IEC 62196

From Wikipedia, the free encyclopedia

IEC 62196 *Plugs, socket-outlets, vehicle couplers and vehicle inlets – Conductive charging of electric vehicles* is an international standard for a set of electrical connectors for electric vehicles and is maintained by the International Electrotechnical Commission (IEC).

The standard is based on IEC 61851 *Electric vehicle conductive charging system* which establishes general characteristics, including charging modes and connection configurations, and requirements for specific implementations (including safety requirements) of both electric vehicle (EV) and electric vehicle supply equipment (EVSE) in a charging system. For example, it specifies mechanisms such that, first, power is not supplied unless a vehicle is connected and, second, the vehicle is immobilized while still connected.[1]

IEC 62196 comprises:

- Part 1: General requirements (IEC-62196-1)
- Part 2: Dimensional compatibility and interchangeability requirements for a.c. pin and contact-tube accessories (IEC-62196-2)
- Part 3: Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers (IEC-62196-3)

Every connector includes control signaling, not only allowing control of local charging, but allowing the EV to participate in a wider electric vehicle network. The signaling from SAE J1772 is incorporated in the standard for control purposes. All connectors can be converted with passive or simple adapters, although possibly not with all charging modes intact.

The following standards are incorporated as connector types:

- SAE J1772, known colloquially as the Yazaki connector, in Northern America;
- VDE-AR-E 2623-2-2, known colloquially as the Mennekes connector, in Europe;
- EV Plug Alliance proposal, colloquially known as the Scame connector, in Italy;
- JEVS G105-1993, with the trade name, CHAdeMO, in Japan.

The Framatome plug by EDF conforms to, but is not incorporated in, the standard.[1]

Contents

History

Part	Edition	Publication date
IEC-62196-1[2]	1.0	28 April 2003
	2.0	13 October 2011
	3.0	19 June 2014
IEC-62196-2[3]	1.0	13 October 2011
	2.0	18 February 2016
IEC-62196-3[4]	1.0	19 June 2014

Charging modes

IEC 62196-1 is applicable to plugs, socket-outlets, connectors, inlets and cable assemblies for electric vehicles, intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding:

- 690 V AC 50–60 Hz at a rated current not exceeding 250 A;
- 600 V DC at a rated current not exceeding 400 A.

IEC 62196-1 refers to the charging modes defined in IEC 61851-1 which each specify required electrical characteristics, protections, and operation as follows:[5]

Mode 1

This is a direct, passive connection of the EV to the AC mains, either 250 V 1-phase or 480 V 3-phase including earth, at a maximum current of 16 A. The connection does not have extra control pins.[6] For electrical protection, the EVSE is required to provide earth to the EV (as above) and to have ground fault protection.

In some countries including the USA, Mode 1 charging is prohibited. One problem is that the required earthing is not present in all domestic installations. Mode 2 was developed as a workaround for this.

Mode 2

This is a direct, semi-active connection of the EV to the AC mains, either 250 V 1-phase or 400 V 3-phase including earth at a maximum current of 32 A. There is a direct, passive connection from the AC mains to the EV supply equipment (EVSE), which must be part of, or situated within 0.3 metres (1.0 ft) of, the AC mains plug; from the EVSE to the EV, there is an active connection, with the addition of the control pilot to the passive components.[6] The EVSE provides protective earth presence detection and monitoring; ground fault, over-current, and over-temperature protection; and functional switching, depending on vehicle presence and charging power demand. Some protections must be provided by an SPR-PRCD conforming to IEC 62335 *Circuit breakers - Switched protective earth portable residual current devices for class I and battery powered vehicle applications*.

A possible example uses an IEC 60309 connector on the supply end, which is rated at 32 A. The EVSE, situated in-cable, interacts with the EV to indicate that 32 A can be drawn.[7]

Mode 3

This is an active connection of the EV to a fixed EVSE, either 250 V 1-phase or 480 V 3-phase including earth and control pilot; Either, with a compulsorily captive cable with extra conductors, at a maximum current of 250 A or, in a manner compatible with mode 2 with an optionally captive cable, at a maximum current of 32 A.[6] The charging supply is not active by default, and requires proper communication over the control pilot to enable.

The communication wire between car electronics and charging station allows for an integration into smart grids.[7]

Mode 4

This is an active connection of the EV to a fixed EVSE, 600 V DC including earth and control pilot, at a maximum current of 400 A.[6] The DC charging power is rectified from AC mains power in the EVSE, which is consequently more expensive than a mode 3 EVSE.[7]

IEC 62196-3 – DC Charging

The 2010/2011 voting ballot of IEC 62196-2 does not contain a proposal for DC charging / Mode 4. This is to be found in *IEC 62196-3* published 19 June 2014.[8] The IEC working group for TC 23/SC 23H/PT 62196-3 (max. 1000 V DC 400 A plugs) has been approved for new work.[9][10][11] Specifications on DC charging have already begun on the national level.

A number of plug types are under consideration for DC charging. The Japanese Chademo plugs have been in use for a number of years already while the common plug type is considered too bulky. China has adopted the Type 2 (DKE) connector adding a mode that puts DC power on existing AC pins. Both of the two connectors use a CAN based protocol between the car and the charging station to switch the mode. In contrast to that both the American SAE and the European ACEA research concentrates on the GreenPHY PLC protocol to plug the car into a smart grid architecture. Both of the latter consider to have a low power / Level 1 configuration where DC power is put on existing AC pins (as specified for the Type 1 or Type 2 plug types respectively) and an additional high power / Level 2 configuration with dedicated DC power pins – the ACEA and the SAE are working on a "Combined Charging System" for the extra DC pins that fit universally.[12][13]

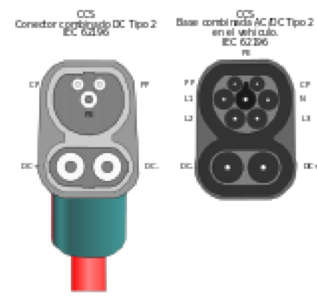
The CHAdeMO specification describes high-voltage (up to 500 V DC) high-current (125 A) automotive fast charging via a JARI Level-3 DC fast charge connector. This connector is the current de facto standard in Japan.[14] The SAE 1772 Task Force works on a proposal for DC loading to be published in December 2011[14] The extension of the VDE plug (Type 2) will be submitted directly to the IEC 62196-2 until 2013.[15] Both China and the SAE consider using the *Type 2 Mode 4* connector for DC charging as well (the Japanese TEPCO plug housing is considerably larger than Type 2).[16]

The VDE has supplied the National Development Plan for Electric Mobility in Germany with the expectation that charging stations for electric vehicles will be deployed in three stages: 22 kW (400 V 32 A) Mode 2 stations are introduced in 2010–2013, the 44 kW (400 V 63 A) Mode 3 stations to be introduced in 2014–2017 and the next generation batteries will require at least 60 kW (400 V DC 150 A) by 2020 allowing to charge the standard 20 kWh battery pack to 80% in less than 10 minutes.[17] Similarly the SAE 1772 DC L2 plan is sketched for charging up to 200 A 90 kW.[14]

Meanwhile, Tesla Motors introduced 90 kW DC charging system called SuperCharger in 2012 for its Model S cars and since 2013 upgraded DC charging system to 120 kW DC. Tesla is using modified Type 2 plug for SuperCharger. This modified connector allows for deeper insertion, and longer conductor pins, allowing for greater current. There is no need for additional DC pins because DC current can flow using the same pins as AC current.

Combined Charging System

The target of only having one charging connector is currently unlikely to occur. This is because there are different electrical grid systems around the world; with Japan and North America choosing a 1-phase connector on their 100–120/240 V grid (Type 1), while China, Europe, and the rest of the world are opting for a connector with 1-phase 230 V and 3-phase 400 V grid access (Type 2). The SAE and ACEA are trying to avoid the situation for DC charging with a standardization that plans to add DC wires to the existing AC connector types such that there is only one "global envelope" that fits all DC charging stations – for Type 2 the new housing is named Combo 2.[18]



Combo coupler for DC charging (using only the signal pins of Type 2) and the Combo inlet on the vehicle (allowing also AC charging)

At the 15th International VDI-Congress of the Association of German Engineers, the proposal of a *Combined Charging System* (CCS) was unveiled on 12 October 2011 in Baden-Baden. Seven car makers (Audi, BMW, Daimler, Ford, General Motors, Porsche and Volkswagen) have agreed to introduce the Combined Charging System in mid-2012.[19][20] This defines a single connector pattern on the vehicle side that offers enough space for a Type 1 or Type 2 connector along with space for a 2-pin DC connector allowing up to 200 A. The seven auto manufacturers have also agreed to use HomePlug GreenPHY as the communication protocol.[21]

CCS 1&2

Plug types and signaling

IEC 61851 refers to plugs and sockets for industrial specified in IEC 60309 to provide electrical power for the charging modes it specifies. The connectors standardised in IEC 62196 are specialized for automotive use. In June 2010, the ETSI and CEN-CENELEC were mandated by the European Commission to develop a European Standard on charging points for electric vehicles.[22] The IEC 62196-2 circulation started on 17 December 2010 and voting closed on 20 May 2011.[5] The standard was published by the IEC on 13 October 2011.[23] The list of IEC

62196-2 plug types includes:[24]

Type 1, single phase vehicle coupler
Reflecting the SAE J1772/2009 automotive plug specifications.

Type 2, single and three phase vehicle coupler
Reflecting the VDE-AR-E 2623-2-2 plug specifications.

Type 3, single and three phase vehicle coupler with shutters
Reflecting the EV Plug Alliance proposal.

Type 4, direct current coupler
Reflecting the Japan Electric Vehicle Standard (JEVS) G105-1993 specifications, from the Japan Automobile Research Institute (JARI).

Type 1 (SAE J1772-2009), Yazaki

The SAE J1772-2009 connector, known colloquially as the *Yazaki* connector (after its manufacturer), is commonly found on EV charging equipment in North America.


SAE J1772-2009 coupler (Type 1)

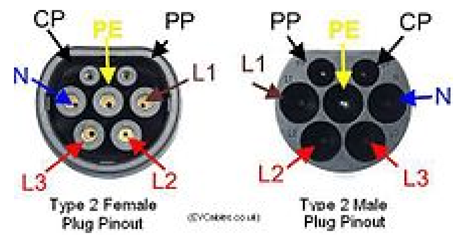
In 2001, SAE International proposed a standard for a conductive coupler which had been approved by the California Air Resources Board for charging stations of EVs. The SAE J1772-2001 plug had a rectangular shape that was based on a design by Avcon. In 2009, a revision of the SAE J1772 standard was published that included a new design by Yazaki featuring a round housing. The SAE J1772-2009 coupler specifications have been included to IEC 62196-2 standard as an implementation of the Type 1 connector for charging with single-phase AC. The connector has five pins for the 2 AC wires, earth, and 2 signal pins compatible with IEC 61851-2001 / SAE J1772-2001 for proximity detection and for the control pilot function.

Note that only the plug type specification of the SAE J1772-2009 has been taken over but not the concept of levels found in the proposal of the California Air Resources Board. (The Level 1 charging mode at 120 V is specific to Northern America and Japan as most regions around the world use 220–240 V and IEC 62196 does not include a special option for lower voltages. The Level 3 for DC charging is not applicable to either IEC 62196-2 or SAE J1772-2009.)

While the original SAE J1772-2009 standard describes ratings from 120 V 12 A or 16 A to 240 V 32 A or 80 A, the IEC 62196 Type 1 specification covers only 250 V ratings at 32 A or 80 A. (The 80 A version of IEC 62196 Type 1 is considered US-only, however.)[25]

Type 2 (VDE-AR-E 2623-2-2), Mennekes

Type 2 coupler, Mennekes



Type 2 plug and socket pinouts.

The connector manufacturer Mennekes had developed a series of 60309-based connectors that were enhanced with additional signal pins – these "CEEplus" connectors have been used for charging of electric vehicles since the late 1990s.[26][27] With the resolution of the IEC 61851-1:2001 control pilot function (aligned with the SAE J1772:2001 proposal) the CEEplus connectors were replacing the earlier Marechal couplers (MAEVA / 4 pin / 32 A) as the standard for electric vehicle charging.[28] When Volkswagen promoted its plans for electric mobility Alois Mennekes contacted Martin Winterkorn in 2008 to learn about the requirements of the charging equipment connectors.[27] Based on requirement of the industry led by utility RWE and car maker Daimler a new connector was derived by Mennekes.[29] The state of charging systems along with the proposed new connector were presented at the start of 2009.[30] This new connector would later be accepted as the standard connector by other car makers and utilities for their field tests in Europe.[29] This choice was supported by the Franco-German joint council on E-mobility in 2009.[31] The proposal is based on the observation that standard IEC 60309 plugs are rather bulky (diameter 68 mm / 16 A to 83 mm / 125 A) for higher current. To ensure easy handling by consumers the plugs were made smaller (diameter 55 mm) and flattened on one side (physical protection against polarity reversal).[32] Unlike the Yazaki connector, however, there is no latch, meaning consumers have no exact feedback that the connector is properly inserted. The lack of a latch also puts unnecessary strain on any locking mechanism.

Since the IEC standardization track is a lengthy process, the German DKE/VDE (*Deutsche Kommission Elektrotechnik*, or German Commission for Electronics of the Association for Electrical, Electronic and Information Technologies) took over the task to standardize the handling details of the automotive charging system and its designated connector published in November 2009 in **VDE-AR-E 2623-2-2**[33] The connector type has been included in the next Part-2 (IEC 62196-2) connector reference as "Type 2".[29] The standardization process of the VDE plug continues with an extension for high current DC loading that will be proposed for inclusion by 2013.[15]

Unlike the IEC 60309 plugs, the Mennekes/VDE automotive solution (German, *VDE-Normstecker für Ladestationen*, or VDE standard plug for charging stations) has a single size and layout for currents from 16 A single-phase up to 63 A three-phase (3.7–43.5 kW)[34] but it does not cover the full range of Mode 3 levels (see below) of the IEC 62196 specification. Since the VDE automotive connector was described first in the DKE/VDE proposal for the IEC 62196-2 standard (IEC 23H/223/CD), it was also called the IEC-62196-2/2.0 automotive connector before it got its own standardization title. The VDE will formally withdraw the national standard as soon as the international IEC standard is resolved.

There has been criticisms of the price of the VDE connector however by the car manufacturer Peugeot comparing it to the IEC 60309 plugs that are readily available.[35] Unlike field tests in Germany, a number of field tests in France and the UK have taken over the campground sockets (blue IEC 60309-2 plug, single-phase, 230 V, 16 A) that are already installed in many outdoor locations across Europe[35] or weatherproofed versions of their normal domestic sockets. Also the Scame plugin is promoted by a French-Italian alliance mentioning its comparable low price.[36] The Chinese Variant of Type 2 in GB/T 20234.2-2011 has limited the current to 32 A allowing for cheaper materials.[37]

The Association des Constructeurs Européens d'Automobiles (ACEA) has decided to use the Type 2 connector for deployment in European Union. For the first phase the ACEA recommends public charging stations to offer Type 2 (Mode 3) or CEEform (Mode 2) sockets while home charging may additionally use a standard home socket (Mode 2). In the second phase (expected to be 2017 and later), a uniform connector shall be used only, whereas the ultimate choice for Type 2 or Type 3 is left open. The rationale of the ACEA recommendation points to using Type 2 Mode 3 connectors however.[38] Based on the ACEA position Amsterdam Electric has put up the first Type 2 Mode 3 public charging station for use with the Nissan Leaf test drive.[39]

Beginning at the end of 2010 the utilities Nuon and RWE have started to deploy a network of charging poles in Central Europe (Netherlands, Belgium, Germany, Switzerland, Austria, Poland, Hungary, Slovenia, Croatia) using the *Type 2 Mode 3* socket type based on the widely available 400 V three-phase domestic power grid. The Netherlands have started to deploy a network of 10,000 charging stations of this type with a common output of three-phase 400 V at 16 A.

In March 2011, the ACEA had published a position paper that recommends Type 2 Mode 3 as the EU uniform solution by 2017, ultra fast DC charging may only use a Type 2 or Combo2 connector[18] The European Commission has followed the lobbying[40][41] proposing Type 2 as the common solution in January 2013 to end uncertainty about the charging station connector in Europe.[42] There had been concerns that some countries require a mechanical shutter for electrical outlets which the original VDE proposal did not include - Mennekes proposed an optional shutter solution in October 2012[40] which was picked up in the German-Italian compromise in May 2013 which the standardization bodies propose for subsequent inclusion in the CENELEC standard of Type 2.[43]

Type 3 (EV Plug Alliance connector), Scame

The EV Plug Alliance was formed on March 28, 2010 by electrical companies in France (Schneider Electric, Legrand) and Italy (Scame).[44]

Within the IEC 62196 framework they propose an automotive plug derived from the earlier Scame plugs (the Libera series) that are already in use for light electric vehicles.[45] Gimélec joined the Alliance on May 10 and a number of more companies joined on May 31: Gewiss, Marechal Electric, Radiall, Vimar, Weidmüller France & Yazaki Europe.[46] The new connector is able to provide 3-phase charging up to 32 A as being examined in the Formula E-Team tests.[36] Schneider Electric emphasises that the "EV Plug" uses shutters over the socket side pins which is required in 12 European countries and that none of the other proposed EV charger plugs is featuring.[47] Limiting the plug to 32 A allows for cheaper plugs and installation costs. The EV Plug Alliance points out that the future IEC 62196 specification will have an annexe categorizing electric vehicle charger plugs into three types (Yazaki's proposal is type 1, Mennekes' proposal is type 2, Scame's proposal is type 3) and that instead of having a single plug type at both ends of a charger cable one should choose the best type for each side — the Scame / EV Plug would be the best option for the charger side / wall box leaving the choice for the car side open. On 22 September 2010, the companies Citelum, DBT, FCI, Leoni, Nexans, Sagemcom, Tyco Electronics joined the Alliance.[48] As of early July 2010 the Alliance has completed the test of products from several partners and the plug and socket-outlet system are made available on the market.[48]

While the first ACEA position paper (June 2010) has ruled out the Type 1 connector (based on the requirement of three-phase charging which is abundant in Europe and China but not in Japan and the USA) it has left open the question whether a Type 2 or Type 3 connector should be used for the uniform plug type in Europe.[38] The rationale points to the fact that Mode 3 requires the socket to be dead when no vehicle is connected so that there can be no hazard that the shutter could protect from. The shutter protection of Type 3 connectors do only have advantages in Mode 2 allowing for a simpler charging station. On the other hand, a public charging station exposes the charging socket and plugs to a harsh environment where the shutter could easily have a malfunction which is not noticeable to the electric vehicle driver. Instead the ACEA expects that Type 2 Mode 3 connectors also to be used for home charging in the second phase after 2017 while still allowing Mode 2 charging with established plug types that are already available in home environments.[38] The impact of some jurisdictions requiring shutters is still being debated.[49]

The second ACEA position paper (March 2011) recommends to use only Type 2 Mode 3 (with IEC 60309-2 Mode 2 and standard home socket outlets Mode 2 being still allowed in Phase 1 up to 2017) being the EU uniform solution by 2017.

Car makers should equip their models only with Type 1 or Type 2 sockets – existing Type 3 infrastructure may be connected with a Type2/Type3 cable in Phase 1 for basic charging (up to 3.7 kW). Fast charging (3.7–43 kW) and ultra fast DC charging (beyond 43 kW) may only use a Type 2 or Combo 2 connector (Combo 2 is Type 2 with additional DC wires in a global envelope that fits all DC charging stations; i.e., even if the AC charging part was built for Type 1).[18]

The EV Plug Alliance had proposed two connectors with shutters. The *Type 3A* is derived from the Scame charging connectors adding the IEC 62196 pins which is suited for single-phase charging – the connector builds on the experience with the Scame connector for charging of light vehicles (electric motorcycles and scooters).[50][51] The additional *Type 3C* adds additional 2 pins for three-phase charging for usage at fast charge stations.[52] Based on its origin the connector is sometimes referred to as the *Scame Type 3* connector.[53]

In October 2012, Mennekes showed an optional shutter solution for its Type 2 socket. In the press material, it is shown that some countries chose the Mennekes' IEC Type 2 connector despite the requirement for shutters on household sockets (Sweden, Finland, Spain, Italy, UK); only France has a decision for the EV Plug Alliance's IEC Type 3 socket type. The Mennekes shutter is inherently IP 54 safe (dust cover) providing an installation option even beyond IP xxD.[40] After the European Commission has settled on Type 2 (VDE/Mennekes connector) as the single solution for the charging infrastructure in Europe in January 2013, the EV Plug Alliance has asked to include the variant of Type 2 with shutters in the upcoming directive in a hearing of the TRAN Committee in June 2013[54] (which makes the VDE/Mennekes plug a variant implementation of the requirements of IEC Type 3). The Italian standardization body CEI tested the Mennekes shutter proposal (where Italy is a country requiring mechanical shutters) and in May 2013 the Italian and German partners approved it as a compromise solution for Type 2 to be included in the CENELEC standardization of electric vehicle charging connectors.[43]

The EV Plug Alliance was last seen in June 2013 at an EU hearing.[54] The web site was not maintained any more and in October 2014 it was replaced with a shutdown notice.[55] Based on the EU recommendation any new project in France for charging stations, beginning in 2015, started to require a Type 2 socket to get funding. In October 2015, it became known that Schneider (a founding member of the EV Plug Alliance) only manufactures charging stations with Type 2S connectors (Type 2 with shutters).[56] In November 2015, Renault started selling its electric vehicles in France with a Type 2 connector cable instead of the previously used Type 3.[57] As such the production of Type 3 connectors has been finally abandoned.

IEC 62196-2 also documents the connector type proposed by the EV Plug Alliance as "Type 3". Following up to Part 2 of IEC 62196 there has been approved new work on a Part 3[58] of the standard covering DC charging.

Type 4 (JEVS G105-1993), CHAdeMO

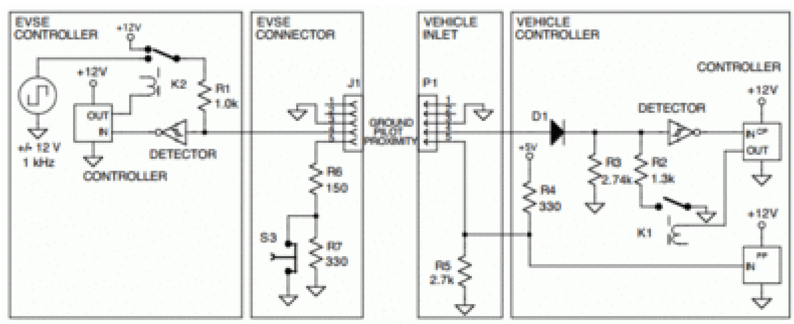
Known by the trade name, *CHAdeMO*, the type 4 connector is used for charging EV in Japan and Europe. It is specified by Japan Electric Vehicle Standard (JEVS) G105-1993 from the JARI (Japan Automobile Research Institute).

Unlike types 1 and 2, the type 4 connection uses the CAN bus protocol for signalling.[59]

CHAdeMO, IEC 62196 type 4

Signaling

The signal pins and their function were defined in SAE J1772-2001, which was included in IEC 61851. All plug types of IEC 62196-2 have the two additional signals: the *control pilot* (*CP*; pin 4) and *proximity pilot* (PP; pin 5) over the normal charging power pins: line (L1; pin 1), line or neutral (N, or L2; pin 2), and protective earth (PE; pin 3).



J1772 signaling circuit

The proximity pilot (or, plug presence) signal allows the EV to detect when it is plugged in. Inside the plug itself, a passive resistance is connected across PP and PE, which the EV then detects. PP does not connect between EV and EVSE. A plug with a closed retention clip is indicated by 150 Ω, and a plug with an open retention clip (i.e., pressed by the user) is indicated by 480 Ω. This allows the EV to

EVSE PP resistances

Resistance, PP-PE	Max. current	Conductor size
Open, or ∞ Ω[60]	6 A	0.75 mm²
1500 Ω	13 A	1.5 mm²
680 Ω	20 A	2.5 mm²
220 Ω	32 A	6 mm²
100 Ω	63 A	16 mm²
50 Ω, or < 100 Ω[60]	80 A	25 mm²

inhibit movement while a charging cable is attached, and to cease charging as the plug is disconnected, so there is no load and associated arcing.

PP also allows the EVSE to detect when a cable is plugged in. Again, inside the plug itself, a passive resistance is connected across PP and PE. The cable can then further indicate its current rating to the EVSE with different resistances. The EVSE can then communicate this to the EV via the control pilot.[61][62]

Control pilot resistances

Status		Resistance, CP-PE
A	EV disconnected	Open, or ∞ Ω
B	EV connected	2740 Ω
C	EV charge	882 Ω ≈ 1300 Ω ‖ 2740 Ω
D	EV charge (ventilated)	246 Ω ≈ 270 Ω ‖ 2740 Ω
E	No power	N/A
F	Error	N/A

The control pilot signal is designed to be easily processed by analog electronics, eliding the use of digital electronics, which can be unreliable in automotive settings. The EVSE starts in state A and applies +12 V to the control pilot. On detecting 2.74 kΩ across CP and PE, the EVSE moves to state B, and applies a 1 kHz ±12 V peak-to-peak square wave pilot signal. The EV can then request charging by changing the resistance across CP and PE to 246 Ω or 882 Ω (with and without ventilation, respectively); if the EV requests ventilation, the EVSE will only enable charging if it is in a ventilated area. The EVSE communicates the maximum available charging current to the EV by pulse width modulation of the pilot signal: 16% duty cycle is 10 A, 25% is 16 A, 50% is 32 A, and 90% flags a fast charge option.[63] The line wires are not made live until an EV is present, and has requested charging; i.e., state C or D.

The EVSE feeds the control pilot with ±12 V through a series 1 kΩ sense resistor, after which it senses the voltage; the CP is then connected, in the EV, through a diode and relevant resistance to PE. The resistance in the EV can be manipulated by switching in a resistor in parallel with always connected 2.74 kΩ detection resistor.[64]

See also

- Wireless power transfer

References

1. Peter Van den Bossche (Secretary of IEC TC69) (2008-05-19). "Defining and Developing Standards" (http://www.ecs-five.ch/parkcharge/documents/P_Van_den_Bossche1.pdf) (PDF). Erasmus University College Brussels. Retrieved 2010-09-02.

2. https://webstore.iec.ch/publication/6582
3. https://webstore.iec.ch/publication/24204
4. https://webstore.iec.ch/publication/6584
5. "IEC International Standard for EV charging - A step forward for global EV roll-out" (http://www.iec.ch/cgi-bin/procgi.pl/www/iecwww.p?wwwprog=doc-det.p&progdb=db1&wcom=23H&wdoc=250), IEC newslog, 3. February 2011 (Resource is no longer available March 30, 2013)
6. "IEC61851 Part 1: Charging of electric vehicles up to 250 A a.c. and 400 A d.c." (http://webstore.iec.ch/preview/info_iec62196-1%7Bed1.0%7Den.pdf), Table 1 "Modes and permissible connections specified in 61851-1, First Edition 2003-04, IEC
7. "Defining and Developing Standards" (http://www.park-charge.ch/documents/P_Van_den_Bossche1.pdf), Pater Van den Bossche, Secretary of IEC TC69, Erasums University College Brussels, 8 April 2009
8. IEC Dashboard - Project: IEC 62196-3 Ed. 1.0 (http://www.iec.ch/dyn/www/f?p=103:38:0::::FSP_LANG_ID,FSP_ORG_ID,FSP_PROJECT:25,1426,IEC%2062196-3%20Ed.%201.0), accessed 27 February 2011
9. "Dimensional interchangeability requirements for pin and contact-tube coupler with rated operating voltage up to 1 000 V d.c. and rated current up to 400 A for dedicated d.c. charging" (http://www.iec.ch/dyn/www/f?p=103:14:0::::FSP_ORG_ID,FSP_LANG_ID:6619,25)
10. "BS EN 62196-3 Plugs, socket-outlets and vehicle couplers – Coductive charging of electric vehicles Part 3: Dimensional interchangeability requirements for pin and contact-tube couplers with rated operating voltage up to 1 000 V d.c. and rated current up to 400 A for dedicated d.c. charging" (http://standardsdevelopment.bsigroup.com/Home/Project/201001974)
11. "Plugs, socket-outlets, vehicle connectors and vehicle inlets - Conductive charging of electric vehicles - Part 3: Dimensional compatibility and interchangeability requirements for d.c. and a.c./d.c. pin and contact-tube vehicle couplers. This part of IEC 62196 applies to high power d.c. interfaces and combined a.c./d.c. interfaces of vehicle couplers specified in IEC 62196-1:2014, and intended for use in conductive charging systems for circuits specified in IEC 61851-1:2010, and IEC 61851-23:2014." (http://webstore.iec.ch/Webstore/webstore.nsf/ArtNum_PK/49799)
12. pictures of the plug types (http://www.phoenixcontact.com/global/industrial-connectors/25791_71188.htm#71193)
13. Dr. Heiko Doerr (2011-11-08). "Current Status of the Combined Charging System" (http://www.ishavsveien.no/wp-content/uploads/2011/11/Current_status_of_the_Combined_Charging_System_v1.2.pdf) (PDF). Coordination Office Charging Interface (Audi, VW, BMW, Daimler, Porsche).
14. "Standards Update / Global Approaches to Vehicle-Grid Connectivity" (http://www.transportation.anl.gov/batteries/us_china_conference/docs/rt3_Charging_Standards%20_kissel.pdf), Gery J. Kissel (GM Engineer and SAE J1772 Task Force Chair), 30 August 2010
15. "Einheitliches Stecksystem für Elektrofahrzeuge" (http://www.atzonline.de/Aktuell/Nachrichten/1/12406/Einheitliches-Stecksystem-fuer-Elektrofahrzeuge.html), ATZ / Springer Automotive, 16. September 2010

16. "SAE Ground Vehicle Standards - SmartGrid" (http://www.sae-na.it/public/allegati_news/RoleintheU.S.RoadmaptoSmartGridInteroperability.pdf), SAE International, 8 November 2010
17. "Zwischenbericht der Nationalen Plattform Elektromobilität" (http://www.bmvbs.de/cae/servlet/contentblob/60020/publicationFile/30843/elektromobilitaet-zwischenbericht.pd), 30 November 2010
18. "ACEA position and recommendations for the standardization of the charging of electrically chargeable vehicles" (https://web.archive.org/web/20121202043526/http://www.acea.be/images/uploads/files/charging_20110511.pdf) (PDF). ACEA – European Automobile Manufacturers Association. 2011-03-02. Archived from the original (http://www.acea.be/images/uploads/files/charging_20110511.pdf) (PDF) on 2012-12-02.
19. "Universal charging for electric cars" (http://www.auto123.com/en/news/universal-charging-for-electric-cars?artid=136620). Auto123.com. 2011-11-15.
20. "Seven Auto Manufacturers Collaborate on Harmonized Electric Vehicle Fast Charging Solution" (https://web.archive.org/web/20120308181718/http://media.ford.com/article_display.cfm?article_id=35430). Ford. Archived from the original (http://media.ford.com/article_display.cfm?article_id=35430) on 2012-03-08. Retrieved 2012-04-09.
21. "Seven Automakers Agree On Combined EV Charging System" (http://www.renewgridmag.com/e107_plugins/content/content.php?content.7457). 2011-10-12. Retrieved 2012-04-09.
22. "Towards a European common charger for electric vehicles (IP/10/857)" (http://europa.eu/rapid/pressReleasesAction.do?reference=IP/10/857&format=HTML&aged=0&language=EN&guiLanguage=en) (Press release). European Union. 2010-06-29. Retrieved 2010-09-02.
23. IEC - Newslog > 2011-10-18: EVs ready to charge ahead (http://www.iec.ch/newslog/2011/nr1611.htm)
24. IEC - Newslog > 2011-02-03: A step forward for global EV roll-out (http://www.iec.ch/newslog/2011/nr0411.htm)
25. "Report on the Current Situation and Future Direction of Electric Vehicle Charger Standardisation" (http://lib.smmt.co.uk/articles/MemberServices/MemberServices/SMMT%20report%20on%20the%20direction%20of%20EV%20Charger%20Standardisation%20-%20July%202010.pdf), SMMT, July 2010
26. "Ladesysteme für Elektrofahrzeuge", Plugs for the world, Mennekes, 2010 (http://www.mennekes.de/web/binaryid?BINARYID=binary%2Ffile%2FmenP1f31e37b%3A123ff7fe87c%3A-76ca%2Fapplication%2Fpdf%2F)
27. "Umwelttechnologien I: Ladestationen für Elektrofahrzeuge - Der Schlüssel zur Elektromobilität", Gesamtmetall (trade union), 21 July 2010 (http://www.gesamtmetall.de/Gesamtmetall/MEOnline.nsf/id/87D78EE7130FF0F7C1257749003047A9?open&ccm=080130)

28. "Internationaler Standard für das Laden von Elektrofahrzeugen - Schlussbericht" (http://www.bfe.admin.ch/php/modules/enet/streamfile.php?file=000000009155.pdf&name=000000210379.pdf), Bundesamt für Energiewirtschaft (Switzerland), 12 December 2001
29. Xavier Navarro (2009-05-20). "The European standard charging plug for cars is selected after Mennekes design" (http://green.autoblog.com/2009/05/20/the-european-standard-charging-plug-for-cars-is-selected-after-m/). Autoblog Green. Retrieved 2010-04-15.
30. Volker Lazzaro (2009-02-18). "Ladesysteme für Elektrofahrzeuge" (https://www.emfm.de/downloads/spezifikation-mennekes-ladesysteme-rev10.pdf) (PDF). Retrieved 2012-04-09.
31. "Abschlussbericht: Deutsch-Französische Arbeitsgruppe "Elektromobilität" " (http://www.bmwi.de/BMWi/Navigation/Wirtschaft/industrie,did=331068.html). Retrieved 2011-04-26.
32. "E-vehicles: Mennekes develops charging systems" (http://www.mennekes.de/web/screen?ID=mennekes/default/%5Blrncontent,%5Bcontent/pres.cnt.page-seqentry/menP-720e0874:12138fce78f:-7ff1/0/,content/exp.def-live/en/\%5D%5D). Mennekes. 2009-08-28. Retrieved 2010-09-02.
33. "VDE-AR-E 2623-2-2 Plugs, socket-outlets, vehicles" (https://www.vde.com/en/dke/std/VDEapplicationguides/Publications/Pages/VDE-AR-E2623-2-2.aspx). *VDE (VDE Association for Electrical, Electronic and Information Technologies e.V)*. DKE (German Commission for Electrical, Electronic & Information Technologies of DIN and VDE). 2009-11-02. Retrieved 2010-09-02.
34. Volker Lazzaro (2010-02-14). "Die Schnittstelle zwischen Elektrofahrzeug und Infrastruktur" (https://intra.saena.de/tycon/file.php?id=1129) [The interface between the electric vehicle and infrastructure] (PDF) (in German). p. 13. Retrieved 2010-07-21.
35. William Diem (2009-12-02). "European Auto Makers Debate EV Charging Standard" (http://wardsauto.com/ar/european_ev_standard_091202/). WardsAuto.com. Retrieved 2010-09-02.
36. "Tweede informaesessie (second information session)" (https://web.archive.org/web/20150618235924/http://www.e-laad.nl/uploads/files/tweede%20informatie%20sessie%2005-08-2010%20e-laad%20v1.pdf) (PDF). *e-laad.nl second information session (http://www.e-laad.nl/ontwikkelingen/informatiesessies-aanbesteding/informatiesessies/informatiesessie-augustus)* (in Dutch). Formula E-Team (Netherlands) (http://www.senternovem.nl/formuleeteam/). 2010-08-05. Archived from the original (http://www.e-laad.nl/uploads/files/tweede%20informatie%20sessie%2005-08-2010%20e-laad%20v1.pdf) (PDF) on June 18, 2015. External link in `|publisher=`, `|work=` (help)
37. GB/T 20234.2-2011 English version, GB/T 20234.2-2011 Connection set for charging - Conductive charging of electric vehicles Part 2: AC charging coupler (English) - Code of Chi... (http://www.codeofchina.com/gb/traffic/14914.html)

38. "ACEA position and recommendations for the standardization of the charging of electrically chargeable vehicles" (http://www.acea.be/images/uploads/files/20100630_Standardisation_e-vehicles.pdf) Archived (https://web.archive.org/web/20110706132407/http://www.acea.be/images/uploads/files/20100630_Standardisation_e-vehicles.pdf) 2011-07-06 at the Wayback Machine., ACEA Brussels, 14 June 2010
39. "City of Amsterdam and Nissan place first Type 2 (mode 3)-charging station" (http://www.nieuwamsterdamsklimaat.nl/amsterdam_electric/amsterdam_electric/electric/news/news/city-amsterdam-and/), Amsterdam Electric, 30 December 2010
40. "The solution for Europe: type 2 charging sockets with or without shutter" (http://www.mennekes.de/uploads/media/The_solution_for_Europe_type_2_charging_sockets_with_or_with.pdf) (PDF). Mennekes Elektrotechnik GmbH & Co KG. 2012-10-19. Retrieved 2012-11-16.
41. "CARS 2020: Action Plan for a competitive and sustainable automotive industry in Europe" (http://ec.europa.eu/enterprise/sectors/automotive/files/com-2012-636_en.pdf) (PDF). European Commission. 2012-11-08. p. 14. COM(2012) 636 final. Retrieved 2012-11-11. "propose a legislative measure at the latest by 2013 to ensure that practical and satisfactory solutions for the infrastructure side of the recharging interface for electric vehicles are implemented throughout the EU, in case no agreement is reached on a voluntary approach among stakeholders involved through the standardisation process."
42. "EU launches clean fuel strategy" (http://europa.eu/rapid/press-release_IP-13-40_en.htm). European Commission. 2013-01-24. press release. IP/13/40. "A common EU wide plug is an essential element for the roll out of this fuel. To end uncertainty in the market, today the Commission has announced the use of the "Type 2" plug as the common standard for the whole of Europe."
43. "Agreement on standardized charging plug - German-Italian compromise for electric vehicles" (http://www.din.de/cmd?level=tpl-artikel&languageid=en&bcrumblevel=1&cmstextid=198030). DIN (Deutches Institut für Normung). 2013-05-27. Retrieved 2014-07-26.
44. "Schneider Electric, Legrand and Scame Create EV Plug Alliance" (http://www.greencarcongress.com/2010/03/evplug-20100328.html). Green Car Congress. 2010-03-28. Retrieved 2010-09-02.
45. "Libera Series LIB-BG-10" (http://www.scame.com/doc/info_ser/LIB-GB-10.pdf) (PDF). Scame Parre Spa. Retrieved 2010-09-02.
46. "EV Plug Alliance announces new members" (http://www.schneider-electric.com/corporate/en/press/press-releases/viewer-press-releases.page?c_filepath=/templatedata/Content/Press_Release/data/en/shared/2010/05/20100531_ev_plug_alliance_announces_new_members.xml) (Press release). Schneider Electric. 2010-05-31. Retrieved 2010-09-02.
47. Alex Wynne (2010-04-12). "EV Plug Alliance aims to "push" market players into standardization" (http://www.agrion.org/articles/agrion-en-EV_Plug_Alliance_aims_to_push_market_players_into_standardization.htm). Agrion. Retrieved 2010-09-02.

48. "EV Plug Alliance announces availability of products and new members" (http://www.schneider-electric.com/corporate/en/press/press-releases/viewer-press-releases.page?c_filepath=/templatedata/Content/Press_Release/data/en/shared/2010/09/20100920_ev_plug_alliance_announces_availability_of_products_and_new_members.xml), press release, Schneider Electronics, 20. September 2010
49. Electric car makers fight over plug standard | EurActiv (http://www.euractiv.com/en/enterprise-jobs/electric-car-makers-fight-plug-standard-news-503854)
50. "LIBERA Series – CONNECTORS" (http://www.scame.com/en/prodotto/ser/libera_connettori.asp). Retrieved 2012-04-09. "Type 3A connectors were developed in Italy in 2000 as the only connection system used to charge electrical vehicles in public areas in mode 3. Featuring a construction derived from the Scame IEC309 plugs, from which it inherited the snap-on quick closing device, it is unique due to the presence of an additional CP contact used for the pilot circuit in order to verify continuity of the protective conductors in compliance with standard CEI 69-6. Due its small size, it is the preferred connector for small vehicles, such as scooters and motorcycles, with power below 3 kW."
51. "Pole Model Products – Sockets (pictures)" (http://www.becharged.eu/en/products/pole-model-aluminium#sockets). Retrieved 2012-04-09.
52. "Série LIBERA - CONNECTEURS" (http://www.scame.com/fr/prodotto/ser/libera_connettori.asp). Scame. Retrieved 2015-07-14.
53. http://fr.chargemap.com/points/details/parking-charles-de-gaulle
54. Claude Ricaud (Chairman, EV Plug Alliance) (2013-06-18). "Hearing for examination of Directive for alternative fuels infrastructure" (http://www.europarl.europa.eu/document/activities/cont/201306/20130625ATT68523/20130625ATT68523EN.pdf) (PDF). Committee on Transport and Tourism (TRAN) of the European Parliament. Retrieved 2013-07-02. "Directive should prescribe the use of both basic Type 2 socket (as written today) and Type 2 with safety shutters, compatible with the existing type 2 plug"
55. Entry page http://www.evplugalliance.org = HTTP "Last-Modified: Wed, 26 Oct 2014 13:19:02 GMT", Content "EV Plug Alliance has closed and this site is no more active", accessed 24 April 2015
56. Jean-Paul BEAUDET (2015-10-05). "Bornes de recharge : un marché en pleine évolution" (http://www.filiere-3e.fr/2015/10/06/bornes-de-recharge-un-marche-en-pleine-evolution/). 3e Médias SAS.
57. "Renault abandona el conector Scame" (http://forococheselectricos.com/2015/11/renault-abandona-el-formato-de-recarga-scame.html). movilidadelectrica.com. 2015-11-15.
58. "Dimensional interchangeability requirements for pin and contact-tube coupler with rated operating voltage up to 1 000 V d.c. and rated current up to 400 A for dedicated d.c. charging" (http://www.iec.ch/dyn/www/f?p=103:14:0::::FSP_ORG_ID,FSP_LANG_ID:6619,25)
59. http://chademo.com/05_protocol.html
60. http://www.ev-power.eu/docs/web/2015/PDF/Simple-EVSE1-1.pdf

61. "Komponenten für Elektrofahrzeuge – Mennekes Lade-Inletz KFZ (gemäß IEC 62196-2)" (http://www.mennekes.de/fileadmin/user_upload/Downloads/Elektromobilitaet/728000DS_Automotive_Komponenten_D.pdf) (PDF). Retrieved 2012-04-08.
62. "EV-Simulator für Ladeeinrichtungen mit Ladestecker / Ladekupplung Typ 2 als Servicekoffer" (http://walther-werke.de/fileadmlity/BA_EV-Simulator_Typ2_Servicekoffer_2_D.pdf) (PDF). Retrieved 2012-04-08.
63. Anro Mathoy (17 January 2008). "Definition and implementation of a global EV charging infrastructure" (http://www.park-charge.ch/documents/EV-infrastructure%20project.pdf) (PDF). BRUSA Elektronik. Retrieved 2012-04-08.
64. "SAE J1772 - SAE Electric Vehicle Conductive Charger Coupler" (http://www.arb.ca.gov/msprog/zevprog/stakeholders/infrastructure/finalsaej1772.doc). August 2001. Appendix A, Typical Pilot Line Circuitry. Retrieved 2012-04-09.

External links

- "Norme International CEI/IEC International Standard 62196-1" (http://www.iec-normen.de/previewpdf/info_iec62196-1%7Bed1.0%7Db.pdf) (PDF). International Electrotechnical Commission. 2004. Retrieved 2009-06-07.
- "Presentation about Menekkes connectorby BMW Daimler" (http://www.arb.ca.gov/msprog/zevprog/2009symposium/presentations/preuschoff_oestreicher.pdf) (PDF). 2009. Retrieved 2009-10-22.
- REMA's version of the type 2 plug (http://www.rema-ev.com/IEC.html)
- Simple overview presentation by REMA (http://www.rema-ev.com/assets/rema_ev_presentation_IEC.pdf)
- Article on cars21 on the subject (http://www.cars21.com/content/articles/2010-02-11-france-and-germany-standardise-plugs.php)
- "IEC 62196-1" (http://www.iec.ch/search/?q=62196-1), "IEC 62196-2" (http://www.iec.ch/search/?q=62196-2), "IEC 62196-3" (http://www.iec.ch/search/?q=62196-3) at International Electrotechnical Commission