

## Science Module: Levels of Vehicle Automation

Levels of vehicle automation established by SAE

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### WHAT IT DOES

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SAE International Levels of Automation, as set by [SAE J3106](#), define six levels of driving automation. The levels are ordinal; as the level increases, more driving tasks shift from the responsibility of the driver to the responsibility of the vehicle. SAE International put forth the classification system to provide the public and the industry with standardized terminology to describe driving systems. Since there are a variety of interchangeable and semantically different terms associated with driving systems, it is important to establish universal classification of the features of these systems to ensure some consistency in manufacturer designs vehicle capabilities. The SAE system has become the most widely used system to classify automation and has been adopted by prominent entities such as the US Department of Transportation, Congress and the Senate.

The six SAE levels of automation indicate whether an autonomous driving system executes steering and acceleration, monitors the driving environment, retains fallback control of the driving task in unideal conditions, and which environments the system can drive in. This division of responsibilities between the operator and the vehicle is illustrated in the figure below. The responsibilities of the autonomous driving system at each level in these four areas are as follows:

- Level 0: No automation: The human driver performs all driving operations.
- Level 1: Driver assistance: The human driver performs most driving operations. The system can assist by executing acceleration or steering, but not both at the same time and only in certain driving modes. Most manufacturers have introduced systems with level 1 automation through features such as adaptive cruise control or lane guidance on models.
- Level 2: Partial automation: The human driver performs most driving operations, but the system can assist by controlling acceleration and steering simultaneously for short periods of time in certain driving modes. Human drivers are still responsible for monitoring the environment, including object and event detection and response, and for retaining fallback control of the driving task.
- Level 3: Conditional automation: The system performs all driving operations under certain conditions, but requests the human driver to retain fallback control of the driving task when it encounters a situation it cannot handle. A significant jump exists moving from level 2 to level 3, as the responsibilities to monitor the environment transfer from the human driver to the system. Systems at level 3 and above are often referred to as highly automated systems, or HAV.
- Level 4: High automation: The system performs all driving operations under certain conditions, monitors the driving environment, and does not require the human driver to retain fallback control of the driving task in any conditions. The human driver has the option to control the system in special circumstances such as a traffic jam, but the system must be able to resolve a problem or end the trip if the human driver does not assume control.
- Level 5: Full automation: The system performs all driving operations and can drive from a start destination to an end destination without human input.



<http://cyberlaw.stanford.edu/blog/2013/12/sae-levels-driving-automation>

**BACKGROUND**

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Further reading:

- (1) <http://www.thedrive.com/sheetmetal/15724/what-are-these-levels-of-autono...>
- (2) <https://driverless.wonderhowto.com/news/definitive-guide-levels-automati...>
- (3) <http://cyberlaw.stanford.edu/blog/2013/12/sae-levels-driving-automation>

**RELATED POLICIES**

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American Vision for Safer Transportation through Advancement of Revolutionary Technologies (AV START) Act (S 1885, [SciPol brief available](#)) establishes regulations for the development of highly automated vehicle (HAV) technologies. The AV START Act uses the SAE Levels in its definition of highly automated vehicles (HAV).

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