CANOO INC

CCS1 Charge Port Asm. Technical Requirements Rev.10

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Contents

Introduction to Project

This document provides functional, mechanical, electrical, and environmental requirements for a CCS1 Charge port to be used in Canoo's Electric Vehicle.

1. Applicable Standards

Standard Name	Standard Title
SAE J1772	Electric Vehicle and Plug in Hybrid Electric Vehicle Conductive Charge Coupler
UL 50	Enclosures for Electrical Equipment, Non-Environmental Considerations
UL 2251	Plugs, Receptacles, and Couplers for Electric Vehicles
IEC 62196	Plugs, socket-outlets, vehicle connectors and vehicle inlets – Conductive charging of electric vehicles
USCAR38-1	Performance Specification for Ultrasonically Welded Wire Terminations

2. Functional Requirements

- The CCS1 Charge port shall act as the mechanical and electrical gateway between the electric vehicle and electric vehicle charging infrastructure in the US market.
- The CCS1 Charge port shall follow all requirements outlined in SAE J1772, UL 2251, IEC 62196, and USCAR38-1.

3. Mechanical Requirements

3.1. Mass

The charge port assembly including connectors, lock actuators, pins, grounding strap and mounting bracket/feature shall be 2.244kg or less.

3.2. Volume

Charge port including front and rear protective caps shall fit in the vehicle with 5mm clearance from the surrounding parts. The part volume should be less than the following dimensions:

140mm (width) x 160mm (height) x 108mm (depth)

3.3. DC Charging Connection

The DC charging pins should be terminated in such a way that, the connections to the cables routed from the vehicle battery shall be done at vehicle general assembly level. This connection needs to be serviceable and sealed to IP67 specification.

3.4. Cable Length and Connectors

- Charge Port and Latch Connector should be 172mm in length and have a connector to match the connector defined by Canoo Low Voltage system

- AC charging cables should 420mm in length and have a connector to match the connector defined by Canoo High Voltage system

3.5. Cable Exiting Direction

From the front view of the charge port, the cables/bulkhead shall exit to the bottom of the charge port component.

All Cable Seals, cable Strain Relief and Cable Exit covers shall be provided off tool and shall not be produced via 3D printing.

3.6. Drainage

Charge port shall include a means to drain water from contact cavities per J1772 locations. Drain hose and drain routing is not required.

3.7. Lock Actuator and manual release

Charge port shall require a lock actuator (ASIL B per ISO 26262). Charge port shall also include a means for manual release.

3.8. Mounting Degree for charge port

The charge port shall be mounted to the vehicle with an angle of 0 degrees with the vehicle reference Z plane.

3.9. Protective Covers for IP protection on DC pins from outdoor environment

Charge port shall require a hinged downward protective cap for IP protection per SAE J1772 requirement for DC pins only. Charge port shall follow an A-class surface design and color/material/finish requirement to be provided at a later date. IP protection to be at least level IP55 rated. Protective cover does not need to be spring loaded.

Hinged Cap component may be produced via 3D printing for Samples.

3.10. Protective Covers for IP protection on inside

Charge port shall require IP protection from rear where such that contact terminals and electrical connections are protected from water and dust. IP protection to be at least level IP67.

It shall be snap fit into place and shall not require separate screw for removal.

3.11. Sealing Surface

The charge port shall have a smooth surface around the inlet to provide as a sealing surface for the Canoo beauty cover.

3.12. Color, Material, Finish

The Charge Port front face shall be molded in color, with a low gloss C Black/ N-101 color surface and a MT -11590 surface finish.

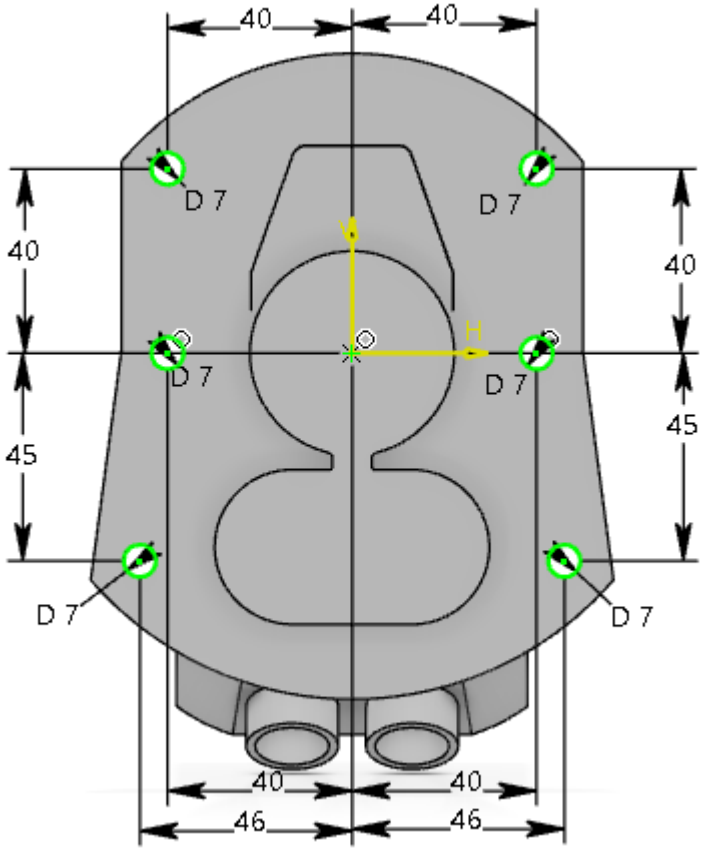
3.13. Flame Rating

The Charge port shall be made of materials that have a minimum UL V-0 Flame Rating

3.14. Mounting

Charge port assembly shall have mounting locations per the following diagram. Center is the origin of the charge port as defined by SAE J1772 OCT2017 per Sheet C-4.

Note*: These are preliminary locations, final locations and possible use of auxiliary bracket to be determined with supplier design*



3.15. Ground Path

The Charge port system shall be grounded through a ground stud located in one of its mounting locations. The system shall provide a current path from all of its components that require grounding connection to the vehicle ground without any additional installation steps specifically for grounding at general assembly.

4. Ergonomic Requirements

4.1. Insertion/Extraction Force

Per SAE J1772, during connection and disconnection, the human efforts required shall be =< 75N at beginning of life.

4.2. Tactile Feel

When fully engaged, the coupler shall provide tactile and audio feedback to the user.

4.3. Abusive Loads

The charge port system shall sustain a load of 1.1 kN applied at the handle in all 6 axes (negative and positive x, y and z) when coupled without significant deflection.

5. Electrical Requirements

5.1. Charging Requirements

Mode	Voltage	Current	Time
AC Charging	110-260V	0-32A	Continuous
DC Fast Charging	300-500V	0-350A	30 minutes at 350A, then taper

5.2. Cable Size and Requirements

Pin	Size
AC Pins	$4mm^2$
Ground	$25mm^2$
Prox/Pilot	$0.5mm^2$
DC Pins	$70\ mm^2$
LV Cables	$0.5mm^2$

AC and DC cables shall be connected to the charge port via validated crimping or welding process and hardware for the respective wire size and electrical loads provided in “Electrical Requirements” Section of this document.

5.3. Lock Actuator Driving

Supplier shall provide instructions on how to drive lock actuator. Actuator shall support unregulated power supply. Lock Actuator shall be a 4-wire current sensor Lock Actuator and compatible with Canoo On Board Charger device. When locked, the lock should sustain a 753N +/- 1N axial load, rate of force application 2N/s. Duration of force application 60s. (Per IEC 61300-2-6). The Lock actuator shall comply with the SAE J1772 requirements.

5.4. Thermal sensing

The charge port shall have 3 thermal sensors. Thermal sensor shall be NTC type thermistor. Supplier shall provide interface definition for thermal sensors. One thermal sensor shall be between the two AC pins. The other two thermal sensors shall in as close proximity to DC pins as possible. Supplier shall be responsible for testing, validating, and reporting relationship between NTC thermistor reading and actual temperature of pin. The temperature sensor chosen by supplier shall have a +/- 0.5C accuracy and a maximum 3 second response time in air. Thermal sensor nominal resistance to be approved by Canoo Low Voltage Team

5.5. LV connector

Pin #	Function
1	Prox
2	Pilot
3	Temp Sense on AC Pin
4	Temp Sense on DC +
5	Temp Sense on DC -
6	Temp Sense Common GND
7	EMPTY
8	EMPTY
9	CP Motor N Motor Negative Terminal (+0 or +12V)
10	CP_MOTOR_SENSE+ + Terminal of current flow from charge port a sense resistor is applied across 2 and 3 attached to a current sense circuit
11	CP_MOTOR_SENSE- - Terminal (TE has it as SENSEGND). We will read the state of the motor through these pins
12	CP_Motor_P Motor Positive Terminal (+0 or +12V)

Charge port shall have a short run of LV wire from the Actuator and Sealed LV Passthrough that coalesces into a single LV inline connector

Below is a table of the preliminary LV connections that Canoo requires. Canoo is open to supplier suggestions.

6. Environmental Requirements

6.1. Environmental Requirements

Altitude: -90m to 450m

Operating Temperature Range: -30C to 50C

Storage, Shipping, Non-Operating Temperature Range: -40C to 80C

7. Design Validation

Supplier to create DFMEA of charge port system

Supplier shall provide DVPR proposal for Canoo review. Supplier to share results of DVPR with Canoo.

Charge port shall pass all tests outlined in SAE J1772 and UL 2251.

8. System Concept Representation

The Image below is a concept Illustration of the charge port and DC Cable for reference only.

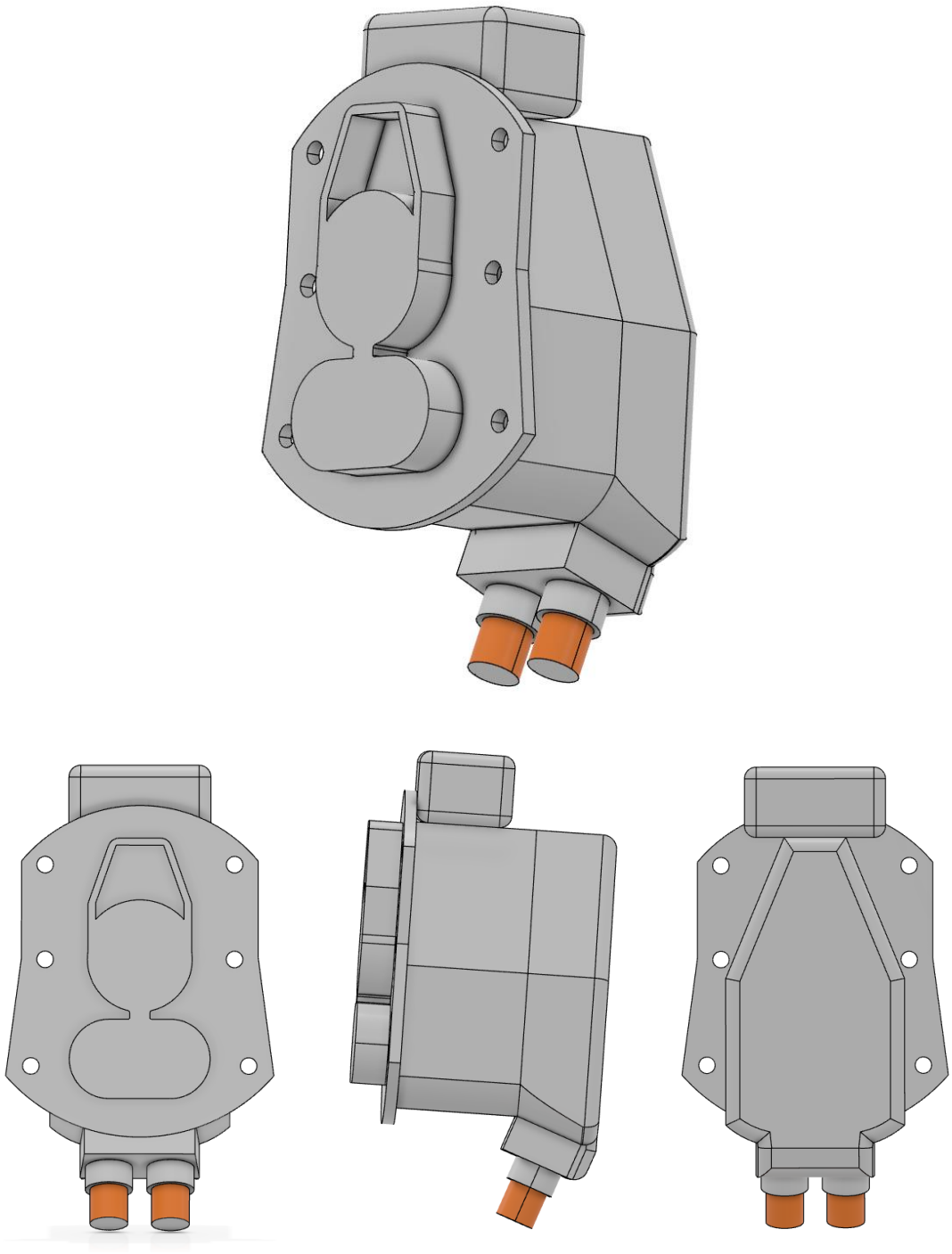


Figure 1. Canoo Charge Port Concept Design

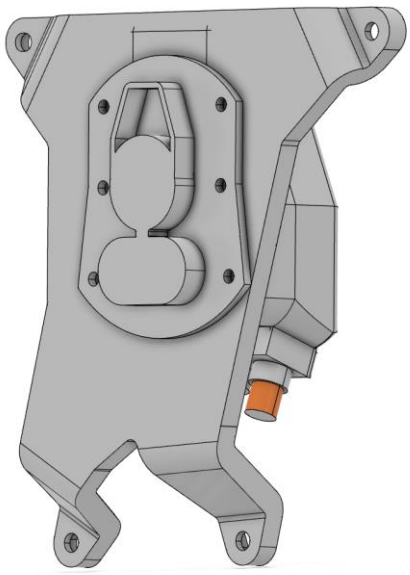


Figure 2. Canoo Charge Port Concept Design with auxiliary bracket

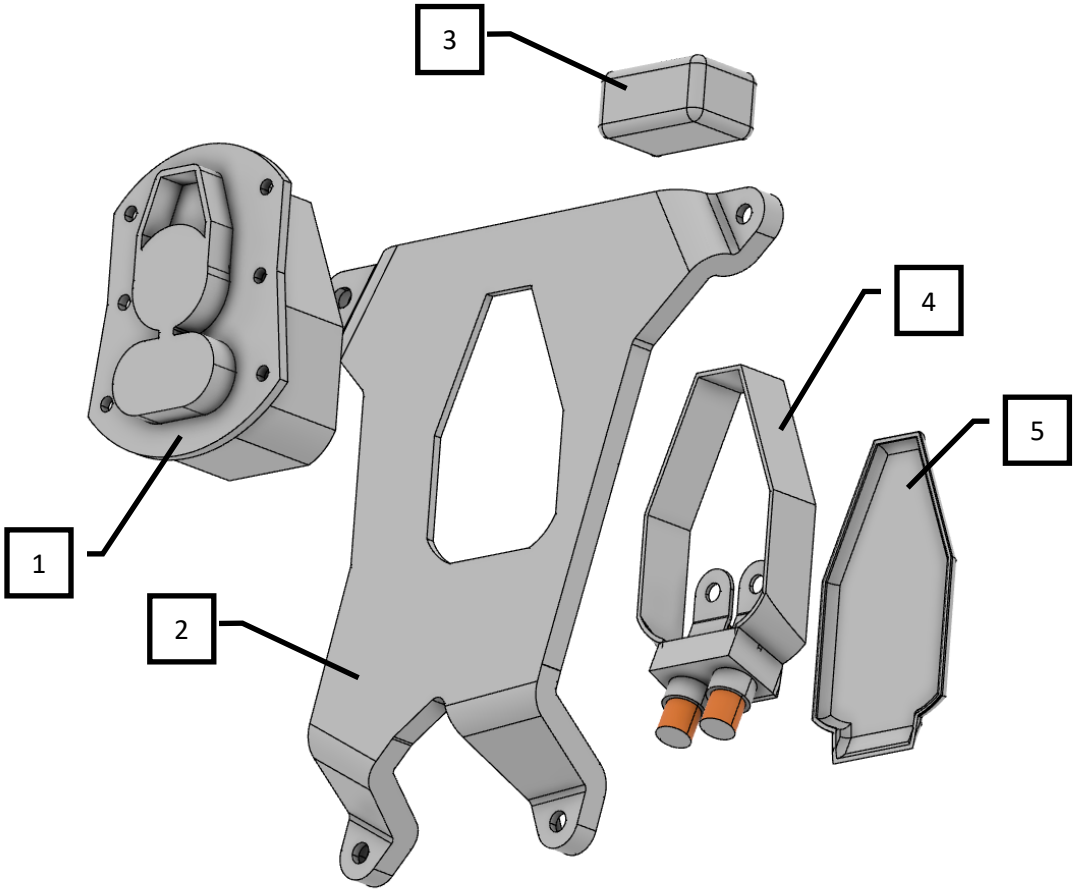
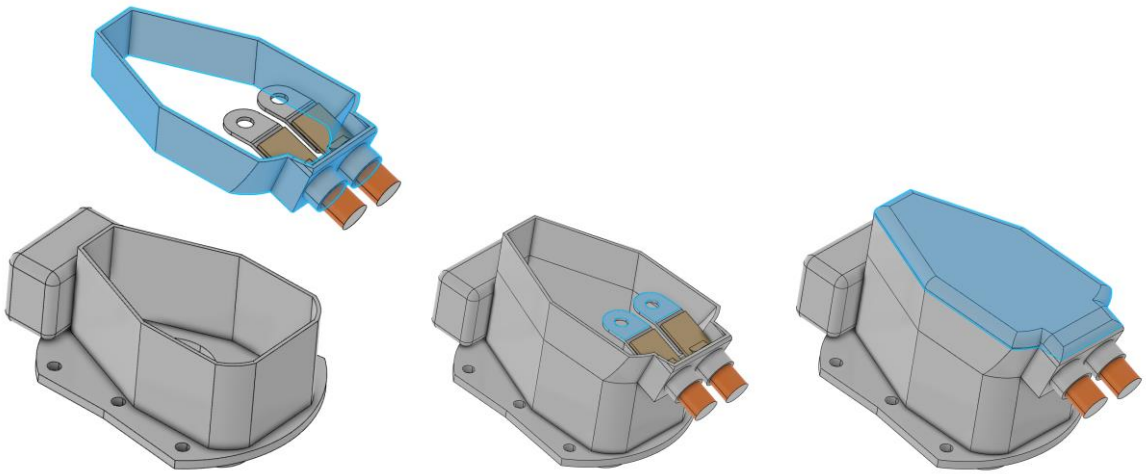


Figure 3. Exploded View and Callouts, Canoo Charge Port Concept Design with auxiliary bracket

1. J1772 Charge Port Inlet
2. Auxiliary bracket (if required)
3. Lock Actuator
4. DC Cable "Header"
5. "Header" Cover

DC Cable Connection – Bolt on Header



(a) ***(b)*** ***(c)***

Figure 2: Representation of and Bolt on Solution

The DC Cable connection to the Charge Port shall be a simple serviceable connection. The connection needs to be accessible for service, however this is only in the event of a repair or replacement. This situation does not require a complex connector solution that would drive a cost increase. In Figure 4 there is a representation of a possible design. The header/ housing (a) can be bolted to the back of the charge port and so can the HV cables to the DC inlets (b). A cover would enclose the header/housing (c). A seal strategy is required in the installation of (a) and (c). This is a concept idea, Canoo engineering team is open to supplier input/ suggestions.

9. Version Control

Version	Date	Author	Revisions
1	08/02/2018	Jason Huang	Initial Release
2	11/26/2018	Kenneth Kawanishi	GND Cable Size. Revision to Thermal sensing section. Revision to Mechanical Section.
3	12/17/2018	Kenneth Kawanishi	Removed Cables from Mass Requirement. Modified Cable Length and Connector Requirement. Included manual release cable length. Removed lighting requirement.
4	01/03/2019	Kenneth Kawanishi	Added USCAR38-1 to Applicable Standards and Functional Requirements. Description of DC pins added to Cable Size and Requirements.
5	01/17/2019	Kenneth Kawanishi	Added details to Lock Actuator and Manual Release
6	03/11/2019	Kenneth Kawanishi	-Revised “Cable Length and Connectors” to include dimensions, P/N of connectors and drawings. -Revised “Cable Exiting Direction” to specify manufacture method for parts. -Revised “Protective Covers for IP protections…” to specify manufacture method for parts. -Revised “Sealing Surface” to include images to increase clarity. -Updated “Mounting” to align with latest design. -Updated “Charging Requirements” to align with latest charging profile. -Revised “Cable Size and Requirements” to specify crimped connection of cables to charge port. -Revised “Lock Actuator Driving” to specify power supply type. -Revised “HV Connectors” to specify P/N of connectors. -Updated “LV Connector” to include P/N and reflect latest pinout.
7	03/20/2019	Jason Huang	-added information on insertion/extraction force and ergo requirement
8	04/17/2019	Jason Huang	Updated 2D drawings and part numbers Added detail to device pinouts Change names to Canoo
9	02/04/2020	Enrico Sala	- Added Numbering and Headers - Added 12V to functional requirements - Updated Mass - Updated Volume - Removed Beta Drawings - Updated Lock Actuator requirements - Updated color, material and finish - Updated Mounting location - Added jump post requirements - Added ground path requirement

			- Added abusive load requirement - Added system representation
10	04/01/2020	Enrico Sala	- Removed 12V Jump post requirements - Updated mounting locations - Updated DC cables routing - Updated concept design