Position Paper
of Charging Interface Initiative e.V.

DC CCS Power Classes V7.2

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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 shallbe backward compatible supporting at least DIN SPEC 70121:2014 and should 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.charin.global/media/pages/technology/knowledge-base/4f8ce6f5d9-1615552574/017charin_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.charin.global/technology/ccs-specification/

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Overview of Power Classes

Table 1 Minimum requirements for Power Classes.

Power Class	Power*	U_{min} in [V]	U_{max} in [V]	I_{min} in [A]	I_{peak} in [A]	$I_{derated}$ in [A]	P_{ref} 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*			

* P_{ref} values (provided by the manufacturer) shall be used (e.g.: HPC 300, FC 50). Validation will be done within CCS quality assurance program.

Class definition per connector: In case of multi-outlet DC charging stations the specified value 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 and in the voltage range U_{min} to U_{ref} (see Table 3) for at least 10 minutes for HPC, 20 minutes for UFC and 30 minutes for FC. After this time, current derating may be used to cool down the system.
P_{ref} shall be provided @25°C, in the voltage range U_{ref} to U_{max} and in the current range above $I_{derated}$ and below I_{peak} for at least 10 minutes for HPC, 20 minutes for UFC and 30 minutes for FC. For LPC & DC the current shall not be derated.

During derating, the output current shall not drop below the derated current $I_{derated}$ = 75% of I_{peak}. $I_{derated}$ shall be always available for continuous charging 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 during the next charging session (beginning of energy flow to the vehicle), after

[3] Reference Documents:

IEC 61851-23 “latest edition”

IEC 62196-3-1 “latest edition

being idle for not more than 3 minutes, e.g. by continuing to actively cool the cable and connector.

Notes:

a) Derating due to noise regulations in specific applications is acceptable and will not affect the power classification.
b) Commercial vehicles may need longer charging operation at I_{peak}.

Legacy Classes

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

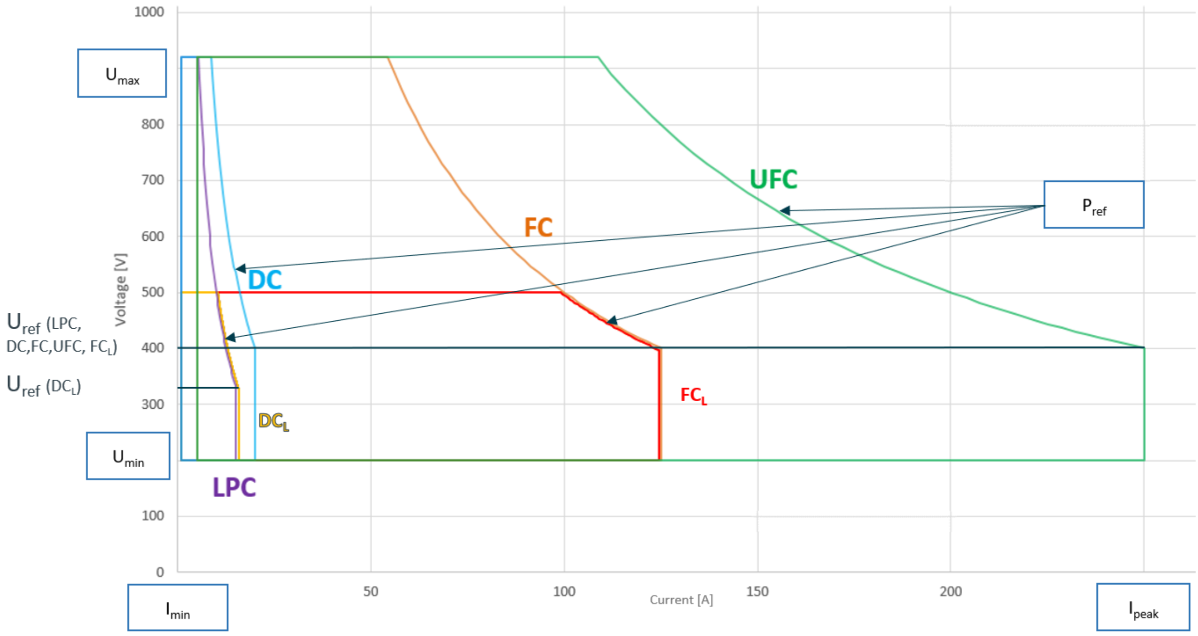
CharIN recommends installing charging stations with legacy classes not beyond 01/2023 (refer to Table 4).

Table 2 Legacy Power Classes in the range of 200-500 V

Power Class	Power*	U_{min} in [V]	U_{max} in [V]	I_{min} in [A]	I_{peak} in [A]	$I_{derated}$ in [A]	P_{ref} 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**	≥93	**≥50 kW**	n.a.	Fast Charging (legacy)

Minimum operating ranges and reference points

Figure 1 depicts the minimum operating ranges of the different Power Classes prior to derating (if derating applicable). The area within the respective colored operating ranges shall be supported by the EVSE to achieve the dedicated Power Class. A DC charging station can provide a wider range of values for voltage, current and power but it shall provide at least the values given in Table 1 to achieve a certain power class rating.



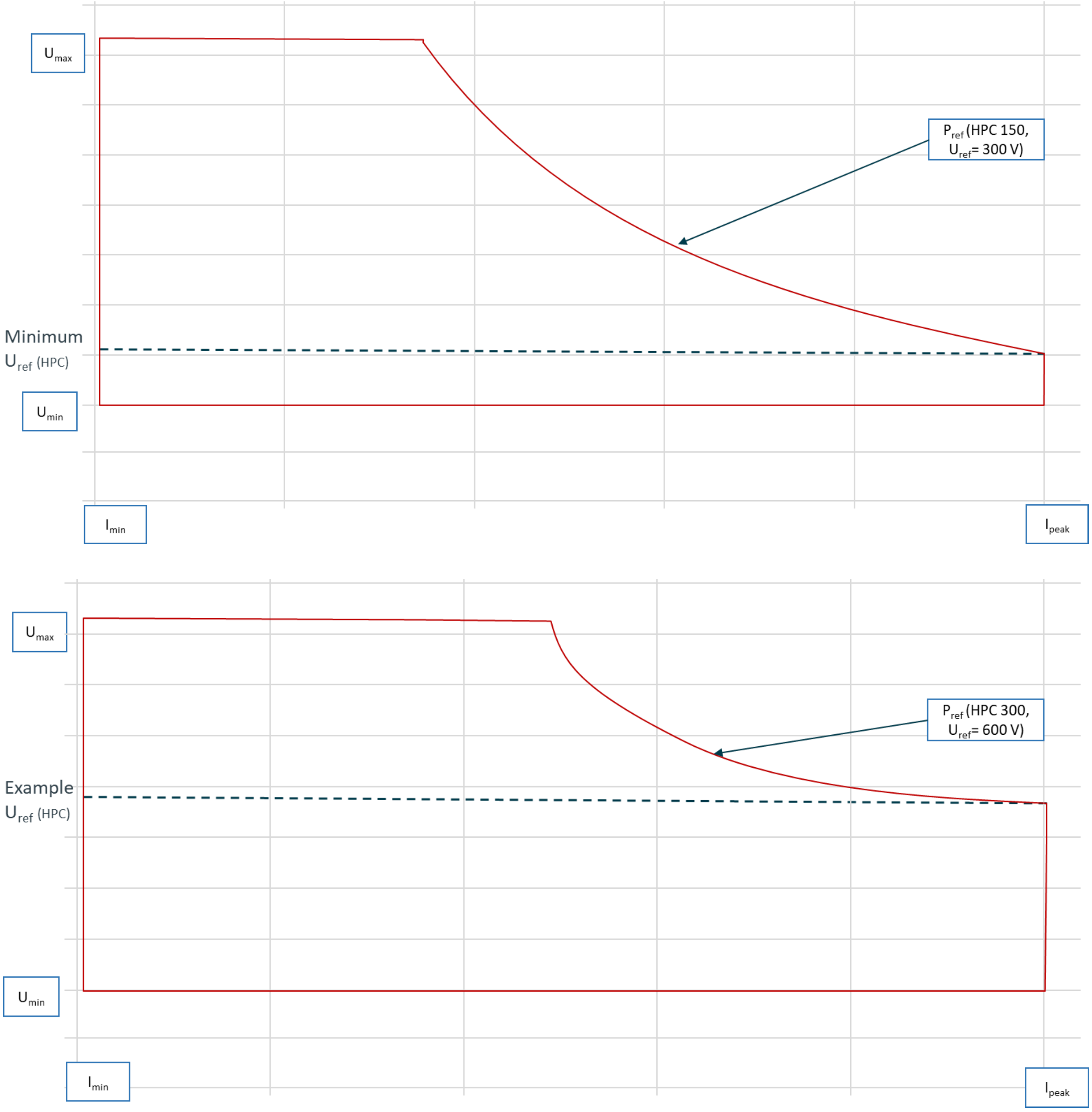


Figure 1. Power Class minimum operating ranges with indicated reference points. Top: Power Classes LPC, DC, FC, UFC as well as the legacy classes DC_L and FC_L. Bottom: Two examples of HPC Power Classes.

0 A min. current is a special case and should always be possible (e.g. charging pauses).

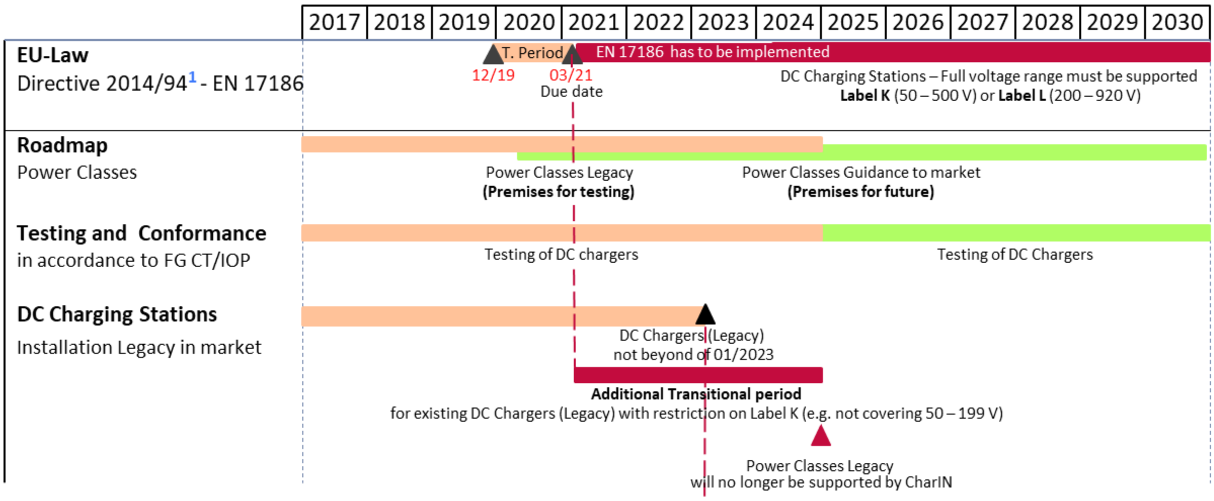
Determination of reference points for the assignment of a Power Class rating:

Table 3 Determination of reference points for the assignment of Power Classes

Equations	Explanations
(1) LPC/DC/FC/FC_L/UFC: U_{ref} = 400 V (2) DC_L: $U_{ref} = P_{ref} / I_{peak}$ (value range: 313 V ≤ U_{ref} ≤ 400 V) (3) HPC: $U_{ref} = P_{ref} / I_{peak}$ (value range: U_{ref} ≥ 300 V)	For LPC/DC/FC/FCL/UFC U_{ref} has been chosen to represent a typical battery architecture. For DC_L and HPC, U_{ref} needs to be calculated using P_{ref} and I_{peak}. The values of P_{ref} and I_{peak} shall be provided by the manufacturer (e.g. in the product data sheet).
(4) $P_{ref} = U_{ref} \times I_{peak}$	• Charging power of a charging point/ coupler as indicated by the manufacturer. • The value of P_{ref} shall be provided by the manufacturer (e.g. in the product data sheet) in order to assign a Power Class according to Table 1. • For P_{ref} < 10 kW, the value shall be given with a resolution of 1 decimal point. • For P_{ref} ≥ 10 kW, the value shall be given as integer. •

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_{ref} is a calculated fixed value of a power class provided by the manufacturer 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 (refer to Table 1, "Duration I_{peak}") at specific environmental conditions. Value shall be provided by the manufacturer.
- $I_{derated}$ of a charging station is the output current that the charging station is able to deliver continuously at specific environmental conditions.
  $I_{derated}$ 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} is the reference voltage at which P_{ref} of the power class is provided prior to derating.

Table 5 Examples of Power Classes

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