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## Methods of Examining Vehicle Electronic Systems in the Course of Automotive Forensic Expert Examinations

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### Abstract

The objects of the article: to publish the results of the analysis of methodical ware, tools and software used by automotive expert witnesses when examining vehicle electronic systems in the course of forensic expert examination; to substantiate the required and sufficient set of diagnostic devices used in automotive forensic expert examinations of vehicles equipped with electronic control systems; to specify diagnostic techniques used while examining vehicles with electronic control systems to solve the questions set for automotive expert witnesses by judicial authorities. The urgency of this publication consists in the necessity of developing an algorithm of actions to be used by forensic expert witnesses while examining parameters of vehicle technical state, parameters of operational processes of assemblies and systems as well as diagnostic codes stored in the vehicle electronic control unit (ECU) memory. In this publication, we draw attention to the fact that information, which has been set forth in technical literature, study materials, and publications over recent years, does not contain specific guidelines on how to organize the work of automotive forensic expert witnesses. The scientific novelty of this publication consists in that it suggests general techniques for an expert's operation with diagnosis reports made as a result of using electronic diagnostic systems, inspection lines and specialized test benches to solve specific tasks, such as determining hidden causes of failures of separate vehicle units based on the data on malfunctions of other mechanisms and systems recorded by electronic units; determining defect (failure) location in vehicle electronic control systems in cases when there is no diagnostic code or the diagnostic code does not indicate a specific type of failure.

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## 1. Introduction

The activity of automotive forensic expert witnesses is notable for their special responsibility established by the legislation of the Russian Federation. To solve the questions set by the court on a professional level, an expert witness shall use more than one hundred years world's experience in vehicle construction, operation and repair, the theory of vehicle motion and driving [Federation Council (2001), Ministry of Justice of the USSR (2006), Rossinskaya (2004)].

In accordance with the law, in judicial proceedings, when settling civil or criminal cases relating to vehicle possession, vehicle operation or changing the technical state of a vehicle, judges must commission various expert vehicle examinations (EVE) [Yakovlev (2003), Sosnin (2008)].

When an EVE is scheduled, the court ruling stating the claim summary and the case files are sent to an expert institution or an independent automotive expert witness. The court ruling must clearly formulate the questions to which the forensic expert witness must give precise, substantiated and unambiguous answers [Henderson and Haynes (2001), White and Randall (2009), Randall (2006)].

Whereas the law does not limit an expert witness's choice of examination techniques, there are also no limitations of diagnostic devices to be chosen by the expert. Table 1 below gives a summary of the stages of development of diagnostic devices as well as general characteristics of diagnostic devices based on their availability, indication, recording, storage and type of diagnostic data (DD) processing.

Table 1. Characteristics of diagnostic devices based on their availability, indication, recording, storage and type of diagnostic data processing during an expert vehicle inspection.

Stages of development of diagnostic devices	Method of DD acquisition	Type of indication	Possibility of recording	DD storage in the unit under test or in an automated measuring and computing system (AMCS)	Method of DD processing	Possibility to communicate with external AMCS
Organoleptic method	Usage of diagnostician's sensory organs	External manifestations of output processes in the diagnostician's sensations	Limited by photographing and video recording Description of the diagnostician's sensations	Not stored	Based on the diagnostician's experience	No
Instrument panel	Measurement of physical quantities obtained from built-in sensors	Indication on pointer-type or indicating devices, indicator lamps	Limited by photographing and video recording Description of the diagnostician's observations	Not stored	Based on the diagnostician's experience	No
Special diagnostic devices to diagnose mechanisms and systems (external)	To be connected during diagnosis. Measurement of 1 or 2 diagnostic parameters	Indication on pointer-type or indicating devices, Displaying oscillograms	Photographing and video recording. Drawing up a measurement report using the form, diagrams of operational processes and oscillograms	Not stored	Based on the diagnostician's experience. If the device is connected to the AMCS, comparison with the AMCS data base	Available if the device level corresponds to the AMCS

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