

TECHNICAL REFERENCE

Autonomous vehicles

– Part 1 : Basic behaviour



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Centre of Excellence for Testing & Research of AVs – NTU
Firemark Labs Singapore, Insurance Australia Group
HERE Technologies
Land Transport Authority
Nova Systems Pte Ltd
nuTonomy
Singapore Road Safety Council
Singapore Traffic Police
SingPilot Pte Ltd
ST Engineering Land Systems Ltd

*The Netherlands Organisation for Applied Scientific Research
Transport Research Centre @ NTU
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Foreword

This Technical Reference (TR) was prepared by the Working Group on Basic Behaviour appointed by the Technical Committee on Automotive under the direction of the Manufacturing Standards Committee.

TR 68 is intended to support the development of AV technology and deployments and consists of the following parts under the generic title “Autonomous vehicles”:

Part 1 – Basic behaviour

Sets out fundamental behaviours AVs should exhibit while driving on public roads in order to co-exist safely with entities on the roads such as other vehicles, cyclists, and pedestrians.

Part 2 – Safety

Sets out the safe design and continuing safety management process requirements, supported by competent personnel and organisational quality certifications that organisations should have in place so that the AVs driving on public roads are inherently safe and behave in the manner that they are designed to.

Part 3 – Cybersecurity principles and assessment framework

Sets out principles and assessment framework for organisations to support development and management of AVs. The assessment framework is intended to provide a cybersecurity safeguard for AVs to satisfy prior to on-road deployment.

Part 4 – Vehicular data types and formats

Sets out what data, resolution, capture frequency and the format in which they should be transmitted so that there is seamless communication between sending party and receiving party.

This TR is a provisional standard made available for application over a period of three years. The aim is to use the experience gained to update the TR so that it can be adopted as a Singapore Standard. Users of the TR are invited to provide feedback on its technical content, clarity and ease of use. Feedback can be submitted using the form provided in the TR. At the end of the three years, the TR will be reviewed, taking into account any feedback or other considerations, to further its development into a Singapore Standard if found suitable.

Acknowledgement is made to the following organisations for their kind permission to reproduce their materials into this TR:

- Singapore Police Force [Basic Theory of Driving (Tenth Edition) and Final Theory of Driving (Ninth Edition)];
- nuTonomy [Figure 7 of this TR].

Attention is drawn to the possibility that some of the elements of this Technical Reference may be the subject of patent rights. Enterprise Singapore shall not be held responsible for identifying any or all of such patent rights.

NOTE

1. *Singapore Standards (SSs) and Technical References (TRs) are reviewed periodically to keep abreast of technical changes, technological developments and industry practices. The changes are documented through the issue of either amendments or revisions.*
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Technical Reference for autonomous vehicles

Part 1: Basic behaviour

0 Introduction

This TR discusses basic driving behaviour for autonomous vehicles (AVs), where the AV is operated by a level 4/5 automated driving system (ADS) as defined in SAE J3016_2018.

AVs are one of the many types of vehicles that are on the roads today. For the purpose of this TR, it is assumed that the regulations in place at the time of its writing that apply to traffic rules have not been changed to accommodate AVs. Based on our current knowledge of how AVs are designed, Annex A of this TR seeks to list traffic rules published in the *Basic Theory of Driving* (Tenth Edition) and *Final Theory of Driving* (Ninth Edition) that may be applicable to AVs.

By listing the basic interactions anticipated in the context of Singapore's public roads, this TR gives provisions on an AV's longitudinal and lateral movements, as well as relevant vehicle controls so that it can co-exist with other road users harmoniously. As older AVs may have some technological limitations, Clause 5 gives provisions on the management of capability limitations.

The meanings of automation driving levels, automated driving system (ADS), operational design domain (ODD), dynamic driving task (DDT) are as defined in SAE J3016_2018.

This TR is applicable to the following:

- AV developers / operators;
- Suppliers and manufacturers;
- Government agencies / local authorities;
- Testing, inspection and certification bodies;
- Private service and data providers;
- Insurance companies.

1 Scope

This TR gives the provisions relating to the dynamic driving task (DDT) and behaviour controlled by an AV's automated driving system (ADS). The scope is as follows:

- a) Conduct of autonomous driving, including but not limited to vehicle-to-vehicle interactions;
- b) Interpretation of road signs, markings and traffic signals; and
- c) Management of non-transferable rules.

This TR covers the key directives, providing safety and maintaining traffic movement, for automated driving and provides a hierarchy of directives and rules to overcome potential conflicts between rules. It introduces a framework for the application of rules as part of a driving policy. The TR also discusses the current capability limitations of AVs and accounts for a continual process of improvement, which includes the refinement of the rulebook and scenario database.

The following are not covered in this TR and may be considered in future revisions:

- a) The interface between an AV and any occupants including the human safety driver;
- b) Rules relating to non-driving tasks and longer term tactical cognitive functions such as route planning; and
- c) Communication or signalling between the AV and external stakeholders including but not limited to pedestrians and other drivers, which extends beyond use of standard vehicle equipment, including lighting and horn, as described in existing driving rules.

There are substantial references to Singapore's *Basic Theory of Driving* (BTD) and *Final Theory of Driving* (FTD) throughout this TR. Where applicable the relevant items of the BTD/FTD are linked in brackets. For example "(BTD 1)" refers to item number 1 of the BTD.

2 Normative references

The following referenced documents are indispensable for the application of this standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BTD	<i>Basic Theory of Driving</i> (Tenth Edition), Singapore Traffic Police, 15 February 2018.
FTD	<i>Final Theory of Driving</i> (Ninth Edition), Singapore Traffic Police, 1 July 2017.
ECE/TRANS/WP.29/GRRF/85	Report of the working party on brakes and running gear on its eighty-fifth session
SAE J3016_2018	Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles