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# HomePlug Green PHY SmartGrid Charging Device – What, Where and Why?

In this article, we will explore the what, where and why of HomePlug Green PHY (HPGP) in layman terms for quick and easy understanding.

## WHAT IS HPGP?

HPGP is a reduced subset of HomePlug communication specification for use in Electric Vehicles (EV) charging, smart meters, small appliances like HVAC thermostats, and home appliances. HPGP is designed for rates of up to 10Mb/s since high data rates are not required for it's intended applications. Data connectivity over home/building network to the power utility is expected; along with the main requirements of low-power, low-cost, compact size and reliable communications.

In terms of power consumption, HPGP was designed to be up to 75% less energy consuming than HomePlugAV (HPAV). HPAV is the 2nd generation of HomePlug targeting multimedia broadband data over power lines.

HPGP achieves reliable communications via the use of HPAV's ROBO (ROBust OFDM) communications mode where QPSK modulation is used along with ½ Turbo Convolutional Code rate. QPSK (Quadrature Phase Shift Keying) is a modulation technique that encodes 2 bits per modulation symbol; meaning each symbol doesn't represent 0 or 1—it represents 00, 01, 10, or 11. The ½ Turbo Convolutional Code rate is a Forward Error Correction (FEC) coding technique applied at the transmitter that allows the receiver to detect and correct errored bits without the need for re-transmission; via the use of redundant repeated bits where each input bit results in 2 output bits hence the notation of 1/2. This is analogous to repeating each message twice when speaking over noisy phone conversation.

HPGP specification was released by HomePlug Alliance in June 2010. HPGP was designed to be fully interoperable with HPAV/2. On October 18, 2016, the HomePlug Alliance announced all of its specifications would be put into the public domain.

HPGP could be referenced as "SmartGrid Charging device" which is a descriptive name; the "SmartGrid" references to the connection to the Grid while "charging device" references the control between charging station and car.

## WHERE IS LUMISSIL HPGP TO BE USED?

As previously mentioned, HPGP was specified for EV SmartGrid charging, meters, small or home appliances and indeed Lumissil HPGP IS32CG5317 is capable of being applied to all these applications and more. In 2011, HPGP was adopted by Ford, GM, Audi, BMW, Daimler, Porsche and VW in their ISO/IEC 15118 specifications as the standard for communication between EV and charging station. In December 2011, HomePlug silicon vendor QualComm announced commercially available HPGP silicon.

Lumissil intends to focus on the automotive market vertical with its HPGP silicon being suited for both inside the vehicle and also inside the charging station; see Figure 1 below.

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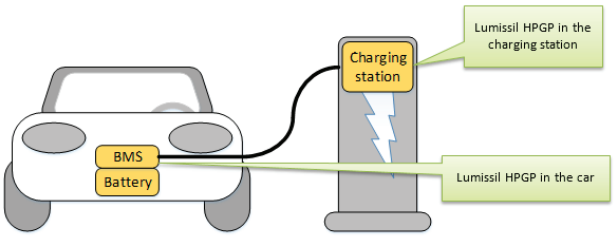


Figure 1 - Lumissil HPGP Automotive Application

Lumissil IS32CG5317 complies with HPGP and ISO/IEC 15118 specifications and meets automotive industry's AEC-Q100 grade 2 quality standard.

All car batteries require Direct Current (DC) for charging which can be provided by charging station or via AC/DC rectifier in the vehicle or in the charging station. Any AC/DC rectifier in a vehicle would be limited in size and current capacity while charging station can have much larger rectifier and current. When the vehicle sources AC for charging, it is termed "AC charging"; and when vehicle sources DC for charging then it is termed "DC charging".

For both AC/DC charging, in North America there are currently 2 levels defined; see Figure 2 below. These are set by SAE (Society of Automotive Engineers) and IEC/ISO for CCS (Combined Charging System). Note that automotive industry often references level 3 (DC fast charging) but actually SAE never finalized this definition.

| Charging level | Power setting | Electrical supply | Driving range (miles per hour of charge) | Application |
|---|---|---|---|---|
| **AC Level 1** | 1.7 kW | 120V ac / 20A | 5 - 6 mi/hr | Residential |
| **AC Level 2** | | | | |
| ***minimum*** | 3.4 kW | 240V ac / 20A | 10 - 12 mi/hr | |
| ***typical*** | 6.7 kW | 240V ac / 40A | 25 - 28 mi/hr | Residential |
| ***maximum*** | 19.2 kW | 240 V ac / 100A | 60 - 70 mi/hr | |
| **DC Level 1** | 40 kW | up to 500v dc / 80A | 120 - 140 mi/hr | Commercial |
| **DC Level 2** | 100 kW | up to 500v dc / 200A | up to 300 mi/hr | Commercial |
| **Tesla (proprietary)** | 120 kW | 480v ac / 250A | 150 mi / 30 min | Supercharger |

Figure 2 – EV Charging In NA

AC charging is not limited to but tends to be used for residential charging; where HPGP is currently optional. The load stress on power grids from increasing EV ownership would likely result in legislative mandate to use HPGP in residential chargers in the near future. When AC chargers are HPGP equipped, they are referred to as "Smart AC Chargers". DC charging often are commercial chargers where the use of HPGP is mandatory. At the same time, Tesla uses proprietary AC Supercharger today. It's likely that Tesla will eventually have to accommodate SAE definitions for its driver's convenience.

In Europe, HPGP is also utilized; sometimes referenced as HPGP PLCC (Power Line Carrier Communications). CHAdeMo which uses CAN (Controller Area Network) for communication is often available as well standalone or side-by-side with HPGP equipped chargers. The charging definitions are in terms of modes; see Figure 3.

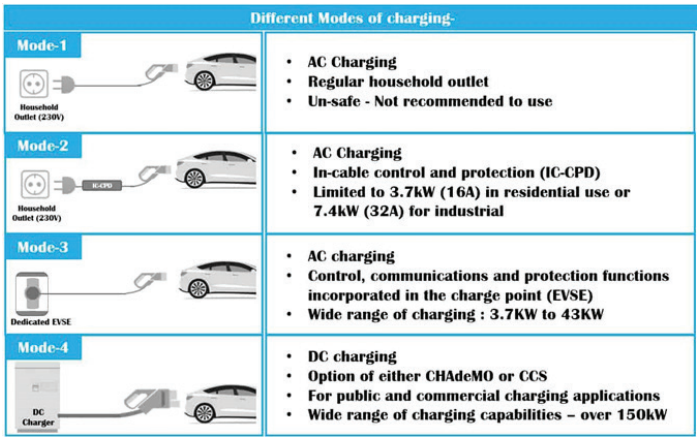


Figure 3 - EV Charging In EU

In Asia Pacific, China defines Guobiao standard GB/T 20234 and Japan defines CHAdeMO standard; both utilize CAN and not HPGP PLCC. See Figure 4 below. Since CAN communications is limited to a maximum of 1Mb/s; it likely would be upgraded to HPGP PLCC for higher data rate in near future.

| | CCS | GB/T | CHAdeMO |
|---|---|---|---|
| **Country of origin** | Germany | China | Japan |
| **Charging Standard** | SAE J1722 | GB/T-20234 | IEC 62196-4 |
| **Physical layer for EVSE-EV Communication** | PLCC | CAN | CAN |
| **Type of Charging** | AC and DC | AC and DC | DC |
| **Charging Limits** | 1000V<br>350A<br>350 kW | 750V<br>200A<br>150 kW | 500V<br>125A<br>400kW |
| **AC Connector** | **TYPE 1**<br>5-Pin<br>Mechanical lock<br>*IEC 62196-2/SAE J1722* | 7-pin<br>Mechanical (optional electronic) lock<br>*GB 20234.2-2011* | 5-pin<br>Mechanical and electronic lock<br>*IEC 62196-2/SAE J1722* |

Figure 4 - EV Charging In Asia Pacific

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## WHY IS HPGP NEEDED IN EV CHARGING?

In CCS, the HPGP communication between the vehicle and charging station is needed to control the charging levels or modes. The vehicle has to indicate to the charger its charging capacity. In addition, payment and billing, time-of-day pricing and home network information etc. needs to be exchanged.

ISO/IEC 15118 specifications also anticipated future need to have connectivity to the Electric Utility (aka SmartGrid V2G – Vehicle to Grid). In the future, EVs may serve as distributed energy storage that could be tapped for balancing the energy on the grid; EV owners may be incentivized by direct payment or credit from utilities. To achieve this, communication between the grid and vehicle (V2G) is required and HPGP would be required in all charging stations; including residential chargers.

## ABOUT LUMISSIL HPGP PRODUCT

Lumissil HPGP SmartGrid Charging device ordering part number is IS32CG5317-QFGA2-TR and will be available for customer evaluation in July 2021.

IS32CG5317 is a new modem designed with stringent automotive requirements in mind, from design to manufacturing; with many features to be a competitive HPGP solution for both EVs and Charging stations OEMs.

This highly integrated chip includes an analog front-end unit in a small EP-LQFP package. To support embedded applications, SPI and R/MII interfaces are available to enable direct connection to standard or low-cost microcontrollers commonly found in charging systems. To reduce the customer's product cost, the use of an on-board flash is optional. IS32CG5317 complies with HPGP, ISO/IEC 15118 and AEC-Q100 grade 2 specifications.

Lumissil connectivity team is committed to provide IS32CG5317 customers strong technical support and abide to ISSI company's mission to maintain long-term support.

Questions or feedback may be sent to:
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