Indigo as (WWH-)OBD Scan Tool

Vector Webinar

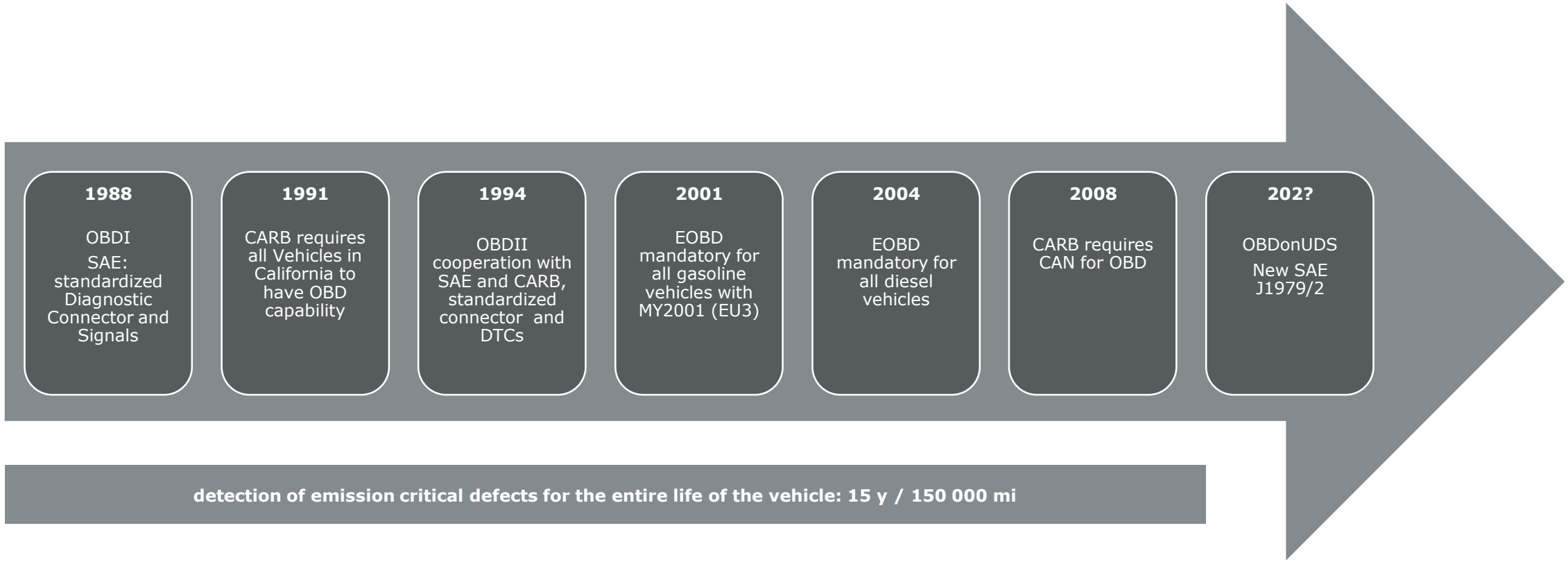
V1.3 | 2018-10-30

Agenda

- **OBD Introduction**
- Diagnostic Protocol
- Discover OBD ECUs
- Read Diagnostic and Vehicle Data
- Fault Memory
- Request On-Board Monitoring Test Results
- Generic OBD Service Access
- OBD Automation API
- Remote Diagnostics
- Further Readings

History of OBD

California Environmental Protection Agency
Air Resources Board



History of OBD

- **California Environmental Protection Agency (CARB)**
  - California has the right to set its own legislation concerning OBD
  - Today the OBD requirements defined by the CARB are not only valid for the state California but for the overall US
  - CARB always leads the debate in the US, the other states follow

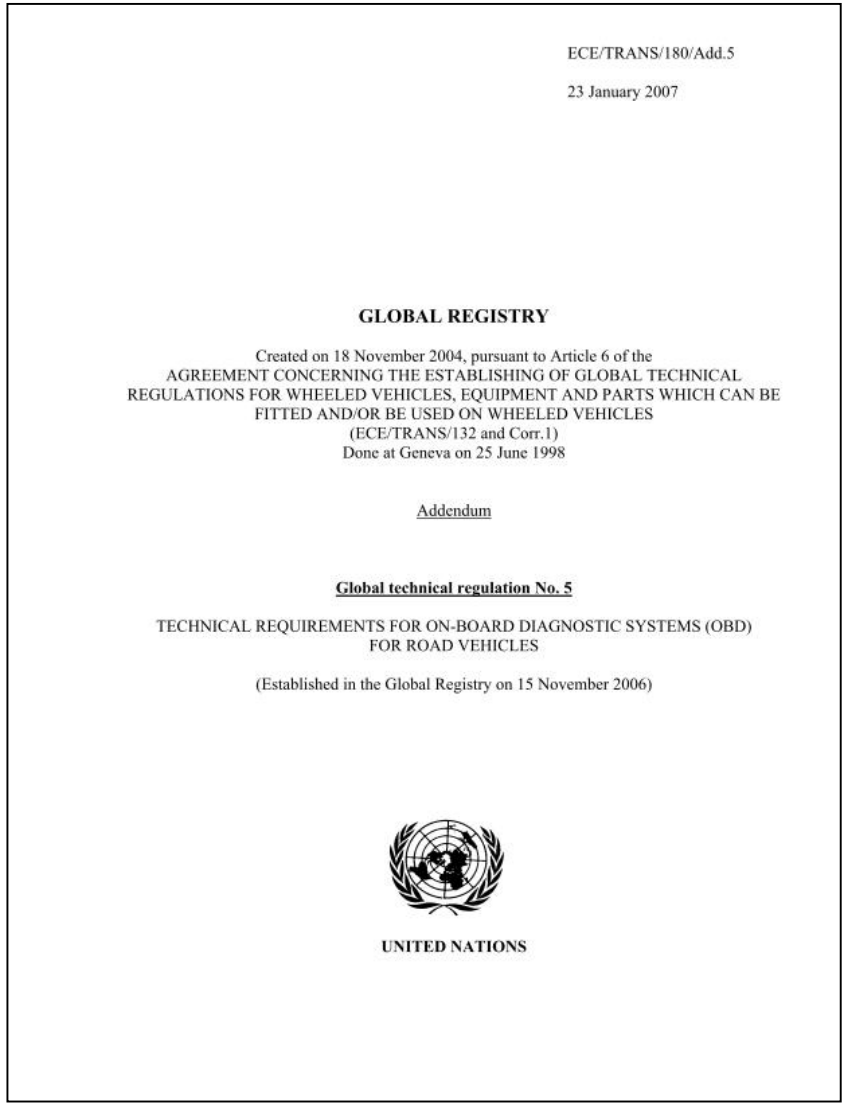
- **European Union (EU)**
  - EU has defined its own set of OBD requirements which are based on the CARB OBD II requirements but are not identical
  - This version of OBD II is called EOBD (European OBD)

History of OBD

- **Different OBD requirements (PID $1C)**
  - OBD II (California ARB)
  - OBD (Federal EPA)
  - OBD and OBD II
  - OBD I
  - EOBD
  - EOBD and OBD II
  - EOBD and OBD
  - EOBD, OBD and OBD II
  - JOBD
  - JOBD and OBD II
  - JOBD and EOBD
  - JOBD, EOBD, and OBD II
  - OBD, EOBD and KOBD
  - OBD, OBD II, EOBD and KOBD
  - Engine Manufacturer Diagnostics (EMD)
  - Engine Manufacturer Diagnostics Enhanced (EMD+)
  - Heavy Duty On-Board Diagnostics (Child/Partial)
  - Heavy Duty On-Board Diagnostics
  - World Wide Harmonized OBD
  - Heavy Duty Euro OBD Stage I without NOx Control
  - Heavy Duty Euro OBD Stage I with NOx Control
  - Heavy Duty Euro OBD Stage II without NOx Control
  - Heavy Duty Euro OBD Stage II with NOx Control
  - Brazil OBD Phase 1
  - Brazil OBD Phase 2 and Phase 2+
  - Korean OBD
  - India OBD I
  - India OBD II
  - Euro VI
  - OBD, OBD II and HD OBD
  - Brazil OBD Phase 3

History of OBD

- **United Nations (UN)**
  - UN try to consolidate the different OBD standards and issued a legislative document to replace the local legislative documents
  - WWH OBD (World Wide Harmonized OBD)



ECE/TRANS/180/Add.5

23 January 2007

GLOBAL REGISTRY

Created on 18 November 2004, pursuant to Article 6 of the
AGREEMENT CONCERNING THE ESTABLISHING OF GLOBAL TECHNICAL REGULATIONS FOR WHEELED VEHICLES, EQUIPMENT AND PARTS WHICH CAN BE FITTED AND/OR BE USED ON WHEELED VEHICLES
(ECE/TRANS/132 and Corr.1)
Done at Geneva on 25 June 1998

Addendum

Global technical regulation No. 5

TECHNICAL REQUIREMENTS FOR ON-BOARD DIAGNOSTIC SYSTEMS (OBD) FOR ROAD VEHICLES

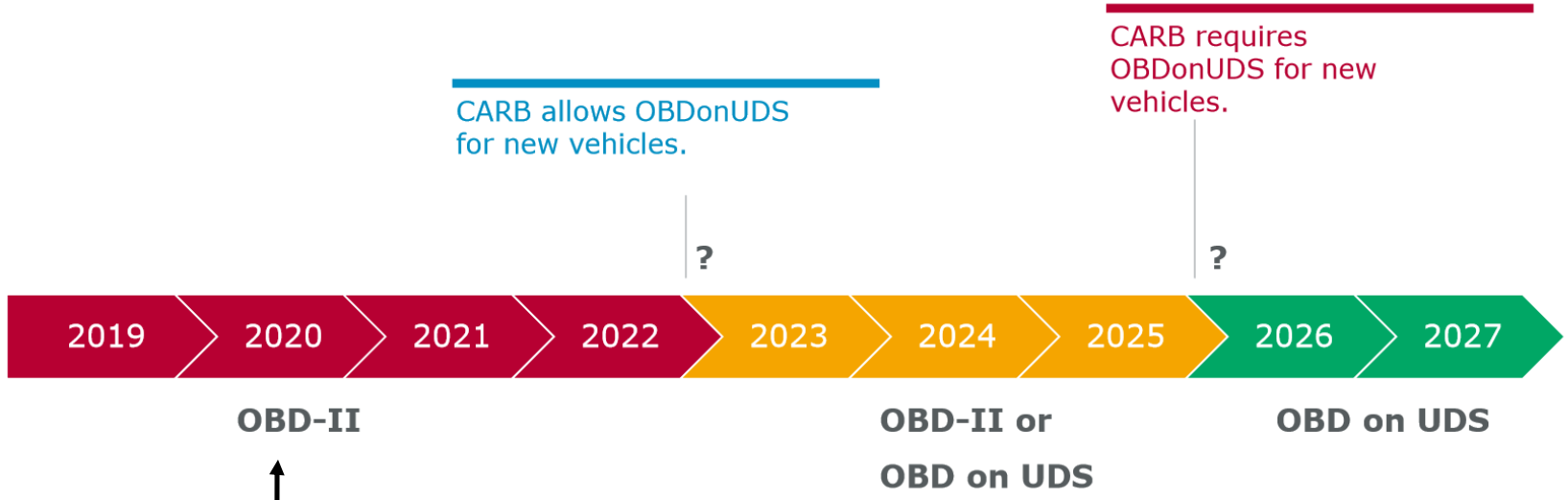
(Established in the Global Registry on 15 November 2006)

UNITED NATIONS

What comes next?

Upcoming SAE J1979-2

- Classic OBD-II to be replaced by UDS services
- New subfunctions for fault memory access
- 10 FreezeFrames
- IUMPR per DTC
- …



Indigo will be OBDonUDS-ready from next version: **Indigo 7**

Standards around OBD

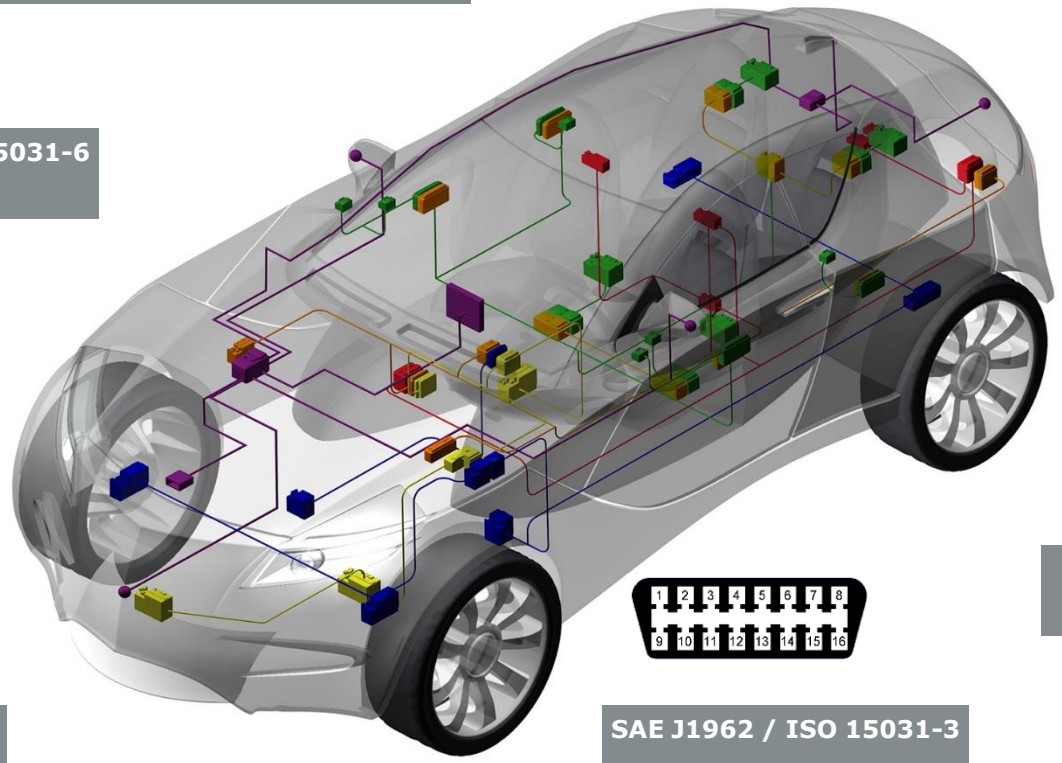
CCR 1968.2
Fault Management and Diagnostics

SAE J1979 / ISO 15031-5
Diagnostic Data

ISO 11898
Physical Layer CAN

SAE J2012 / ISO 15031-6
P Codes

SAE J1699
OBD Compliance Test



ISO 27145
WWH-OBD

SAE J2534
PassThru / Flashing

ISO 15765-4
DoCAN OBD

SAE J1978 / ISO 15031-4
Scan Tool (GST)

New SAE J1979-2
OBDonUDS

SAE J1962 / ISO 15031-3
OBD Connector

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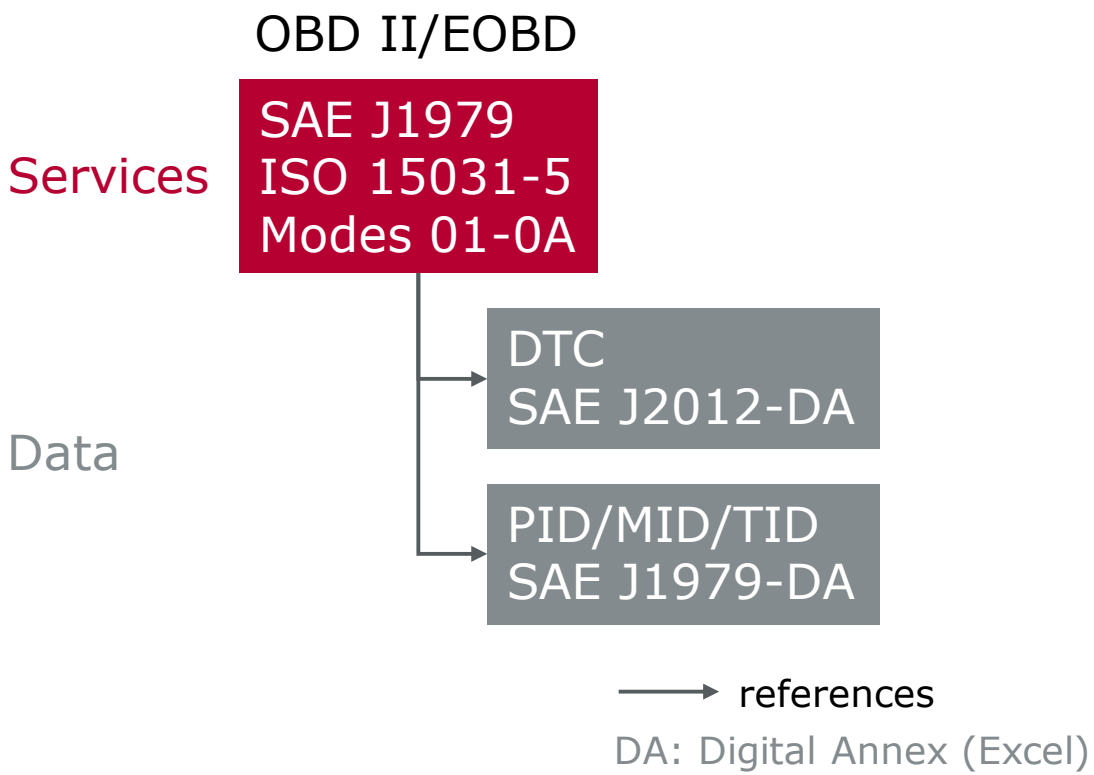
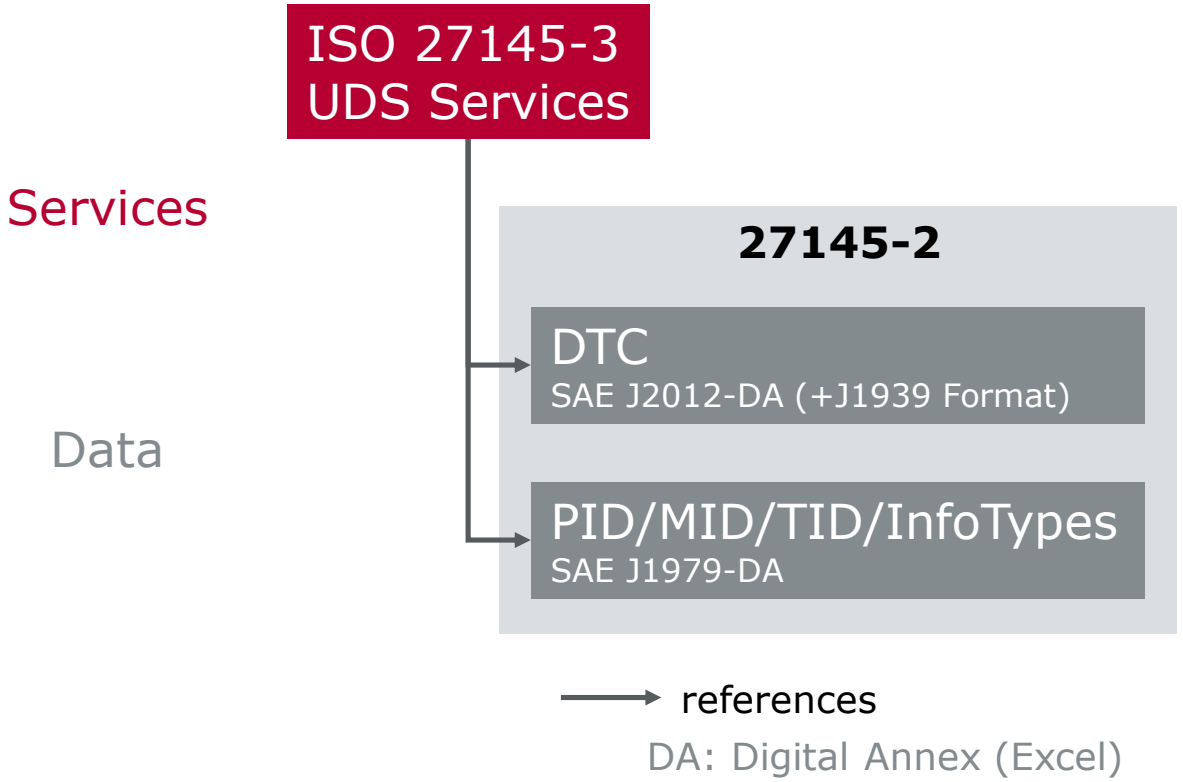
OBD II



WWH-OBD



- The "Digital Annexes" of SAE J2012 and SAE J1979 are referenced in WWH-OBD

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Discovery Message and CAN IDs

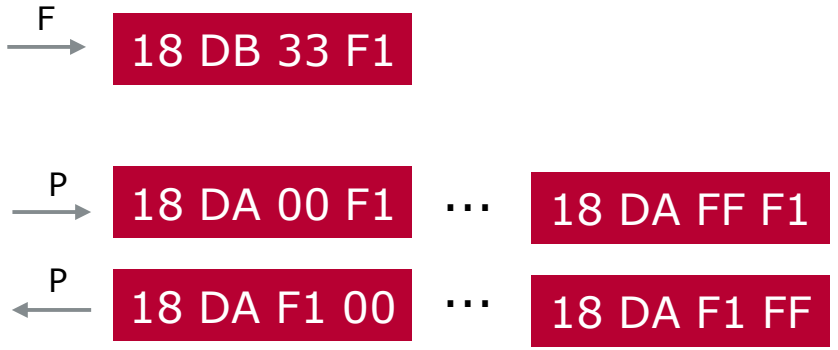
OBD II

WWH-OBD

- Only OBD ECUs send positive responses

11 Bit CAN-IDs

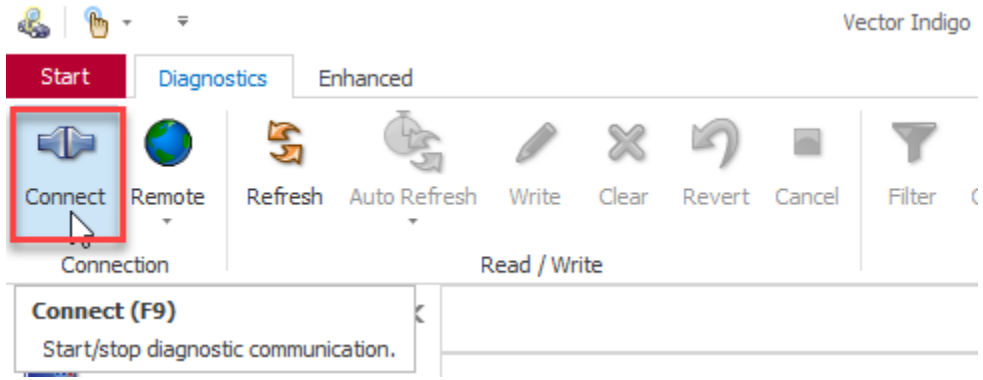
29 Bit CAN-IDs



Discovery Message and CAN IDs

Indigo

- Simply start connection to run OBD discovery



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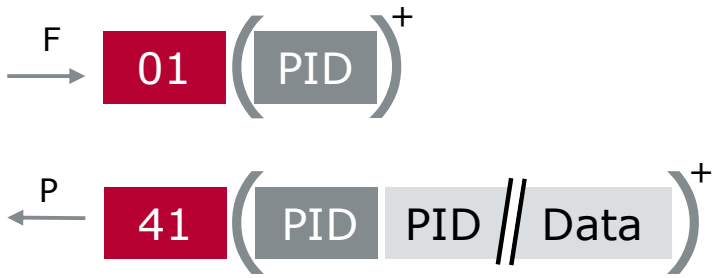
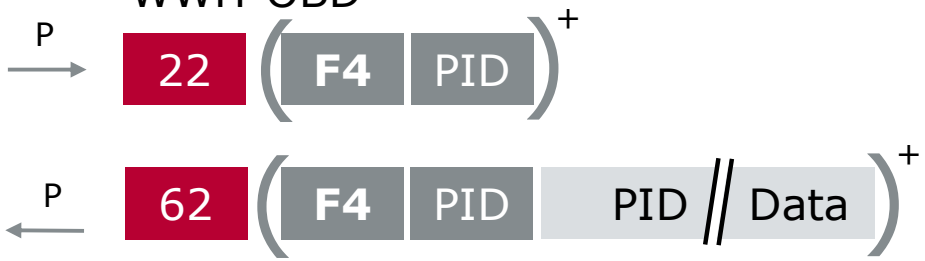
Read Current Diagnostic Data

OBD II

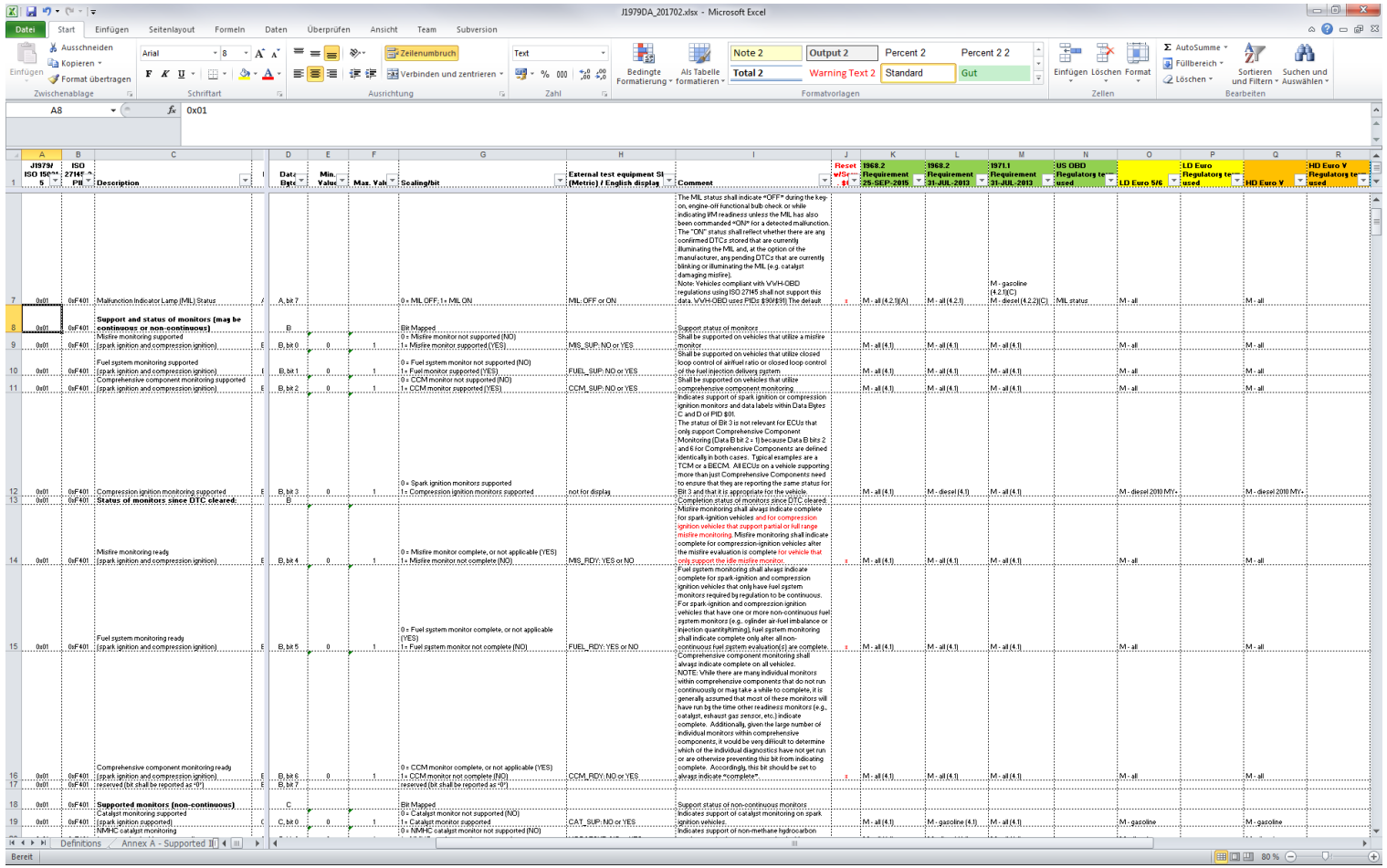


WWH-OBD



Read Current Diagnostic Data

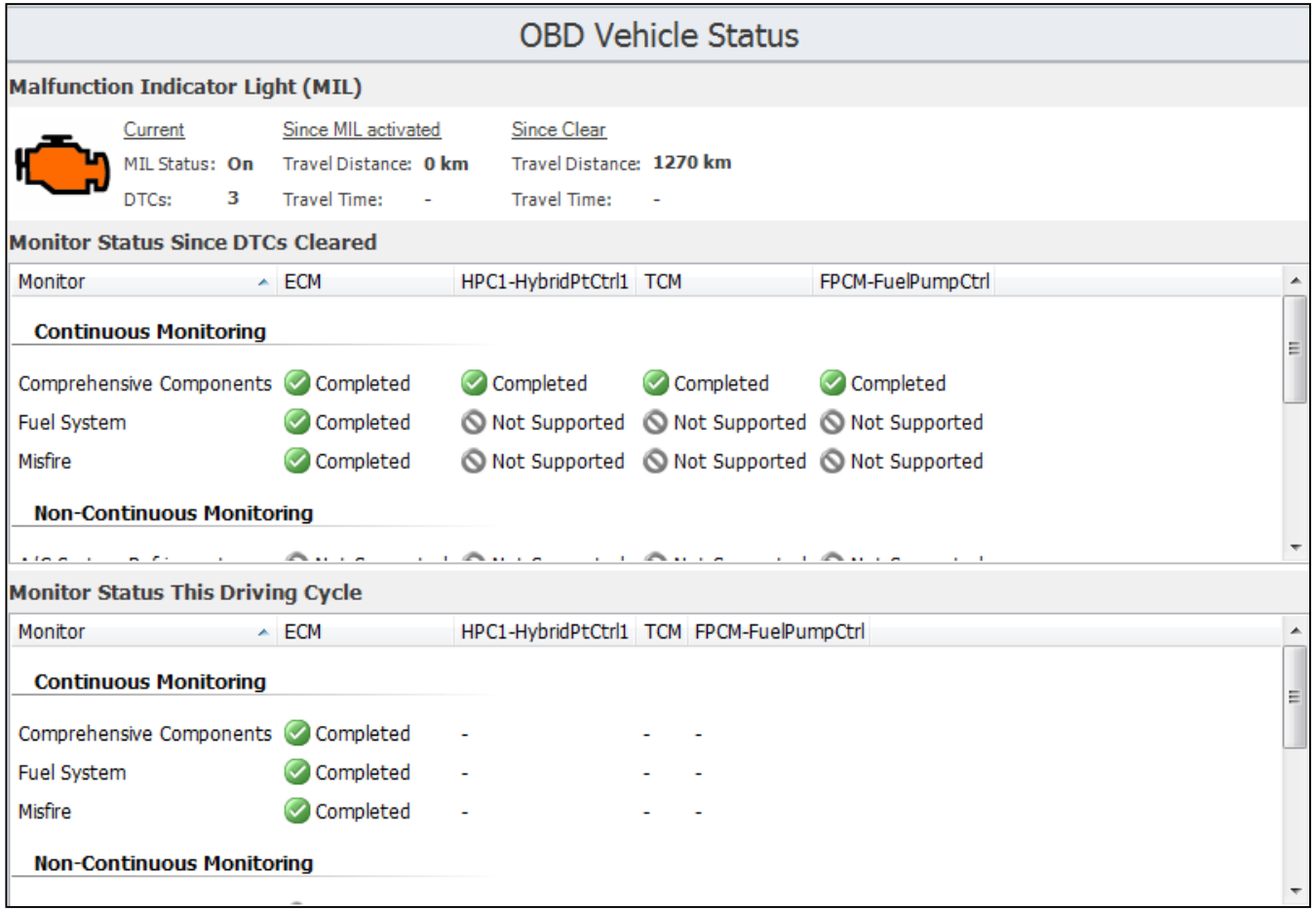
- Which data can be read?
  - Parameter Ids (PIDs) are defined in SAE J1979 DA



Read Current Diagnostic Data

- System State and Vehicle Readiness: PID $01
  - Byte A: System State (DTCs and MIL)
  - Byte B: Support and Status of Monitors
  - Byte C: Supported Tests (run at least once per trip)
  - Byte D: Status of Tests (run at least once per trip)

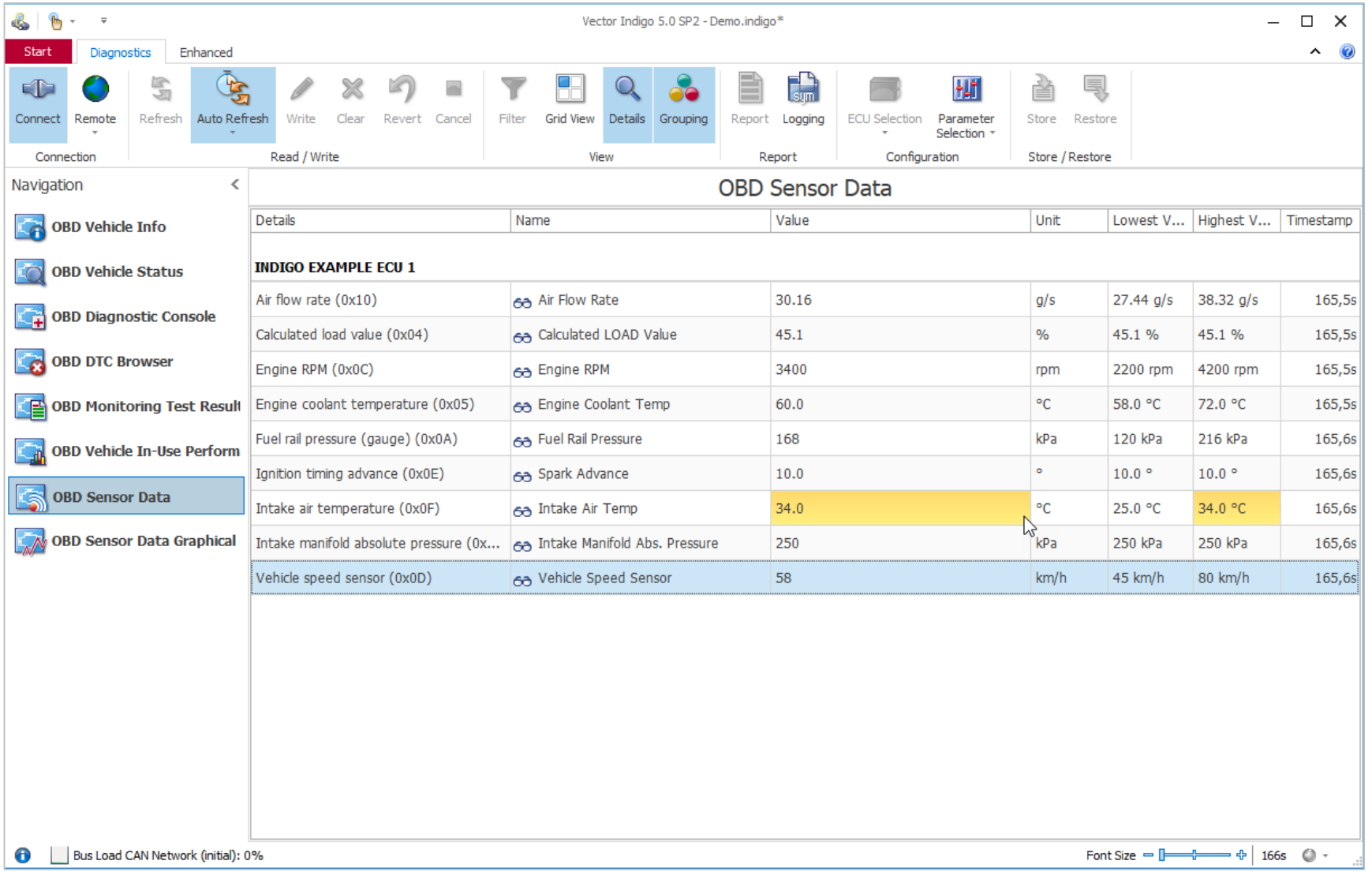
Indigo: OBD Vehicle Status



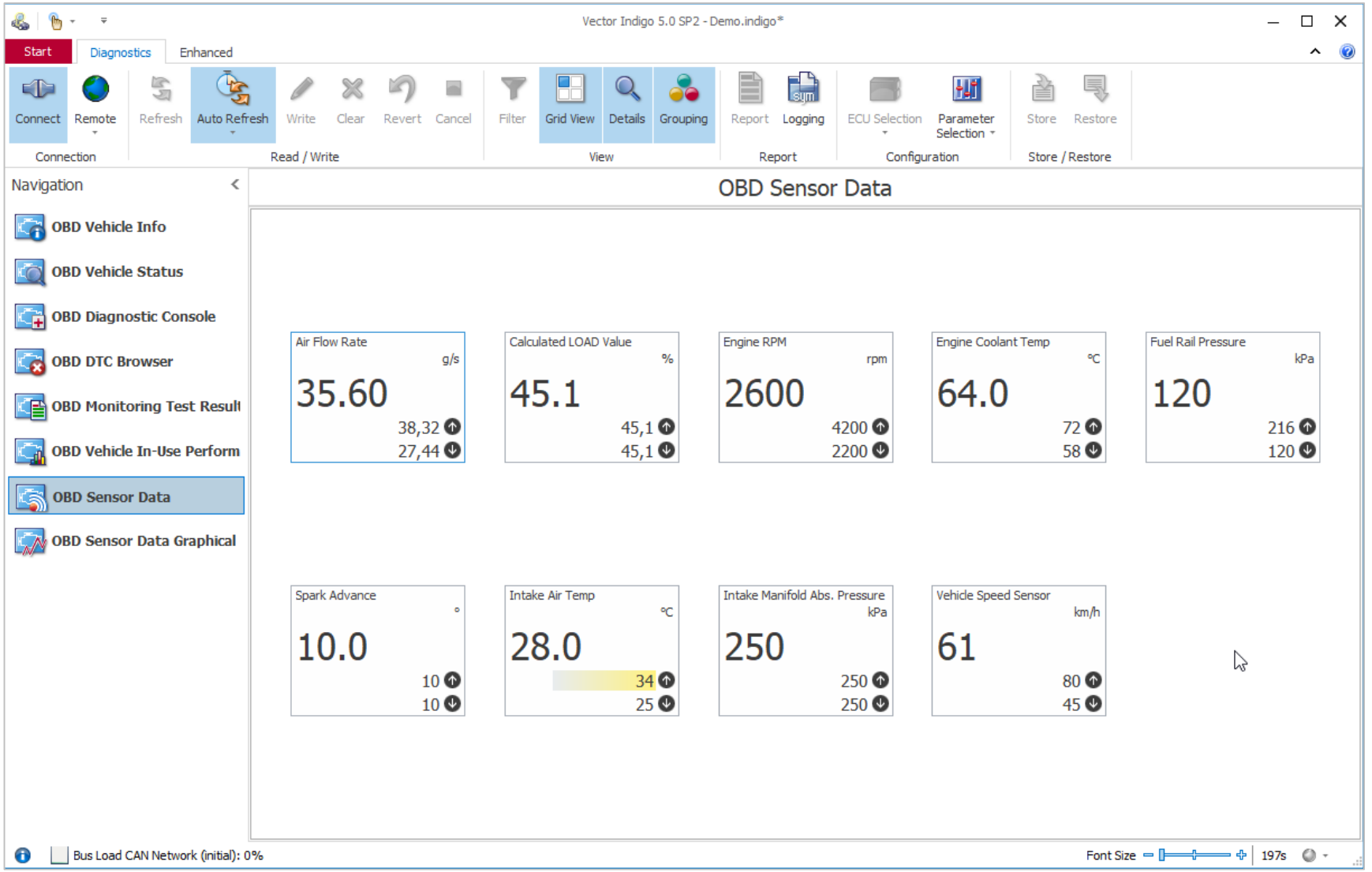
Read Current Diagnostic Data

- Which data can be read?
  - Secondary Air Status
  - Air Flow Rate
  - Intake Air Temperature
  - Absolute Throttle Position
  - O2 Sensors for each block and each bank
  - OBD Type (OBD II, EOBD, …)
  - …

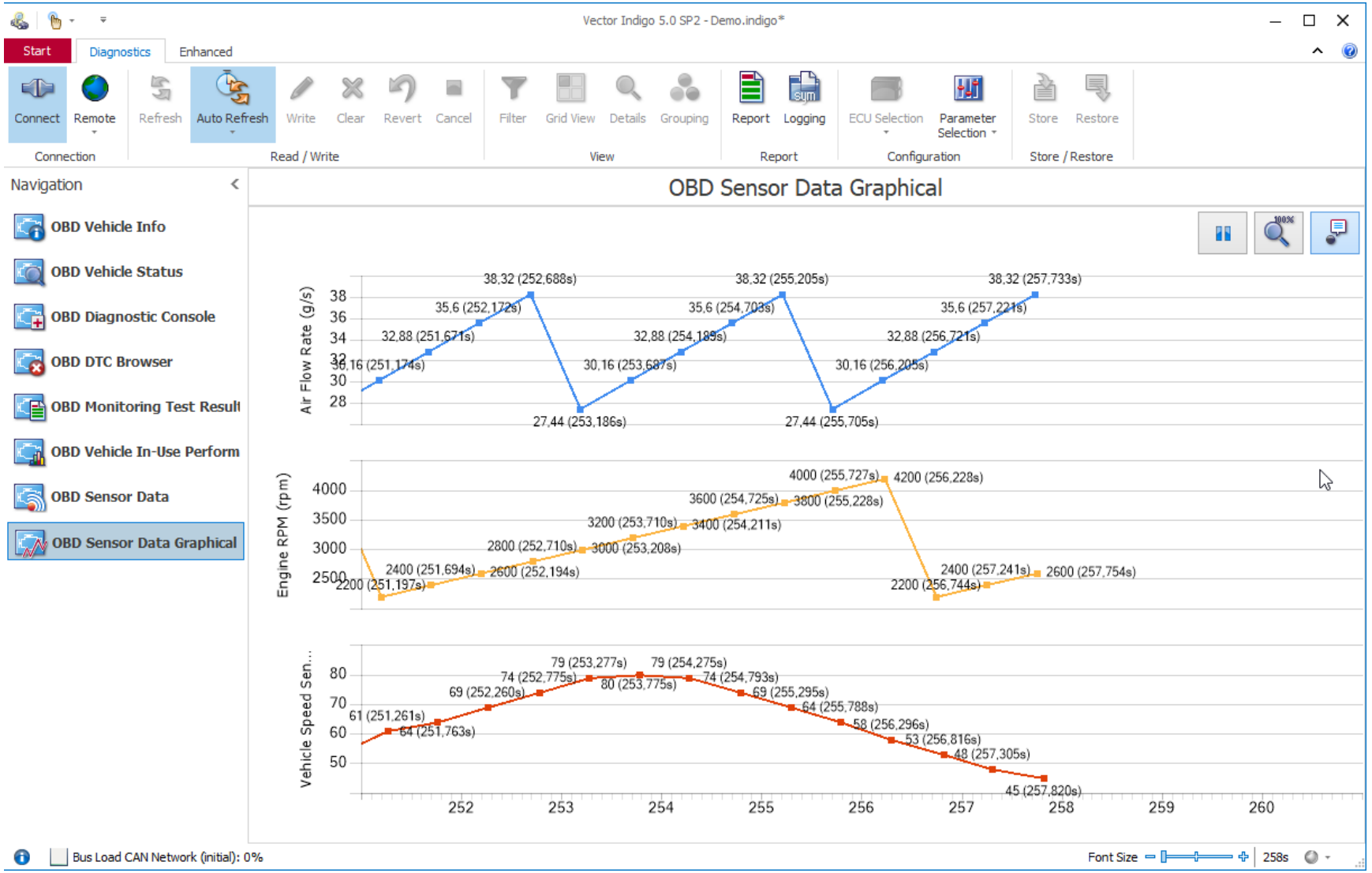
Indigo: OBD Sensor Data



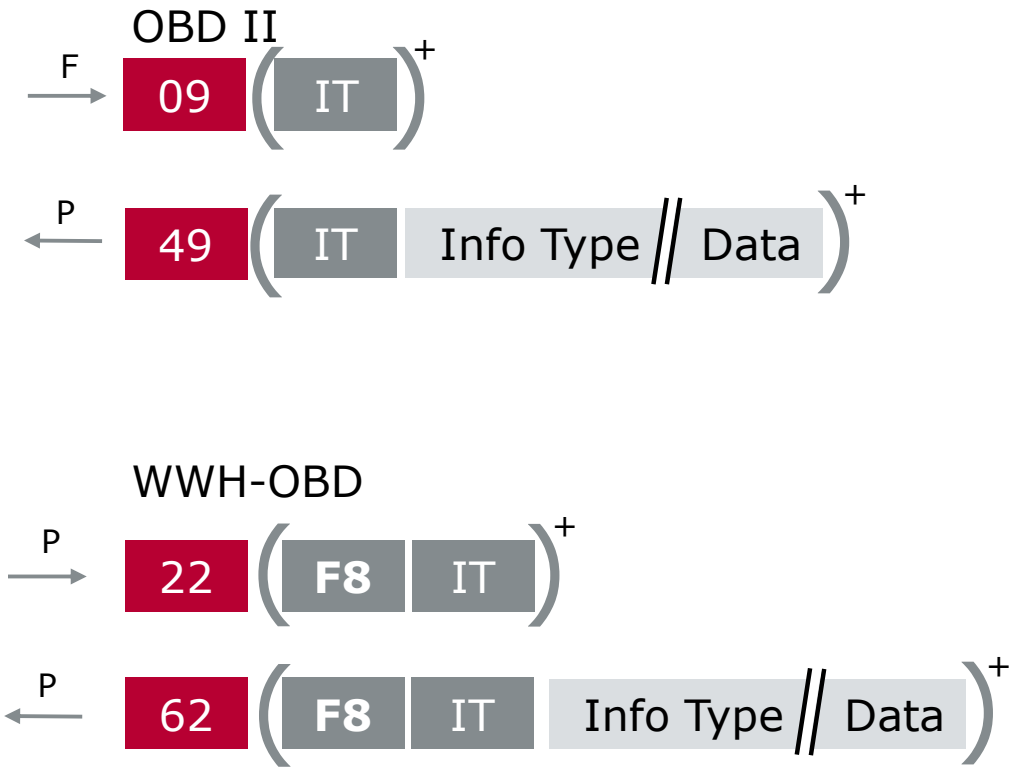
Indigo: OBD Sensor Data



Indigo: OBD Sensor Data



Request Vehicle Information

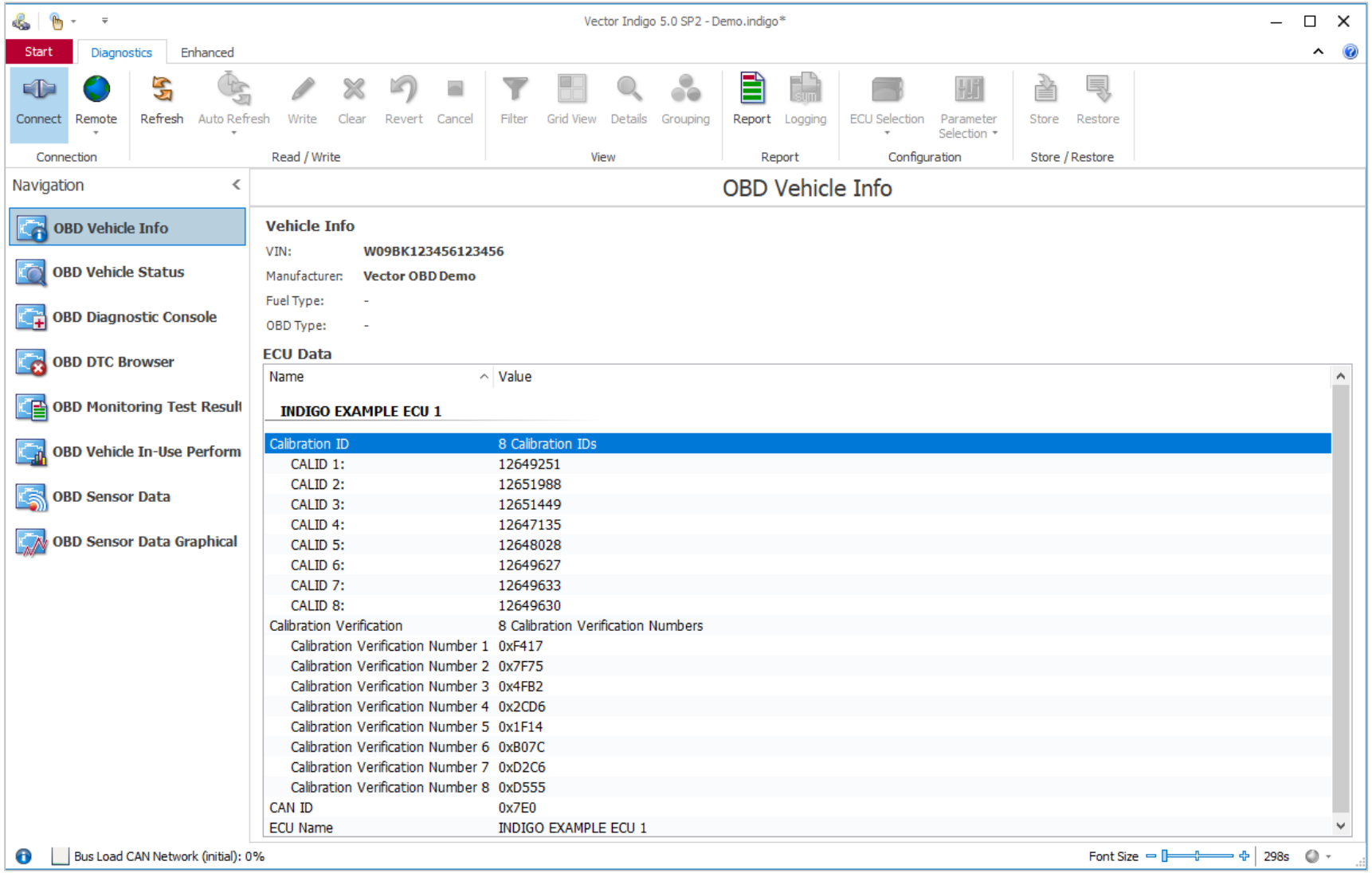


Request Vehicle Information

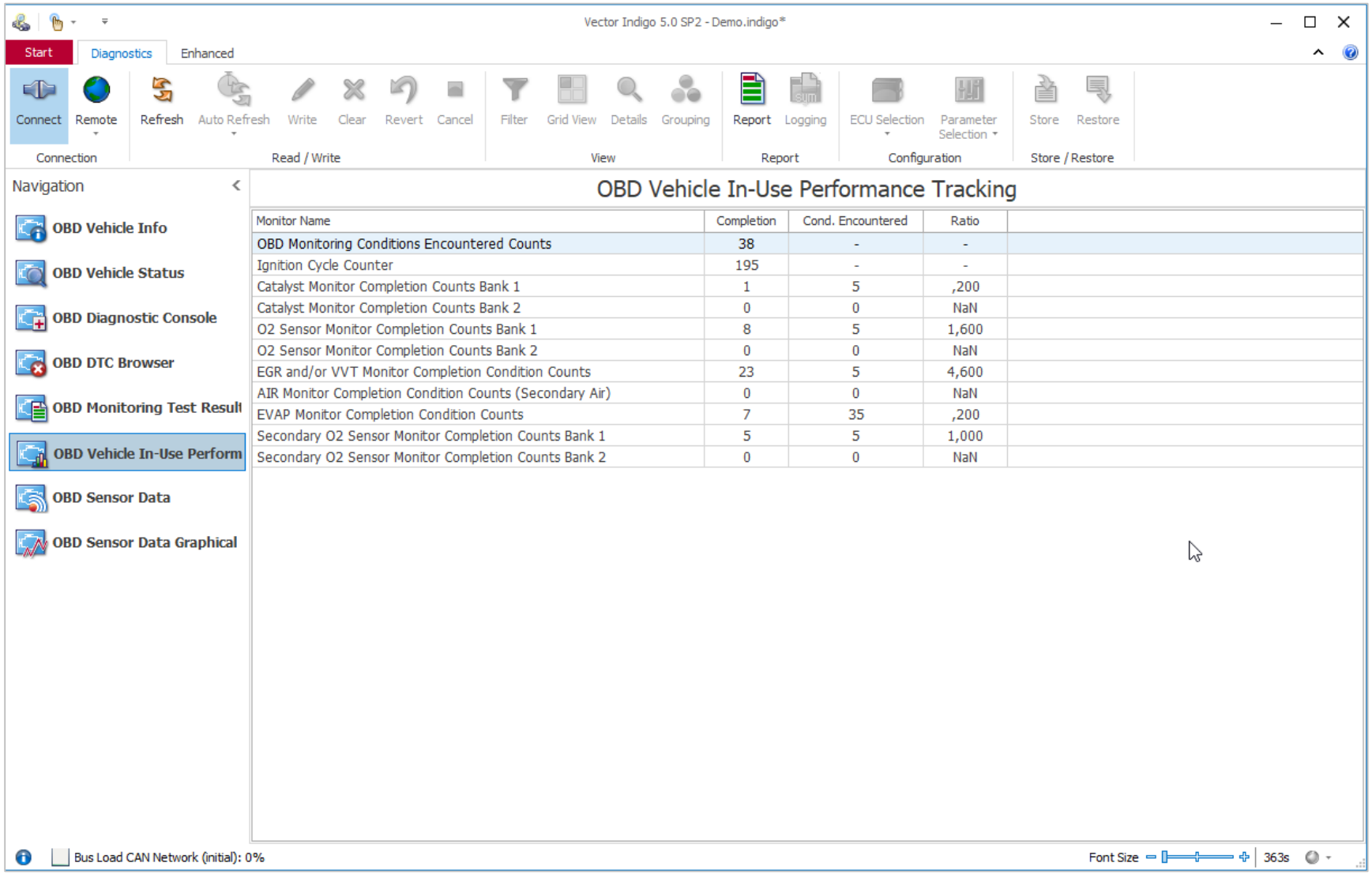
Examples

IT	Meaning
02	VIN
04	Calibration ID
06	Calibration Verification Number
…	…

Indigo: OBD Vehicle Info



Indigo: In-Use Performance Tracking



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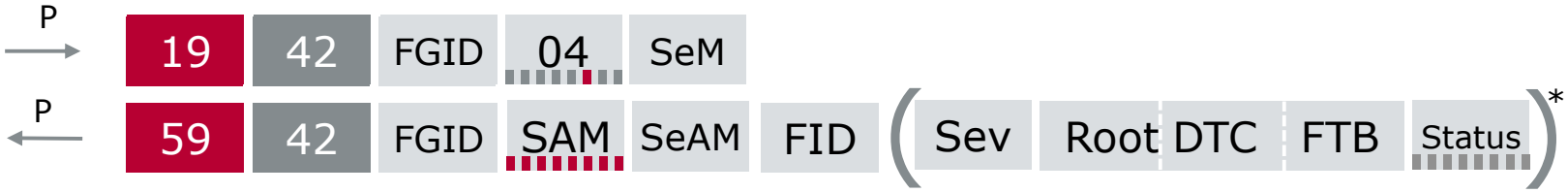
Read Pending DTCs

OBD II

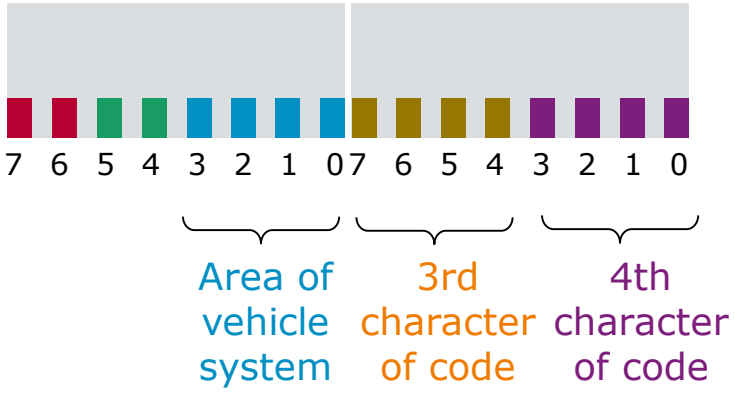
Value	Description
FGID	Functional Group ID (0x33)
SM	Status Mask
SeM	Severity Mask
SAM	Status Availability Mask
SeAM	Severity Availability Mask
FID	Format Identifier
Sev	Severity

WWH-OBD



DTC Structure

Fault location AND type



Value	Description
00	Powertrain (P)
01	Chassis (C)
10	Body (B)
11	Network (U)

Value	Description
00	ISO/SAE controlled
01	Manufacturer controlled
10	ISO/SAE controlled
11	ISO/SAE controlled

Value	Description
P00-P02	Fuel and air metering
P03	Ignition system or misfire
P04	Auxiliary emission controls
P05	Vehicle speed, idle control, and auxiliary inputs
P06	Computer and auxiliary outputs
P07-P09	Transmission
P0A-P0E	Hybrid Propulsion

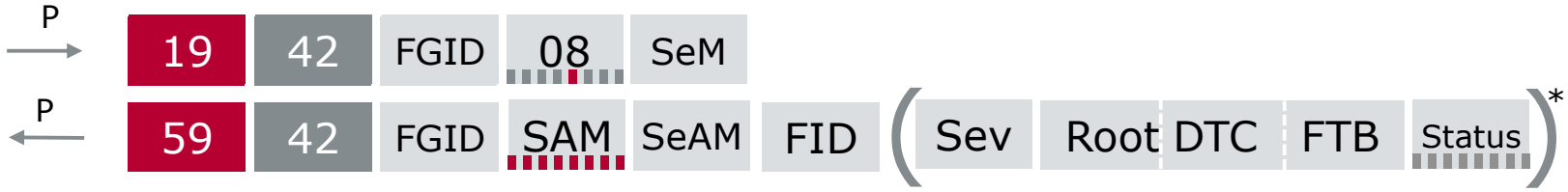
Example: P0070 (0x0070) Ambient Air Temperature Sensor Circuit "A"

Read Confirmed DTCs

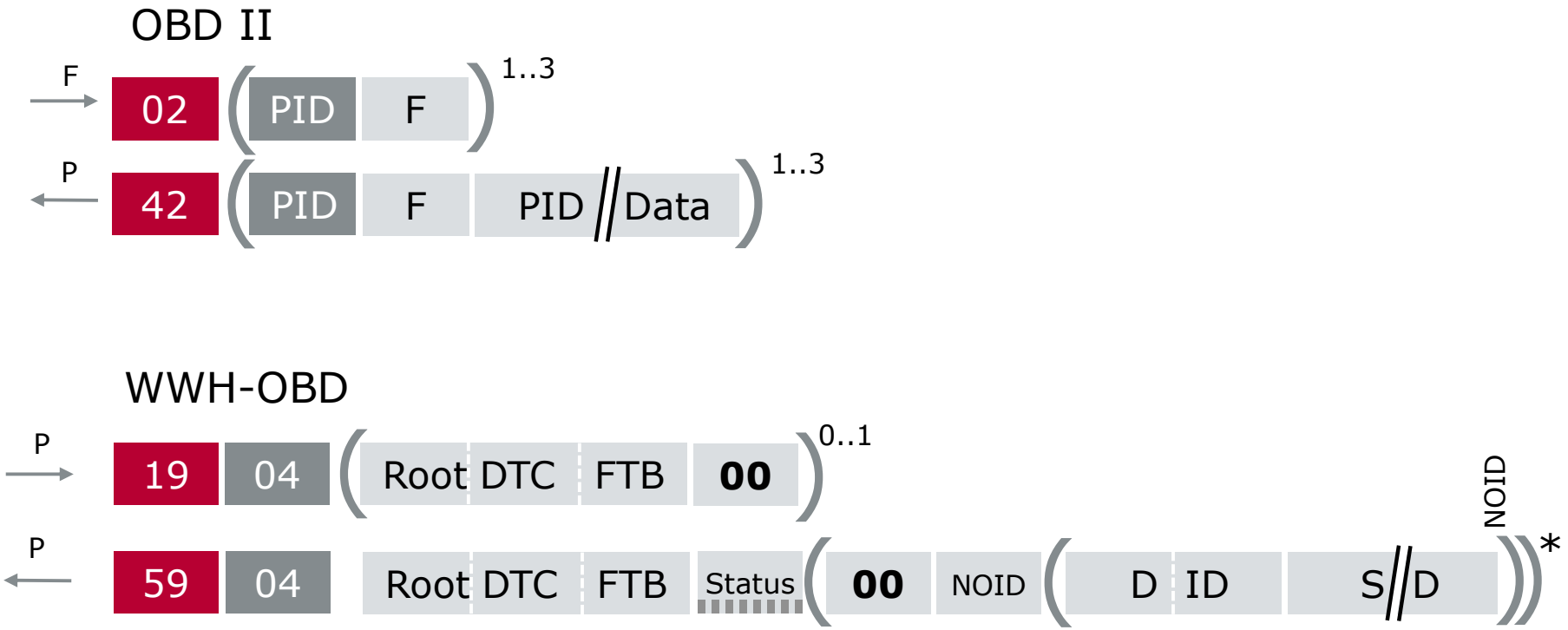
OBD II

Value	Description
FGID	Functional Group ID (0x33)
SM	Status Mask
SeM	Severity Mask
SAM	Status Availability Mask
SeAM	Severity Availability Mask
FID	Format Identifier
Sev	Severity

WWH-OBD

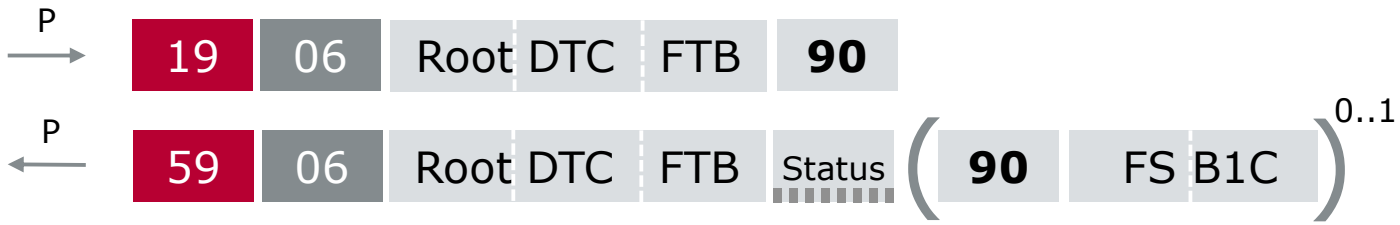


Read Freeze Frame Data / Snapshot Data Records

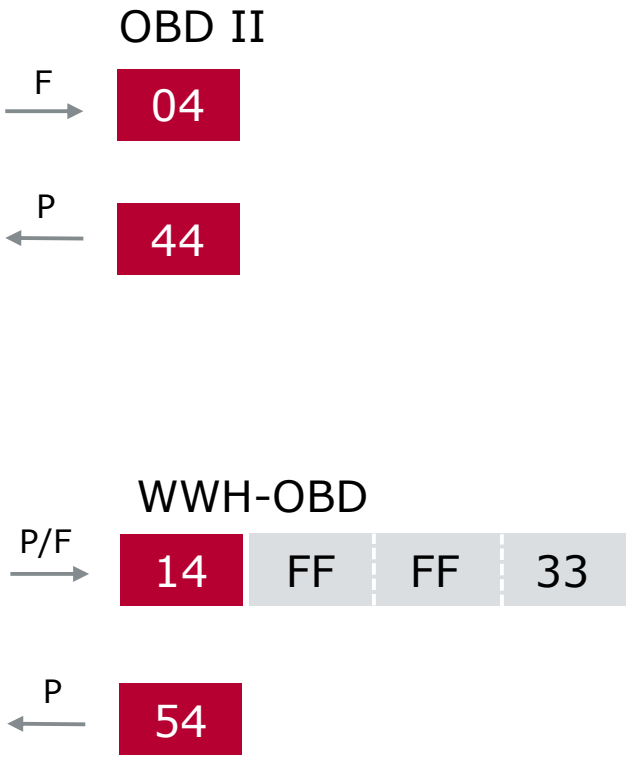


WWH-OBD: 0x19 06 Read Extended Data Record

- Extended Data Records contain statistical data of DTCs
  - Example: Occurrence counter or B1 counter



Clear/Reset Emission Related Diagnostic Data

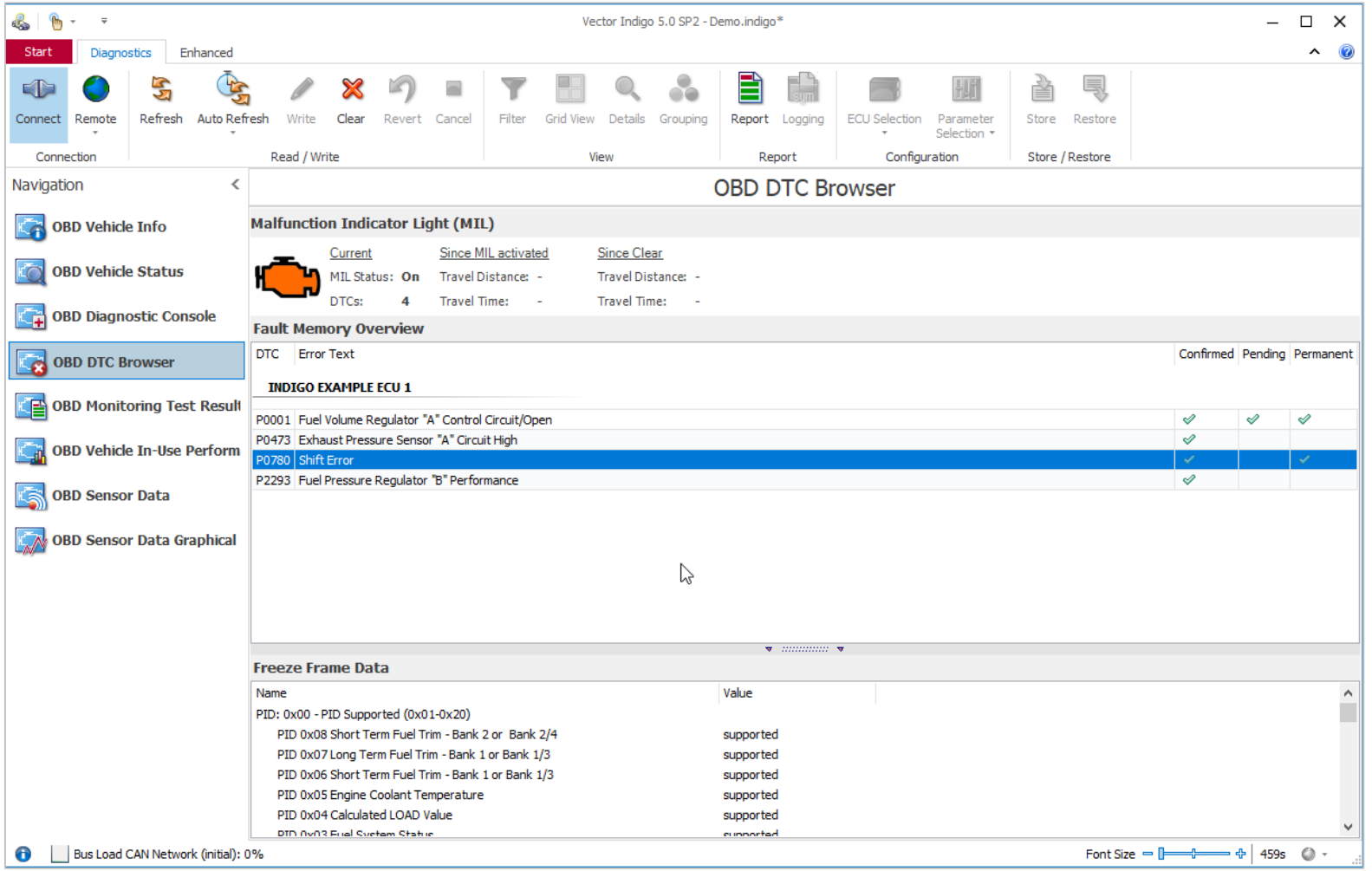


Clear Diagnostic Data

Data	Mode	PID
Number of DTCs	01	01
Freeze Frames	02	
Confirmed DTCs	03	
Pending DTCs	07	
Oxygen Sensor Monitoring Test Results	05	
On-Board Monitoring Test Results for Specific Monitored Systems	06	
I/M Readiness Data	01	01
Distance Traveled While MIL is Activated	01	21
Number of warm-ups since DTCs cleared	01	30
Distance traveled since DTCs cleared	01	31
Monitor status this driving cycle	01	41
Engine run time while MIL activated	01	4D
Engine run time since DTCs cleared	01	4E
EWMA (Exponential Weighted Moving Average) misfire counts	06	0B

Indigo: OBD DTC Browser

- Read OBD DTCs
  - Confirmed
  - Pending
  - Permanent
- Read Freeze Frames & Extended Data Records
- Clear Diagnostic Data
- Reports



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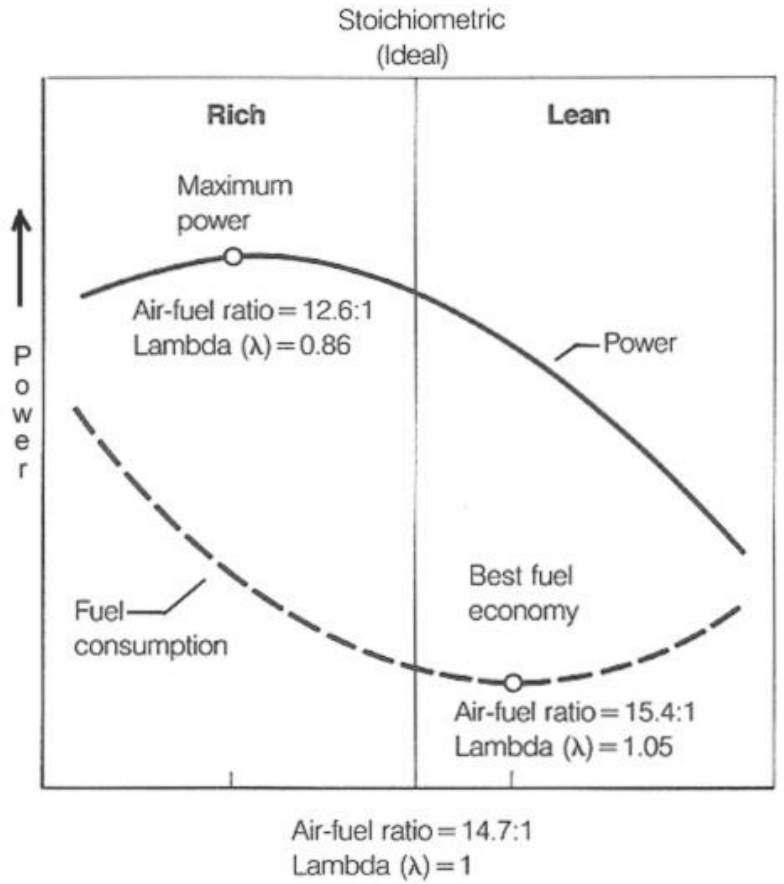
Introduction to O2 sensors

- Stoichiometric combustion
  - 1kg GAS (95 ROZ) requires 14,7kg air (14,7 : 1 = Lambda 1)



Source: https://en.wikipedia.org/wiki/File:Ideal-stoichiometry.jpg

Introduction to OBD Mode $06

- Allow access to results for on-board diagnostic monitoring tests of specific components (continuous / non-continuous monitored)
- Latest valid test values (results) are retained over multiple ignition OFF cycles
- Test values (results) are requested by OBD Monitor ID
  - Always reported with minimum and maximum test limits
- Many OBD monitors have multiple tests
- PID $41: Monitor status this driving cycle

Protocol

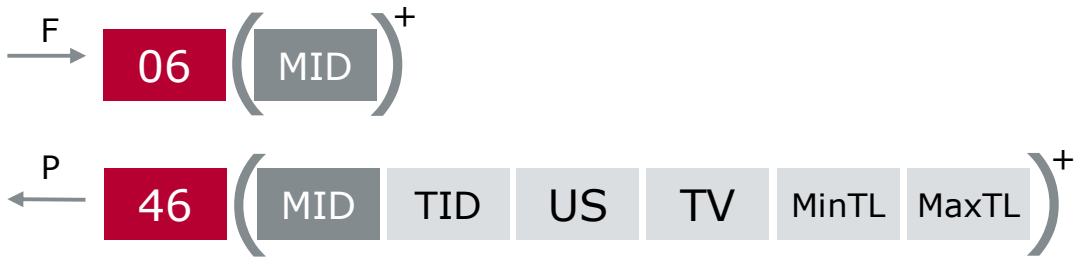
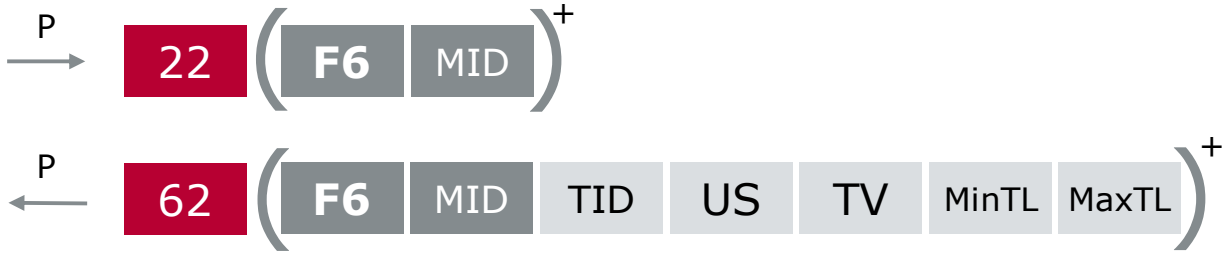


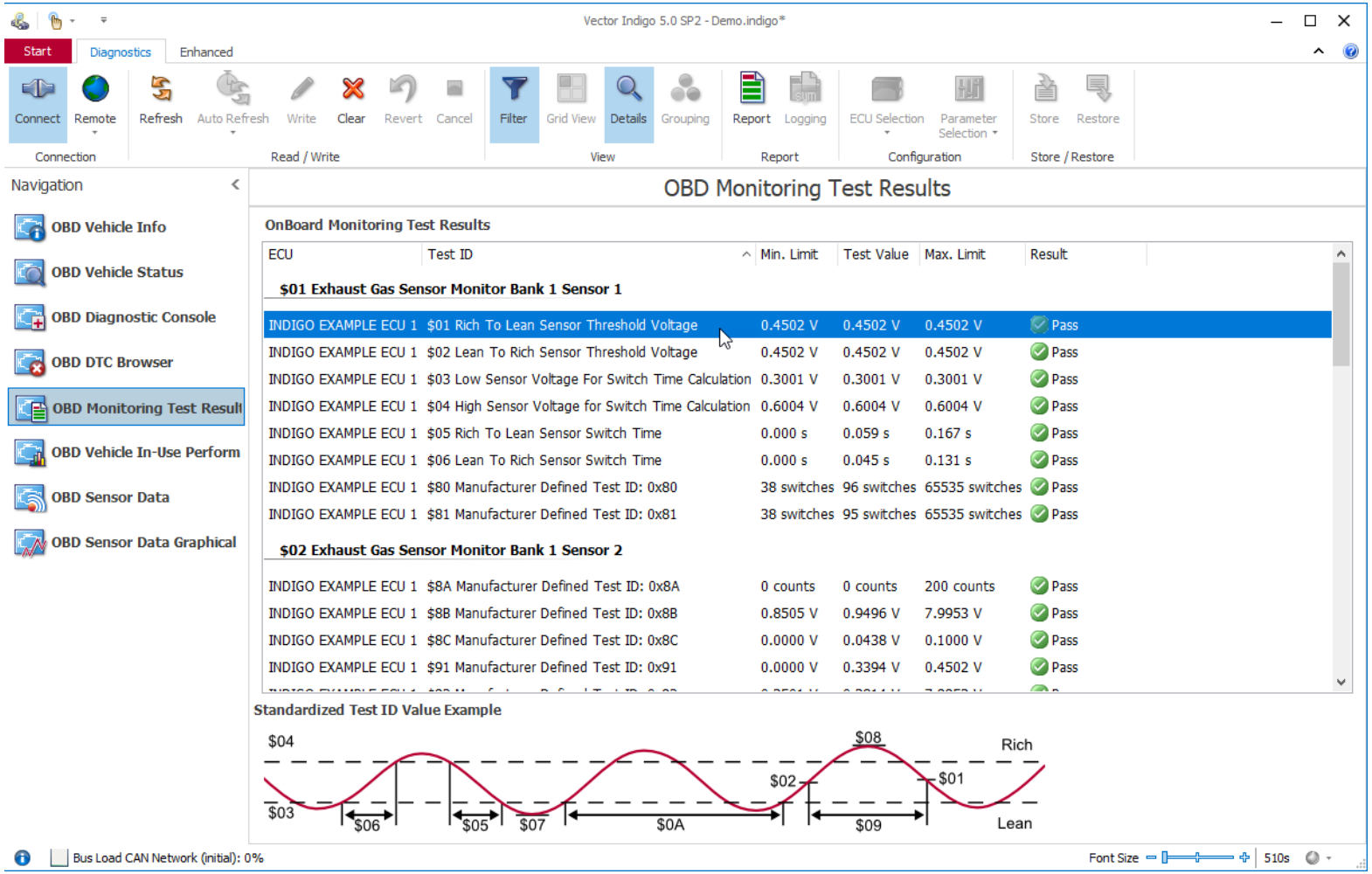
Abb.	Description
MID	Monitor ID
TID	Test ID
US	Unit Scaling
TV	Test Value
MinTL	Min. Test Limit
MaxTL	Max. Test Limit

WWH-OBD



Indigo: OBD Monitoring Test Results

- OBD Monitoring Test Results Window



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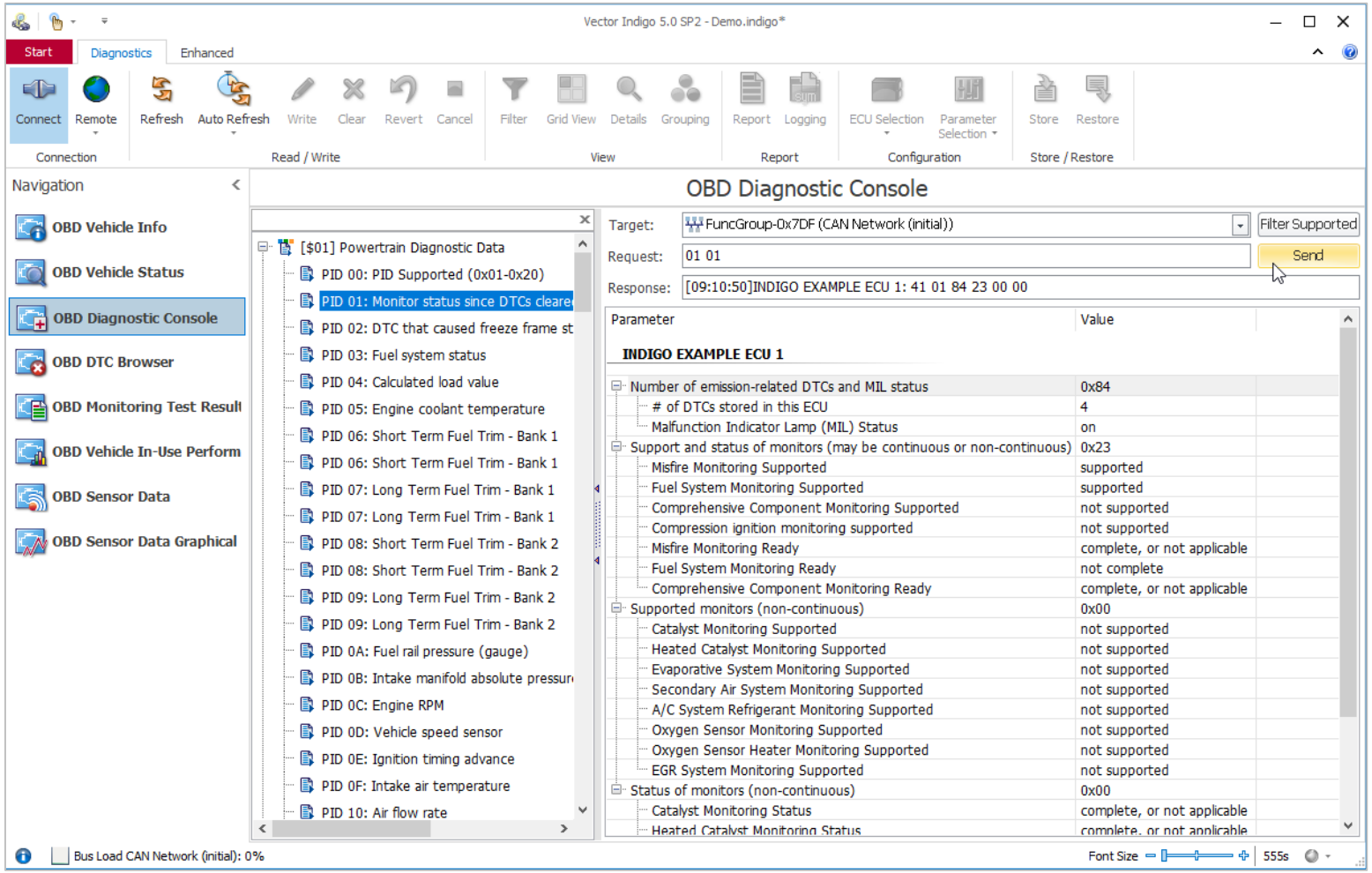
Indigo: OBD Diagnostic Console

- OBD Diagnostic Console allows sending all OBD request to
  - An OBD Functional Group (all OBD ECUs)
  - A selected OBD ECU
- Filter by supported data
- Search OBD Service Data
- Read data cyclically



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Introduction

- Vector.Diagnostics.OBD
  - Based on Microsoft .NET
  - Additional library to Vector Diagnostics Scripting Library

- Read out OBD information with just a view lines of C# code

- Use Cases
  - Implement your own OBD logger
  - Implement your own OBD report in your own format / output
  - Access OBD PIDs/MIDs/TIDs as well as OBD DTCs and Freeze Frames conveniently

- Runtime environment
  - Indigo
  - vScriptDiagnostics on VN8810

VECTOR

Examples: Reading out IUMPR

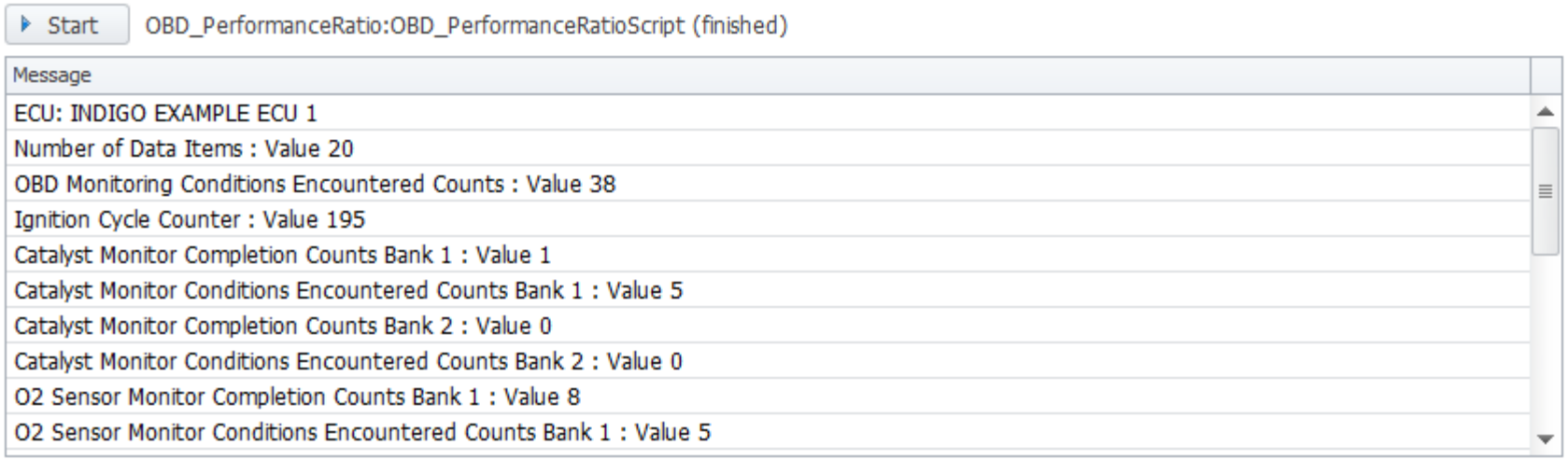
```
// run OBD discovery and detect OBD ECUs
var result = ObdDiscovery.Discover();

// decide whether working with the OBD functional
// group or OBD ECUs via physical communication
var functionalGroup = result.ObdFunctionalGroup;

// read out InfoType $08 - In-Use Performance Tracking
var performanceTracking =
functionalGroup.ReadObdInfoType(ObdInfoTypeCategory.InfoType_08_InUsePerformanceTracking);

// Iterate through the response data and output content
foreach (var obdInfoType in performanceTracking)
{
  Output.WriteLine("ECU: " + obdInfoType.Ecu);
  foreach (var data in obdInfoType.Data)
  {
    Output.WriteLine(string.Format("{0} : Value {1}", data.Name, data.Value));
  }
}
```

Examples: Reading out IUMPR



Examples: Reading out OnBoard Monitoring Tests

```
var discovery = ObdDiscovery.Discover();
var functionalGroup = discovery.ObdFunctionalGroup;


foreach (ObdMonitoringTestResultCategory obdMonitorId in
Enum.GetValues(typeof(ObdMonitoringTestResultCategory)))
{
  Output.WriteLine("Monitor: " + obdMonitorId);


  //Read out all Monitoring Test Results
  var monitoringTestResultsData = functionalGroup.ReadObdMonitoringTestResult(obdMonitorId);
  foreach (var dataCollection in monitoringTestResultsData)
  {
    foreach (var testResult in dataCollection.ObdMonitoringTestResults)
    {
      Output.WriteLine(string.Format("Test {0}: Minimum :  {1} | Maximum: {2} | Value: {3}",
testResult.Name, testResult.MinimumValue, testResult.MaximumValue, testResult.TestValue));
    }
  }
}
```

Examples: Reading out OnBoard Monitoring Tests

Start OBD_Read_MonitoringTestResults:OBD_Read_MonitoringTestResultsScript (finished)

Message
Monitor: OBDMID_01_20_supported
Monitor: ExhaustGasSensorMonitorBank1Sensor1
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.4502 | Maximum: 0.4502 | Value: 0.4502
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.4502 | Maximum: 0.4502 | Value: 0.4502
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.3001 | Maximum: 0.3001 | Value: 0.3001
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.6004 | Maximum: 0.6004 | Value: 0.6004
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.000 | Maximum: 0.167 | Value: 0.059
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 0.000 | Maximum: 0.131 | Value: 0.045
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 38 | Maximum: 65535 | Value: 96
Test Exhaust Gas Sensor Monitor Bank 1 Sensor 1: Minimum : 38 | Maximum: 65535 | Value: 95

Agenda

- OBD Introduction
- Diagnostic Protocol
- Discover OBD ECUs
- Read Diagnostic and Vehicle Data
- Fault Memory
- Request On-Board Monitoring Test Results
- Generic OBD Service Access
- OBD Automation API
- **Remote Diagnostics**
- Further Readings

Use-Cases

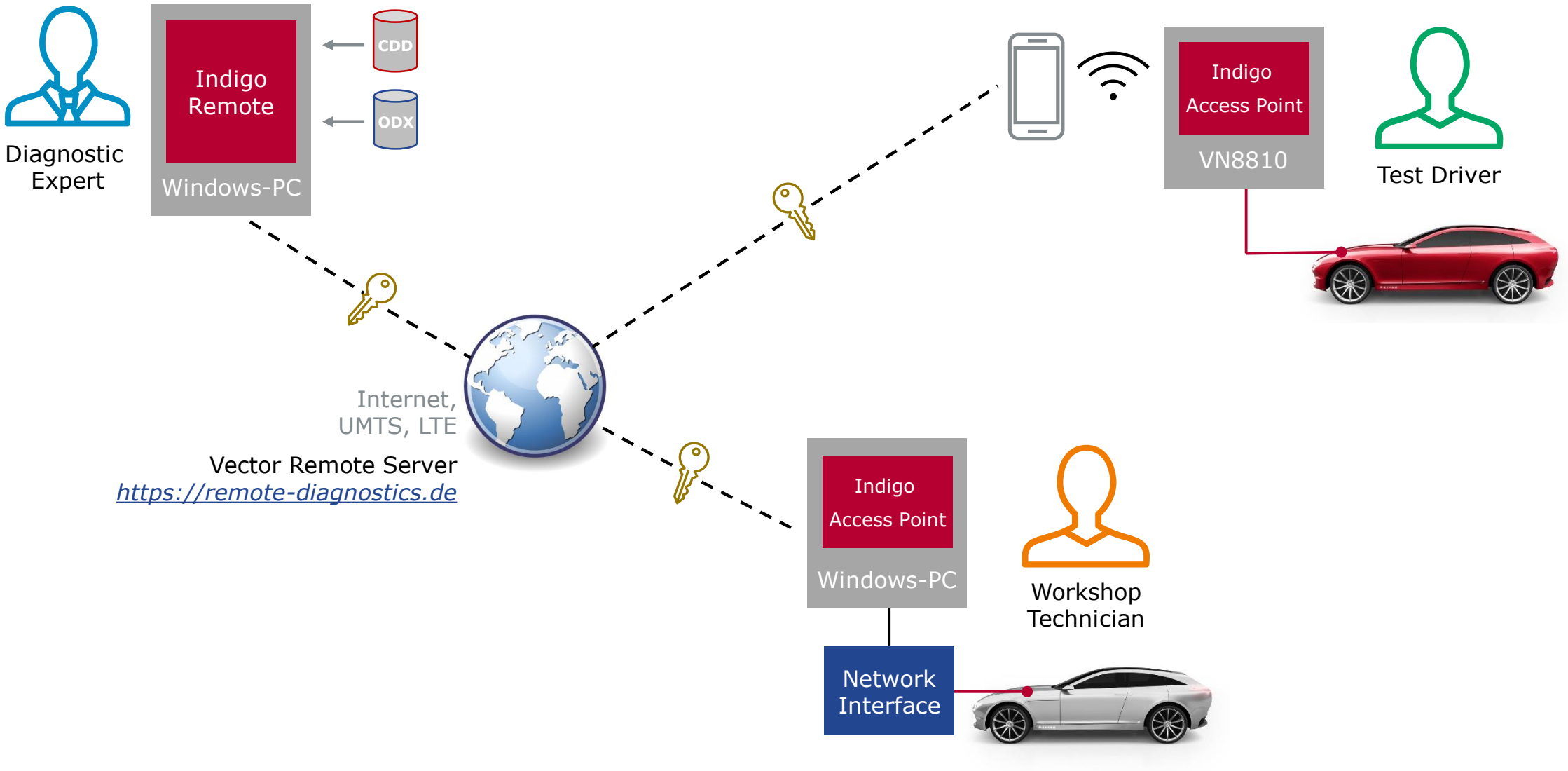
- **Issue on test drive**
  Issue with a vehicle on test drive: Help from (or for) the developer without the need to travel.

- **Issue in production plant**
  Issue with a vehicle, ECU or system in production plant (potentially in another country):
  Short-term help from a developer from a distance.

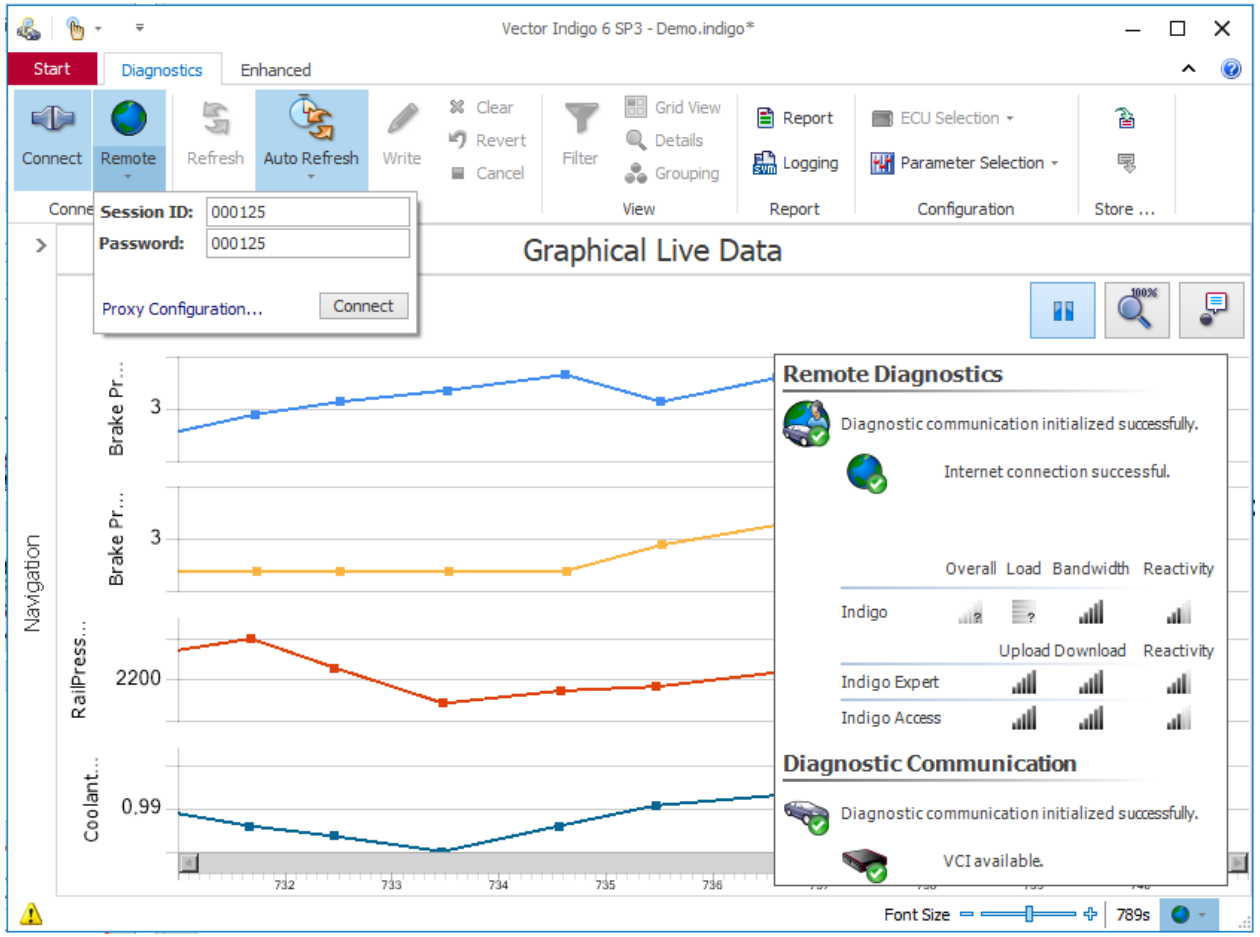
- **Issue in after-sales garage**
  Issue with customer's vehicle in after-sales garage:
  Short-term help from a "vehicle doctor" or developer from the central facility.

- **Issue with integrated 3rd party system**
  Issue with 3rd party system or component in the vehicle (e. g. in OEM cooperation, integrated engine/transmission):
  Help from a system expert from a distance.

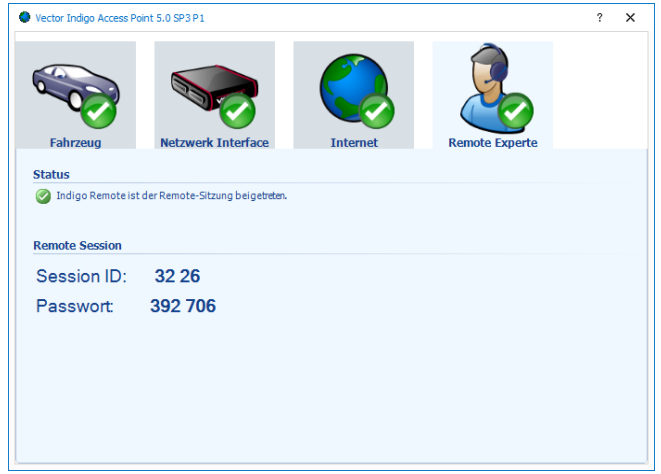
Indigo Remote System



Indigo Remote user interface



or



Indigo Access Point on PC

Characteristics

- Works worldwide, just requires broadband connection
  LAN, WLAN, UMTS, … (on vehicle as well as on expert site)

- Software, diagnostic data, sequences and security algorithms are kept on the diagnostic expert's machine (and are not transported)
  Software/data on diagnostic expert's machine can be updated at any time.
  No security issues resulting from (transfer of) data to the vehicle specialist's machine.

- Getting started quick and easy
  If not available the Access Point can be downloaded from the server.
  The vehicle specialist starts a remote session on the server, the diagnostic expert connects to it.

- High data transfer speed
  "Smart blocks"

- Supports 3rd party diagnostic hardware
  PassThru API (SAE J2534), D-PDU API (ISO 22900-2)

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- **Further Readings**

"Legislated OBD in AUTOSAR and Vector Tools"

Author: Jeff Craig

https://assets.vector.com/cms/content/events/2019/VA/VECO19/Day_2/Legislated_OBD_in_AUTOSAR_and_the_Rest_of_the_Vector_Tool_Chain_-_Jeff_Craig.pdf

"WWH-OBD – made simple! Implementation of the new WWH-OBD Requirements for OEMs and Suppliers"

Author: Helmut Frank

https://assets.vector.com/cms/content/know-how/_technical-articles/diagnostics/WWH_OBD_AEL_201208_PressArticle_EN.pdf

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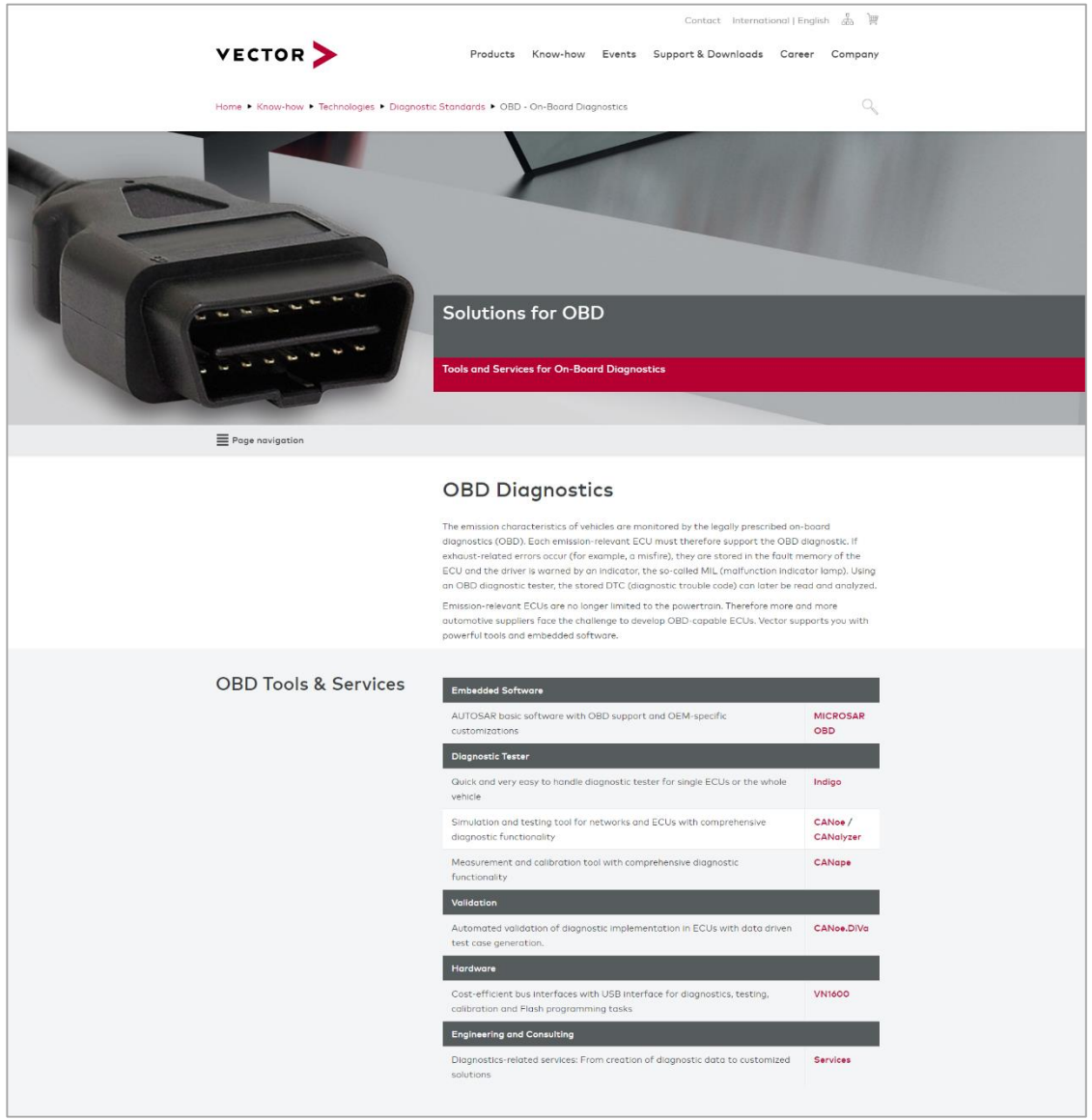
Vector solutions for OBD

- Embedded Software
- Diagnostic Testers
- Validation
- Hardware
- Engineering and Consulting

http://www.obd-solution.com



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