*Vcrit – Entry_Vx (Vx$_1$), where Entry_Vx is the speed of the train at the starting Ay peak for this metric. Therefore maneuvers that begin significantly above critical speed are not as penalized for reducing the train Vx to become stable. If this value is non-zero, all corresponding points are also scaled by its value.
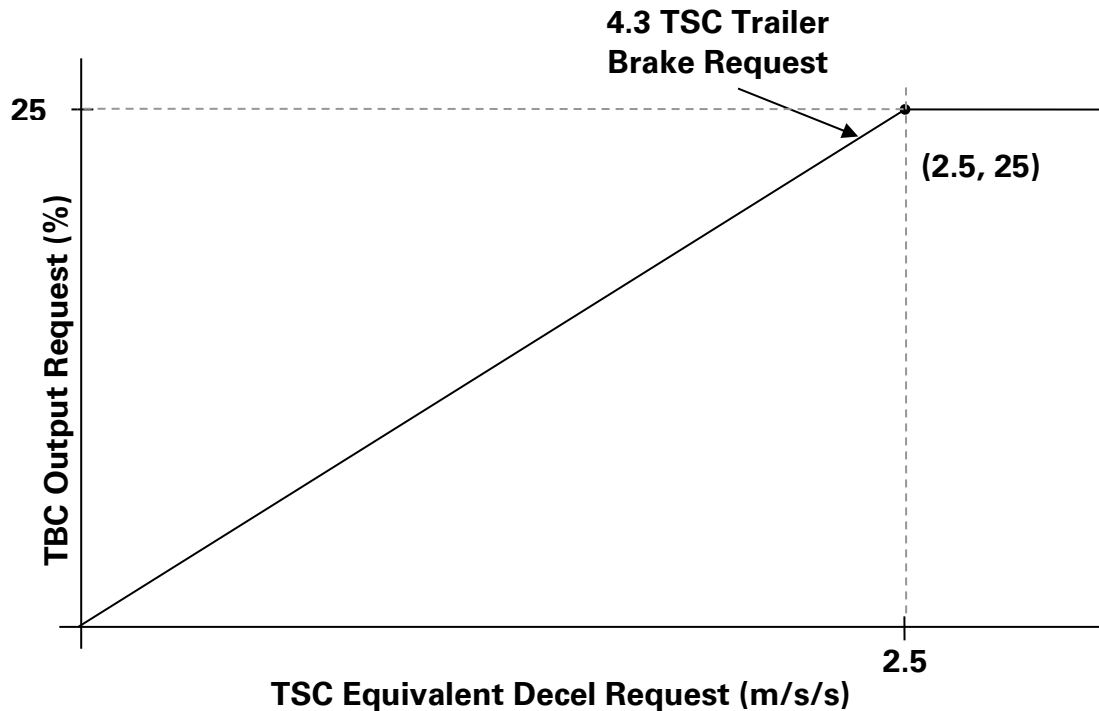
The TSC Efficiency specification is SPECIFICATION level for any maneuver where the accelerator pedal position is >SteadyStateAccelerator – 5% and a single intervention lasts < 10s.

The TSC Efficiency specification is REFERENCE level for any maneuver where the accelerator pedal position is < SteadyStateAccelerator – 5%. In order to apply the efficiency spec to these maneuvers it is necessary to subtract the natural deceleration of the vehicle train without intervention from the AvgDecel$_N$ values prior to plotting them.

5.3. Trailer Brake Request

A TSC deceleration request shall be communicated with the Trailer Brake Controller (TBC) to optimize overall system performance. NOTE: This requirement only pertains to vehicle configurations that include the optional TBC installed on the vehicle. Further details relating to this requirement can be found in section 6.2.

The TSC shall send the TBC a request for trailer proportional to the severity of the event, such that requirements 5.1 and 5.2 are met. The TBC request must be at least as large as the transfer function illustrated below relative to the braking done on the tow vehicle (expressed as decel). The intent is to use the trailer brakes to maintain tension at the hitch joing.

4.3 TSC Trailer Brake Request

(2.5, 25)

25

TBC Output Request (%)

2.5

TSC Equivalent Decel Request (m/s/s)

5.4. TSC Function while turning

Trailer sway control shall function for quasi-steady-state maneuvers where Lateral Acceleration < 0.6g.

5.5. TSC Notification

The driver must be notified via the AdvanceTrac telltale and the message center anytime TSC induces more than $0.3 m/s^2$ of deceleration.

The message center text shall be defined according to Cluster functional specification, but is contained here for reference only. The message center shall read:

<div align="center">

TRAILER SWAY
REDUCE SPEED

</div>

5.6. AdvanceTrac Switch Function and ESC Modes

In vehicles where ESC may be disabled through a Driver selection, the TSC system shall be disabled whenever ESC is disabled. This shall result in the ESC lighting the AdvanceTrac telltale solid. For each new ignition cycle the TSC system shall be re-

enabled (default/initial value == ON). Whenever ESC is reenabled through a Driver selection, the TSC system shall be reenabled.

For vehicles where multiple ESC modes are selectable by the driver, either through PATA switch modes ("Sport") or selectable drive modes ("Mud/Sand"), the TSC system may be disabled in certain modes per program direction. Additionally, TSC may be disabled directly through the message center. See section 7.1 of this document.

Anytime the TSC system is disabled for any of the above reasons, the TRAILER_SWAY_CONFIG_STAT message shall be broadcast as TSC_Off (0x0). See section 6.3 of this document.

5.7. TSC Interventions without Trailer

When any trailer type is not physically connected to the hitch:

1. The system shall not indicate to the driver that it is active (i.e. no message center or telltale activations).

2. The system shall not induce greater than 0.3 m/s^2 of decel

3. The system shall not activate for longer than 1 sec.

6. Network Signal Interface Requirements - Transmitted

6.1. TRLR_SWAY_EVNT_IN_PROGRESS

6.1.1. Description Text

This signal flags whether a trailer sway event is in progress. A "0" will indicate there is no control event, where a "1" will indicate a trailer sway control event is occurring. NOTE: See "Processing Details" below for the definition of a trailer sway event as pertains to this signal requirement.

This signal is used to request the cluster to display trailer sway related warning messages.

6.1.2. Processing Details

The TRLR_SWAY_EVNT_IN_PROGRESS flag shall be based on entrance and exit criteria for a trailer sway event. The flag shall be "NO" (0x0) for all conditions other than a trailer sway control event. The flag shall be set to "YES" (0x1) for the start of all/any interventions and shall remain for 2 seconds after the intervention has ended. Within this 2 second interval if any more interventions occur the 2 second counter shall be reset for each new intervention. This 2 second parameter shall be tunable. This is to prevent "flashing" of the related cluster message center display.

Functional Ex: if an intervention lasts 4 seconds and a second intervention occurs 1 second later lasting 2 seconds, this flag would remain "YES" (0x1) for 9 seconds total.

6.2. TrlrBrk_Pc_Rq

6.2.1. Description Text

This signal communicates the output request to the Trailer Brake Controller (TBC) by the ESC during a trailer sway event. The signal determines the amount of duty cycle output the TBC shall send to the trailer brakes during a brake controls event. NOTE: This duty cycle output will still be scaled according to the customer set gain level on the TBC.

6.2.2. Processing

When there is no trailer sway event in progress, the ESC shall send 0x0. During a trailer sway event, the ESC shall send a value from 0 to 100 (0-100%) proportional to the severity of the trailer sway. (See section 5.3 of this document.)

6.3. TRAILER_SWAY_CONFIG_STAT

6.3.1. Description Text

This signal communicates the Trailer Sway Control enabled configuration as set in the ESC module. A "1" will indicate the ESC module has enabled TSC, where a "0" will indicate the ESC module has disabled TSC. Status will default to "1" at Ignition ON, and then reflect the customer requested status as communicated in the signal TRAILER_SWAY_CONFIG_CMD (see 7.1), provided the ESC is capable of providing TSC functions.

6.3.2. ESC Module Processing Details

6.3.2.1. *Response to Cluster Mode Request (TRAILER_SWAY_CONFIG_CMD)*

The ESC module shall transmit signal "TRAILER_SWAY_CONFIG_STAT" to the instrument cluster to acknowledge the cluster mode request and verify compatibility within 100ms of receiving state changes or present value of the "TRAILER_SWAY_CONFIG_CMD" (signal is periodic with message).

6.3.2.2. *Response to ESC Switch or Mode Selection*

The ESC module shall transmit signal "TRAILER_SWAY_CONFIG_STAT" according to the current TSC status as defined for the current ESC mode. When a mode change is initiated and accepted by the ESC module, "TRAILER_SWAY_CONFIG_STAT" shall be updated to the new correct value within 100 ms of the ESC module acknowledging the mode change.

6.3.2.3. *ESC Fault Signal Compatibility*

If a fault occurs in the ESC system that prevents TSC interventions, the TSC enable parameter "TRAILER_SWAY_CONFIG_STAT" shall be set according to the ability of the system to perform TSC interventions. Therefore, if a fault exists that would disable TSC, the ESC module shall send "OFF" (0x0) for "TRAILER_SWAY_CONFIG_STAT", regardless of the state of "TRAILER_SWAY_CONFIG_CMD".

6.3.2.4. *Cluster-ESC Signal Compatibility*

No DTCs shall be set if the "TRAILER_SWAY_CONFIG_STAT" and "TRAILER_SWAY_CONFIG_CMD" are not equal.

6.3.2.5. *EOL Configuration*

On vehicles where TSC is developed, it will be a standard part of the ESC system. No EOL Configuration is required.

6.4. StopLamp_B_RqBrk

6.4.1. Description Text

This signal is used by the ESC module to request brake lamps be lit (by the SJB/SPDJB) during a trailer sway control event. A value of "1" corresponds to the ESC requesting the brake lamps be lit, while a "0" will indicate that ESC is not requesting brake lamps to be lit.

6.4.2. ESC Module Processing Details

The ESC module shall transmit signal "StopLamp_B_RqBrk" to the SPDJB to request that the vehicle brake lamps (and hence resulting trailer brake lamps) be lit during a TSC intervention. This signal shall NOT be set according to the "TRLR_SWAY_EVNT_IN_PROGRESS" as the hysteresis on that signal is not desired, but shall be set to "1" (brake lamp request) according to the supplier chosen TSC entry/exit criteria.

6.5. DrvSlipCtlLamp_D_Rq

6.5.1. Description Text

This section is specific to the function of the telltale as it relates to TSC and has no functional requirements of the telltale for other brake controls features.

This signal is used to command the cluster when to light the AdvanceTrac warning telltale. This telltale is flashed during a brake controls event or is on solid if a fault exists in the system or certain brake controls features are disabled via the AdvanceTrac switch. A "0" will mean there is no request for lamp activation, a "1" is a solid ON, a "2" is a slow flash, and a "3" is a fast flash.

6.5.2. ESC Module Processing Details

6.5.2.1. *Trailer Sway Control Event*

The ESC module shall flash the telltale (transmit 0x3) while the ECU is performing a trailer sway control intervention. The timing for the illumination of this telltale should comply with AN-0008, and may not exactly match the indication of TRLR_SWAY_EVNT_IN_PROGRESS.

6.5.2.2. *TSC Configuration*

If the configuration of TSC has been disabled by the customer (via the TRAILER_SWAY_CONFIG_CMD and STAT signals), the ESC module shall NOT light the telltale (transmit 0x0), except for other appropriate stability control events according to the program specific state chart.

6.5.2.3. *Other Disabled Features*

If a brake controls features have been disabled (via switch or mode selection), the telltale shall follow the program specific state chart regardless of TSC configuration.

7. Network Signal Interface Requirements – Received

7.1. TRAILER_SWAY_CONFIG_CMD

7.1.1. Description Text

This signal determines the customer chosen enable status for the trailer sway control system. The cluster message center provides a method for the customer to choose whether to enable or disable trailer sway control. This status shall be broadcast by the cluster for the ESC module to respond. A "1" will correspond to a customer choice to enable TSC, where a "0" will indicate the customer has selected to disable TSC.

7.1.2. ESC Module Processing Details

7.1.2.1. *Normal Operation*

The ESC module shall receive signal "TRAILER_SWAY_CONFIG_CMD" from the Instrument Cluster and enable/disable TSC according to the state of this signal for that given ignition cycle (0=OFF, 1=ON), provided no faults exist in the system (not including initialization). Missing Value

If the TRAILER_SWAY_CONFIG_CMD signal should go missing, the ESC module shall set the TSC configuration to "ON" (0x1 = TSC On).

7.1.2.2. *EOL Configuration Compatibility*

If TSC has not been configured for the vehicle according to End of Line, but the ESC module receives "ON" (0x1 = TSC On) for the "TRAILER_SWAY_CONFIG_CMD" signal, the ESC shall remain in the EOL configuration state.

7.2. TrlrBrkActCnnct_B_Actl (formerly CONNECT_TRAILER_STAT)

7.2.1. Description Text

This signal contains the trailer connectivity status information. A "0" will mean that a trailer is not electrically connected or has become disconnected, while a "1" will mean that a trailer is electrically connected.

NOTE: This signal cannot fail as a false positive – meaning this signal will never falsely state that a trailer is electrically connected.

7.2.2. ESC Module Processing Details

7.2.2.1. *TrlrBrkActCnnct_B_Actl State Change*

During a given ignition cycle, the ESC shall update an internal trailer connectivity parameter for use with Trailer Sway Control. Upon receipt of "Connected" (0x1) this connectivity parameter shall assume a trailer is connected. Should the value change to "Not_Connected" (0x0) the TSC shall assume the trailer is not connected (i.e. electrically disconnected - hence no trailer brakes), and change the state of its internal parameter. This parameter may be used to modify exit and entry criteria to improve trailer sway control performance for the trailer connected state. The value of this signal shall not prevent TSC from performing interventions. It shall only be used to modify its performance based thresholds.

7.2.2.2. *Missing Signal Strategy*

In any given ignition cycle, if the TrlrBrkActCnnct_B_Actl signal is missing, the ESC/TSC shall assume a trailer is not connected (0x0).