Charger Control Module Communications Interface Specifications

APPROVED BY/DATE

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REVISION HISTORY

Revision Number	Date	Author	Description	Database
0.1	5/10/2010	Matt Johnson	Initial draft.	
0.2	9/13/2010	Matt Johnson	Added Charge Complete and Charge System Fault command signals.	
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1 Introduction

1.1 Purpose

The purpose of this document is to establish, in one location, the communication interface and communication functional requirements for a Charger system to work properly with the Eaton Hybrid Electric System.

1.2 Scope

This document describes the Controller Area Network (CAN) communications interface as well as communication functional requirements between the HCM and Charger.

1.3 Definitions, Acronyms, and Abbreviations

The following terminology is used in this specification:

Acronym / Abbreviation / Term	Definition
Charger	Charger Control Module
CAN	Controller Area Network
DCR	DC series resistance
DTC	Diagnostic Trouble Code
FMI	Failure Mode Indicator
HEV	Hybrid Electric Vehicle
HCM	Hybrid Control Module
OC	Occurrence Count
PGN	Parameter Group Number
SAE	Society of Automotive Engineers
SOC	State Of Charge
SOH	State Of Health
SPN	Suspect Parameter Number

Table 1.3-1 Acronym, Abbreviation, Terminology

1.4 References

The following documents are referenced in this specification:

Document / Model / Simulation / Prototype	Type	Version	Description
J1939-71	SAE Document	2009-04	Application Layer - Parameters
J1939-73	SAE Document	2004-03	Application Layer - Diagnostics
J1939-21	SAE Document	2001-04	Data Link Layer
DCN-119	Eaton Specification	1.7	J1939 Diagnostics Support Specification for Non-Eaton Products

Table 1.4-1 Specification References

2 Hybrid Communications Overview

2.1 Post Population Programming

The Charger and all sub-controllers shall support post population programming via the CAN bus. The Charger shall support programming as specified in DCN-119 section 8. The Eaton service tool, ServiceRanger, will be used to perform programming updates by tunneling commands through the HCM. The Charger need only interface with the HCM for this operation. The method to program sub-controllers is TBD.

The Charger and all sub-controllers shall remain in a state that is capable performing programming if the application becomes corrupted, either by a failed programming sequence, corrupt ECU flash memory, or any other reason.

2.2 Data Access

The Charger shall support access to internal parameters via CCP or XCP. Vector CANape will be the tool used to extract the data. The Charger supplier shall provide a CANape configuration which is able to access supported parameters. The following is a list of parameters that shall be made available:

- TBD

3 Communications Interface

3.1 General

The Charger shall communicate to the HCM using a high speed CAN bus with the following features:

- CAN Version: 2.0b
- Bit timing:
  - Nominal bit rate: 500kbs
  - Number of quanta per bit: 20Tq
  - Sample point: 60%
  - SJW: 4Tq (20% of bit time)
  - Format: standard
- Data Format: Least significant byte arrives first and the most significant byte arrives last (Intel/Little endian format).
- Identifier Format: 29bit identifier as defined in the SAE J1939-21 specification.

3.2 Signal Ranges

All signals shall conform to the following data ranges for Normal, Error and Not Available ranges unless otherwise defined by a signal.

Signal Length (Bits)	Data Range Values	Data Range Name
2	0 ~ 1	Normal
	2	Error
	3	Not Available
8	0 ~ 250 0x00 ~ 0xFA	Normal
	251 ~ 254 0xFB ~ 0xFE	Error
	255 0xFF	Not Available
12	0~4015 0x000 ~ 0xFAF	Normal
	4016 ~ 4079 0xFB0 ~ 0xFEF	Error
	4080 ~ 4095 0xFF0 ~ 0xFFF	Not Available
16	0 ~ 64255 0x0000 ~ 0xFAFF	Normal
	64256 ~ 65279 0xFB00 ~ 0xFEFF	Error
	65280 ~ 65535 0xFF00 ~ 0xFFFF	Not Available

Table 3.2-1 CAN signal ranges

The Charger shall respond appropriately for signals that are received in Error and ignore signals received as Not Available. When transmitting signals, if the signal value is internally calculated beyond the defined signal range

and the signal is not faulted or in error, the signal output shall be saturated to the signal range limit to prevent signal overflow and rollover. If the signal is faulted or is in error, then the signal output shall be set to a value within the Error region. All unused or unsupported signals and bits shall be set to all ones to indicate Not Available.

The message and signal tables for the signals defined in this document specify min and max values for the Normal range in engineering units.

For ASCII strings, characters shall be limited to the ISO Latin 1 character set as defined in the SAE J1939-71 specification.

3.3 Control Messages

3.3.1 Status

Message Name	Status
Transmission Rate	100ms
Data Length	8 Bytes
Default Priority	0x6
PGN	0xFF40
Source Address	0x49

Start Bit	Length (bits)	Signal	Reference
0	8	Input Voltage	3.3.1.1
8	8	Output Voltage	3.3.1.2
16	8	Input Current Limit Max	3.3.1.3
24	8	Input Current	3.3.1.4
32	8	Output Current	3.3.1.5
40	8	Temperature	3.3.1.6
48	2	Ignition Status	3.3.1.7
50	3	Charger State	3.3.1.8
53	3	Fault Active/Severity Indicator	3.3.1.9
56	4	Message Counter	3.3.1.10
60	4	Message Checksum	3.3.1.11

3.3.1.1 Input Voltage

The voltage applied to the charger from the EVSE.

Signal	Scale	Offset	Unit	Min	Max
Input Voltage	2	0	Vrms	0	500

3.3.1.2 Output Voltage

The high voltage charger output voltage.

Signal	Scale	Offset	Unit	Min	Max
Output Voltage	2	0	V	0	500

3.3.1.3 Input Current Limit Max

The current limit of the charger coupler as reported by the EVSE.

Signal	Scale	Offset	Unit	Min	Max
Input Current Limit Max (*evEVSECurrentLimit*)	0.5	0	Arms	0	125

3.3.1.4 Input Current

The amount current the charger is drawing from the EVSE.

Signal	Scale	Offset	Unit	Min	Max
Input Current	0.5	0	Arms	0	125

3.3.1.5 Output Current

The amount current the charger is supplying to the vehicle.

Signal	Scale	Offset	Unit	Min	Max
Output Current	0.5	0	A	0	125

3.3.1.6 Temperature

The temperature of the warmest component within the charger.

Signal	Scale	Offset	Unit	Min	Max
Temperature	1	-40	C	-40	210

3.3.1.7 Ignition Status

Indicates the status of the enable (vehicle ignition) electrical connection.

Signal	Value	Meaning
Ignition Status	0	Off (*evIgnitionSwitchOff*)
	1	On (*evIgnitionSwitchOn*)
	2	Error
	3	Not Available

3.3.1.8 Charger State

Indicates the state of the charger.

Signal	Value	Meaning
Charger State (*evChargerStatus*)	0	Not Connected
	1	Connected Standby
	2	Connected Charging
	3 ~ 6	Reserved
	7	Not Available

3.3.1.9 Fault Active/Severity Indicator

Indicates when one or more faults are active within the Charger system and the highest severity level of all currently active faults. For each active fault the Charger shall determine the appropriate severity so as to protect the Charger from damage or hazardous conditions. Faults shall start at the lowest severity possible; and then if conditions remain or continue to deteriorate, the severity level shall be increased to the next higher level until the highest level is reached. If a fault reaches or necessitates the highest severity level, the Charger shall ramp charging current to zero within 2.0 seconds.

The following is a description of the fault severity levels and how the HCM will react:

- "*Warning, no action*" is the lowest severity level. The Charger is operating in a degraded condition that does not require the main contactors to be opened, but is causing a reduction in available power.
- *"Soft Failure"* The Charger has ramped current to zero due to a recoverable fault; the system will remain active and resume charging when the fault condition clears.
- *"Hard Failure"* is the highest severity level. The Charger is operating outside its safe operating limits and requires the main contactors to be opened. The HCM will open the main contactors when zero current achieved or within 5.0 seconds which is first.

Signal	Value	Meaning
Fault Severity Indicator	0	No fault active.
	1	Warning, no action.
	2 ~ 4	Reserved.
	5	Soft Failure, ramp current to zero
	6	Hard Failure, open main contactors.
	7	Not available.

3.3.1.10 Message Counter

A rolling message counter shall be used to monitor the integrity of the processor. The receiving node shall check to ensure the counter value changes every cycle and that it is in the normal range.

If the value does not change or is in the error range for one or more CAN frames, all signals from the sending node shall be considered in error. If the counter value does not change for three or more CAN frames, a message counter fault shall be set with severity "*Failure*" and the output current shall be ramped to zero. If while the counter fault is active and Charger operation drifts outside its normal operating limits, the appropriate fault and severity shall be set for the condition.

Normal operation shall be resumed and the message counter fault cleared if the counter value changes and is in the normal range for three consecutive CAN frames. If the counter value is received as not available (0xF - all bits set to one), it shall be treated as a valid and changing counter value.

Signal	Value	Meaning
Message Counter	0 ~ 7	Counter Value
	8 ~ 14	Error
	15	Not Available

3.3.1.11 Message Checksum

A message checksum shall be used to monitor the integrity of the memory. The receiving node shall check to ensure the checksum value matches the checksum of the received message.

If the checksum does not match for one or more CAN frames, all signals from the sending node shall be considered in error. If the checksum does not match for three or more CAN frames a message checksum fault shall be set with severity "*Failure*" and the output current shall be ramped to zero. If while the checksum fault is active and Charger operation drifts outside its normal operating limits, the appropriate fault and severity shall be set for the condition.

Normal operation shall be resumed and the message checksum fault cleared if the checksum matches for three consecutive CAN frames. If the checksum value is received as not available (0xF - all bits set to one), it shall be treated as a matching checksum.

The message checksum shall be computed as follows using integer numbers:

Sum = Message Byte1 + Message Byte2 + Message Byte3 + Message Byte4 + Message Byte5 + Message Byte6 + Message Byte7 + Message Rolling Counter & 0x0F + Sum of Message ID Bytes;

Message Checksum = ((Sum >> 6) + (Sum >> 3) + Sum) & 0x07;

Signal	Value	Meaning
Message Checksum	0 ~ 14	Checksum Value
	15	Not Available

3.3.2 Command

Message Name	Command
Transmission Rate	100ms
Data Length	8 Bytes
Default Priority	0x6
PGN	0xFF4A
Source Address	0xEF

Start Bit	Length (bits)	Signal	Reference
0	2	Charge Enable	3.3.2.1
2	2	Charge Complete	3.3.2.2
4	2	Charge System Fault	3.3.2.3
8	12	Voltage Limit	3.3.2.4
20	12	Current Limit	3.3.2.5
56	4	Message Counter	3.3.1.10
60	4	Message Checksum	3.3.1.11

3.3.2.1 Charge Enable

This command indicates when charging (output power) is allowed.

Signal	Value	Meaning
Charge Enable	0	Disable (*evChargingDisable*)
	1	Enable (*evChargingEnable*)
	2	Error
	3	Not Available

3.3.2.2 Charge Complete

This command indicates when charging has completed. This is used to control the charge status indicator light.

Signal	Value	Meaning
Charge Complete	0	Not Complete
	1	Complete
	2	Error
	3	Not Available

3.3.2.3 Charge System Fault

This command indicates when fault has occurred within the system which prevents charging. This is used to control the charge status indicator light.

Signal	Value	Meaning

Charge System Fault	0	No Fault
	1	Fault Active
	2	Error
	3	Not Available

3.3.2.4 Voltage Limit

This command indicates the maximum charging voltage.

Signal	Scale	Offset	Unit	Min	Max
Voltage Limit	0.2	0	V	0	803

3.3.2.5 Current Limit

This command indicates the maximum charging current.

Signal	Scale	Offset	Unit	Min	Max
Current Limit (*evHCMCurrentLimit*)	0.05	0	A	0	200.75

3.4 Identification Messages

3.4.1 Component Identification

The Charger shall support the Component Identification (CI PGN 0xFEEB) as it is specified in the SAE J1939-71 specification. The Make, Model and Serial Number fields shall be populated with ASCII strings. The Make field shall be set to the Charger supplier name. The Model shall be set to the Eaton Charger part number. The Serial Number field shall be set to the Charger supplier serial number. The content of all fields shall be alphanumeric. Additional fields may be added at the discretion of the supplier.

3.4.2 Software Identification

The Charger shall support the Software Identification (SOFT PGN 0xFEDA) as it is specified in the SAE J1939-71 specification. The first software identification field shall be set to the Eaton Charger software part number. The second software identification field shall be set to the supplier software version in ASCII representation. The content of all fields shall be alphanumeric ASCII strings. Additional fields may be added at the discretion of the supplier.

3.5 Diagnostic Fault Messages

3.5.1 DM1 - Active DTCs

The Charger shall report all active fault codes using the Diagnostic Message #1 (DM1 PGN 0xFECA) as it is specified in the SAE J1939-73 specification. The lamp status bytes (byte 1 and 2) shall not be used and shall be set to 0xFF. The suspect parameter number (SPN), failure mode indicator (FMI), and occurrence count (OC) parameters shall be used. If more than one active DTC is present, the Charger shall use the transport protocol (refer to SAE J1939-21) to send the data.

3.5.2 DM2 - Inactive DTCs

The Charger shall report all previously active fault codes since reception of the last clear inactive DTC's request using the Diagnostic Message #2 (DM2 PGN 0xFECB) as it is specified in the SAE J1939-73 specification. The lamp status bytes (byte 1 and 2) shall not be used and shall be set to 0xFF. The suspect parameter number (SPN), failure mode indicator (FMI), and occurrence count (OC) parameters shall be used. If more than one previously active DTC is present, the Charger shall use the transport protocol (refer to SAE J1939-21) to send the data.

3.5.3 DM3 - Clear Inactive DTCs

The Charger shall support clearing all previously active fault codes through request of the Diagnostic Message #3 (DM3 PGN 0xFECC) as it is specified in the SAE J1939-73 specification. The Charger shall respond to a request for DM3 by clearing all of the DM2s in its memory. The ECU shall respond with a Positive Acknowledge PGN once it has cleared the DTCs. If the Charger determines that the request was sent to the global address (0xFF), it shall not respond with an Acknowledge.

3.5.4 DM4 - Freeze Frame Parameters

The Charger shall support freeze frame parameters through request of the Diagnostic Message #4 (DM4 PGN 0xFECD) as it is specified in the SAE J1939-73 and DCN-119 specifications. The Charger shall populate the standard fields: Freeze Frame Length, SPN, FMI, and Occurrence Count. Additionally the Charger shall support Time Since First Fault Occurrence and Time Since Last Fault Occurrence according to section 3 of the DCN-119 specification.

3.5.5 DM11 - Clear Active DTCs

The Charger shall support clearing all active fault codes through request of the Diagnostic message #11 (DM11 PGN 0xFED3) as it is specified in the SAE J1939-73 specification. The Charger shall respond to a request for DM11 by clearing all of the DM1s in its memory. The ECU shall respond with a Positive Acknowledge PGN once it has cleared the DTCs. If the Charger determines that the request was sent to the global address (0xFF), it shall not respond with an Acknowledge.

3.5.6 DM13 - Start Stop Broadcast

The Charger shall support the Diagnostic Message #13 (DM13 PGN 0xDF00) according to the DCN-119 specification sections 6 and 8 for data and application transfers.

3.5.7 DM14 - Memory Access Request

The Charger shall support the Diagnostic Message #14 (DM14 PGN 0xFED6) according to the DCN-119 specification sections 6 and 8 for data and application transfers.

3.5.8 DM15 - Memory Access Response

The Charger shall support the Diagnostic Message #15 (DM15 PGN 0xFED7) according to the DCN-119 specification sections 6 and 8 for data and application transfers.

3.5.9 DM16 - Binary Data Transfer

The Charger shall support the Diagnostic Message #16 (DM16 PGN 0xFED8) according to the DCN-119 specification sections 6 and 8 for data and application transfers.

3.5.10 DM18 - Data Security

The Charger shall support the Diagnostic Message #18 (DM18 PGN 0xD400) according to the DCN-119 specification sections 6 and 8 for data and application transfers.

4 Fault Codes

4.1 General

The Charger shall be capable of continuously monitoring the components of the Charger system to detect when a component is operated in extreme or harsh conditions, has drifted out of normal operating ranges, or fails. The Charger shall indicate component failure or abnormal conditions through fault codes.

4.2 Diagnostic Trouble Codes

The Charger shall use Diagnostic Trouble Codes (DTC) to report fault code information as defined in the SAE J1939-73 specification. DTCs shall contain a Suspect Parameter Number (SPN) to indicate the item which has faulted, a Failure Mode Indicator (FMI) to indicate the fault conditions and an occurrence count (OC). The SPN Conversion Method shall always be set to zero.

The OC shall be incremented when a particular fault SPN becomes active regardless of the FMI.

Fault code FMI and OC data shall be accessible through data access parameters, refer to the Data Access (2.2) section for details.

4.3 Fault Code Time Stamp

For every fault the Charger shall capture the time of the first occurrence and the time of the last occurrence and use the values to compute the time since first occurrence and time since last occurrence.

Time shall be keep as the value of a runtime meter that is incremented every second (one second resolution) while power is applied to the Charger. The value of the runtime meter shall be saved to non-volatile memory during power down and restored during power up so that the value of the runtime meter reflects the number of seconds the Charger has been powered. Note this implies the value of the runtime meter will not be saved if the main contactors are not commanded to close.

Fault code time stamp data shall be accessible through data access parameters, refer to the Data Access (2.2) section for details.

4.4 Fault Table

The charger shall implement the faults detailed in Table 4.4-1 Charger Fault Codes and the component responses shown in Table 2 System and Component Response.

In cases where more than one sensor or component exists to measure a characteristic, the fault for that characteristic should be determined by the worst case condition of all conditions measured. For example: The fault “Voltage Above Normal - Most Severe” would be set if the Charger exceeds its safe operating voltage limit.

When detecting out of range sensor failure the Charger shall, in addition to signal range, determine sensor drift due to temperature and set the appropriate fault if drift is excessive. If the sensor drifts high, then the out of range high fault shall be set. Likewise if the sensor drifts low, the out of range low fault shall be set.

Signal	Description	Fault	FMI	Fault Severity Indicator	Condition to Set Fault Active	Condition to Set Fault Inactive	SPN
Bulk 1 Voltage	Internal Charger voltage supply 1	Bulk 1 Error- Most Severe	31	5	Bulk1 voltage below 350 volts operating level for 100 ms or greater.	Internal Bulk1 voltage above 360 volts for 100ms or EVSE disconnection and reconnection.	520422
Bulk 2 Voltage	Internal Charger voltage supply 2	Bulk 2 Error- Most Severe	31	5	Bulk2 voltage below 350 volts operating level for 100 ms or greater.	Internal Bulk2 voltage above 360 volts for 100ms or EVSE disconnection and reconnection.	520422
Bulk Voltage	Internal Charger voltage supply 1 and 2	Bulk Voltage Error- Most Severe	31	6	Bulk1 or Bulk2 voltage below 350 volts for over 1 minute.	EVSE disconnection and reconnection.	520422
CAN	Controller area Network	High Message Error Rate	19	1	Charger counter of nonsequential message errors reaching 64, with every good message causing the same counter to decrement until it saturates at zero.	Charger nonsequential message count returns to zero.	520423
CAN	Controller area Network	Command Timeout Error	19	5	Valid CAN Command not received for 300 ms or greater.	Valid CAN Command received.	520423
Check Sum	Memory integrity algorithm	Bad Intelligent Device Or Component	12	6	Trigger condition shall be a Checksum interrupt.	EVSE disconnection and reconnection	520423
Cold Plate Temperature	Main indicator of Charger temperature	Data Valid But Below Normal Operating Range - Least Severe	17	1	Charger cold plate temperature is less than -30 degC for 1 second or greater.	Charger cold plate temperature is above -25 degC for 1 second.	520424
Cold Plate Temperature	Main indicator of Charger temperature	Data Valid But Above Normal Operating Range - Least Severe	15	1	Charger cold plate temperature is Higher than +65 degC for 1 second or greater and/or the Charger is derating the Output current to keep the temperature below +85 degC.	Charger cold plate temperature is below +60 degC for 1 second and the Charger is not derating the output to control temperature.	520424
Cold Plate Temperature	Main indicator of Charger temperature	Data Valid But Above Normal Operating Range - Moderately Severe	16	5	Charger cold plate temperature is Higher than +85 degC for 1 second or greater.	Charger cold plate temperature is below +80 degC for 1 second.	520424
Cold Plate Temperature	Main indicator of Charger temperature	Data Valid But Above Normal Operating Range - Most Severe	0	6	Charger cold plate temperature is Higher than +85 degC for 30 seconds or greater.	EVSE disconnection and reconnection.	520424
IGBT Temperature	Main Power Transistor temperature	Data Valid But Above Normal Operating Range - Least Severe	15	1	Not implemented	NA	520425
IGBT Temperature	Main Power Transistor temperature	Data Valid But Above Normal Operating Range - Moderately Severe	16	5	Not Implemented	NA	520425
Input Current	Alternating Current from the Electric Vehicle Service Equipment	Current Above Normal - Moderately Severe	6	5	Charger AC input Current exceeds 32 amps and/or the Current Limit set by the EVSE per SAE J1772 for 300 ms.	Charger AC input current is below 30amps and EVSE current limit for 300ms.	520426
Input Current	Alternating Current from the Electric Vehicle Service Equipment	Current Above Normal - Most Severe	6	6	Charger AC Input Current exceeds 32 amps and/or the Current Limit set by the EVSE per SAE J1772 for 600 ms.	EVSE disconnection and reconnection.	520426
Input Voltage	Alternating Voltage from the Electric Vehicle Service Equipment	Voltage Below Normal - Moderately Severe	4	5	Charger AC input voltage below than 100 VAC for 300 ms with SAE J1772 switch “S2” closed for more than 3 seconds.	Charger AC input voltage above 114Vac for 300ms.	520427
Input Voltage	Alternating Voltage from the Electric Vehicle Service Equipment	Voltage Above Normal - Moderately Severe	3	5	Charger AC input voltage higher than 250 VAC for 300 ms or greater.	Charger AC input voltage below 245Vac for 300ms.	520427
Input Voltage	Alternating Voltage from the Electric Vehicle Service Equipment	Voltage Above Normal - Most Severe	3	6	Charger AC input voltage that exceeds the safe input voltage of the charger 265 Volts for 300 ms or greater.	EVSE disconnection and reconnection.	520427
Interlock Loop	High Voltage Interlock Loop signal	Open Circuit	5	6	When the any connector interlock is open.	EVSE disconnection and reconnection.	520428
Logic supply Voltage	Internal Charger Logic voltage supply	Voltage Below Normal - Most Severe	4	6	Internal logic supply below 9 volts for 300 ms or greater.	EVSE disconnection and reconnection.	520429
Logic Temperature	Logic Circuit Temperature	Data Valid But Above Normal Operating Range - Most Severe	0	6	Logic temperature exceeds +85 degC for 1 second or greater.	EVSE disconnection and reconnection.	520430
Magnetics Temperature	Magnetic component Temperature	Data Valid But Above Normal Operating Range - Most Severe	0	6	Magnetics temperature exceeds +105 degC for 1 second or greater.	EVSE disconnection and reconnection.	520431
Output Current	Charger Output Current to the High Voltage DC bus	Current Below Normal - Least Severe	5	1	Charger unable to produce the output current to meet the minimum voltage limit of 298 volts for 1 second or	Charger able to produce an output current to meet an output voltage of more than 298 volts for 1 second the	520432

					greater.	Warning is reset.	
Output Current	Charger Output Current to the High Voltage DC bus	Current Above Normal - Most Severe	6	6	Charger Output Current exceeds 16.5 amps for and/or the Current Limit set by the HCM for 300 ms.	EVSE disconnection and reconnection.	520432
Output Voltage	Charger Output Voltage to the High Voltage DC bus	Voltage Below Normal – Least Severe	4	1	Not implemented	NA	520433
Output Voltage	Charger Output Voltage to the High Voltage DC bus	Voltage Above Normal – Most Severe	3	6	Charger Output voltage exceeds 448V or the voltage limit sent in the Command Message for 300 ms.	EVSE disconnection and reconnection.	520433
Pilot Signal	SAE J1772 Pilot signal from the Electric Vehicle Service Equipment	Abnormal Frequency Or Pulse Width Or Period	9	6	EVSE Pilot frequency exceeds 1020 Hz or less than 980 Hz for 300 ms and is not sitting at a valid DC level.	EVSE disconnection and reconnection.	520434
Pilot Signal	SAE J1772 Pilot signal from the Electric Vehicle Service Equipment	Condition Exists	31	6	Charger detects a SAE J1772 PILOT signal error.	EVSE disconnection and reconnection.	520434
Proximity Signal	SAE J1772 Proximity signal from the Electric Vehicle Service Equipment	Condition Exists	31	6	Charger detects a SAE J1772 PROXIMITY signal error	EVSE disconnection and reconnection.	520435
Self Test	Charger internal fault diagnostics	Bad Intelligent Device Or Component	12	6	Failure detected by internal Charger Diagnostics	EVSE disconnection and reconnection.	520436
Vehicle Power Voltage	Vehicle power voltage to the Charger	Voltage Below Normal - Moderately Severe	4	5	When 12 Volt vehicle power falls below 8 volts for 1 second or 24 Volt vehicle power falls below 16 volts for 1 second. (The voltage and time shall be calibratable).	12 Volt vehicle power is above 8 volts for 300 milliseconds or 24 Volt vehicle power is above 16 volts for 300 milliseconds.	520437
Vehicle Power Voltage	Vehicle power voltage to the Charger	Voltage Above Normal - Least Severe	3	1	When 12 Volt vehicle power is above 16 volts for 300 milliseconds or 24 Volt vehicle power is above 32 volts for 300 milliseconds.	12 Volts vehicle power is below 16V for 300 milliseconds or 24 Volts vehicle power is below 32V for 300 milliseconds.	520437
Vehicle Power Voltage	Vehicle power voltage to the Charger	Voltage Above Normal - Moderately Severe	3	5	When 12 Volt vehicle is above 16 volts for 5 seconds or 24 Volt vehicle power is above 32 volts for 5 seconds.	12 Volt vehicle power is below 16 volts for 5 seconds or 24 Volt vehicle power is below 32 volts for 5 seconds.	520437

Table 4.4-1 Charger Fault Codes

Fault Severity Indicator	Meaning	Actions
0	No fault Active	
1	Warning is the lowest severity level.	The Charger is operating and does not require the main contactors to be opened. If necessary to protect the Charger hardware, the Charger shall operate in a degraded condition that results in a reduction in available output power.
2,3,4	Reserved	
5	Soft Failure is the middle severity level.	The Charger is operating in a condition that it can not safely maintain and is ramping down the Output Current to zero in 2.0 seconds. The charger shall monitor the "Soft Failure" condition and resume operation if the "Soft Failure" condition clears.
6	Failure is the highest severity level.	The charger is operating outside its safe operating limits. The charger shall attempt to ramp the Output Current to zero within 2.0 seconds. The charger shall command the EVSE to open the contactors when the Output Current reaches zero or after 2.0 seconds. The HCM will open the Charger HV DC bus contactor, when zero Output Current achieved or within 2.0 seconds whichever is first.
7	n/a	n/a

Table 2 System and Component Response