

ISO 15118 Part 4 Conformance Test

Today there has been a significant increase in development of electric vehicles. Smart charging is the intelligent way forward, where charging can be shifted based on grid loads and in accordance to the vehicle owner's needs. So along with EVs (Electric Vehicles) their com-munication with the EVSE (Electric Vehicle Supply Equipment) has to be considered. ISO 15118 specifies the communication between Electric Vehicles (EV), including Battery Electric Vehicles and Plug-In Hybrid Electric Vehicles, and the Electric Vehicle Supply Equipment (EVSE). The complexity of the protocol necessitates considerable amount of testing as described in Part 4 of the standard to enable interoperability between multiple independent implementations. This article describes the approach and the solution used to perform conformance testing on a simulation platform and the actual hardware according to ISO15118 Part 4 standard.

ISO 15118: Road Vehicles – Vehicle to Grid Communication Interface

The ISO 15118 Standard is divided into 5 parts as follows:

- ISO 15118-1 introduces the overall flow of communication.
- · ISO 15118-2 deals with the requirements of messages exchanged by EV and EVSE
- ISO 15118-3 consists of physical and data link layer requirements
- ISO 15118-4 includes the conformance tests for ISO 15118-2
- ISO 15118-5 consists of the conformance tests for ISO 15118-3

The remaining parts of the standard deal with wireless communication.

ISO 15118 – Part 1						
	Application	SDP + V2G messaging				
	Presentation	• EXI –Efficient XML				
ISO 15118 – Part 2	Session	• V2GTP				
	Transport	TLS/TCP/UDP				
	Network	• IPv6				
ISO 15118 – Part 3	Data Link	MAC Layer				
	Physical	Green PHY				

Figure 1: ISO15118 OSI Model



ISO15118 part 1 defines the general requirements and use cases. ISO15118 Part 2 standard provides the requirements for the top 5 layers of the Open System Interconnection (OSI) model viz. Application Layer, Presentation Layer, Session Layer, Transport Layer and Network Layer. The EV and EVSE communicate with each other over Power Line Communication (PLC). During the communication, EV and EVSE exchange various messages over IPV6 UDP/TCP Protocols. These messages have been described in ISO 15118 Part 2. The Data Link Layer and Physical Layer functionality is described in ISO 15118-3.

ISO 15118 Part 4: Conformance Test- Concept

The Generic test architecture reference model defined by ISO15118 –Part4 is as follows:



Figure 2: ISO15118 - Part4 Standard Test Architecture

These test cases are only applicable for communication protocol defined in part 2 of the ISO15118 standard and do not consider any power flow between EV and EVSE. The conformance test cases in part 4 are specified for OSI network layer 3 and above.

ISO 15118 Part 4: Test Architecture System

KPIT has developed a generic test framework for ISO15118-Part4 conformance testing and a simulated EVSE stack using CANoe and VT system from Vector. The reference architecture mentioned in section 3 was mapped as mentioned below.



Figure 3: KPIT Test Architecture

The test system architecture in a simulated environment is mentioned below:



Figure 4: Test Architecture in simulated mode

The test system architecture in a real environment is mentioned below:



Figure 5: Test Architecture using real hardware

A completely simulated EVSE stack has been developed according to Part 2 of the standard. The stack has been developed in the following way:

- Codec: Efficient XML Interchange (EXI) Encoder/Decoder implementation.
- Codec: CANoe.IP was used for IPv6/UDP and TCP.
- ISO15118 Part2 Adapter: Supply Equipment Commnication Controller (SECC) timers and message handlers.
- ISO61851 Adapter: Application programming Interface (API) to control the SECC side control pilot circuit.
- Test Management: Implementation of CAPL unit test module for use cases and test cases.

• Creation of wrapper Dynamic Link Library (DLL) – Message API has been exposed as wrapper function to read and write data from CAPL.





The below mentioned network architecture along with Graphical User Interface (GUI) was used for conformance testing. A complete test module to test whether the EV meets the ISO 15118 – 2 standard has been implemented. This consists of the all the 197 ISO 15118-4 Conformance Tests.

Figure 6: SECC stack

ISO 15118 Part 4: Network Architecture and GUI



Figure 7: Network Architecture

ISO15118_Panel_Main_MessageMonitor	- X ISO15118_Panel_SECC		- ×	SO 15118_Panel_Main_Re	esponseMe ×	ISO15118_Panel_TLS	-
Reg Res Reg Res	START Charging Mod	Payment Mode		Response Message Control		TLS Version Indicator	Handshake Messages
Session Setup	Status Mode	O EIM O Phc	KPIT	Supported App Protocol	Chg Parameter	SSL 3.0	Client Hello
Service Discovery	Receipt STOP Manual (Auto () UseCases	Toron 4 Industry	Session Setup	Cable Check	TLS 1.0	Certificate
Payment Ser. Sel. Session	Detection SECC Readings	100 Veba	Message	Service Discovery	PreCharge	TLS 1.2	Server Key Exchang
Certificate Installation	SECC Present Current	100 Amo	Sequence	Service Detail	Power Delivery		Cetificate
Payment Details	MeterPearling	00	Communication Setup	Payment Service	Charging Status	Record Type Indicator	Client Key Exchange
Authorization	Catfords Sector	Watthr	Direct No. 4	Certificate Installation	Current Demand	ChangeCipherSpec	Certificate Venty
Chg Parameter Dis.	Certificate Services O Instal	Update None	None ~	Certificate Update	Metering Receipt	ApplicationData	Finished
Precharge	Receipt Required	Receipt Required O Yes No		Payment Details Authorization	Welding Detection Session Stop	Alert	 Change Cipher Spec Finished
Power Delivery	C Ye						
START Run Mode Autoton	ases_Main natic () UseCases	KF		ISO15118_Pan	el_UC_Messag	Req Res	- X
ISO 15118_Panel_UseCa START Run Mode O Autoton Certificate Services Install Update	ases_Main natic O UseCases Timeout Indicator Message Sequence Ongoing	Charging AC Payment	Node DC Mode	ISO 15118_Pan Req Res Supporte Session Service Payment	el_UC_Messag edAppProtocol Setup Discovery Detail t Ser. Sel.	Req Res Prec Pow Char Mete	- × harge er Delivery ging Status ent Demand ering Receipt
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ISO 15118_Panel_UseCo START Run Mode O Autotom Certificate Services Install Update IdentificationValid SECC None	ases_Main Timeout Indicator Message Sequence Ongoing Communication EVSE Notification Vone Stop Charging	Charging AC Payment I EIM Receipt F	Mode DC Mode PnC Required	ISO 15118_Pan Req Res Supporte Session Service Service Service Rayment Certificat Certificat Authoriza Chg Par	ed_UC_Messag edAppProtocol Setup Discovery Detail t Ser. Sel. te Installation te Update t Details ation ameter Dis.	Req Res Prec Pow Char Curr Wek Sess	- × harge er Delivery rging Status ent Demand ering Receipt ding Detection ion Stop
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Figure 8: GUI

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Security

OpenSSL libraries have been used for the following:

• Use of OpenSSL API for signature generation and verification using Elliptic Curve Digital Signature Algorithm (ECDSA) algorithm

- Use of OpenSSL API to generate the shared secret key using Elliptic-curve Diffie-Hellman (ECDH) algorithm.
- Implementation of Concatenation hash based Key derivation function (KDF) algorithm.
- Use of OpenSSL AES128_CBC API to encrypt the private key of Contract certificates.
- Use of OpenSSL API's to read the X509 certificates.
- Use of OpenSSL API for hashing using Secure Hash Algorithm (SHA256).

Summary

The Conformance test suite developed by KPIT using industry standard tools is easy to use and can be easily customized or extended to include additional test cases apart from the ones mentioned in the standard. It also ensures that the communication between EV and EVSE is according to the protocol mentioned in the standard and ensures that the EV is interoperable with independent implementations of EVSE.



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About KPIT

KPIT (BSE:532400; NSE: KPIT) is a global technology company focused on providing technology solutions and expertise to the Automotive & Transportation Industry. KPIT is at the forefront of automotive engineering globally with solutions in the areas of Autonomous Driving, Connected Mobility, Vehicle Electrification, AUTOSAR & In-Vehicle Networks and Vehicle Diagnostics. Together with its customers and partners, KPIT creates and delivers technologies to enable creating a cleaner, greener and more intelligent world that is sustainable and efficient.

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