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Road vehicles — Open diagnostic data exchange (ODX) —

Part 3: Fault symptom exchange description (FXD)

Véhicules routiers — Diagnostic généralisé, échange de données (ODX) —

Partie 3: Format d'échange de système de défaut (FXD)

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Foreword

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This document was prepared by Technical Committee ISO/TC 22, *Road vehicles*, Subcommittee SC 31, *Data communication*.

Annex A, B and C of this document are normative and Annex D is for information only.

A list of all the parts in the ISO 22901 series can be found on the ISO website.

Introduction

0.1 Overview

This document has been established in order to define a new format called FXD (Fault symptom eXchange Description) which has been developed for provision of machine-readable descriptions of mainly fault symptom algorithms which are implemented as diagnostic software in an Electronic Control Unit (ECU).

The main business case is the data exchange from a function and software supplier to a vehicle manufacturer in a standardized format (FXD XML-Schema) in order to enable a tool based processing.

The software supplier will provide software related raw data, which have to be extended and refined by the vehicle manufacturer for different use cases. Based on the FXD content and associated calibration values, several end user documents can be generated such as the summary table for OBD documentation.

The expected main benefits of the FXD approach are an overall improved efficiency as well as an independency of system supplier and vehicle manufacturer-specific format handling.

FXD is an extension of ODX in order to support the documentation and fault symptom data exchange use cases for type approval and repair and maintenance information (RMI).

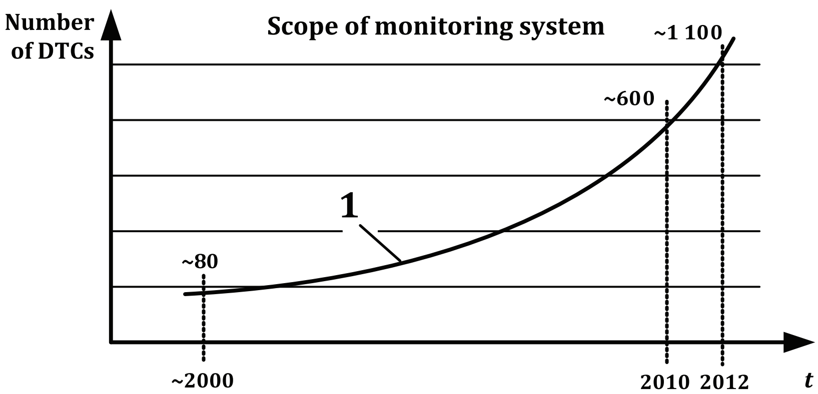
A normative annex will include the FXD XML-Schema which represents the data model for the digital exchange of the FXD data.

0.2 Motivation

The complexity of OBD monitoring systems is continuously evolving. Technological progress and regulatory updates drive the complexity of both engine systems themselves and the related OBD monitoring systems. For instance, the number of monitors and thereby also Diagnostic Trouble Codes (DTC) has considerably increased over time as shown here for a 6-cylinder gasoline application from calendar year 2000 up to 2012.

In addition to the pure number of monitors, also the OBD monitors themselves have become more and more sophisticated.

Figure 1 shows the evolving complexity of OBD systems.



Key

1 6-cyl gasoline engine

Figure 1 — Evolving complexity of OBD systems

0.3 Project complexity

Today's project complexity (e.g. variants) at the vehicle manufacturers is also an important aspect for diagnostic documentation. For all OBD-relevant monitoring strategies, the corresponding OBD documentation is generated. When these monitors are integrated by often different project teams, they may need to be specifically adapted and calibrated in order to operate properly in the different projects.

To ensure accurate OBD documentation across all projects, considerable efforts for synchronization and manual adjustment are necessary. Obviously, this specific approach will provide only a limited reuse potential.

Figure 2 shows the project complexity and accurate OBD documentation.

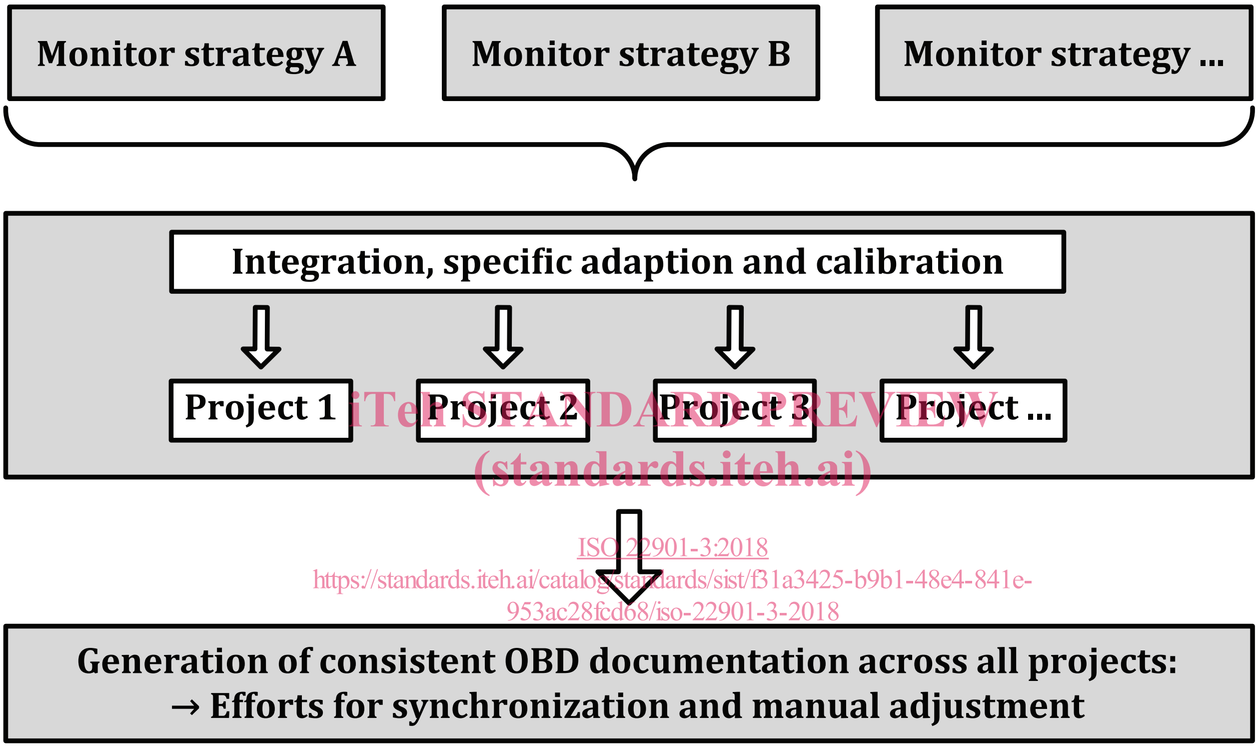


Figure 2 — Project complexity and accurate OBD documentation

In addition more complicated business models (multiple job shares across companies) challenge the OBD documentation process.

In the past, typically one ECU supplier also supplied most of the corresponding software. Nowadays and even more in future with the Autosar approach, the trend towards software packages from vehicle manufacturer and 3rd parties will increase.

As a consequence, multiple suppliers provide the information for the generation of OBD documentation with different format, structure and content. For understanding, it is often necessary to dig into the details of the complete software documentation itself. This is why the efforts for the integration and generation of OBD relevant information increases due to manual analysis and adjustment. Obviously this scenario will allow only a limited reuse.

Figure 3 shows the challenging job share and consistent OBD documentation.

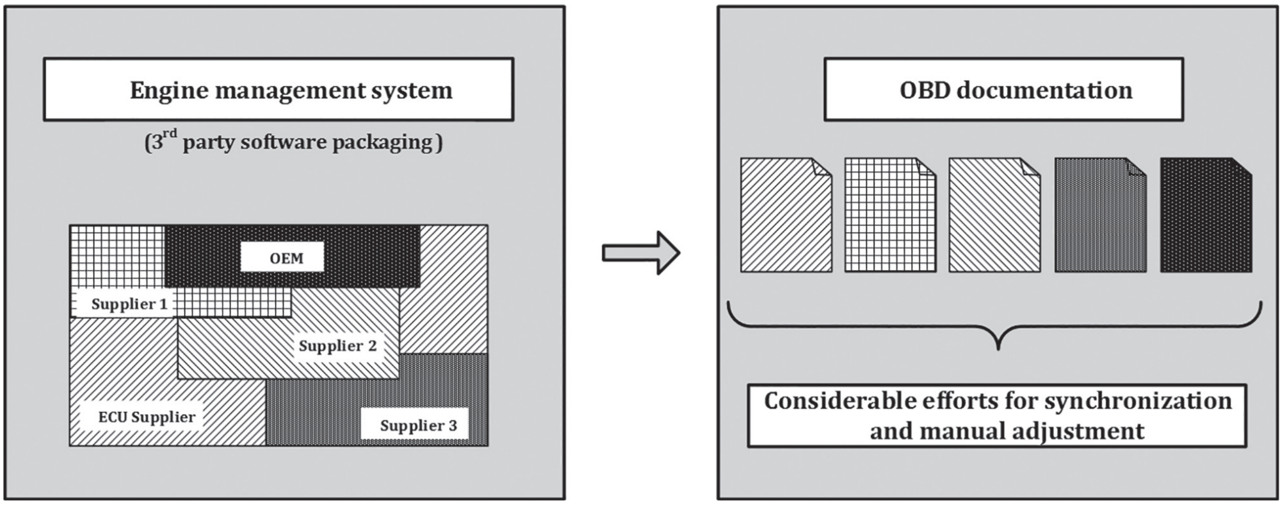


Figure 3 — Job sharing challenge and consistent OBD documentation

Scheduling constraints for generating OBD documentation during the development phase also represent a motivating factor for the introduction of the FXD approach. As the OBD development has become more and more extensive, the documentation is established as early as possible, but on the other hand late changes will cause iterations. Without efficient management of the corresponding OBD-relevant information, it is nearly impossible to answer to the challenging engineering targets and tight project schedules of today.

Road vehicles — Open diagnostic data exchange (ODX) —

Part 3: Fault symptom exchange description (FXD)

1 Scope

This document specifies machine-readable descriptions of all fault symptom algorithms which are implemented as diagnostic software in an electronic control unit (ECU). The main use case is the standardized data exchange from a function & software supplier to a vehicle manufacturer (VM) in order to enable a tool-based information processing. Based on the FXD content and associated calibration values, several end user documents can be generated such as the "summary sheet" needed as part of the vehicle type approval documentation package or the "repair and maintenance information" (RMI). The expected main benefits of the FXD approach are an overall efficiency improvement as well as an independency of supplier- and VM-specific format handling.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 22901-1, *Road vehicles — Open diagnostic data exchange (ODX) — Part 1: Data model specification*

SAE J1930-DA, *Digital Annex of E/E Systems Diagnostic Terms, Definitions, Abbreviations, and Acronyms*

SAE J1979-DA, *Digital Annex of E/E Diagnostic Test Modes*

SAE J2012-DA, *Digital Annex of E/E Diagnostic Trouble Code Definitions and Failure Type Byte Definitions*

3 Terms and definitions

No terms and definitions are listed in this document.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

4 Abbreviated terms

For the purposes of this document, the abbreviated terms given in SAE J1930-DA, SAE J1979-DA and SAE J2012-DA and the following apply.

a2l	ASA P2 description file
AUTOSAR	AUTomotive Open System ARchitecture
DCY	driving cycle
DTC	diagnostic trouble code

ECU	electronic control unit
enum	enumeration
FCM	fault code memory
FID	function identifier
FXD	Fault symptom eXchange Description
HDO	ASAM harmonized data objects
MCL	monitoring checklist
MIL	malfunction indicator light
OBD	on-board diagnostics
OEM	original equipment manufacturer
OID	object identifier
OSC	oxygen storage capacity
RMI	repair and maintenance information
SENT	single edge nibble transmission
SI	système international d'unités
SW	software
URI	uniform resource identifier
VM	vehicle manufacturer
W3C	world wide web consortium
XML	extended mark-up language

5 Specification release version information

5.1 Specification for FXD XML-Schema release version

The schema specification release version of this document is: 2.0.0.

6 FXD concept

6.1 Overview

The automotive industry specified the requirements for provision of OBD-relevant information and developed a corresponding concept and format.

The main objectives were:

— Develop a machine-readable automotive format,

  — for single source of fault symptom description for different documentation use cases (e.g. type approval, repair and maintenance information) across project variants;

  - for possible data processing utilizing state-of-the-art tooling;
- the use of XML as a base technology for the format definition (FXD XML-Schema);
- the reuse of structural patterns based on ISO 22901-1;
- the naming of structure elements which shall be close to the end user's needs.

6.2 Traditional workflow

Traditionally, the FXD-relevant information is exchanged between vehicle manufacturers and ECU software suppliers based on proprietary templates and formats.

Even the main FXD use cases "type approval" and "repair and maintenance information" are driven by different stakeholders and lead to incompatible exchange formats and processes for one and the same vehicle manufacturer.

The software suppliers have to process the full variety of templates and formats with limited reuse and a lot of manual interaction.

Finally, the integration and document generation at the vehicle manufacturer's site cannot be automated due to the non-availability of stable and standardized data formats.

6.3 Raw information

6.3.1 General definition and background

An abstract and structured description of all conditions/criteria/parameters that influence the monitoring process or strategy. It shall be possible to detect and heal a real fault via test conducted by using the "raw information" description.

The "raw information" description is a neutral description which is not biased towards any vehicle-manufacturer-specific end-user documentation.

"Raw information" descriptions will naturally need a subsequent, manual adaptation to reflect the respective requirements of the vehicle manufacturer, the project and end user documentation. This manual adaptation is within the responsibility of the vehicle manufacturer, see 6.4.

6.3.2 Requirements

6.3.2.1 General

“Raw information” descriptions shall be designed in a way to enable an automated value analysis when the relevant calibration labels are entered.

“Raw information” descriptions should refer to the corresponding software implementation. Therefore, a certain abstraction of software implementation is necessary. Furthermore, formal editing features have to be used to improve the readability (e.g. logical grouping of conditions / use of headlines where appropriate). For specific rules, see FXD rules.

The sequence of the fault detection algorithm shall be described by using a formal language. This formal language shall allow automatic processing of the information like the substitution of physical units, replacement of variable names (e.g. for different language areas), replacement of calibration labels and system constants by values, simplification and partial evaluation of expressions. The formal language shall allow the visualisation of the information for various audiences. It shall optionally be possible to describe algorithms textually if a formal description is not feasible or not desired.

6.3.2.2 Requirements for generating of raw information descriptions

Detailed requirements are defined in the rules for generation of FXD descriptions as detailed in Annex C.

6.3.2.3 Requirements for readers of "raw information" description

The information provided by the “raw information” description shall enable technically skilled staff with a general knowledge of vehicles, but no specific knowledge of diagnostics/OBD, to understand the physical process of the monitor.

Requirements:

— general engine and vehicle knowledge;

— general knowledge of diagnostics and OBD; and

— knowledge of this document (FXD).

The supplier will not assume any responsibility in case this “raw information” is forwarded to further audiences (e.g. certification authority, aftersales/service). An FXD file as provided by the supplier will not contain values of referenced calibration labels.

In case information may consist of prescribed values only, respective generic selection lists, will be provided and maintained by ISO.

6.4 FXD format and example

The main challenges for the FXD XML-Schema lie in meeting the documentation requirements of the "OBD summary sheet".

In order to enable an automatic publishing process from the FXD format to an "OBD summary sheet", all relevant information needs to be captured in the FXD format.

The fault symptom is the main structure criterion for the "OBD summary sheet". All fault-symptom-related information is organized underneath the corresponding node inside the FXD-Schema, which is called "FAULT-SYMPTOM".

Within the "OBD summary sheet" the most complex information deals with nested algorithmic expressions for "MALFUNCTION-CRITERIA" and "ENABLE-CONDITIONS". No control structures as known from programming languages are necessary.

Sample expression:

<parameter_1(operand)> < greater than…(operator)> < threshold_1(operand)>

<and/or (operator)>

<parameter_2(operand)> < less than…(operator)> < threshold_2(operand)>

The operands and operators have to be marked separately within the XML structure, as both have to be prepared for specific rendering, e.g. publishing to different table columns.

As the FXD data delivered by the software supplier will contain raw data based on the software implementation, a refinement concept is necessary to support different use cases. Therefore, the principle of inheritance is introduced to FXD, i.e. the symptom related raw data can be refined for a specific use case just by adding refined information characteristics to the FXD data. Later on, the tool chain will process the use-case-specific characteristics.

The raw data will contain software names for parameters and calibration data labels for e.g. thresholds. For generating OBD documentation, the software names have to be replaced by an end-user wording and the calibration data labels have to be replaced by the corresponding values. Both replacement mechanisms need to be supported by the FXD format.

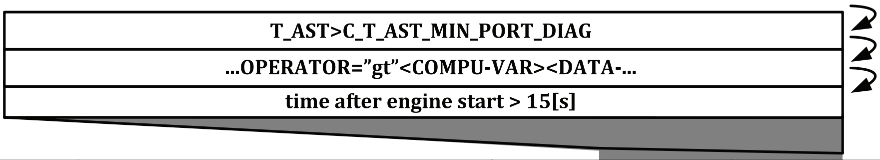
In addition to the requirements described above, the following content requests were taken into account to specify the FXD-Schema.

— interlocking matrix;

— management of FXD data at the vehicle manufacturer's site (e.g. ID management, link to function and software specifications, ...); and

— repair and maintenance information (e.g. language attribute).

Figure 4 shows the OBD summary sheet as one main motivation for the FXD format definition.



Component / System	Fault Code	Fault Code SAE Text	Monitor Strategy Description	Malfunction Criteria	Threshold Value	Secondary Parameters	Enable Condition	Monitor Time	Frequency of Checks	MIL Illum.
Intake Manifold Runner Flap Position Sensor	P 2004	Intake Manifold Runner Control Stuck Open Bank 1	stuck closed check	signal voltage	<2,9[V]	timer after engine start	>15[s]	4[s]	continuous	2 DC

Figure 4 — OBD summary sheet as one main motivation for the FXD format definition

6.5 Basic concept of FXD

6.5.1 Basic requirements

The modelling of algorithmic expressions is a core part of the FXD-Schema and will be explained more in detail.

After analysing the content of the OBD summary sheets for algorithmic expressions, the following requests were captured:

— enable a formal description of nested algorithmic expressions, which are based on the software implementation;

— enable formal expressions (one operand may be a text string), which cannot be mapped 1:1 to the software implementation, but are necessary to reduce complexity;

— enable free text for e.g. repair and maintenance information; and

— enable direct re-use of raw information.

6.5.2 Formal description of diagnosis algorithms

For the description of fault-symptom-related conditions, the element COMPUTATION, is introduced. It can be:

— either a formal expression (ABSTRACT-SYNTAX); or

— an informal description (EXPLANATION).

The ABSTRACT-SYNTAX represents an expression tree, whose nodes may be:

— an operator (or function) OP with its arguments (operands) as child nodes (which might be again an expression tree);

— a variable COMPU-VAR, which consists of a reference DATA-DECLARATION-REF to an ECU variable, calibration parameter or system constant;