Technical Document

USE OF ELECTRONIC BRAKING SYSTEMS (EBS) WITH ALLISON TRANSMISSIONS

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1.0 INTRODUCTION

This document describes the interface between Allison transmissions and brake blending systems, commonly called Electronic Braking Systems (EBS).

2.0 REFERENCED DOCUMENTS

Unless otherwise noted, all documents referenced in this document may be found in the Extranet channel of the Allison Transmission website, *www.allisontransmission.com*. To locate the referenced documents, which are identified by *italic* font, look for Tech Data under the Engineering heading on the Extranet home page. Contact your Allison Transmission representative if you do not have access to the Allison Transmission Extranet. A list of all items referenced in this document can be found at the end of this document.

3.0 EBS DESCRIPTION

EBS is a feature used in the commercial vehicle market, most prominently in Europe. An EBS system integrates all the various braking systems of a vehicle into one electronic controller. Such controlled systems include but may not be limited to:

- Anti-lock brake
- Traction control
- Engine compression brake
- Exhaust brake
- Transmission retarder
- Driveline retarder

A typical EBS system calculates a desired deceleration rate based on service brake air pressure. The system then requests a specific amount of brake absorption from each braking component to achieve the desired deceleration rate. As a result, the service brakes can be electronically controlled to improve service brake response, control, wear, fade, and diagnostics.

4.0 EBS INTEGRATION WITH ALLISON TRANSMISSIONS

EBS may be used with Allison transmissions both with and without the Allison integral hydraulic retarder. The use of EBS with non-retarder transmissions is fairly simple and does not require modifications to the transmission or to the transmission calibration. Refer to 5.0, EBS in Non-Retarder Brake Blending Applications, below.

Applications of EBS that blend the Allison retarder into the braking system have special requirements. These requirements include a special retarder configuration that must be ordered with the transmission. Refer to 6.0, EBS in Retarder Applications. The EBS retarder configuration is available only with specific models and only in specific geographical locations. To determine if the EBS retarder configuration is available with your model in your region, refer to the *Customer Specification Sheets (CSS)* under Engineering on the Extranet; or, consult your Allison representative.

5.0 EBS IN NON-RETARDER BRAKE BLENDING APPLICATIONS

For non-retarder brake blending applications, no hardware, calibration or datalink modifications are required for Allison transmissions to function with EBS. However, one message broadcast by the transmission controller is used by the EBS controller in determining vehicle load, as described in 5.4, TCM Outputs, below.

5.1 SPECIAL HARDWARE

No transmission hardware modifications are required to integrate non-retarder Allison transmissions into EBS applications. This may change in the future as vehicle integration becomes more complex.

5.2 SPECIAL CALIBRATION SETTINGS

No transmission calibration modifications are required to integrate non-retarder Allison transmissions into EBS applications. This may change in the future as vehicle integration becomes more complex.

5.3 INPUTS TO THE TCM

The transmission controller does not require any special inputs for blending non-retarder Allison transmissions with EBS applications. This may change in the future as vehicle integration becomes more complex. Refer to *Datalink Communications* for the latest details on datalink inputs.

5.4 TCM OUTPUTS

The transmission controller does not require any special outputs for blending non-retarder Allison transmissions with EBS applications. However, one message transmitted by the transmission controller is of particular importance to EBS systems:

- J1939 ETC8 Torque Converter Torque Ratio (PGN 61452)

NOTE: In calibrations where a torque-managed engine is not selected, and the default torque converter is assigned, the converter torque ratio sent by the Allison controller in the ETC8 message is based on an average of all available torque converters. This torque ratio is not the exact torque ratio of the specific converter used in a particular vehicle.

In addition to the above message, the EBS system may take into account transmission torque ratio through the geartrain. See *Datalink Communications* for the latest details on such outputs.

6.0 EBS IN RETARDER APPLICATIONS

Some EBS applications integrate the Allison retarder into their braking system. Incorporation of the retarder with EBS allows the system do more of the braking with the retarder versus the service brakes. This may result in longer brake service intervals.

For proper operation, an EBS coordination device requires the following J1939 retarder torque information from the Allison Transmission Control Module (TCM):

- ERC1 Actual Retarder - Percent Torque: the amount of output torque currently created by the driveline retarder, expressed as a percentage of RC Reference Retarder Torque.
- ERC1 Actual Maximum Available Retarder – Percent Torque: the maximum amount of output torque the driveline retarder could generate if requested, expressed as a percentage of RC Reference Retarder Torque.

As a result of the above requirements, the accuracy between the broadcast retarder torque and real retarder torque must be kept to tighter tolerances than for non-retarder brake blending applications. For the 3000 Product Family, the retarder broadcast torque is expected to be between +15% and -25% of real retarder torque. For the 4000 Product Family, the retarder broadcast torque is expected to be between +20% and -30% of real retarder torque.

In order to meet the accuracy requirements for the broadcast retarder torque, Allison retarder brake blending applications use a pressure transducer to monitor retarder pressure. Given this parameter as well as output speed and retarder oil temperature, certain variations within the retarder system can be eliminated, which allows the Allison controller to broadcast a more accurate torque to the EBS controller.

6.1 SPECIAL HARDWARE

Special Allison retarder brake blending hardware consists of a retarder pressure transducer and proper interfacing hardware for the transducer.

6.1.1 PRESSURE FEEDBACK TRANSDUCER

The Allison retarder brake blending system uses a thread-in pressure sending unit to measure the fluid pressure in the path that leads into the retarder cavity. This transducer threads into the retarder valve body and uses an O-ring for sealing. The transducer is available from the Allison Parts Distribution Center. Refer to retarder related support equipment, *Transmission Support Equipment* for the latest part numbers for the transducer.

6.1.2 ELECTRICAL CONNECTOR

The electrical connector of the transducer interfaces with the TCM via a 3-pin GT150 electrical connector assembly. The three pins connect the feedback transducer to the TCM 5-volt supply, analog ground, and retarder feedback pressure signal. For wire numbers and pin-outs, refer to the System Schematic Installation Drawing:

- *AS07-522* for 3000 & 4000 6-speed models
- *AS07-524* for 4000 7-speed models

For the transducer connector information, refer to the *Connector Information Installation Drawing, AS07-505*. For wiring harness and mating connector information, refer to *Technical Document 173 (TD173), Wiring Harnesses for Allison Transmissions*.

Note that the transducer interface uses the same three TCM pin locations and wire numbers as the analog throttle position sensor (TPS). So, even with the required J1939 messages, the feedback transducer is not compatible in any system that uses an analog TPS.

6.1.3 RETARDER EBS VALVE BODY

The retarder feedback transducer is installed in a M16 X 2.0 threaded hole in a chamfered, faced boss on the retarder EBS valve body. For the specific location of the boss, refer to the Retarder Installation Drawing:

- *AS66-406* for 3000 Product Family models
- *AS67-406* for 4000 Product Family models

NOTE: The Retarder-EBS option must be specified when ordering the transmission in order to include the special retarder EBS valve body. The EBS transducer boss is not available on the standard retarder valve body.

6.2 SPECIAL CALIBRATION SETTINGS

In order for the Allison retarder to properly function with brake blending, certain transmission calibration settings are required. When using the *ACCT (Allison Calibration Configuration Tool – Allison 5th Generation Controls)* to request a calibration, answer YES to the following question / VEPS parameter:

RETARDER: Use Pressure Sensor for EBS?

Answering YES to this will result in the following changes to the calibration and software:

- Analog TPS voltage diagnostics are disabled.
- Feedback pressure transducer diagnostics are enabled.
- Retarder feedback transducer input is enabled.
- Retarder broadcast torque (ERC1 Actual Retarder – Percent Torque) uses the sensor instead of the commanded retarder pressure for calculations, which provides a more accurate retarder torque value.

6.3 INPUTS TO THE TCM

When used with brake blending systems, the Allison retarder is compatible with the same TCM inputs as any other retarder system. Current inputs to the TCM include:

- Analog Retarder Modulation Request (RMR): The traditional input device on Allison systems. Comes in many styles, including a 6-position lever, auto-apply, variable pedal, and multi-level brake pressure switches.
- J1939 TSC1 (PGN 0): Contains retarder torque control commands or limits. For example, the antilock brake system could limit torque when ABS is active.
- J1939 ERC1 (PGN 61440): Besides TSC1, certain devices including the EBS controller can request a specific amount of retarder torque by way of the ERC1 Retarder Selection, Non-Engine.

As with non-brake blending retarder applications, these inputs can be received simultaneously and are arbitrated as necessary to determine a final requested retarder torque. Refer to the *Allison 5th Generation Controls Manual* for details of the analog RMR. Refer to *Datalink Communications* for the latest details on the datalink input messages.

6.4 TCM OUTPUTS

The TCM sends the same datalink messages when the Allison retarder is used with brake blending systems as when it is used with non-brake blending systems. Current outputs include:

- J1939 ERC1 (PGN 61440)
- J1939 ETC8 (PGN 61452)
- J1939 Retarder configuration message (PGN 65249)

In addition to the information below, refer to *Datalink Communications* for the latest details of these output messages.

6.4.1 ERC1 OUTPUTS

EBS systems require the following information from the J1939 datalink:

- ERC1 Actual Retarder – Percent Torque: Also known as broadcast torque. This is the amount of retarder torque the TCM calculates is being generated. Expressed as a percentage of RC Retarder Reference Torque.
- ERC1 Intended Retarder – Percent Torque: Also known as the torque target. This is the amount of retarder torque that the TCM is attempting to generate. Expressed as a percentage of RC Retarder Reference Torque.
- ERC1 Retarder Selection, Non-Engine: For Allison RMRs only. This is the amount of torque that the RMR device is requesting from the retarder. Expressed as a percentage of the driver's input device (0 – 100%).

- ERC1 Actual Maximum Available Retarder – Percent Torque: The amount of torque that is available under the current conditions. Expressed as a percentage of RC Retarder Reference Torque.

Allison Transmission recommends that EBS systems support the following J1939 ERC1 message:

- ERC1 Requesting Brake Light: This message can be used to turn on the vehicle's brake lights when the retarder is on. If the Actual Retarder - Percent Torque message is used to activate the brake lights, use of the Requesting Brake Light message provides redundancy if there is a loss of signal from the EBS sensor circuit. If the EBS sensor signal is lost, the TCM broadcasts ERC1 Actual Retarder – Percent Torque message as 'error'.

See *Datalink Communications* for the latest details on these output messages.

6.4.2 ETC8 TORQUE CONVERTER TORQUE RATIO OUTPUT

The EBS system uses the following J1939 ETC8 message:

- ETC8 Torque Converter Torque Ratio (PGN 61452): If the ratio is greater than 1.0, this is the converter's torque ratio at the current speed. If the ratio is 1.0, the torque converter is in lockup mode.

NOTE: In calibrations where a torque-managed engine is not selected, and the default torque converter is assigned, the converter torque ratio sent by the Allison controller in the ETC8 message is based on an average of all available torque converters. This torque ratio is not the exact torque ratio of the specific converter used in a particular vehicle.

See *Datalink Communications* for more detail on this output.

6.4.3 RETARDER CONFIGURATION MESSAGE OUTPUT

The J1939 retarder configuration message (RC) contains several details on the retarder type and capabilities. The message includes the following information:

- RC Retarder Type: Describes the type of retarder to which the message refers. For the Allison driveline retarder, this is always Hydraulic.
- RC Retarder Location: Describes the physical location of the retarder. For the Allison retarder, this is always Transmission Output.
- RCFG Retarder Control Method: Describes the type of control to which the retarder can be subjected. For the Allison retarder, this is always Continuous.
- RC Retarder Configuration Map: Describes the maximum available torque of the retarder as a function of speed in five points, including the absolute maximum available torque as a reference.

Refer to *Datalink Communications* for the latest details.

6.5 PRESSURE FEEDBACK CONTROL

When the Allison retarder is used in a brake blending system, Allison uses a feedback pressure transducer to reduce variation between the actual retarder torque and the torque that is broadcast to other systems on the datalink. This is accomplished by replacing the commanded pressure in the retarder characterization logic with the measured pressure.

Figure 1 shows how retarder broadcast torque is calculated in a non-brake blending system. Basically, the logic uses commanded pressure, retarder temperature, and output speed to calculate a broadcast torque, which is then filtered prior to sending across the J1939 link. Effec-

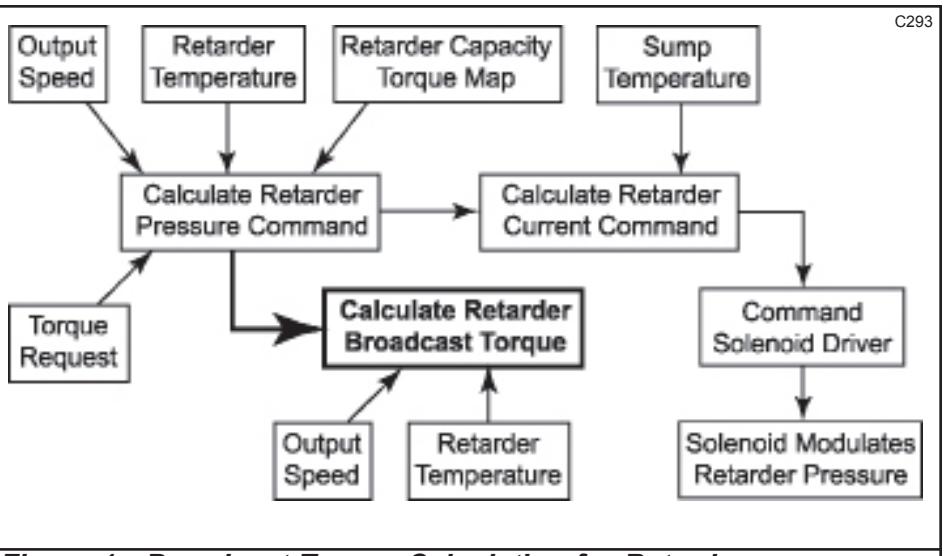

Figure 1: Broadcast Torque Calculation for Retarder Applications Without Brake Blending

tively, the calculation of the solenoid's electrical current, the solenoid driver strength, and the solenoid variation cannot be taken into account.

In contrast, Figure 2 describes the calculation of retarder broadcast torque using the feedback transducer. Rather than beginning with the calculated pressure command to determine the broadcast torque, the feedback method replaces the calculated command with a filtered pressure signal from the feedback pressure transducer. In doing so, the feedback transducer compensates for any added error from the calculation of the solenoid's electrical current, the solenoid driver, and the solenoid.

Due to concerns with the ability to diagnose a pressure transducer signal that may deviate from specification, the system is open-loop, and therefore does not attempt to compensate for the error between pressure command and feedback pressure. Rather, the broadcast torque calculations basically replace the commanded pressure with the feedback pressure transducer

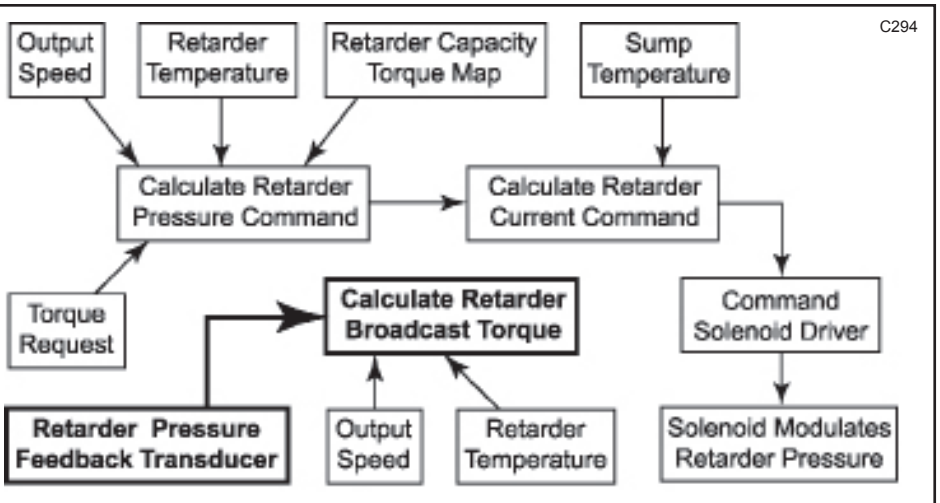

Figure 2: Broadcast Torque Calculation for Retarder Applications With Brake Blending

signal. Additionally, if a diagnostic code regarding the feedback pressure transducer activates, the broadcast torque (ERC1 – Actual Retarder – Percent Torque) is sent as Error.

6.6 INSTALLATION REQUIREMENTS

When making use of the driveline retarder brake blending feature of an EBS controller, Allison has established requirements that are necessary to assure improved torque accuracy between the actual broadcast torque and real retarder torque. Non-retarder transmissions have no special requirements associated with the use of EBS.

NOTE: The requirements listed in Figure 3 are IN ADDITION to the standard installation requirements. The transmission installation also must meet applicable installation requirements documented in Allison Transmission's *Tech Data* and in the *Allison 5th Generation Controls Manual*.

REQUIREMENT	DESCRIPTION	RISK OF NON-COMPLIANCE
Accepted Installation Review Required	Allison Transmission must review vehicle installations with brake blending for each combination of chassis, engine, and transmission for compliance with the requirements in this document.	Allison will not support applications that do not have an accepted Installation Review.
Fluid Type	TES-295 licensed fluid	Increased variation in retarder torque accuracy.
Capacity Level	Low, Medium, and High Capacity	Increased variation in retarder torque accuracy and phasing.
Accumulator Installation and Air Supply (if applicable)	If applicable, the installation of the retarder accumulator, all hoses, fittings, and air supply pressure must comply with installation drawing (3000 Product Family) or (4000 Product Family)	Delayed retarder response of harsh torque overshoots upon apply.
Transmission Cooling System	The oil pressure drop across the transmission's retarder cooling system should not exceed 290 kPa at 227 liters/minute at 149ºC.	Increased variation in retarder torque accuracy.

Figure 3: Requirements for Brake Blending Applications with the Allison Retarder

LIST OF REFERENCED DOCUMENTS

- *Transmission Support Equipment*
- *Allison 5th Generation Controls Manual*
- *Customer Specification Sheets (CSS)*
- *Datalink Communications*
- *ACCT (Allison Calibration Configuration Tool – Allison 5th Generation Controls)*
- *Tech Data (main menu)*

Installation Drawings

- *AS07-505, Connector Information*
- *AS07-522, System Schematic for 3000 & 4000 6-Speed Models*
- *AS07-524, System Schematic for 4000 7-Speed Models*
- *Retarder Installation* for 3000 Product Family
- *Retarder Installation* for 4000 Product Family

Technical Documents (TD's)

- *TD-173, Wiring Harnesses for Allison Transmissions*

REVISION HISTORY

REVISION E, JANUARY 24, 2018
- In Figure 3, Capacity Level Description changed to “Low, Medium, and High Capacity”

REVISION D, NOVEMBER 11, 2015
- In 5.4, revised note to indicate “In calibrations where a torque-managed engine is not selected, and the default torque converter is assigned, ...”
- In 6.0, changed Percent Torque to ERC1 Actural Retarder - Percent Torque, and changed RCFG Reference Retarder Torque to RC Retarder Reference Torque
- In 6.2, change CAN EBS Ret Pressure Sensor? to Retarder: Use Pressure Sensor for EBS, and delete first bullet “Autodetect for analog TPS is disabled”
- In 6.3, corrected TCM typo, was TMC
- In 6.4, changed RCFG Reference Retarder Torque to RC Retarder Reference Torque, changed ERC1 Requesting Brake Light to ERC1 Retarder Requesting Brake Light, changed Retarder Percent Torque to Actual Retarder - Percent Torque, revised NOTE in 6.4.2 to match revised NOTE in 5.4, changed RCFG to RC in 6.4.3
- In 6.5 changed “indeterminate” to “Error”

REVISION C, SEPTEMBER 30, 2015
- No content changes to document. However, “Export” of InDesign file to Adobe pdf file during revision B distorted the information in Figure 3, making it difficult to read. This has been corrected in revision C.

REVISION B, MAY 19, 2015
- Updated document for Allison 5th Gen Controls. ACCT (Allison Calibration Configuration Tool for Allison 5th Gen Controls) replaces eCSS. AS07 drawing numbers updated to 5th Gen Control versions. All Extranet links updated.
- In 6.2, changed wording of EBS pressure sensor question to: “RETARDER: Use Pressure Sensor for EBS (20040)?”, was “CAN EBS Ret Pressure Sensor?”. Revise wording matches wording in ACCT.

REVISION A, MAY 29, 2008
- In 6.2, replaced PCCS with eCSS (electronic Customer Specification Sheet – Allison 4th Generation Controls)
- Updated AS07-423 to AS07-424 for 4000 7-Speed System Schematic installation drawing
- Added 2.0, Referenced Documents, and List of Referenced Documents

NEW TD, AUGUST 22, 2006
- Created new document.