Position Paper of Charging Interface Initiative e.V.

DC CCS Power Classes V7.1

Charging Interface
Initiative (CharIN) e.V.
c/o innos GmbH
Kurfürstendamm 11
10719 Berlin Germany

Contact
André Kaufung
Phone +49 30 288 8388-0
Fax +49 30 288 8388-19

2021-06-14

Contents

Introduction

CharIN is dedicated to support and establish the Combined Charging System (CCS) as the standard for charging Battery Electric Vehicles (BEVs) of all kinds.
Charging infrastructure plays a pivotal role for the market uptake of Electric Vehicles (EVs), and new technological developments need to be integrated quickly in order to shorten charging times. For that reason, CharIN envisions the following:

- The Combined Charging System is the worldwide standard[1] with extended power and voltage range and functionality.
- In the coming years, multiple car makers will launch EVs of every segment, supporting higher battery capacities and faster charging, introducing an increased voltage level beyond 800V, (commercial vehicles up to 1500 V).
- The wide range of output voltage in the CCS charging infrastructure ensures forward and backward compatibility with new and existing EVs.
- A uniform charging infrastructure technology for all vehicles offers the operators an improved utilization of the locations.
- Charging Infrastructure and EVs should be backward compatible supporting DIN SPEC 70121:2014 and forward compatible supporting current and future versions of ISO 15118.
- CharIN is working continuously on harmonized certification devices and processes (e.g. organizing CharIN CCS Test Systems (CCTS) validation events), and actively supports the update of standards to reflect the newest technologies, and to assure safe and interoperable EVs and charging infrastructure, also at higher power levels and/or higher voltage levels.
- CharIN recommends a detailed project evaluation before installing charging infrastructure according to local and international standards applicable for the location and the use case in which a station is set up.
- This evaluation shall consider:
    - Business model of the charge point operator (CPO)
    - Electrical installation and emissions
    - Max. available (grid) power on site
    - Usage of load management (e.g. to avoid unsymmetrical and/or peak load)
- Note: This document is focusing on passenger cars with DC unidirectional power flow in a voltage range of 200-920 V. Additional requirements for commercial vehicles as well as bidirectional power flow may be introduced in a future document.

[1] https://www.charinev.org/fileadmin/Downloads/Papers_and_Regulations/CharIN_One_Pager_Connectors_used_worldwide.pdf

A complete description of the Combined Charging System can be found in the "CharIN_Implementation_Guide_CCS_Basic"[2], which is available on request.
Specified Power Classes can be applied to all steps of CCS Step model. To ensure the interoperability between legacy and future DC CCS EVs and charging stations, particularly the compatibility of the respective operating ranges, power classes for charging stations shall be considered. They need a clear definition for supported voltage, current and guaranteed power for the costumer. Additionally, charging station manufacturers as well as EV-OEMs need to ensure that their products are compatible at least with all current and former communication protocol versions and implementations.

[2] https://www.charinev.org/request-technical-documents/

Overview

Table 1 Minimum requirements for power classes. For details refer to the following pages.

Power Class	Power*	U_{min} in [V]	U_{max} in [V]	I_{min} in [A]	I_{peak} in [A]	I_{rated} in [A]	$P_{reference}$ in [kW]	Duration I_{peak}	Name (EN)
LPC	*xx (kW)*	≤200	≥920		**<20**	*<20*	**<8**	*inf*	*Low-Power Charging*
DC	*xx (kW)*	≤200	≥920	≤1	**≥20**	*≥20*	**≥8**	*inf*	DC Charging
FC	*xxx (kW)*	≤200	≥920	≤1	**≥125**	*≥94*	**≥50**	>=30 min	Fast Charging
UFC	*xxx (kW)*	≤200	≥920	≤5	**≥250**	*≥188*	**≥100**	>=20 min	Ultra-Fast Charging
HPC	*xxx (kW)*	≤200	≥920	≤5	**≥500**	*≥375*	**≥150**	>=10 min	High-Power Charging
MCS						*TBD*			

* Values (e.g.: HPC 300, FC 50) can be derived out of Table 2, Formula (5), which is to be used with values provided by EVSE manufacturer. Validation will be done within CCS quality assurance program.

Class definition per connector: In case of multi-outlet DC charging station the specified values of a DC Charging Power Class applies to a single charging point/coupler. Simultaneous use of multiple charging points/couplers is out of scope.

I_{peak} shall be provided @25°C for at least 10 minutes for HPC, 20 minutes for UFC and 30 minutes for FC. After this time, derating may be used to cool down the system. LPC & DC shall not be derated. I_{peak} derating shall not drop below 75% I_{peak}.

Derated current (I_{rated}) shall be available always in the temperature range of -5 to 40°C[3]

After stopping the energy flow of a charging session, the charger shall ensure that it is able to reach I_{peak} again until the next charging session (beginning of energy flow to the vehicle),

[3] Reference Documents:

IEC 61851-23 “latest edition”

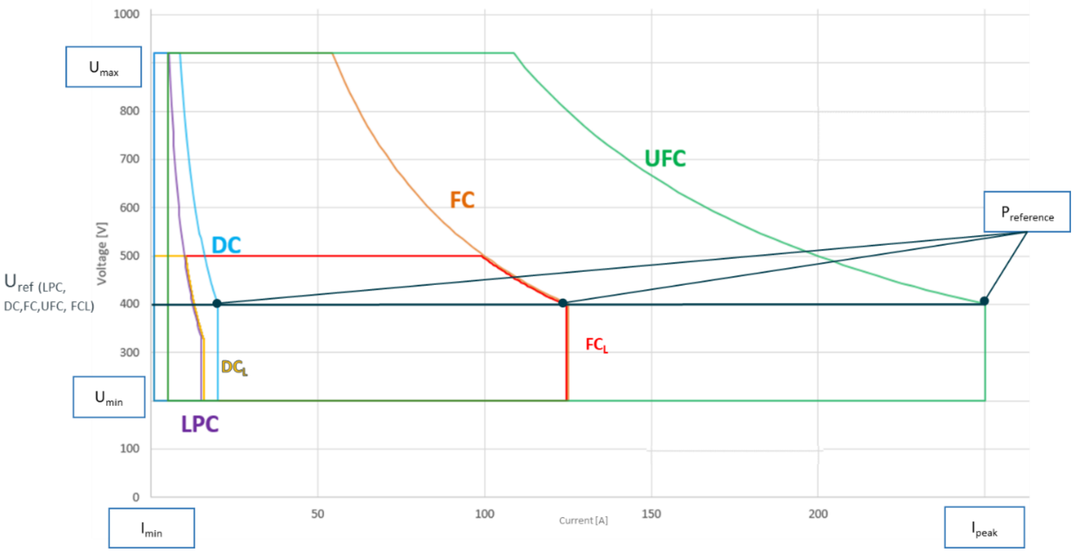
IEC 62196-3-1 “latest edition

after being idle for at most 3 minutes, e.g. by continuing to actively cool the cable and connector.

Note: Derating due to noise regulations in specific applications is acceptable and will not affect the rated power classification. Commercial vehicles may need longer I_{peak} operation.

Power Class - voltage and current range

The dashed blue area must be supported by the EVSE to achieve the dedicated class. A DC charging station can provide a wider range of values for voltage, current and power but it must provide at least the values given above (Table 1 Minimum requirements for power classes. For details refer to the following pages. Table 1) to achieve a certain power class rating



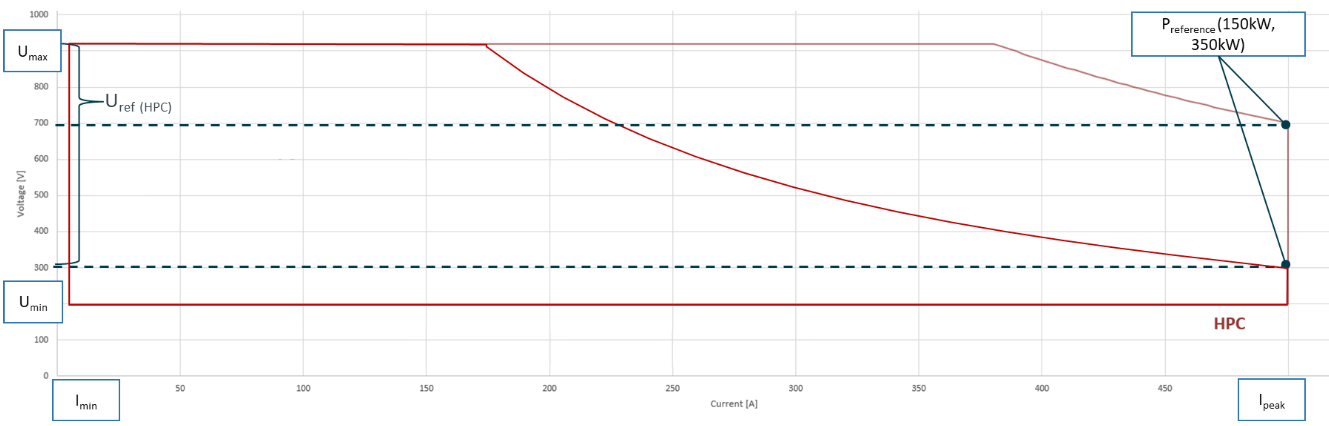


Figure 1 power class range diagram

0 A min. current is a special case and should always be possible.

Calculation base for charging power value:

Table 2 calculation formulas for power values

(1) Removed (unnecessary)	
(2) LPC/DC/FC/FC$_L$/UFC: U_{ref} = 400 V (3) DC$_L$: 313 V ≤ U_{ref} ≤ 400 V	• U_{ref} is a value of a power class which needs to be determined by the manufacturer for DC$_L$ and HPC.
(4) HPC: 300 V ≤ U_{ref}	
(5) $P_{reference} = U_{ref} \times I_{peak}$	• Charging power value of a charging point/coupler for classification ref. to Table 1. • For $P_{reference}$ < 10 kW 1 decimal point should be used. • only valid for $P_{reference} <= P_{peak}$ $P_{reference} = P_{peak}$ for $P_{reference} > P_{peak}$. • Value of $P_{reference}$ has to be provided by EVSE manufacturer.

Legacy Classes

CharIN works currently on a validation and certification process for DC chargers to validate conformance and interoperability with electric vehicles.

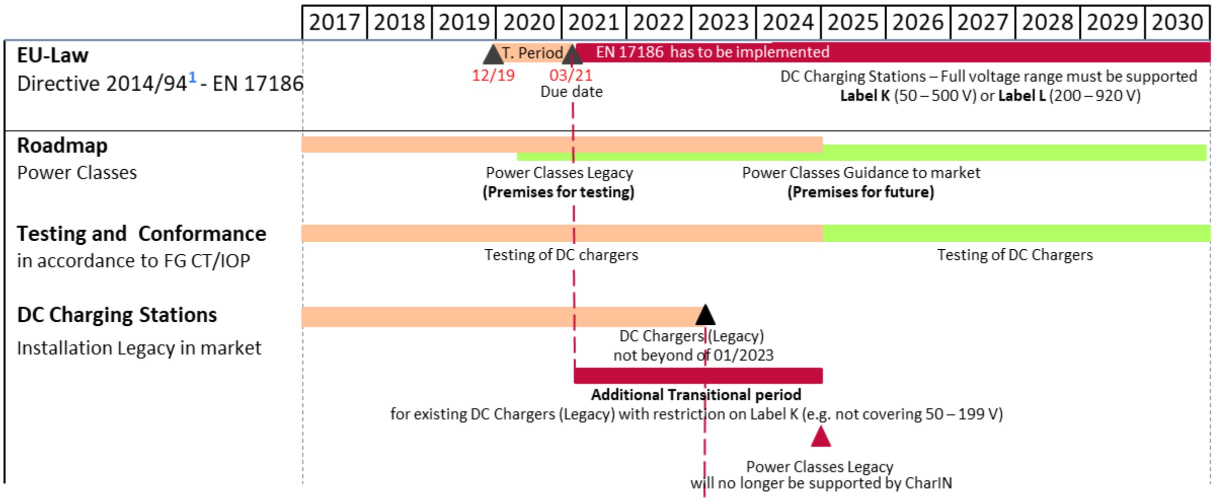
CharIN recommends installing charging stations with legacy classes (refer to Table 3 Legacy Power Classes in the range of 200-500V) not beyond 01/2023.

Table 3 Legacy Power Classes in the range of 200-500V

Power Class	Power*	U_{min} in [V]	U_{max} in [V]	I_{min} in [A]	I_{peak} in [A]	I_{rated} in [A]	$P_{reference}$ in [kW]	Duration I_{peak}	Name (EN)
DC_L	*xx (kW)*	≤200	≥500	≤1	**≥16**	≥16	**≥5 kW**	n.a.	DC Charging (legacy)
FC_L	*xxx (kW)*	≤200	≥500	≤1	**≥125**	≥94	**≥50 kW**	n.a.	Fast Charging (legacy)

Appendix

Table 4 Transition Roadmap: Legacy to Advanced Power Classes



[1] The directive 2014/94/EU (Deployment of alternative fuels Infrastructure, Article 7) became law on December 13th 2019. Transitional period ends on March 19th 2021.

Additional definitions:

- DC = Direct Current
- AC = Alternating Current
- P_{peak} of a charging station is the maximum output power that the charging station is able to deliver for a specific time at specific environmental conditions.
- $P_{reference}$ / P_{ref} is a calculated fixed value of a power class to represent the capability of a charging station.
- I_{peak} of a charging station is the maximum output current that the charging station is able to deliver for a specific time at specific environmental conditions.
- I_{rated} of a charging station is the output current that the charging station is able to deliver continuously at specific environmental conditions.
  I_{rated} of a charging station shall be at least 75% of I_{peak} of the charging station.
- I_{min} of a charging station is the minimum output current that the charging station is able to deliver continuously at specific environmental conditions.
- U_{max} of a charging station is the maximum output voltage that the charging station is able to deliver continuously at specific environmental conditions.
- U_{min} of a charging station is the minimum output voltage that the charging station is able to deliver continuously at specific environmental conditions.
- U_{ref} determines the reference calculation value for a dedicated power class. It is used to calculate a meaningful value in respect to the EV battery architecture.

Table 5 Examples for power classes

PowerClass	**FC60**	**DCL 6.4**	**DCL 7.4**	**FC88**	**UFC100**	**UFC140**	**UFC140**	**UFC150**	**HPC150**	**HPC350**
U_{min} [V]	200	200	200	200	200	200	200	200	200	200
U_{max} [V]	920	500	500	920	920	920	920	920	920	920
I_{min} [A]	1	1	1	1	1	5	5	5	5	5
I_{peak} [A]	150	16	18	220	250	350	400	250	500	500
$P_{reference}$ [W]	60000	6400	7200	88000	100000	140000	140000	150000	150000	350000
P_{peak} [W]	60000	7200	7200	140000	140000	140000	140000	150000	150000	350000
I_{rated} [A]	112,50	12,00	13,50	165,00	187,50	262,50	300,00	187,50	375,00	375,00
$P_{reference} = U_{ref} * I_{peak}$	60000	6400	7200	88000	100000	140000	160000	100000	150000	350000
U_{ref} (specified) or (calculated) = $P_{reference}/I_{peak}$	400	400	400	400	400	400	400	400	300	700
Note (*)		*		*	*		*			

*The power class is always referring to the power available at U_{ref}. This means: Even if P_{peak} is higher than P_{ref}, but cannot be delivered at U_{ref}, the power class shall refer to P_{ref}. If P_{peak} is lower than P_{ref}, the power class shall refer to P_{peak}