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(R) All-Wheel Drive Systems Classification**Foreword**

This Document has been updated to reflect changes in nomenclature and classification of All-Wheel Drive Systems within the industry.

1. Scope

In this SAE Recommended Practice, attention will be given to passenger cars and light trucks (through Class III).

1.1 Purpose

The definitions are intended to outline basic nomenclature and to categorize all-wheel drive concepts. The goal is to give those working in the field a common base for discussion regarding the type of all-wheel drive systems independent of marketing terminology.

2. References

There are no referenced publications specified herein.

3. Definitions**3.1 All-Wheel Drive System Description**

A conventional all-wheel drive system consists of a means to distribute torque to all axles of a vehicle. Based on desired performance, traction and handling characteristics, there are different types of systems to achieve these ends. These all-wheel drive systems include 4X4, 6X6, etc... There are three basic types of systems defined below, but hybrid combinations of these systems may also be used.

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3.2 Part-Time All-Wheel Drive System Description

In a part-time all-wheel drive system, driver intervention is required to rigidly couple primary and secondary axles.

When a part-time system is in the locked mode, the primary and secondary axles are rigidly connected through the torque managing / distribution device (i.e. Power Transfer Unit (PTU), transfer case). The primary axle is normally connected unless in neutral mode. The secondary axle(s) is/are engaged in all-wheel drive and disengaged in two-wheel drive. The torque managing / distribution device is commonly referred to as a transfer case in primary rear wheel drive based all-wheel drive vehicles. In a primary front wheel drive based vehicle, the torque management / distribution functions are typically handled in the PTU, transaxle, or secondary axle(s).

This basic type of system requires the driver to select between two-wheel drive and all-wheel drive using either a switch or lever. Part-time systems may allow the driver to shift between two-wheel drive and all-wheel drive while the vehicle is in motion.

Part-time systems may have two speeds - one for normal driving (High-range) and one for improved ground speed control and increased gradeability (Low-range).

Although part-time all-wheel drive achieves maximum traction under certain conditions it should be limited to off-pavement usage or on-pavement usage in low traction scenarios. Torque "wind up" is experienced during on-road dry pavement usage when making moderate to tight low speed turns. This "wind up" (also referred to as crow hop or binding) is due to the fact the front and rear axles are rigidly connected (no center differential) and rotating at the same speed but traveling different distances.

3.3 Full-Time All-Wheel Drive System Description

In a full-time all-wheel drive system front and rear axles are driven at all times through a center differential.

Unlike a part-time system, the full-time system employs a center (inter-axle) differential that allows the front and rear axles to turn at different speeds on wet or dry surfaces. Depending upon the gear ratio in the differential, the input torque can be nominally split to the front and rear axles in a fixed ratio. A 35:65 split means that 35% of the torque is directed to the front axle and 65% to the rear axle.

For maximum traction, torque through the center differential must be modulated to distribute power to the axles with the greatest traction. Torque modulation can be done passively, actively, with a torque biasing device, or with brake based traction control systems.

This type of system can be used on any surface at any speed.

3.4 On-Demand All-Wheel Drive System Description

In an on-demand all-wheel drive system, the secondary drive axle is driven by an active or passive coupling device.

In a typical on-demand all-wheel drive system, the vehicle operates in two-wheel drive (either front or rear depending upon the basic vehicle architecture) until all-wheel drive is required, such as during primary axle slip, yaw correction, or by other control strategies. Torque transfer from the primary to the secondary axle(s) can be modulated, dependent on driving conditions. Most systems are typically relative speed control devices and activate when there is a speed difference between the primary and secondary axle(s) due to slippage; however, pre-emptive slip or other control strategies are common.

This type of system can be used on any surface at any speed.

3.5 AWD Synchronization

The act of bringing two or more torque carrying members to the same speed to engage all-wheel drive while the vehicle is in motion.

3.6 Speed Differentiation

A difference in speed between two or more driven members.

3.7 Longitudinal Torque Distribution

3.7.1 FIXED TORQUE DISTRIBUTION

Output torque distribution is fixed by the design of the device. Typical examples include open center differentials.

3.7.2 VARIABLE TORQUE DISTRIBUTION

Output torque distribution is variable by the design of the device. Typical examples include couplings and torque biasing devices.

3.7.3 INDETERMINATE TORQUE DISTRIBUTION

Output torque distribution is not determined by the device but by the input torque and tractive capability. Typical examples include part-time all-wheel drive systems.

3.8 Coupling Device

Primary functions are to connect input and output elements (analogous to series powerflow) and vary torque (continuously or discretely).

3.9 Active control

Possesses variable tuning based on external control feedback. Actively controlled systems typically incorporate an electronic control unit. Active systems include electronically controlled electro-magnetic, electro-mechanical and electrohydraulic actuated wet clutches. Active systems can be integrated with other vehicle control systems to improve traction and/or stability .

3.10 Passive control

Possesses preset tuning without external control feedback. Passively controlled systems do not incorporate an electronic control unit and thus do not sense non-driveline variables or interact with other vehicle control systems. Passive devices include viscous couplings and hydraulically activated clutch pack couplings - without external controls.

3.11 Power Transfer Unit (PTU)

In a transverse mounted drivetrain based vehicle, this term refers to the drive mechanism that distributes power towards the secondary axle. Its primary function is to change the direction of powerflow. The PTU may also contain torque management devices. Typically, PTUs are utilized in front wheel drive based applications.

NOTE—A Power Take Off Unit (PTO), not the same as a PTU, is a device whose primary function is to drive accessories (a PTO is not utilized to propel the vehicle).

3.12 Torque Biasing Device

A coupling device in parallel with a differential.

3.13 Transfer Case

In a longitudinal mounted drivetrain based vehicle, this term refers to the drive mechanism that distributes power to the front and rear axles. Its primary function is to offset the powerflow. The transfer case may also contain torque management devices.

3.14 All-Wheel Drive Systems Classification Diagram

4. Notes

4.1 Marginal Indicia

The change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions have been made to the previous issue of the report. An (R) symbol to the left of the document title indicates a complete revision of the report.