J3134
Automated Driving System (ADS) Lighting

AVSR GRE Task Force Summary
12/2018

J3134 - ADS Lighting Status

Automated Driving System
Marker Lamps











J3134 - ADS Lighting Status

Studies
ADS Vehicle-to-Pedestrian Communication

Stanford University - People need acknowledgement that they have been noticed to be comfortable walking or bicycling in front of autonomous cars

Duke University - There is a need for new methods of vehicle to pedestrian communication to communicate intent information in the immediate area

CityMobil2 project in Europe - The most important message that needs to be communicated to cyclists and pedestrians is whether they have been detected…At the moment the most important thing is there is absolutely no information and communication between the vehicle and the people…So pedestrians don't know its intentions." -

Chalmers University of Technology - There is a need for external communication interface between pedestrians and automated vehicles to compensate for the loss of the driver and perceived safety.

Semcom's Smiling Car Experiment - 80% of all respondents said that, as pedestrians, they seek eye contact with the driver.

2016 NHTSA's Voluntary Guidance for Automated Driving Systems (updated 2017) - HMI design should also consider the need to communicate information regarding the ADS's state of operation relevant to the various interactions it may encounter and how this information should be communicated…

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SURFACE VEHICLE RECOMMENDED PRACTICE	J3134™	3rd ballot
	Issued 20xx-xx Revised Proposed Draft 2018-12 Superseding – N.A.	
Automated Driving System (ADS) Marker Lamp(s)		

SAE J3134 Development

- **December 2015 - UMTRI, Ann Arbor, MI.** The subject of Automated-Driving Vehicle lighting was raised for discussion and the SAE Lighting Committee agreed to start investigation on automated vehicle lighting.
- **September 2016 – Portland, Oregon.** The status on the development of automated vehicles and examples of automated vehicle lighting was presented. It was decided to form a task force to investigate automated vehicle lighting
- **November 2016** - SAE J3134 – Automated Driving System (ADS) Lamps was opened
- **January 2017** – “Call for experts” was sent out for development of J3134
- **February 2017** – First task force meeting of J3134
- **January 2019 – 3rd** ballot being considered by SAE Signal and Marking Committee

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J3134 Task Force

- Monthly meetings.
- Currently has over 75 members. Included as members in the task force are most of the major OEMs (GM, Toyota, Ford, FCA, Nissan, Mercedes, VW, and Honda), tier 1 and 2 lighting suppliers, academia; NHTSA and Transport Canada, GTB, ISO members.
- The main discussion topics: signals/messages needed, how to communicate these signals/messages with lights, the location of the lamps, color of the lamps, photometry, installation, etc.

J3134 Draft Rationale

Usage of pictorials or symbols:
Pictorials, symbols, text and other forms of communication are not addressed in this document as they were deemed to fall outside the scope of the Task force members' expertise. This document is not intended to preclude the use of such types of communication, however, it is strongly encouraged for manufacturers to consider certain aspects of J3134 when using illuminated pictorials, symbols, and text including color, photometry, installation location, and visibility.

ADS lamps:
Current signal lamps, i.e. turn signals, stop lamps, indicating the vehicle's intended or change in movement would be retained on ADS-equipped vehicles. However, until the assumption of presence of a human driver wanes and the lack of a human driver becomes the norm, additional vehicle-to-road-user communication may be beneficial. ADS lamps(s) would indicate the ADS-equipped vehicle's ADS status, e.g. when the ADS is engaged.

ADS lamps in this recommended practice are intended to be seen from the front of the vehicle. There may be no vehicle driver or there may be a person sitting in the traditional driver's seating position that is does not have the role to be involved in the driving tasks in an ADS-equipped vehicle. These ADS lamps provide information to the road user, in the absence of a driver, as to the vehicles' ADS status and intent, and may provide comfort and ease of acceptance as ADS-equipped vehicles are introduced into the market. Vehicles with the ADS engaged are inherently safe, so these ADS lamps are intended to provide additional information to road users. ADS lights to the side and rear are not covered in this document, because the intent of these lamps is to make road users feel comfortable in the absence of a conventional driver as seen from the front of the vehicle, but they are not prohibited.

Concerns have been raised that the use of ADS marker lamps, that indicate the vehicle's ADS is engaged could attract intentional interference from other road users. Early studies suggest that other road users' opinions are that they would prefer some type of indicator identifying that a vehicle is driving autonomously and that the vehicle is "yielding" or transitioning to "not yielding". However, there is no evidence that the absence of these signals poses any safety concern and there is a concern that these signals may pose a safety hazard due to potential confusion over what a signal may be communicating. Therefore, this document does not recommend mandating the use of any ADS lamps, but instead attempts to standardize any ADS lamp signals to reduce the risk that conflicting signals are executed in the field."

J3134 Draft Rationale

The photometric intensities and angles were determined considering the following unique features of the ADS lamps:

1. ADS lamps are intended to be visible to road users (i.e. nearby pedestrians, pedal cyclists and motorists) in close proximity to the vehicle;
2. the ADS Marker lamp is designed to be activated both in daytime and nighttime conditions;
3. the wide range of mounting heights of ADS lamps.

ADS signals:

Early in the development of this document, the task force considered the following ADS messages: 1) ADS status (on or off), 2) yielding, 3) ready to go. These messages were matched with the following light signals from simplest to more complex: 1) steady, 2) flash or sweeping, 3) flash or sweeping. As the document progressed, the task force decided that further research and studies are needed to evaluate the use and effectiveness of flashing and sweeping light signals to communicate the ADS yield and ready to go messages. As a result, this document currently only focuses on a marker light to indicate the ADS status.

Color and location:

Current regulations prescribe particular emitted colors for lighting functions in defined locations. Therefore, depending on the location, the use of these regulatory-prescribed colors for ADS lamps could be confused with existing required lamps, thereby diminishing the recognition and effectiveness of ADS lamps. Experts from OEM's, Tier suppliers and research institutions, such as University of Michigan Transportation Institute (UMTRI) and University of Tübingen in Germany, evaluated potential ADS lamp colors. These evaluations support the use of blue-green light for ADS lamps. A unique color allows greater flexibility in mounting location relative to other, required lamps, and facilitates innovation for new automotive ADS lamps. This document recommends the use of a unique light color, e.g. blue-green

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Scope:

This SAE Recommended Practice provides guidelines for the use, performance, installation, activation and switching of marking lamps on Automated Driving System (ADS)-equipped vehicles.

Definitions:

Automated Driving System (ADS) - The hardware and software that are collectively capable of performing the entire dynamic driving tasks (DDT) on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a level 3, 4, or 5 driving automation system (SAE J3016)

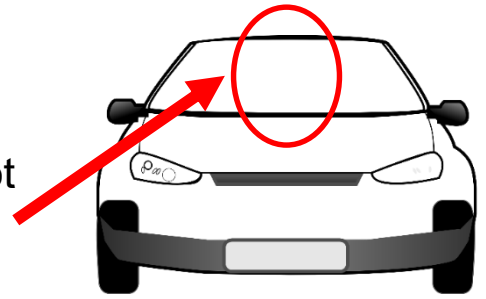
ADS Marker Lamp(s) – A device(s) emitting light to indicate when a vehicle's ADS is engaged in the operation of the vehicle.

~~**ADS Signal Lamp(s)** – A device(s) emitting light to communicate the vehicle's ADS motive intentions.~~

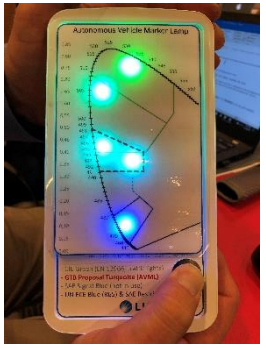
(NOTE: ADS Signal Lamp(s) was removed from J3134 after the first ballot because, the SAE Committee recognized that more research was needed to determine the which form of signal, e.g. flashing, sweeping, etc., is best for communicating the vehicle's ADS intentions.)

J3134 PROPOSED ADS LAMP COLOR AND LOCATION

Early meetings proposed only the use of current approved colors…e.g. yellow, white, selective yellow. This meant that the lamp location would be the primary indication of an ADS-equipped vehicle…a unique location for the ADS lamps was needed so as not to be confused with existing lamps. Location was limited to centerline of vehicle around the front glass opening (windshield).

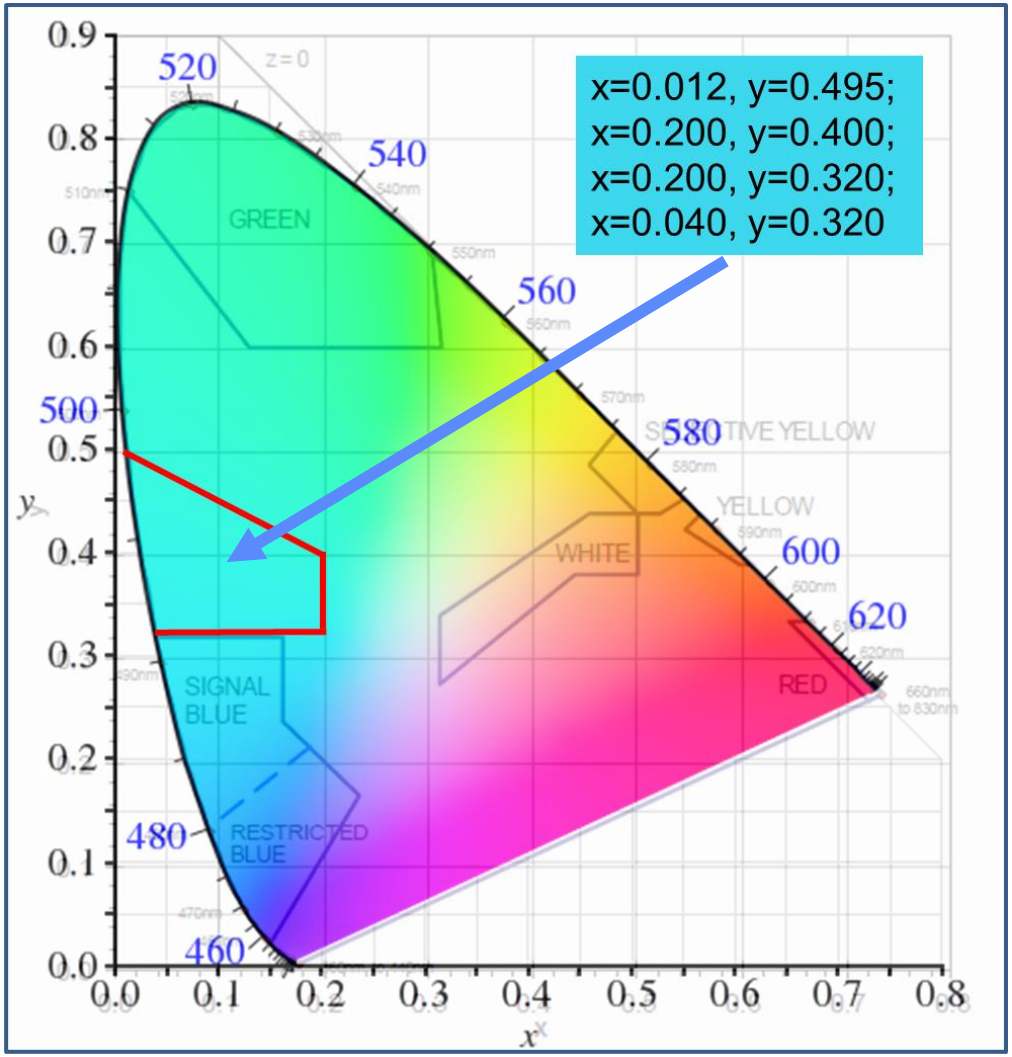


Later meetings…the task force recognized that limiting the location was restrictive to design and there were concerns with performance, installation and manufacturing…opened up location options. But, now ADS lamps could be near existing lamps…so to differentiate ADS lamps they had to have a unique color. Currently blue-green is the proposed color.



J3134 CURRENT PROPOSED ADS LAMP BLUE-GREEN COLOR

CIE (1931) Chromaticity Diagram



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Why a unique color?

WHICH VEHICLES HAVE ADS ACTIVATED?

FIND THE ADS LIGHTS?

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The goals of J3134 task force are to foster harmonization efforts in the development of ADS lamps, that automated driving vehicles would use to communicate with pedestrians and other road users and to create a quality document that can be used globally as a guide.

We hope that the publication of this Recommended Practice will encourage other regions to communicate with SAE if they are considering developing their own ADS lamp standard or regulation.