SAE INTERNATIONAL

SURFACE VEHICLE RECOMMENDED PRACTICE

J3068™ SEP2024

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Superseding J3068 JUL2022

(R) Electric Vehicle Power Transfer System Using a Three-Phase Capable Coupler

RATIONALE

This document has been revised to better support installations for refrigerated trucks and other medium-duty and heavy-duty vehicles for North American application, provide universal AC power transfer using a socket-outlet with carry-along cable assemblies across all vehicle classes, harmonize with SAE J3400 for single-phase application, and fix known errata in the document.

FOREWORD

SAE J3068 is a recommended practice for conductive charging of electric vehicles and supply equipment that may be capable of utilizing three-phase AC power. Presenting a symmetric three-phase load enhances grid stability, especially at high power levels. SAE J3068 standardizes an AC three-phase-capable charging coupler and digital control protocols, offering sufficient power and reliability for the commercial vehicle market. Existing technology is combined to provide higher power than existing charging solutions from the passenger car sector, with added diagnostics. SAE J3068's LIN-CP is harmonized with IEC 61851-1, Annex D. DC charging on separate contacts with PLC controls is also described, as is AC charging with PWM controls.

TABLE OF CONTENTS

1. SCOPE

This document covers the general physical, electrical, functional, testing, and performance requirements for conductive power transfer to an electric vehicle using a coupler capable of, but not limited to, transferring three-phase AC power. It defines a conductive power transfer method including the digital communication system. It also covers the functional and dimensional requirements for the electric vehicle inlet, supply equipment connector, and mating housings and contacts. Moveable charging equipment such as a service truck with charging facilities are within scope. Charging while moving (or in-route-charging) is not in scope.

2. REFERENCES

2.1 General

This document specifies requirements and solutions for (but not limited to):

- Three-phase AC charging (constant voltage) using a conductive electrical coupler with seven contacts. It also gives requirements for providing single-phase and DC power transfer.

- Globally focused usage of a baseband digital communication method (LIN-CP) over the control pilot circuit to allow use of different grid voltage levels, currents, and grid topologies. An electrical compatibility check is done before energizing the power supply.

- Universal socket-outlet for utilizing AC power transfer. This approach provides a universal socket-outlet where a fully detachable carry-along EV cable assembly that provides one type of plug on the infrastructure side and one of three connectors (SAE J3068, SAE J1772, or SAE J3400) is mated with the inlet on the vehicle side.

2.2 Document Overview

Defined terms used in this document are shown in *italic* font. See 8.3 for related formatting specifications for signal names and values.

All requirements are given level-four section numbers, and appear in the text from Sections 5 through 10. See 5.1.1.1 as an example of one of the first requirements.

Section 5 gives requirements for the conductive electrical coupler and general charging requirements.

Section 6 defines the control pilot circuit, which is similar to the circuits defined in SAE J1772 and SAE J3400. The primary difference is that the PWM signaling is replaced with, or supplemented by, baseband digital communication signals (LIN bus, Local Interconnect Network). The control pilot communicates system status, available voltage and currents, etc.

Section 7 defines the coupler proximity circuit.

Section 8 defines the LIN communication protocol.

Sections 9 and 10 define the application program.

Appendix A shows examples of startup and shutdown sequences and gives an overview of hardware status and LIN communication signal values.

Appendix B provides requirements for SAE universal socket-outlet AC power transfer.

Appendix C provides requirements and clarifying examples for using single-phase couplers.

Appendix D shows a summary of LIN signals, frames, and schedules.

Appendix E links to a reference implementation including an example of a LIN definition file (LDF file).

Appendix F provides assistance in managing asymmetric SE current limits for an EV that loads from line-to-line.

Appendix G summarizes requirements (all of which have four-level section numbers) and provides links to explanatory text in context to assist verification planning.

2.3 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

2.3.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J1211 Handbook for Robustness Validation of Automotive Electrical/Electronic Modules

SAE J1772 SAE Electric Vehicle and Plug-in Hybrid Electric Vehicle Conductive Charge Coupler

SAE J2012 Diagnostic Trouble Code Definitions

SAE J3068/1 Identification of Vehicles and Supply Equipment for Conductive AC Charging

SAE J3068/2 Control of Bidirectional Power for AC Conductive Charging

SAE J3400 NACS Electric Vehicle Coupler

2.3.2 ANSI Accredited Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ANSI C84.1 Electric Power Systems and Equipment - Voltage Ratings (60 Hz)

2.3.3 California Code of Regulations Publications

Copies of these documents are available online at https://oal.ca.gov/.

13 CCR § 1971.1 On-Board Diagnostic System Requirements – 2010 and Subsequent Model-Year Heavy-Duty Engines.

2.3.4 CSA Publications

Available from CSA International, 178 Rexdale Boulevard, Toronto, Ontario, Canada M9W 1R3, Tel: 416-747-4000, www.csa-international.org.

CSA C22.1 Canadian Electrical Code Part 1, Section 86

CSA C22.2 NO. 280 Electric Vehicle Supply Equipment

CSA C22.2 NO. 281.1 Standard for Safety for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General Requirements

CSA C22.2 NO. 281.2 Standard for Safety for Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

CSA C22.2 NO. 282 Plugs, Receptacles, and Couplers for Electric Vehicles

2.3.5 DIN Publications

Copies of these documents are available online at https://www.din.de/en/.

DIN SPEC 70121 Electromobility - Digital communication between a d.c. EV charging station and an electric vehicle for control of d.c. charging in the Combined Charging System

2.3.6 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 60664-1 Insulation Coordination for Equipment within Low-Voltage Supply Systems - Part 1: Principles, Requirements and Tests

IEC 61851-1 Electric Vehicle Conductive Charging System - Part 1: General Requirements

IEC 62196-1 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets - Conductive Charging of Electric Vehicles - Part 1: General Requirements

IEC 62196-2 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets - Conductive Charging of Electric Vehicles - Part 2: Dimensional Compatibility and Interchangeability Requirements for AC Pin and Contact-Tube Accessories

IEC 62196-3 Plugs, Socket-Outlets, Vehicle Connectors and Vehicle Inlets - Conductive Charging of Electric Vehicles - Part 3: Dimensional Compatibility and Interchangeability Requirements for DC and AC/DC Pin and Contact-Tube Vehicle Couplers

2.3.7 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 100 CD Standards Dictionary: Glossary of Terms and Definitions

2.3.8 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 15118-3 Road vehicles - Vehicle to grid communication interface - Part 3: Physical and data link layer requirements

ISO 17987-1 Road Vehicles - Local Interconnect Network (LIN) - Part 1: General Information and Use Case Definition

ISO 17987-2 Road Vehicles - Local Interconnect Network (LIN) - Part 2: Transport Protocol and Network Layer Services

ISO 17987-3 Road Vehicles - Local Interconnect Network (LIN) - Part 3: Protocol Specification

ISO 17987-4 Road Vehicles - Local Interconnect Network (LIN) - Part 4: Electrical Physical Layer (EPL) Specification 12V/24V

ISO/TR 17987-5 Road Vehicles - Local Interconnect Network (LIN) - Part 5: Application Programmers Interface (API)

ISO 17987-6 Road Vehicles - Local Interconnect Network (LIN) - Part 6: Protocol Conformance Test Specification

ISO 17987-7 Road Vehicles - Local Interconnect Network (LIN) - Part 7: Electrical Physical Layer (EPL) Conformance Test Specification

NOTE: LIN Specification 2.2.A (2010) from the LIN consortium (http://www.lin-subbus.org/) has been discontinued and transcribed to ISO 17987 Parts 1-7.

2.3.9 NFPA Publications

Available from National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

NFPA 70 National Electrical Code

2.3.10 Normas Mexicanas

Available from Sistema Integral de Normas y Evaluación de la Conformidad (SINEC), Insurgentes Sur 1735, Col. Guadalupe Inn., Delegación Alvaro Obregón, México, D.F. C.P. 01020, Tel: (01)-(55)-2000-3000, www.gob.mx.

NOM-001-SEDE Instalaciones Electricas (Utilización) Artículo 625

NMX-J-668/1-ANCE Vehículos eléctricos (VE) - Sistemas de protección personal para circuitos de alimentación - Parte 1: Requisitos generales

NMX-J-668/2-ANCE Vehículos eléctricos (VE) - Sistemas de protección personal para circuitos de alimentación - Parte 2: Requisitos particulares para dispositivos de protección para utilizarse en sistemas de carga

NMX-J-677-ANCE Vehículos eléctricos - Equipos de alimentación

NMX-J-678-ANCE Vehículos eléctricos - Clavijas, receptáculos y acopladores

2.3.11 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 943 Ground-Fault Circuit-Interrupters

UL 2231-1 Personnel Protection Systems for Electric Vehicle Supply Circuits: General Requirements

UL 2231-2 Personnel Protection Systems for Electric Vehicle Supply Circuits: Particular Requirements for Protection Devices for Use in Charging Systems

UL 2251 Plugs, Receptacles, and Couplers for Electric Vehicles

UL 2594 Electric Vehicle Supply Equipment

2.4 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.4.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

SAE J551-5 Performance Levels and Methods of Measurement of Magnetic and Electric Field Strength from Electric Vehicles, 150 kHz to 30 MHz

SAE J1113-21 Electromagnetic Compatibility Measurement Procedure for Vehicle Components - Part 21: Immunity to Electromagnetic Fields, 30 MHz to 18 GHz, Absorber-Lined Chamber

SAE J1742 Connections for High Voltage On-Board Vehicle Electrical Wiring Harness - Test Methods and General Performance Requirements

SAE J1812 Function Performance Status Classification for EMC Immunity Testing

SAE J2847-2 Communication Between Plug-in Vehicles and Off-Board DC Chargers

SAE J2894-1 Power Quality Requirements for Plug-In Electric Vehicle Chargers

SAE J2931-1 Digital Communications for Plug-in Electric Vehicles

SAE J2931-4 Broadband PLC Communication for Plug-in Electric Vehicles

SAE J3072 Interconnection Requirements for Onboard, Grid Support Inverter Systems

2.4.2 Code of Federal Regulations (CFR) Publications

Copies of these documents are available online at https://www.ecfr.gov.

40 CFR Part 600 Fuel Economy and Greenhouse Gas Exhaust Emissions of Motor Vehicles

47 CFR Part 15, Subpart A Radio Frequency Devices, General

47 CFR Part 15, Subpart B Radio Frequency Devices, Unintentional Radiators

47 CFR Part 18, Subpart C Industrial, Scientific, and Medical Equipment, Technical Standards

2.4.3 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

CISPR 12 Vehicles, Boats and Internal Combustion Engines - Radio Disturbance Characteristics - Limits and Methods of Measurement for the Protection of Off-Board Receivers

IEC 61000-4-3 Electromagnetic Compatibility (EMC) - Part 4-3: Testing and Measurement Techniques - Radiated, Radio-Frequency, Electromagnetic Field Immunity Test

IEC 61000-4-6 Electromagnetic Compatibility (EMC) - Part 4-6: Testing and Measurement Techniques - Immunity to Conducted Disturbances, Induced by Radiofrequency Fields

2.4.4 ISO Publications

Available from International Organization for Standardization, ISO Central Secretariat, 1, ch. de la Voie-Creuse, CP 56, CH-1211 Geneva 20, Switzerland, Tel: +41 22 749 01 11, www.iso.org.

ISO 11451-2 Road Vehicles - Vehicle Test Methods for Electrical Disturbances from Narrowband Radiated Electromagnetic Energy - Part 2: Off-Vehicle Radiation Sources

2.4.5 Swedish Standard Institute Publications

Available from the Swedish Standard Institute, SE-118 80 Stockholm, Sweden, Tel: +46-8-555-523-00, www.sis.se.

SEK TS 4810515 Electric Vehicle Conductive Charging System - Control Pilot Function that Provides CAN Communication Using the Control Pilot Circuit

2.4.6 UL Publications

Available from UL, 333 Pfingsten Road, Northbrook, IL 60062-2096, Tel: 847-272-8800, www.ul.com.

UL 50 Standard for Enclosures for Electrical Equipment

UL 62 Flexible Cord and Fixture Wire

UL 94 Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 231 Power Outlets

UL 746A Standard for Polymeric Materials - Short Term Property Evaluations

UL 840 Insulation Coordination Including Clearance and Creepage Distances for Electrical Equipment

UL 1439 Determination of Sharpness of Edges on Equipment

3. DEFINITIONS

3.1 API

Application Programming Interface.

3.2 APPLICATION PROGRAM

The implementation of the *control sequence* on an *EV* or *SE*.

3.3 CABLE ASSEMBLY, EV

A portable *cable assembly* consisting of a length of *EV* cable, a vehicle *connector* on one end, and an *EV plug* on the other.

3.4 CASE A

The *EV* connects to the *SE* via a cable permanently attached to the *EV*.

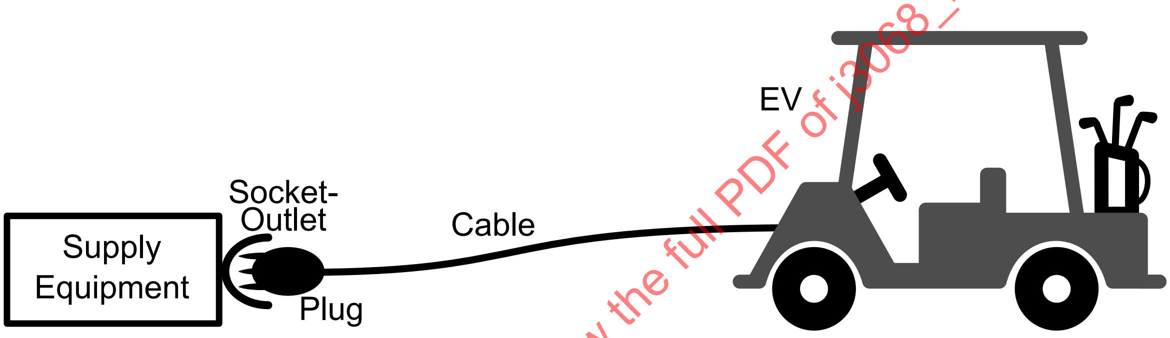

Figure 1 - Case A: Charging cord attached to vehicle

3.5 CASE B

The *EV* connects to the *SE* via an *EV cable assembly* that is detachable by the driver at both ends.

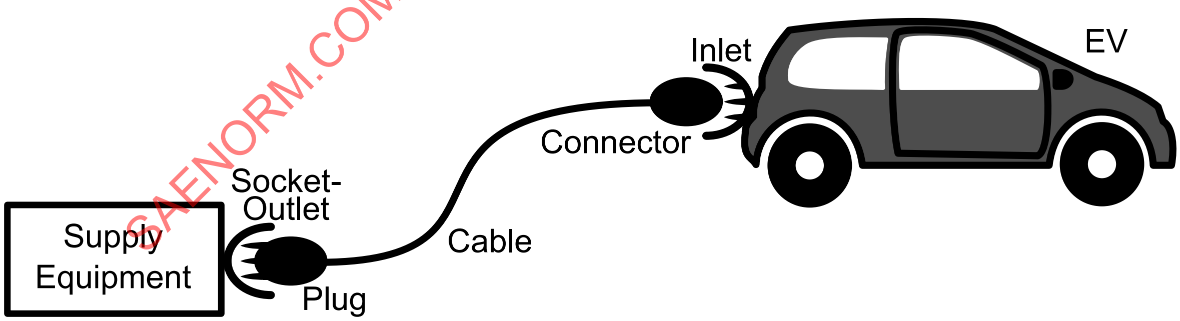

Figure 2 - Case B: Fully detachable EV cable assembly

3.6 CASE C

EV connects to the *SE* via a *connector* permanently attached to the *SE*.

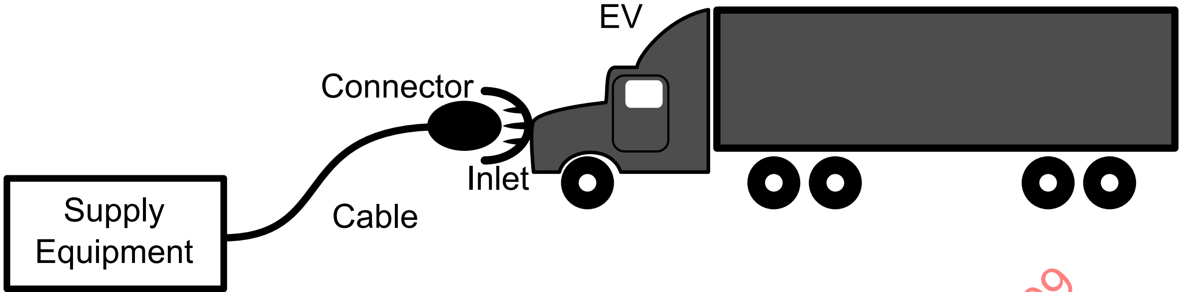

Figure 3 - Case C: Connector permanently attached to SE

3.7 CCID

Charging circuit interruption device, as defined in the *Tri-National EVSE Safety Standards*. A *CCID* interrupts the charging circuit if differential current exceeds a threshold, usually 20 mA for permanently wired installations. AC and DC thresholds are specified, and automatic reclosure is allowed under certain conditions. Contrast to UL 943 for *ground* fault circuit interrupters.

3.8 CHARGER

An electrical device that converts alternating current energy to regulated direct current for replenishing the energy of a rechargeable energy storage device (i.e., battery) and may also provide energy for operating other vehicle electrical systems.

3.9 CHASSIS GROUND

The *conductor* used to connect the non-current carrying metal parts of the *EV* high voltage system to the *equipment ground*. See 3.25.

3.10 COMBINED CHARGING SYSTEM (CCS)

A system where dedicated DC contacts are added to AC charging *couplers*. *CCS1* refers to SAE J1772 (IEC 62196-2 type 1) *couplers* with DC functionality added. *CCS1* is called “configuration EE” in IEC 62196-3 and “DC Level 2” in SAE J1772. *CCS2* refers to SAE J3068 (IEC 62196-2 type 2) *couplers* with DC functionality added. *CCS2* is called “configuration FF” in IEC 62196-3 and “SAE J3068 DC_8” in SAE J3068. *CCS couplers* may or may not include AC contacts. *CCS connectors* always use a *case C* (*connector* fixed to the *EVSE*).

3.11 CONDUCTOR

A body, usually in the form of a wire, cable, or bus bar, suitable for carrying an electric current. Refer to IEEE 100 CD.

3.12 CONNECTION SESSION

A *connection session* starts when the *connector* is inserted into the *inlet* and ends when the *connector* is removed from the *inlet*. A normal *connection session* may contain one or more periods of charging.

3.13 CONNECTOR

A hand-held conductive device at the end of a flexible cable from the *SE*, which is inserted into the *EV inlet* to charge the battery.

3.14 CONTACTOR

A switching device capable of repeatedly interrupting normal load currents, but not necessarily rated to interrupt short circuit current as a circuit breaker would. A *contactor* is similar in concept to a relay, but generally has higher power capacity. (Relays "click," *contactors* "clunk.") "*Contactor*" may also refer to a high-power (and silent) solid-state relay.

3.15 CONTROL PILOT (CP)

An electrical signal that is sourced by the *SE*, controlled by the *EV* and the *SE*, and used for the following functions:

a. Verifies that the *EV* and *SE* are present and connected

b. Controls energization/de-energization of the charging power supply

c. Transmits operating parameters and constraints between *SE* and *EV*

d. Monitors the presence of the *equipment ground*

3.16 CONTROL SEQUENCE

A sequence of automated *tasks* performed by the *EV* and the *SE* during a *connection session* for the purpose of charging the *EV*. A new *control sequence* occurs at the beginning of a *connection session* and after a *restart*. See Section 10.

3.17 COUPLER, EV

A physical and electrical mating system connecting the *SE* to the *EV*. The *coupler* includes the *connector* at the end of the flexible cable of the *SE*, and the *inlet* on the *EV*.

3.18 CP LEVEL

Control pilot level refers to the nominal high-level voltage of the *control pilot* waveform (during *LIN-CP*). This voltage is a function of the *EV* being plugged in or unplugged and of the *EV* closing or opening the switch S_2; see Figure 11. *CP level* is denoted as 12, 9, 6, etc.; see Table 9.

"*CP level*" is similar to "State" in SAE J1772, but not identical. The negative amplitude differs (-12 V for *PWM-CP* and approximately 0 V for *LIN-CP*). The analog control function of S_2 is supplemented by digital *signals*; see Figure 10.

3.19 DATA LINK

In general, a digital communication bus such as *LIN*, CAN, Ethernet, *PLC*, fiber optic, Wi-Fi, etc. The specific *data link* described in this recommended practice is *LIN*.

3.20 DELTA CONNECTED LOAD (also Δ LOAD)

A three-wire type of three-phase connection, the three corners of the delta or triangle, as diagrammatically represented, being connected to the three wires of the circuit. Contrast to *wye connected load*. See 3.62.

3.21 ELECTRIC VEHICLE (EV)

A vehicle designed to receive energy from an *SE*. This term is used to cover *electric vehicles* and plug-in hybrid *electric vehicles*. This includes on-road *electric vehicles*, off-road *electric vehicles*, airport ground support equipment, etc.

3.22 ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE)

A device responsible for safely providing power to the *EV* through the use of certain control functions which are defined in this recommended practice and is listed according to the *Tri-National AC EVSE Standard*. It may be permanently wired or connected via a cord to the premises wiring. To supply the *EV*, it may have a permanently attached cable and *connector*, or an *SE socket-outlet* (see 3.51) which accepts a *plug* (see 3.41). Contrast this with *SE* which does not encompass the connection method (see 3.55).

3.23 EQUIPMENT GROUND

A *conductor* used to connect the non-current carrying metal parts of the *SE* to the system *grounding conductor*, the *grounding* electrode *conductor*, or both, at the *supply equipment*. See 3.25.

3.24 FRAME

A *LIN* communication entity consisting of a *header* and *response*. All *frames* in this document have 8 byte payloads.

3.25 GROUND CONDUCTOR (GROUNDING CONDUCTOR or GROUND)

A *conductor* which does not carry current under normal operating conditions, but is capable of carrying sufficient fault current to trip circuit protection such as a fuse or circuit breaker. Also known as Protective Earth outside of North America. See 3.9 for *EV ground* nomenclature and 3.23 for *SE ground* nomenclature.

3.26 HEADER

The first part of a *LIN frame* that contains a *frame* identifier to request a specific *response*. It is always sent by the commander *LIN* node.

3.27 INLET

The component on the *EV* into which the *connector* mates. This is part of the *coupler*.

3.28 kbps

Thousand bits per second.

3.29 LIN

Local Interconnect Network; refer to ISO 17987.

3.30 LIN-CP

The control method using *LIN signals* and *CP levels*, as described in this document.

3.31 LIN DEFINITION FILE (LDF)

A file that describes the nodes, *frames*, and *signals* of a *LIN* cluster and is used for automated node generation.

3.32 LINE CONDUCTOR (LINE)

A *conductor* that is not connected to the *neutral* point of a system that is intended to carry current under normal conditions.

3.33 LOCAL ELECTRICAL CODES

Refers to the regulations governing electrical installations in their corresponding jurisdictions: NFPA 70, CSA C22.1, or NOM-001-SEDE, and/or any applicable local regulations.

3.34 LOCK (UNLOCK)

The act of engaging or disengaging the *locking mechanism* (e.g., "*lock* the *inlet*" means "engage the *inlet's locking mechanism*).

3.35 LOCKING MECHANISM

A component associated with the *inlet* that, when engaged, prevents removal of the *connector*. The *locking mechanism* may be engaged for reasons related to safety, operational reliability, and/or tamper prevention. See 5.4.3 and Sections 9 and 10.

3.36 MCU

Micro Controller Unit.

3.37 NEUTRAL CONDUCTOR (NEUTRAL)

The *conductor* connected to the *neutral* point of a system that is intended to carry current under normal conditions. Refer to NFPA 70 (National Electrical Code), Article 100.

3.38 NOT AVAILABLE

A special value for a *signal* that means that a value for this *signal* is *Not Available* or invalid, and should not be used in calculations or decisions. See *valid value* in 3.61.

3.39 ON-BOARD CHARGER

A *charger* located on the *electric vehicle*.

3.40 POWER-LINE CARRIER (PLC)

The supplementary communications mechanism defined in ISO 15118-3 and DIN SPEC 70121. A *PLC* modem facilitates this connection.

3.41 PLUG

A hand-held conductive component at one end of an *EV cable assembly* which mates into the *socket-outlet*; see *case B* (see Figure 2) and *case A* (see Figure 1). Not present *in case C* (see Figure 3).

3.42 PROTOCOL VERSION

The particular communications format in use. This document defines *Protocol Version* 2, and IEC 61851-1:2017, Annex D, defines *Protocol Version* 1. Future editions and/or companion documents may define additional *Protocol Versions*.

3.43 PROXIMITY DETECTION (PROXIMITY or PROX)

A method whereby the *EV* can ascertain whether a *connector* is plugged into the *inlet*, without requiring active elements in the *connector* or cable. *Proximity detection* may also provide additional functionality. See *proximity detection* (Section 7). This function is also used between the *plug* and the *socket-outlet*; see Appendix B.

3.44 PUBLISHER

A *LIN* node which has been assigned to provide the *response* for a specific *frame*. Each *frame* can have only one *publisher*.

3.45 PWM

Pulse-width modulation.

3.46 PWM-CP

The control method using *PWM signals* and *CP levels*, as described in SAE J1772.

3.47 RESPONSE

The last part of a *LIN frame* that contains the *frame* data requested in the *header*. It is sent by the *LIN* node which is the *publisher* for the requested *response*.

3.48 RESTART

An event within a *connection session* where *LIN-CP* communication begins again in a new *control sequence*. See Section 10.

3.49 S2

A means for the *EV* to change the *control pilot level* between levels 9 and 6.

3.50 SCHEDULE

The *schedule* describes the *frames* and the timing of the *frames* transmitted on the *data link*. See 8.2. Refer to ISO 17987-3.

3.51 SOCKET-OUTLET

The component on the *EVSE* into which the *plug* of an *EV cable assembly* is inserted. S*ocket-outlets* only exists in *case A* (see Figure 1) and *case B* (see Figure 2) applications. The *SE* may instead have a permanently attached cable; see *case C* (Figure 3). These components are not general-purpose (e.g., NEMA) receptacles, but are instead specifically for *EVs*. These components are not used to provide a connection between the premises wiring and the *supply equipment*, but instead connect the *EV cable assembly* to the *supply equipment*.

3.52 SIGNAL

A datum communicated over the *LIN data link*. One or more *signals* are packaged in an 8 byte *frame*. In this recommended practice, most *signals* contain a minimum of 2 bits so that even a "binary" *signal* with normal values such as *Incomplete* and *Complete* can also indicate the values of *Error* and *Not Available* for exceptions. Parametric *signals* typically encode a range of data (for example, with 8 bits) with the maximum value encoding *Not Available*. See 3.61.

3.53 START VALUE

A value stored internally in a *LIN* node (usually referring to a *signal* from the other node) at the start of a *control sequence* before an actual *signal* is received from the other *LIN* node. *Start values* are sometimes defined to set safe start conditions or to set values that can be distinguished from *valid* received *values* (making it clear from the variable value when nothing has yet been received from the other side of the network).

3.54 SUBSCRIBER

A *LIN* node which has been assigned to receive the *response* for a specific *frame*. Each *frame* can have zero, one, or several *subscribers*.

3.55 SUPPLY EQUIPMENT (SE)

Supply equipment (also "*Se*..." in *signal* names and *frame* names). In this recommended practice, *supply equipment* does not encompass the connection method, which has distinct voltage and current ratings that are not necessarily reflected in the *SE* rating *signals*. Contrast this with *EVSE* (see 3.22) which does encompass the connection method ratings in addition to the control box ratings.

3.56 TASK

There are three primary *tasks* in SAE J3068: *Protocol Version selection* (see 9.5), *Initialization* (see 9.6), and *Operation* (see 9.7). Each *task* has a corresponding *LIN schedule* assigned to accomplish it.

3.57 TRI-NATIONAL AC EVSE STANDARD

Refers to the *EVSE* product standard in their corresponding jurisdictions: UL 2594, CSA C22.2 No. 280, or NMX-J-677-ANCE.

3.58 TRI-NATIONAL COUPLER STANDARD

Refers to the standards documents covering *plugs*, *socket-outlets*, *cable assemblies*, *connectors, and inlets* in their corresponding jurisdictions: UL 2251, CSA C22.2 No. 282, or NMX-J-678-ANCE.

3.59 TRI-NATIONAL EVSE SAFETY STANDARDS

Refers to the *EVSE* safety standards in their corresponding jurisdictions: UL 2231-1 and UL 2231-2, CSA C22.2 No. 281.1 and CSA C22.2 No. 281.2, or NMX-J-668/1-ANCE and NMX-J-668/2-ANCE.

3.60 UART

Universal asynchronous receiver/transmitter.

3.61 VALID VALUE

A *signal* value that is not set to *Not Available* (binary value of all ones) and not set to *Error*. In other words, a useable value that does not need to be ignored.

3.62 WYE CONNECTED LOAD (also Y LOAD)

Electrical loads (typically three loads) connected between *neutral* and a *line* (hot wire) of a three-phase AC supply. Contrast to *delta connected load* (also Δ *load*; see 3.20).

4. DOCUMENT AND SYSTEM OVERVIEW

4.1 System Overview

Signaling and power flow for *case C* is shown in Figure 4 (informative). The center green box encloses the systems which this recommended practice focuses on. A similar diagram for *case B* is shown in Appendix B, Figure B1.

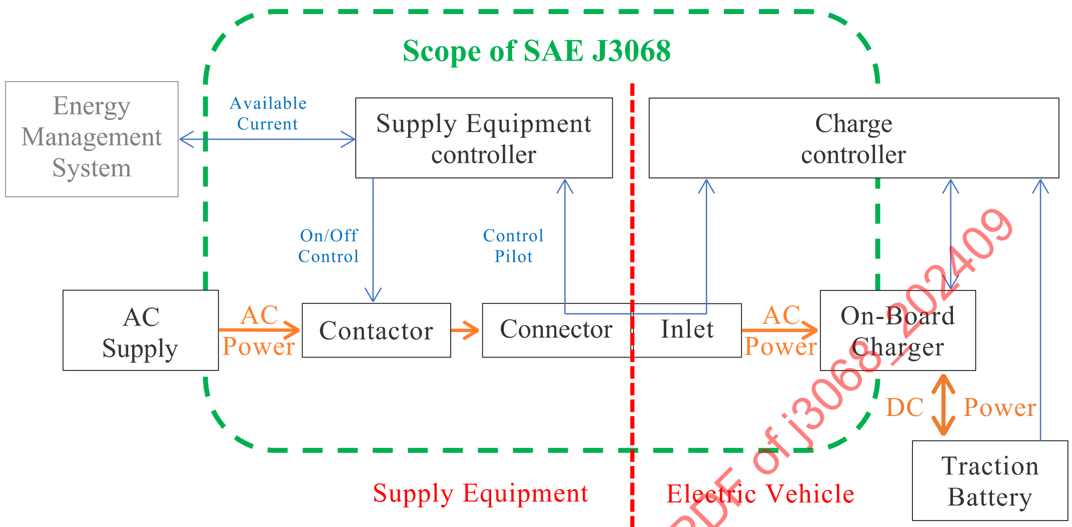

Figure 4 - General AC conductive charging system topology for case C

4.2 Functional Concept of Digital Control

The digital *control pilot* circuit enables the *EV* and *SE* to function as a system. There is ancillary control of the *SE contactor* via the *EV's* control of the positive voltage of the *control pilot* waveform (*CP level*). Only if the digital *signals* agree with the analog *CP level* will the *contactor* remain closed. The digital system functions may be visualized as in Figure 5, where connection between the *EV* and *SE* occurs at the left, and the *connection session* ends at the right.

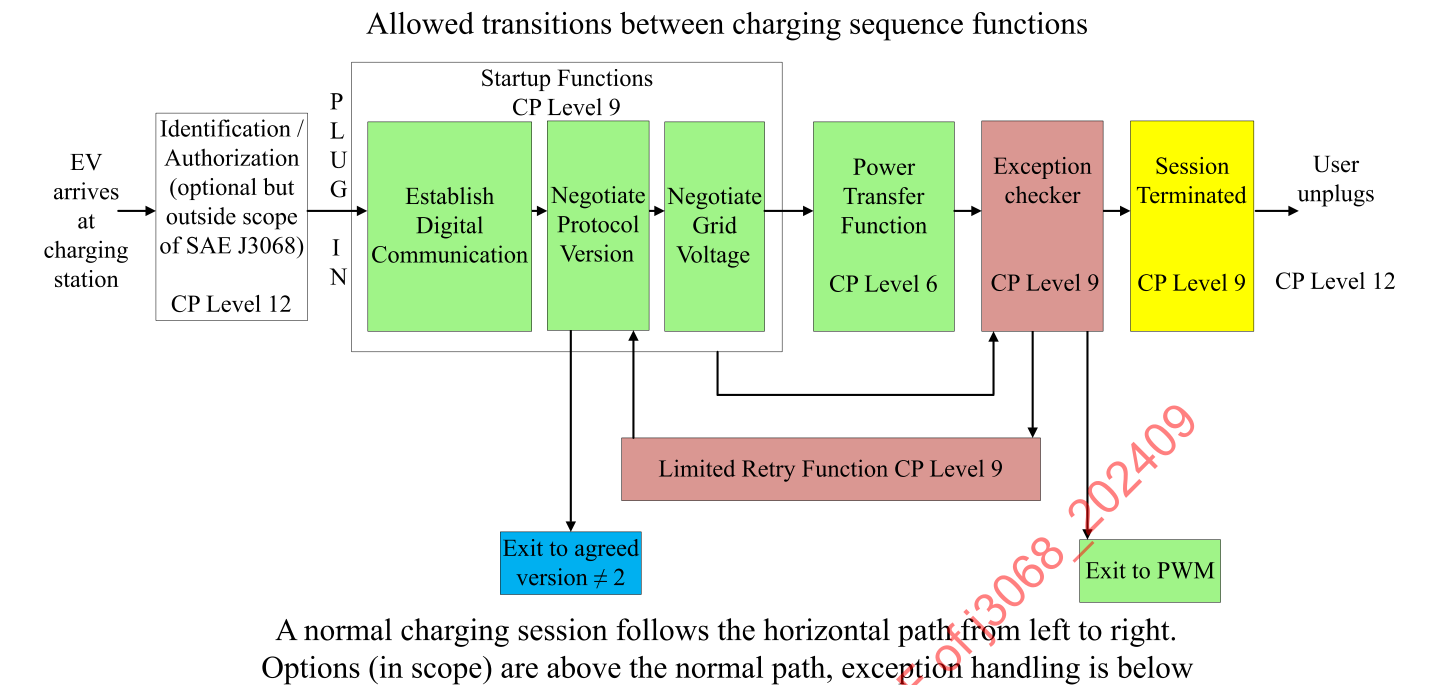

Figure 5 - Connection session managed by the digital control pilot

The *connection session* initiates when a connection is made between an *electric vehicle* (*EV*) and the *supply equipment* (*SE*). The *SE* and *EV* attempt to select a common communications *Protocol Version*. If *LIN-CP* communications cannot be established, the *SE* may fall back to *PWM-CP* if supplied voltages are within allowable limits. See 6.2.3.

After *Protocol Version* selection completes successfully, during *LIN-CP Initialization* (see 9.6), the *EV* signals its maximum nominal input voltage, frequency, and which contacts are present. If the *SE* can supply power at a voltage equal to or less than the *EV's* maximum nominal voltage, then the available current (per phase, including *neutral*) and nominal operating voltages are signaled by the *SE*, and charging of the *EV* battery may commence.

Optionally, the *SE* may reconfigure and signal the supply configuration during *LIN-CP Initialization* based on *signals* first provided by the *EV* (see 9.6.2.1), or when falling back to *PWM-CP* (e.g., under *PWM-CP*, the *SE* could be optimized for two-wire single-phase charging). The following are example use cases for this function:

- *SE* may be able to supply an alternative voltage and phase configuration. For example, a single-phase *EV* may connect to a three-phase 208Y/120 VAC *EVSE*; and without accommodation, the *EV* would receive only 120 VAC. Instead, the *SE* may dynamically reconfigure to optimize charging for 208 VAC single-phase charging.

- A three-wire split-phase 240/120 VAC *SE* may instead provide 240 VAC two-wire single-phase power to optimize charging. This reconfiguration ability is useful for *EVSE* used in Vehicle-to-Home or Vehicle-to-Load applications (refer to SAE J3068/2) where three-wire configurations eliminate the need for a neutral-forming transformer, but the ability to switch to two-wire to support single-phase-only charging is desired.

- If the *EVSE* is connected to multiple AC supplies (e.g. 208Y/120 and 480Y/277, or even an arbitrary AC voltage source), the *EV Initialization signals* can be used to determine what should be provided.

Once voltage ratings are negotiated and all other *Initialization* is successful, the *SE* signals that it is ready to start charging. The *EV* signals that it is able to charge by signaling via the *data link* and by closing S_2 (which sets the positive amplitude of the *control pilot* to 6 V nominal). The *SE* closes the *contactor* only when all conditions are met. See 9.7.2.

An energy management system is optional, and may be used to optimize facility electric demand or delay charging for more favorable cost, etc. The current limits of each of the three supply phases may be adjusted at any time by an energy management system, which may also be influenced by signals from the electric utility with the intention of maintaining stability of the electric grid or providing advantageous pricing by time-of-use. The *neutral* current limit is typically static, limited by the connection cable, and primarily influences single-phase/split-phase operation.

Billing systems are optional but not shown. A billing system would typically communicate with the *SE* and authenticate the customer account before charging is allowed to begin.

An optional system for a *cable assembly* node on the *data link* is referred to in 6.2.4. This node can be used to communicate the ratings and/or temperatures of the *EV cable assembly*; this could be required, for example, in *case B* applications where the *EV cable assembly* is rated higher than 63 A three-phase or 70 A single-phase. For *case C*, the ratings are typically signaled by the *SE* on behalf of the *connector* when a *cable assembly* node is not present. See 5.3.2.1.

Temperature monitoring in *couplers* is recommended for derating and required in some situations. See 5.5.2.10.

4.3 Coupler Topology

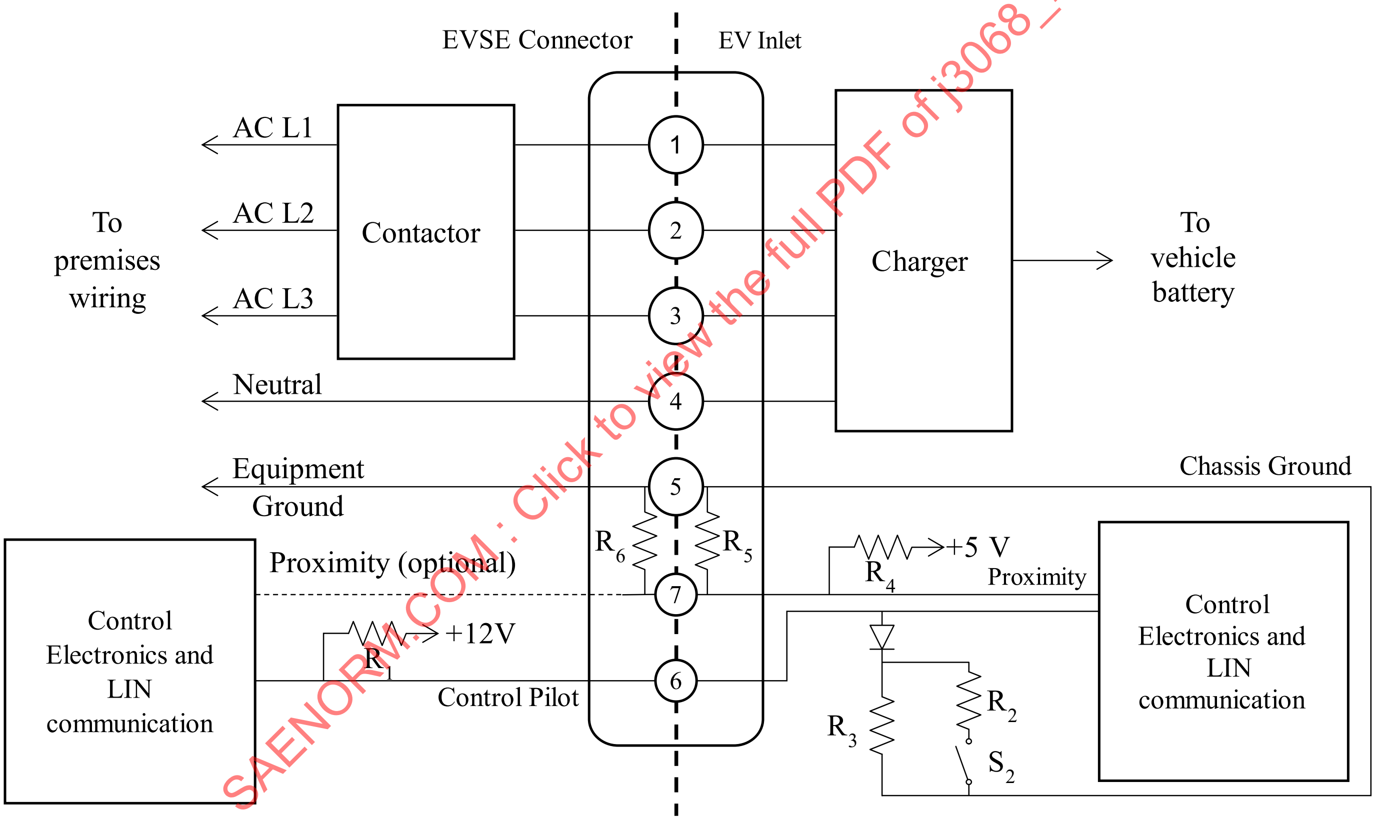

Figure 6 - Coupler block diagram for three-phase supply (informative)
(SE that supports LIN-CP only with EV that supports LIN-CP and PWM-CP shown)

5. GENERAL REQUIREMENTS

5.1 Coupler Connection Types

SAE J3068 defines conductive electrical *couplers* capable of, but not limited to, three-phase AC charging. The *couplers* can be configured to use five, seven, or nine contacts. See Tables 1 and 4.

5.1.1 Connection Types

Mechanically, SAE J3068 *couplers* comply with the requirements in 5.5.

SAE J3068 *couplers* and *socket-outlets* are classified as listed in Table 1.

5.1.1.1 SAE J3068 *case C EVSE* and *case A EVs* shall use a *connector* type defined in Table 1.

5.1.1.2 SAE J3068 *case B* and *case C EVs* shall use an *inlet* type defined in Table 1.

5.1.1.3 SAE universal *EVSE* (*case A* and *case B)* shall use the *socket-outlet* type defined in Table 1.

Table 1 - EVSE connection types

Coupler type	**Contact positions used, see Table 4**
SAE J3068 AC_6	L1, L2, L3, N, *ground*, *CP*, *proximity*
SAE J3068 DC_8 No AC	*Ground*, *CP*, *proximity*, DC+, DC-
SAE J3068 DC_8/AC_6	L1, L2, L3, N, *ground*, *CP*, *proximity*, DC+, DC-
Socket-outlet type	
SAE universal AC_6	L1, L2, L3, N, *ground*, *CP*, *proximity*

Note 1: The subscripts 6 and 8 denote the diameters in millimeters of the power pins used. See Table 4.
Note 2: Type SAE J3068 DC_8/AC_6 is typically used for the *EV inlet*. *SE* supports either DC or AC, typically not both.
Note 3: Using 6-mm pins for DC is not supported in this edition of SAE J3068.
Note 4: For providing single-phase power transfer, N (*Neutral*) can be wired to a *line conductor*. See 5.3.1.5.

5.2 EVSE and EV Classification

SAE J3068 *EVSE* and *EV* are classified as listed in Tables 2 and 3. The tables also list the maximum allowed power for each *SE* and *EV* type.

5.2.1 SE and EV Classification Tables

5.2.1.1 An SAE J3068 *SE* shall comply with applicable requirements listed in Table 2.

5.2.1.2 An SAE J3068 *EV* shall comply with applicable requirements listed in Table 3.

Table 2 - SE classification

Line	SE type	Power capability	
1	SAE J3068 AC_6 *LIN*	≤600 VAC, nominal, *line*-to-*line* ≤160 A	
2	SAE J3068 AC_6 *PWM* Not recommended for new designs	≤277 VAC nominal *single-phase 70 A* ≤480 VAC nominal *line-to-line 63 A*	
3	SAE J3068 AC_6 *LIN/PWM*	As in line 1 when *LIN* is used As in line 2 when *PWM* is used	
4	SAE J3068 DC_8 *PWM/PLC*	Refer to SAE J3400/SAE J1772	
5	SAE universal AC_6 *LIN/PWM* (see Appendix B)	As in line 1 when *LIN* is used As in line 2 when *PWM* is used	

Table 3 - EV classification

Line	EV type	Power capability	
1	SAE J3068 AC_6 *LIN*	≤600 VAC nominal *line*-to-*line* ≤160 A	
2	SAE J3068 AC_6 *PWM* Not recommended for new designs	≤277 VAC nominal *line*-to-*neutral* ≤63/70 A	
3	SAE J3068 AC_6 *LIN/PWM*	As in line 1 when *LIN* is used As in line 2 when *PWM* is used	
4	SAE J3068 DC_8 No AC *PWM/PLC*	Refer to SAE J3400/SAE J1772	
5	SAE J3068 DC_8/AC_6 *PWM/PLC*	As in line 2 when AC is used As in line 4 when DC is used	
6	SAE J3068 DC_8/AC_6 *LIN/PWM/PLC*	As in line 1 when AC, *LIN* is used As in line 2 when AC, *PWM* is used As in line 4 when DC is used	

5.2.2 Supplied AC Voltage Compatibility

The *LIN-CP* communications specified in this document allow for an electrical compatibility check before the voltage is supplied by the *EVSE* (see 9.6.2.3 and 9.6.3.1).

5.2.2.1 The *SE* shall communicate its nominal system voltage rounded as specified in ANSI C84.1 (see 8.3.27 and 8.3.28).

5.2.2.2 The *EV* shall communicate its nominal voltage range by transmitting its minimum and maximum nominal voltage rounded as specified in ANSI C84.1. The *EV* may transmit a wider range, but whatever limits it transmits, it shall not be damaged by voltages 15% outside this transmitted range (see 8.3.7, 8.3.8, 8.3.10, and 8.3.11).

5.2.2.3 If the vehicle transmits its limits according to ANSI C84.1 nominal system voltage, it shall operate normally to ANSI C84.1 utilization voltage range B or wider.

NOTE: The common Canadian four-wire three-phase 600 VAC configuration is omitted from ANSI C84.1 and should be represented as 600.0Y/347.0. Refer to IEC 60664-1, Annex B tables under “Nominal voltages presently used in the world” for other nominal voltages outside of North America.

EXAMPLE 1: A vehicle intended to operate with North American *EVSE* supplying either 208Y/120 or 480Y/277 should transmit limits of 208.0/120.0 to 480.0/277.0 using *LIN-CP*.

EXAMPLE 2: A vehicle intended to operate with 208Y/120 (U.S.), 240/120 (U.S.), or 400Y/230 (E.U.) should transmit limits of 208.0/120.0 to 400.0/240.0 using *LIN-CP*.

EXAMPLE 3: A vehicle intended to operate with 200/100 (Japan), 400Y/230 (E.U.), 415Y/240 (Middle East) should transmit limits of 200.0/100.0 to 415.0/240.0 using *LIN-CP*.

5.3 EVSE Requirements

5.3.1 EVSE General Requirements

5.3.1.1 The installation of the *EVSE* shall be done in accordance with *local electrical codes*.

5.3.1.2 The *EVSE* shall meet and be listed to the general product requirements specified in the *Tri-National AC EVSE Standard*.

5.3.1.3 The *EVSE* shall incorporate a personnel protection system as specified in the *Tri-National EVSE Safety Standards*.

The *EVSE* implements *proximity detection* as required in Section 7.

5.3.1.4 An *SE* of type SAE J3068 AC_6 *LIN/PWM* (see Table 1) shall first attempt *LIN-CP* after plug-in. If *LIN* communication fails, then the *SE* may start *PWM-CP*. See 9.5.4.

Only symmetric three-phase supplies are supported in this edition of SAE J3068. Future editions of SAE J3068 may support asymmetric three-phase topologies (such as high-leg *delta* or corner-*grounded delta*), but this edition does not. See 8.3.27.3.

5.3.1.5 *Neutral* shall be provided with the following exceptions:

EXCEPTION 1: This requirement does not apply for application-specific *EVSE* installations designed to serve a limited set of vehicles which are not intended for use by the general public. Therefore, under this exception, contact number 4 is not wired to provide *neutral*. It is strongly recommended that new electrical installations include *neutral* to support single-phase charging or any *on-board charger* requiring *neutral*. This exception is intended to provide a way for *EVSE* to make use of existing 480 VAC three-wire *delta* power feeds for exclusive non-public applications.

EXCEPTION 2: *EVSE* when providing two-wire single-phase power transfer (e.g. 208 VAC, 240 VAC split-phase or single-phase) can wire contact 4 to a *line conductor* and would therefore not provide *neutral*. This reconfiguration could be dynamic; see 4.2, 9.6.2.1, and B.1.4.1.7.

5.3.1.6 If present, *neutral* shall be wired through the *EVSE* to *connector* or *socket-outlet* contact number 4. See Figure 7 and Table 4.

5.3.1.7 At least contact number 1 shall be wired to a *line conductor*. See Figure 7 and Table 4.

5.3.1.8 *EVSE* providing three-phase power transfer shall be wired in time sequence for clockwise rotation and the *EVSE* is permitted to check for proper phasing as part of its startup self-check.

NOTE: For installations with multiple *EVSE*, which allow single-phase charging from three-phase supplies, the mapping of premises wiring should be varied to limit phase imbalance while maintaining clockwise rotation.

EXAMPLE: In an installation with several *EVSE* with phase contact numbers 1, 2, and 3, and premises phases A, B, and C, the first *EVSE* would be wired as 1-A, 2-B, 3-C; the second *EVSE* as 1-B, 2-C, 3-A; and the third *EVSE* as 1-C, 2-A, 3-B, etc.

5.3.2 Operation Limits Defined in IEC 61851/IEC 62196 versus SAE J3068

SAE J3068 is designed to interoperate with type 2 *coupler* systems defined in IEC 61851-1 and IEC 62196-2 which indicate support for system voltages up to 480 VAC and currents up to 63 A three-phase or 70 A single-phase. To support systems beyond the aforementioned voltage and/or current limits, certain constraints are imposed on *EVSE*.

5.3.2.1 *EVSE* designed to provide more than 63 A three-phase and/or more than 70 A single-phase shall be *case C* and be tested and listed as a complete assembly to the *Tri-National AC EVSE Standard.*

NOTE: Future versions of this document may fully define *cable assembly* nodes (outlined in 6.2.4), which can provide arbitrary voltage and current coding for *case B*.

5.3.2.2 *EVSE* shall not use *PWM-CP* controls when nominal system voltages exceed 480Y/277 VAC (single-phase 277 VAC). *LIN-CP* shall be used when these voltage limits are exceeded (e.g. 600Y/347 VAC).

NOTE 1: IEC 62196-2 states compatibility with 480 VAC three-phase, but this is in conjunction with a single-phase voltage rating of 250 VAC. As this is mathematically incongruent (480 divided by the square root of 3 is 277, but 250 multiplied by the square root of 3 is approximately 433), the higher rating is taken for North American application.

NOTE 2: *EVSE* which are designed for use outside of North America may round-down the incongruent three-phase and single-phase ratings in the IEC, and may limit *PWM-CP* to systems not exceeding a 440Y/250 VAC rating.

NOTE 3: Under IEC 60664-1, three-phase supplies at 480Y/277, 230Y/400, 240 high-leg *delta* correspond to the same impulse over-voltage requirements and other requirements for insulation, creepage, and clearance because they all exceed 150 VAC phase-to-*ground* but are less than 300 VAC phase-to-*ground*.

PWM-CP (only) *SE* are not recommended for new designs.

5.4 EV Requirements

These requirements apply to vehicles with SAE J3068 *inlets.*

5.4.1 EV Cable Ampacity Coordination

Vehicle cabling and wiring should be protected against overcurrent and limit their short-circuit rating. Example protection methods include proper wire sizing and/or provision of circuit protection, such as fuses. The maximum rating for the three-phase AC energy transfer (with advanced contacts) is 160 A using a 200 A circuit breaker. The design of the *electric vehicle* wiring from the *connector* to the *charger* needs to consider the full range of *EVSE* output.

5.4.2 EV General Requirements

5.4.2.1 The *on-board EV* charging system electronic components shall meet the requirements specified in SAE J1211.

5.4.2.2 If the *EV* is designed to draw current only from a single-phase, it shall be capable of drawing current between SAE J3068 AC_6 contact numbers 1 and 4 (see Figure 7 and Table 4).

The *EV* implements the *proximity detection* as required in Section 7.

5.4.2.3 The *EV* shall not support *PWM-CP* unless it is designed to indefinitely withstand 277 VAC nominal if single-phase and 480Y/277 VAC if three-phase.

5.4.3 Inlet Locking

To protect personnel safety and to prevent premature wear of electrical contacts in the *coupler*, the *inlet* is *locked* whenever voltage is supplied. See 9.7.2.1 and 10.8.5.1.

The *locking mechanism* includes the ability to electronically monitor the state of the *mechanism*. See 5.5.2.8. An electronically controlled *locking mechanism* is typical, but a manually actuated *mechanism* may be preferred in some applications.

There are many factors to consider when choosing a *locking* scheme. These include: the probability of *locking* success, sharing *EVSE* between vehicles, the use of energy management systems, user convenience, implementation complexity, and the connection case (i.e., *case B* or *case C*). As many of these factors are not under the control of the *EV* manufacturer, operator configurability may be appropriate.

Locking success is most probable when the *locking mechanism* is mounted in one of the side positions (note the left-mounted servo motor in the top right photo in Figure 7) and *locking* occurs while the operator is holding the *connector*. Otherwise, the weight of the cable or other external factors can cause the locking pin to be misaligned with the hole (especially when the servo is mounted in the top position). Therefore, *locking* quickly upon insertion is recommended as SAE J3068 is designed to allow charging to commence as quickly as possible. *Locking* upon successful completion of *Initialization* (typically around 250 ms; see 9.6.2) ensures *locking* will occur while the *connector* is being held without having to *unlock* if the vehicle and *EVSE* are incompatible.

In a situation where *EVSE* are shared, and the *EVSE* are configured for *case C*, it is preferable for *inlets* to be *unlocked* when charging is complete so a *connector* may be moved from the *inlet* of a full vehicle to another vehicle without the operator of the full vehicle being present. However, *unlocking* when not charging may be problematic when energy management systems are in use as *re-locking* may fail when power again becomes available. In situations where *case B* charging is a possibility, an *EV's inlet lock*ing mechanism is controlled by the operator to prevent theft of the *EV cable assembly*.

Use of an auxiliary *locking mechanism* in one of the other mounting positions responsible for ensuring success of the primary *mechanism* and tamper prevention simplifies these considerations significantly. A manually actuated *locking mechanism* confers similar advantages.

5.5 Couplers, Socket-Outlets, and Plugs

5.5.1 General Requirements

5.5.1.1 *Couplers* (which encompass *connectors* and *inlets*), *socket-outlets*, and *plugs* shall fulfill the requirements defined in the *Tri-National Coupler Standard*.

5.5.1.2 Equipment and components utilizing *sockets-outlets* and/or *plugs* shall meet the applicable requirements in Appendix B.

Couplers, socket-outlets, and *plugs* manufactured according to this recommended practice may be marked on its outer surface in Arial font: "SAE J3068." Any party providing such identification warrants that the *socket-outlets*, *plugs*, *connector*, and/or vehicle *inlet* complies with all mandatory requirements of this recommended practice and agrees to indemnify and hold SAE harmless from any and all liability arising out of any failure to comply and any resulting injury or damage arising from such failure.

5.5.2 Coupler Requirements

5.5.2.1 SAE J3068 AC_6 *connectors* shall have a mechanical design according to IEC 62196-2:2022, Sheet 2-IIe, Sheet 1 and Sheet 2.

5.5.2.2 SAE J3068 AC_6 *inlets* shall have a mechanical design according to IEC 62196-2:2022, Sheet 2-IIf, Sheet 1 and Sheet 2.

5.5.2.3 SAE J3068 DC_8 No AC and SAE J3068 DC_8/AC_6 *couplers* shall have a mechanical design according to IEC 62196-3:2014 Standard Sheets 3-IVa Sheet 1 through Sheet 5, and Standard Sheets 3-IVc Sheet 1 through Sheet 5.

5.5.2.4 All SAE J3068 *couplers* shall comply with requirements 26.7 (insulating end caps pull test) from IEC 62196-1:2020.

5.5.2.5 *Couplers* shall have contact functionality according to IEC 62196-2 and IEC 62196-3; see Table 4 for a summary.

5.5.2.6 SAE J3068 AC_6 *inlets* shall provide packaging room for the *connector* according to IEC 62196-2:2022, Sheet 2-IIh.

5.5.2.7 SAE J3068 DC_8/AC_6 or SAE J3068 DC_8 No AC *inlets* shall provide packaging room according to IEC 62196-3:2014 Standard Sheets 3-IVd Sheet 1.

IEC 62196-2 specifies maximum rated current at 63 A three-phase and 70 A single-phase for type 2 (mechanically equivalent to SAE J3068 AC_6) *couplers*. SAE J3068 AC_6 supports higher AC rated current, and higher AC voltages. See 5.3.2.

Couplers may be commonly rated with a *line*-to-*line* nominal voltage of 480 VAC, 600 VAC, or 1000 VDC in North America.

5.5.2.8 *Inlets* shall be equipped with a *locking mechanism* that includes a monitoring function indicating whether it is *locked* or *unlocked*.

5.5.2.9 SAE J3068 *connectors* shall apply current coding via the *proximity* circuit, as defined in 7.2. *Connectors* rated >63 A three-phase or >70 A single-phase shall signal current limit via the digital *data link* and the *proximity* resistor shall be coded for 63 A three-phase (70 A single-phase). See 5.3.2.1.

5.5.2.10 Temperature monitoring shall be used in *inlets* at current levels >63 A for three-phase or >70 A for single-phase.

Temperature monitoring for *inlets* is recommended at current levels >32 A and allowed at any current level.

Temperature monitoring is recommended for *case C connectors* (or *case A plugs)* at current levels >32 A and allowed at any current level.

NOTE: Thermal cutouts could fulfill temperature monitoring requirements; however, this limits derating and may increase operational risk while charging.

Figures 7 and 8 show the contact placement for different *connector* and *inlet* types.

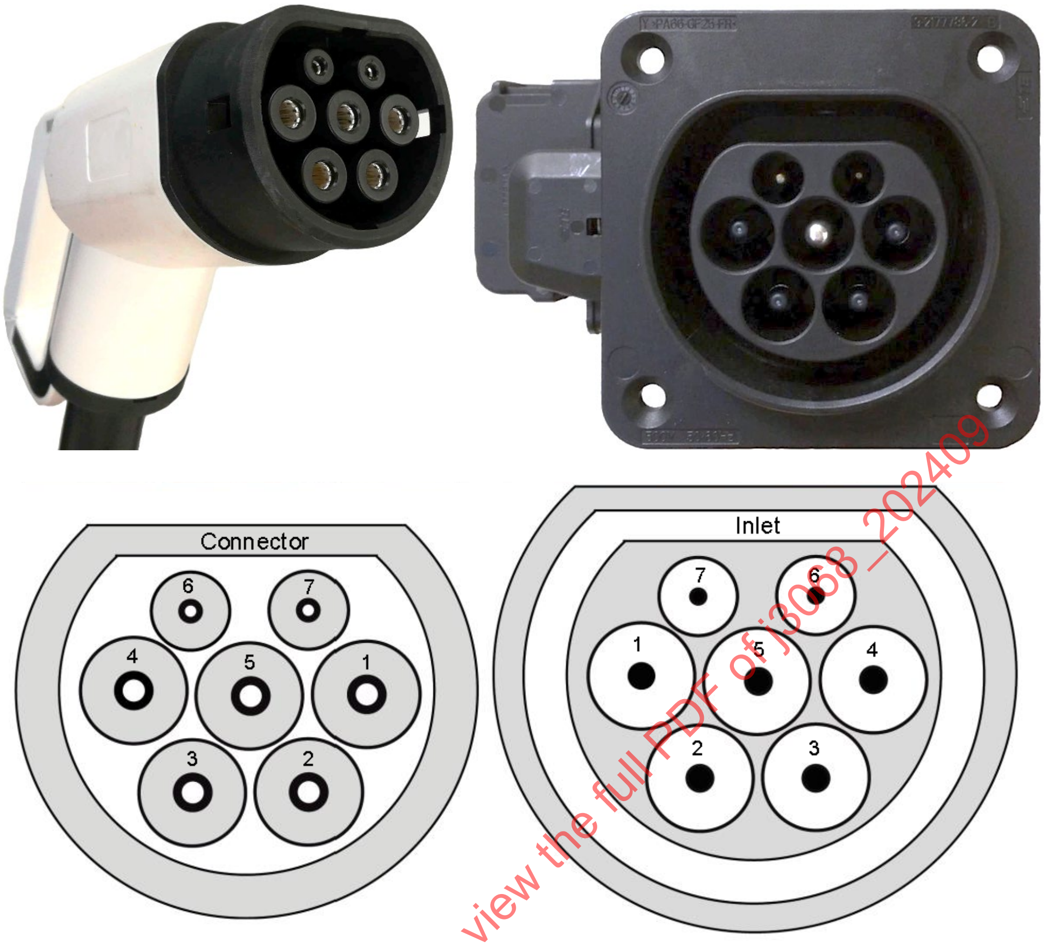

Figure 7 - Typical SAE J3068 AC$_6$ connector and inlet photos (contact placement as seen by user)

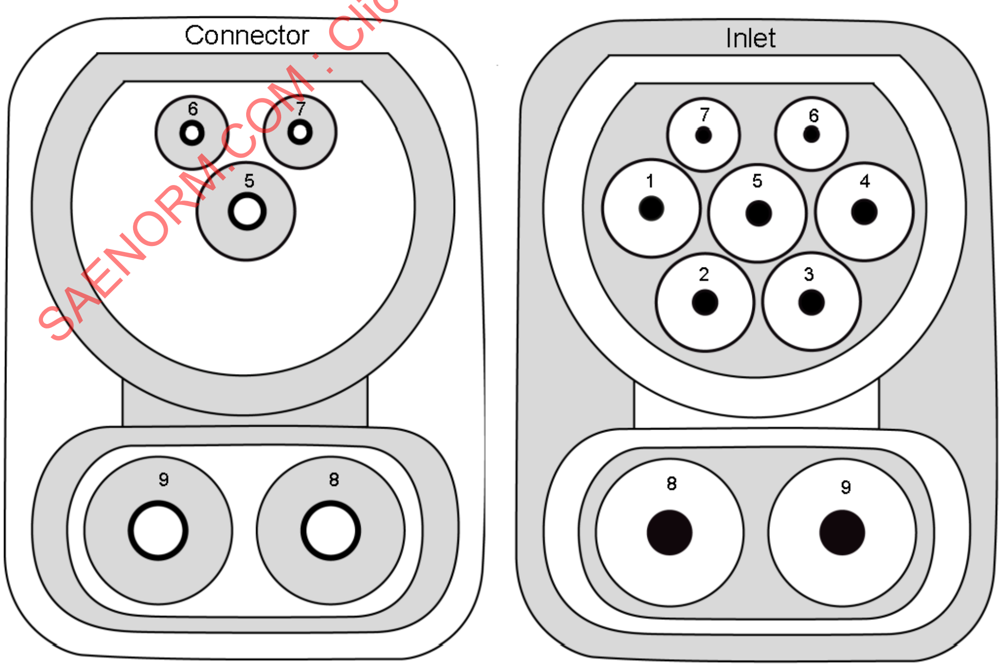

Figure 8 - SAE J3068 DC$_8$ no AC connector and SAE J3068 DC$_8$/AC$_6$ inlet (contact placement as seen by user)

Table 4 - Coupler contact functions

Contact Number	Contact Pin Diameter (millimeters)	Nominal Contact Function	Description
1	6	L1 AC	Power phase *line* 1 (see 5.3.1.7)
2	6	L2 AC	Power phase *line* 2
3	6	L3 AC	Power phase *line* 3
4	6	*Neutral*	*Neutral* (may be a *line conductor* for single-phase charging; see 5.3.1.5)
5	6	*Equipment Ground*	Connects *SE equipment grounding conductor* to *EV chassis ground* during charging
6	3	*Control Pilot*	Primary control *conductor* (function described in Section 6)
7	3	*Proximity* Pin	Allows *EV* to detect presence of *connector* (function described in Section 7)
8	8	DC negative	DC power transfer (see 5.6.2)
9	8	DC positive	DC power transfer (see 5.6.2)

5.5.2.11 The *couplers* described in IEC 62196-2:2022, Sheets 2-IIc and 2-IId (illustrated in Figure 9) shall not be used in North America.

These *couplers* are also forbidden in many other regions. They are used in regions that allow charging without an *EVSE*. Refer to the "EV charging modes" section of IEC 61851-1.

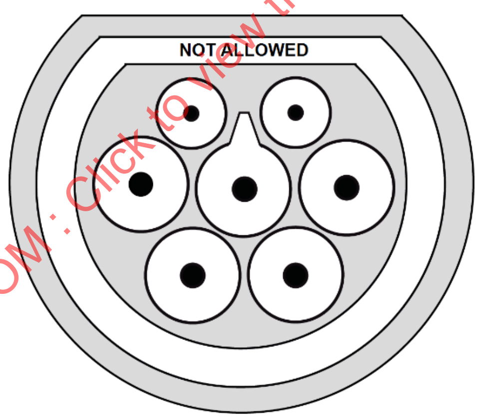

Figure 9 - AC$_6$ keyed couplers, NOT ALLOWED

5.6 Communication Requirements

5.6.1 LIN-CP Communication

LIN-CP communication is used between the *SE* and the *EV* if nominal system voltage is greater than 480Y/277 VAC. See 5.3.2.2.

LIN-CP is recommended for new designs; *PWM-CP* (only) is not recommended for new designs.

LIN-CP communication is used to verify the power compatibility between the *SE* and the *EV* before the *SE* supplies voltage to the *EV*. See 9.6.2.3 and 9.6.3.1.

SE uses *LIN-CP signals* to indicate to the *EV* that it is able or not able to supply voltage. See 9.7.2.

SE uses *LIN-CP signals* to indicate to the *EV* the maximum available current. See 9.7.3.1.

The *EV* draws no more than the indicated maximum available current. See 9.7.3.3.

If *LIN-CP signals* are interrupted, the *SE* stops supplying voltage. See 10.7.1.1.

See 6.2 and Sections 8, 9, and 10 for implementation requirements.

SE determines whether the *connector* is inserted into the *EV inlet* and properly connected to the *EV*. See 9.4.1.1.

The *SE equipment ground's* connection to the *EV chassis ground* is monitored during charging. If a disconnection is detected, the *SE* stops supplying voltage. See 10.8.4.1.

SE detects disconnection from the *EV*. If a disconnection is detected, the *SE* stops supplying voltage. See 10.8.4.1.

The *EV* indicates to the *SE* if it allows the *SE* to supply voltage or if it requests the *SE* to stop supplying voltage. See 9.7.2.

See 6.2 and 9.7.2 for implementation requirements. See 8.3.16.1 and Figure 15.

5.6.2 DC Charging

5.6.2.1 For control of DC charging with the SAE J3068 DC_8 *coupler*, the system shall meet the requirements of SAE J3400 for DC power transfer except:

- Identify as an SAE J3068 DC_8 (*CCS2*) system via digital communication
- Implement *EV proximity detection* as required by Section 7, which harmonizes with SAE J3400, including required *EVSE proximity* monitoring and thermal warning/shutdown

Vehicles with SAE J3068 *inlets* use +5 VDC for the *proximity* supply, and require the *inlet* be fitted with a 2.7k Ω R_5 resistor. Additionally, as required by 7.2.1.6, SAE J3068 DC_8 *EVs* allow DC power transfer using both the IEC 62196-3 type 2 DC *proximity* coding resistor (1500 Ω) and the SAE J3400 DC *proximity* coding resistor (150 Ω). This permits interoperability with stations which are required to monitor *proximity*, including SAE J3400 and SAE J1772.

Accessories that adapt SAE J3068 DC_8 *connectors* (*CCS2*) to SAE J1772 or SAE J3400 *inlets* include a parallel *proximity* resistor R_D (refer to the SAE J3400 series) to adapt 1500 Ω to the typical SAE J3400 R_6 of 150 Ω (R_D = 166.6 Ω or similar).

An *EV* that can charge using both DC and AC may also implement *LIN-CP*.

5.6.3 Proximity Function

The *coupler* system provides a means to detect the presence of the *connector* in the *EV inlet*. Detection of the *connector* occurs at a depth of insertion at which damage to the *coupler*, *EV*, or *EVSE* is possible if the *EV* were to be intentionally moved. See 5.5.2.1 and 5.5.2.2. The *EV* is immobilized even if that *connector* is not connected to the service equipment. The *EV* detects this connection via the *proximity* pin resistor in the *connector*. See 9.4.1.1.

The *connector* and *plug* system also provide *proximity* coding using resistors to help determine the ampacity of the cable attached. See *proximity detection* (Section 7) for implementation requirements for SAE J3068 *couplers*, and Appendix B for *socket-outlet* and *plug proximity detection* requirements.

6. CONTROL PILOT

6.1 General

The *control pilot* circuit is the primary control means to ensure proper functioning when connecting an *EV* to the *SE*. This section describes the *control pilot* circuit hardware and how it is used to enable signaling between the *EV* and the *SE*. It also describes the transceivers used for *LIN* communication.

The *control pilot* circuit in SAE J3068 is related to the *control pilot* circuit defined in the “Control Pilot” section of SAE J1772. This may facilitate designing an *SE* or an *EV* that is interoperable with both *LIN-CP* and *PWM-CP*.

The added transceivers enable bidirectional baseband *LIN* communication with a bit rate of 19.2 *kbps*. At this bit rate, 1-bit duration is approximately 50 µs, which is the same as the pulse width for a 5% *PWM*.

LIN transceivers as defined in ISO 17987-4 are well-suited for this application because they are designed for communication over a single wire and *ground*, and for a bus topology with a 1 kΩ resistor as a pull-up resistor to +12 V. Most *LIN* transceivers contain an internal 30 kΩ pull-up resistor that can interfere with detection of SAE J1772 State F. See 6.2.3.

The transceiver contains a transmitter that sends logic zero bits by closing a switch to *ground* to create a *control pilot* voltage close to *ground* level. This level is called the dominant level.

When the transmitter switch is not closed, the transmitter is passive and the *control pilot* voltage is positive, as a function of the remainder of *control pilot* circuit. This positive level represents logic-one bits and is called the recessive level.

The transceiver also contains a receiver that detects if received bits are logic-one or logic-zero.

A *data link* node typically consists of the *LIN* transceiver chip connected to a serial port (*UART*) of an *MCU*. The *MCU* has software that handles the *LIN* protocol and the *application program*.

Figure 10 shows a comparison between the *signals* sent on the *control pilot* when using *PWM-CP* as in SAE J1772, and *LIN-CP* as in SAE J3068.

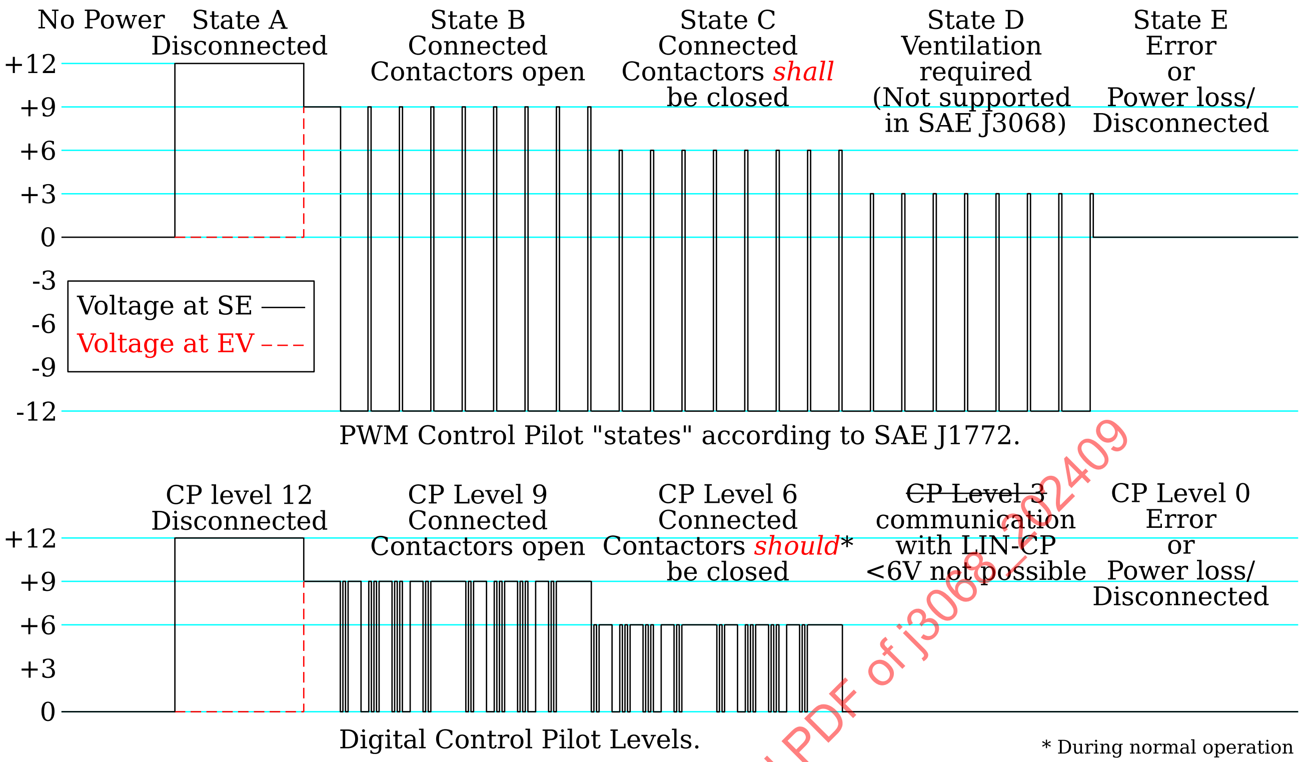

Figure 10 - Comparison of SAE J3068 CP levels to SAE J1772 states (not to scale)

6.2 Control Pilot Circuit

Figure 11 shows recommended *control pilot* circuit schematics that may meet the requirements of SAE J3068. These schematics are provided for illustration only, not intended to constrain designs.

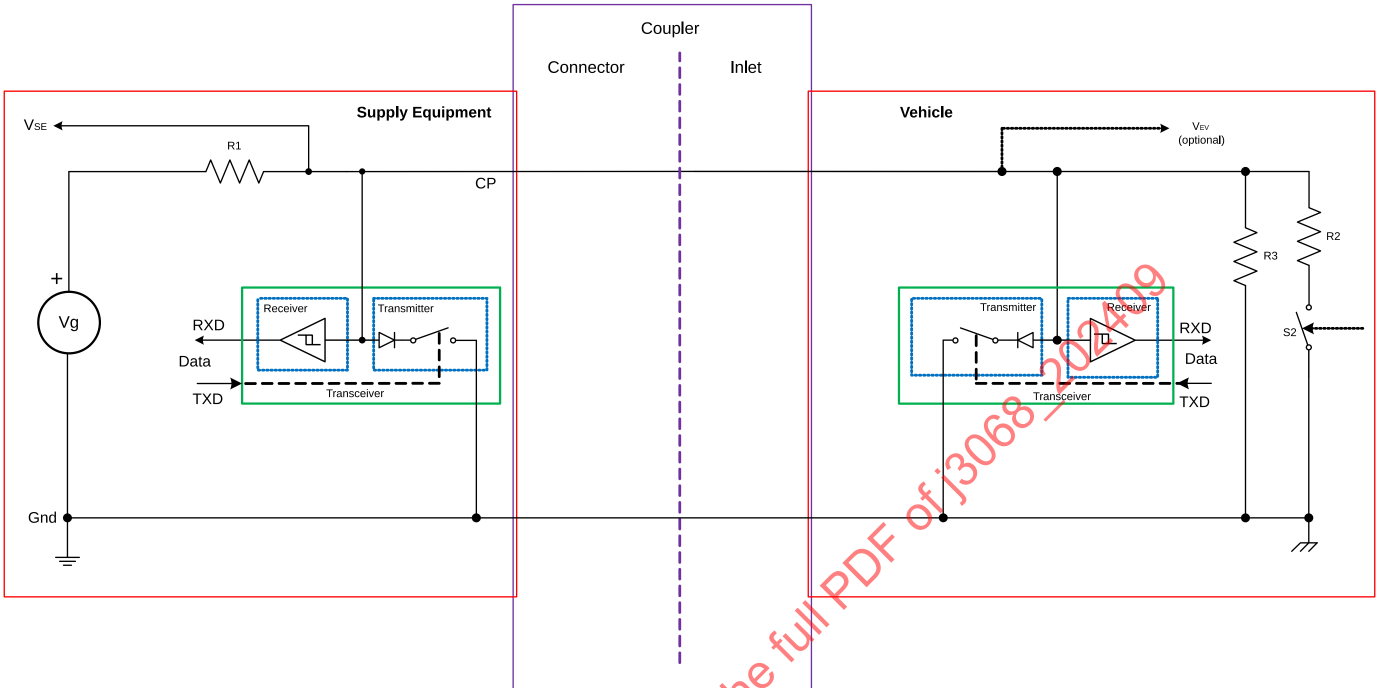

Figure 11A - Configuration without PWM-CP compatibility

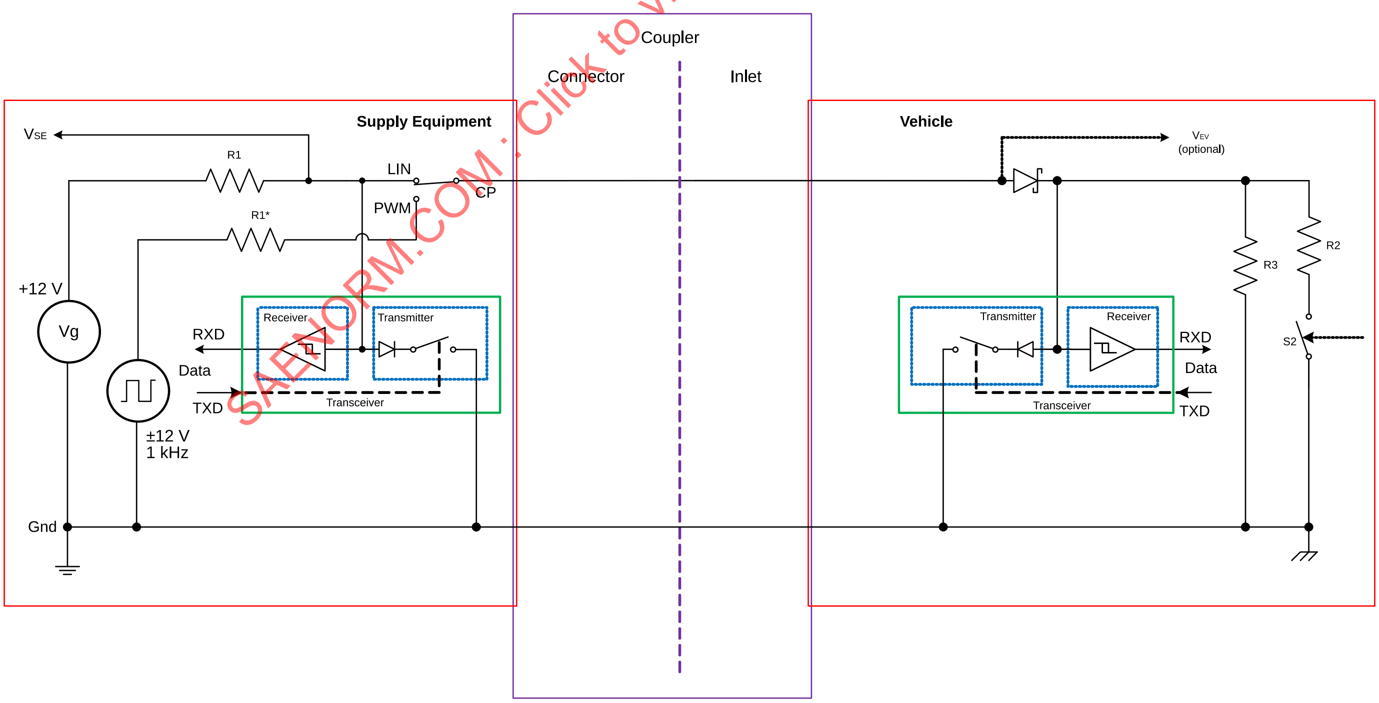

Figure 11B - Configuration with PWM-CP compatibility for SE and EV

Figure 11 - Suggested electrical equivalent circuit diagrams for connection of LIN nodes to the control pilot

6.2.1 Control Pilot Tables

Table 5 - SE control pilot circuit parameters

Parameter	Symbol	Units	Nominal Value	Max Value	Min Value
Voltage supply, open circuit	Vg	V	12.00	12.60	11.40
Output resistance	R_1	Ω	1000[2]	1030[1]	970[1]
Capacitance between *CP* and *ground*, without cable Not shown in Figure 11	Not shown	Pico farads	Not applicable	Not applicable	300
Capacitance between *CP* and *ground*, with cable Not shown in Figure 11	Not shown	Pico farads	Not applicable	3100	Not applicable

(1) Maximum and minimum resistor values are ±3% of nominal. Tolerances to be maintained over the environmental conditions and useful life as specified by the manufacturer.
(2) It may be appropriate to reduce the value of R_1 by the resistance of the *PWM* switch.

6.2.1.1 The *SE* implementation shall provide a *control pilot* source impedance equivalent to that listed in Table 5.

Table 6 - EV control pilot circuit parameters

Parameter	Symbol	Units	Nominal Value	Max Value	Min Value
Resistor always connected[1]	R_3	Ω	3000	3090[2]	2910[2]
Resistor, connected when S_2 is closed	R_2	Ω	1400/1500[4]	1442/1545[2] [4]	1358/1445[2] [4]
Capacitances between *CP* and *ground* Not shown in Figure 11	C2	Pico farads	Not applicable	2400	Not applicable
Diode forward voltage drop[3]	Vd	V	0.15/Not applicable[4]	0.50/Not applicable[4]	0.00/Not applicable[4]

(1) This resistor may be connected via a switch if the ability to simulate a disconnect is desired.
(2) Maximum and minimum resistor values are ±3% of nominal. Tolerances to be maintained over the environmental conditions and useful life as specified by the manufacturer.
(3) Schottky small-signal diode, -40 to 85 °C, forward current ≥15 mA, reverse leakage ≤100 μA.
(4) The first value given is for an *EV* that does support *PWM* signaling, and the second is for one that does not.

6.2.1.2 The *EV* implementation shall provide *control pilot* load impedances equivalent to those listed in Table 6.

Table 7 - Transceiver parameters (SE and EV)

Parameter	Symbol	Units	Nominal Value[4]	Max Value	Min Value
Transceiver supply voltage[1]	Vsup	V	6.5	7.0	6.0
Output level when transmitting logic zero bits[2] [3]		V		1.0	0

(1) ISO 17987-4 specifies minimum supply voltage 7.0 V. The lower supply voltage, required here, improves noise margins when communicating at *CP level* 6. Transceivers with a minimum supply voltage of 5.5 V or lower, are available. See example list below.
(2) ISO 17987-4 does not clearly specify this parameter. Selecting a transceiver with low dominant bus level and use of Schottky diode improves noise margins.
(3) See Table 8 lines 2 and 3 for the recessive levels for *LIN* communication.
(4) ISO 17987-4 specifies the receiver input threshold voltages relative to the transceiver supply voltage. An input voltage >60% of the supply voltage will be detected as logic one level and an input voltage <40% of the supply voltage will be detected as logic zero level.

6.2.1.3 The *LIN-CP* transceivers shall comply with the parameters listed in Table 7.

6.2.1.4 The *LIN* transceiver shall comply with the requirements for 12 V *LIN* systems in the “Line driver/receiver” section of ISO 17987-4.

6.2.1.5 The transceiver shall implement pulse-forming (slope control) on both rising and falling waveform edges.

Examples of *LIN* transceiver types which have been tested to meet these requirements: MCP2003B, MLX80020, BD41030FJ, SIT1021T, SN65HVDA100, TJA1021T/20, TLE7257, TLIN1021, ATA663211, ATA6664, NCV7329. Related types with additional features are available but have not been tested. Parts including bus dominant clamping fault management such as MAX13021 are not recommended. Parts supporting low slope mode such as MAX13020 and TJA1020 should be used with care.

6.2.2 Comparison with the Standard ISO 17987-4 LIN Bus Circuit

While a supply voltage of 6.5 V ± 0.5 V is below the limits given in ISO 17987-4, it has been shown that off-the-shelf automotive-grade *LIN* transceivers are available that support this supply voltage and also support communication with a recessive voltage that is higher than the supply voltage (see Table 8 lines 2 and 3 for recessive levels at the *SE*, *CP levels* 9 and 6).

As shown in Figure 11, R_1 need not have a diode in series. This is in contrast to ISO 17987-4 where “$R_{commander}$” is required to have diode $D_{ser\_commander}$ in series. Note that dedicated *LIN* applications differ from SAE J3068 where R_1 is also critical to *PWM* operation. In *PWM* mode, a diode in series with R_1 could block the negative 12 V portion of the *PWM* waveform. Also note that R_1 is supplied by Vg (12 V nominal) while the *LIN* transceiver itself is supplied by regulated 6.5 V in SAE J3068. Contrast this to dedicated *LIN* applications defined by ISO 17987-4 where the pull-up resistors and transceiver are supplied by the same voltage. Another difference is that while conventional *LIN* uses simple pull-up resistors to the positive supply voltage, SAE J3068 uses a voltage divider formed by R_1 in the *SE* and R_2 parallel with R_3 in the *EV*.

NOTE: If the series diode is included, the impedance of R_1 will need to be adjusted accordingly.

6.2.3 Requirements for PWM-CP (Optional)

If *PWM-CP* is implemented, the following additional requirements in this clause apply:

6.2.3.1 During *PWM-CP* operation, the *SE* shall not signal available current higher than the current rating of the lowest rated *conductor* including *neutral*.

NOTE: *LIN-CP* has an ampacity *signal* for each *conductor*, which allows, for example, the use of a *case C* connection with an undersized *neutral* to be used. See 8.3.21.

6.2.3.2 If *PWM-CP* is supported, the internal nominal 30 kΩ pull-up resistances in the *LIN* transceivers shall not interfere with the detection of “State F” when in *PWM* mode.

NOTE: The differences between the *EV control pilot* circuitry recommended in this section (as of SAE J3068 Edition 2) and that which is referenced in SAE J1772 are in service of this requirement.

6.2.3.3 In *PWM-CP* mode, the *EV* and *SE* shall fulfill all requirements in the “General Conductive Charging - Control Pilot” section of SAE J1772 not superseded by requirements in SAE J3068.

An *EVSE* using *PWM-CP* for AC charging supplies nominal 480Y/277 VAC or less; *LIN-CP* is used at higher AC voltages. See 5.3.2. For additional requirements on devices supporting *PWM-CP*, see 5.3.1.4 and 5.4.2.3.

6.2.4 Optional Cable Assembly Node

It is intended that a third node may be present to provide *signals* relating to its configuration and capabilities to enable *case B* and/or separate certification of *EVSE* and *connector* when voltages exceed 480Y/277 VAC, and/or currents exceed 63 A three-phase/70 A single-phase (see 5.3.2). This could also enable smart *coupler* adapters. These nodes are not fully defined in this edition of SAE J3068.

6.3 CP Level Signaling

6.3.1 CP Level Definition

The *control pilot* circuit, shown in Figure 11, enables the *EV* to control the voltage level on the *CP conductor* with respect to the *ground conductor*. The voltage levels indicate if the *EV* is connected or disconnected and if the *EV* S_2 switch is open or closed. Table 8 gives a list of the voltage ranges and defines the corresponding *CP levels* referred to in this document. Only normal behavior is shown. Other voltage levels may be caused by abnormal *control pilot* conditions.

When no *LIN signals* (or no *PWM signals*) are sent, the *control pilot* voltage is a constant DC level. When *LIN signals* (or *PWM signals*) are sent, the listed voltages are the positive levels.

Table 8 - Definition of CP levels

Line	CP Level	Normal SE Interpretation of the CP Level	Normal EV Interpretation of the CP Level	Control Pilot Voltage with Maximum and Minimum Supply and Component Values (V)	Remark
1	*CP level* 12	*EV* not connected	Not applicable	11.4 to 12.6 at *SE*	State A in SAE J1772
2	*CP level* 9	*EV* connected and S_2 open	*EV* connected	8.30 to 9.59 at *SE* and *EV*	State B in SAE J1772
3	*CP level* 6	*EV* connected and S_2 closed		5.47 to 6.53 at *SE* and EV	State C in SAE J1772
4	*CP level* 0	Short circuit in the *CP* circuit	*EV* not connected	0 to 3.25 at *SE* and *EV*	State D and E in SAE J1772

Note: Table values based on calculations in SAE J1772 "Control pilot state voltage range reference from mated charge coupler interface table" for *PWM-CP* compatibility. Voltages with maximum and minimum supply and component values are calculated assuming ±3% resistors in the *SE* and *EV* circuitry and ±5% Vg tolerance. The calculated values do not take into account variances such as *ground* shift, chassis resistance, active accessories (air conditioning, rear defog, etc.), or other factors that may shift these values. These values do not include *SE* cable or *EV inlet* to *EV* charge controller cable resistance. *EV* manufacturers should minimize these factors in their *EV* design.

6.3.2 CP Level Detection by the EV

6.3.2.1 The *EV* shall detect if the *CP level* is = 0 or ≠ 0 to enable control functions specified in the *application program*; see Sections 9 and 10.

Detecting *CP level* ≠ 0 by the *EV* indicates that the *control pilot* circuit is connected and that *LIN* communication is possible. The *EV* may detect other specific *CP levels* for proprietary purposes.

CP level = 0 may be detected in the following circumstances:

- When the *EV* is disconnected from the *SE*
- When the *ground conductor* is interrupted
- When the *CP conductor* is interrupted
- When the *SE* has a power outage
- When there is a short circuit between the *ground conductor* and the *CP conductor*

The *EV* is immune to temporary *CP level* glitches to ensure reliable operation. See 9.7.2.7.

6.3.3 CP Level Detection by the SE

6.3.3.1 The *SE* shall measure the *control pilot* voltage between the *CP conductor* and the *ground conductor* and determine if the measured voltage represents *CP level* 12, 9, 6, or 0. See Table 9.

CP levels 12, 9, 6, and 0 are referred to as internal control signals in the *SE* when specifying the system behavior in Sections 9 and 10.

SE is immune to temporary *CP level* glitches to ensure reliable operation. See 9.7.2.6.

SE may use the Vg voltage as reference for the measurement to cancel the tolerance as shown in Table 9. Alternatively, Vg may be regulated more tightly such as to make compensation unnecessary.

Detection of a *CP level* change should be based on several factors including timing requirements and noise immunity.

Table 9 - Recommended CP level detection by the SE

Line	Measured Control Pilot Voltage Range Relative to Vg (V)	Determined CP Level	Interpretation by SE
1	> Vg/12 * 10.5	*CP level* 12	Normal: *EV* disconnected Not normal: *ground conductor* interrupted, *CP conductor* interrupted, hardware fault in *SE* or *EV*
2	Vg/12 * 7.5 - Vg/12 * 10.5	*CP level* 9	Normal: *EV* connected, S_2 open
3	Vg/12 * 4.5 - Vg/12 * 7.5	*CP level* 6	Normal: *EV* connected, S_2 closed
4	< Vg/12 * 4.5	*CP level* 0	Not normal: hardware fault in *SE* or *EV* or short circuit between the *ground conductor* and the *CP conductor*

Note 1: Vg/12 is used here to make the limits relative to Vg.
Note 2: *CP level* 0 is a steady-state condition. Each *frame* will contain many dominant periods (zero voltage), which should not be interpreted as *CP level* 0.

NOTE 1: While the positive peak voltages for *CP levels* 12, 9, 6, and 0 coincide with SAE J1772 States A, B, C, and E, the negative peak nominal is zero volts for *LIN-CP* and not -12 V for *PWM-CP*.

NOTE 2: *LIN-CP* does not define a "*CP level* 3." This is because nominal +3 V positive peak of the *CP* waveform would be too low for *LIN* communication. Therefore, applications requiring ventilation are not supported by *LIN-CP*. An *EV* that requires ventilation during charging should use *PWM-CP* where appropriate.

7. PROXIMITY DETECTION

7.1 General

7.1.1 Proximity Detection

The *coupler* provides a means to detect insertion of the *connector* into the *EV inlet*. Detection of the *connector* occurs at a point where damage could occur to the *coupler*, *EV*, or *EVSE* if the *EV* were to be intentionally moved. See 5.6.3, 5.5.2.1, and 5.5.2.2.

7.1.2 Immobilization

When a *connector* is mated to an *EV*, that *EV* is immobilized even if there is no connection to the *EVSE*. See 7.2 and 9.4.1.1.

The *EV* detects this connection via the *proximity* pin resistor in the *connector*. This resistor is normally present even if the cable is damaged or severed.

7.1.2.1 If the *EVSE* is mobile, i.e., a truck or trailer, the mobile *EVSE* shall be immobilized when connected to an *EV*. In *case C* (see 3.6), when the *control pilot* leaves *CP level* 12, the mobile *EVSE* shall be immobilized.

7.1.2.2 Resistor R_5 in Figures 12 and 6 shall be placed in the *inlet* assembly to enable diagnostics unless another method of detecting removal of the *inlet* assembly is provided.

NOTE: If an *inlet* is disconnected from the internal *EV* controller, it becomes impossible to detect a mated *connector* in the *inlet*, and therefore, immobilization cannot be guaranteed. At a minimum in such a case, an *EV* should notify the driver that it cannot detect the connection state of the *inlet* and should be acknowledged before moving. Plug-in hybrids are required under 13 CCR § 1971.1 "comprehensive component monitoring" to diagnose such a condition and report it to a generic scan tool (refer to SAE J2012 codes P0D56 through P0D5A).

7.2 SAE J3068 Coupler Proximity Detection Circuit

7.2.1 SAE J3068 Coupler Proximity Detection Circuit General Requirements

The following requirements apply to systems with SAE J3068 *couplers* (SAE J3068 *EV* and *EVSE* with *case C connectors*). See Appendix B for the *socket-outlet* configuration.

7.2.1.1 An SAE J3068 *inlet EV* shall use the *proximity detection* circuit shown in Figure 12.

7.2.1.2 An SAE J3068 *case C EVSE* shall use the *proximity detection* circuit shown in Figure 12.

This circuit is similar to the *proximity detection* circuit found in SAE J1772 and SAE J3400. To fulfill the requirements in IEC 62196-2 and in Annex B of IEC 61851-1 on a *proximity detection* circuit for type 2 *couplers*, the circuit simultaneously indicates *proximity* status and cable current capability to the *EV*.

7.2.1.3 The *proximity detection* circuit shall present impedances equivalent to those listed in Table 10.

7.2.1.4 The *proximity detection* circuit and components shall be designed to tolerate 12 V indefinitely.

7.2.1.5 *EV* supply voltage to R_4 shall be 5.0 V ±5%.

The *EV* may use the R_4 supply voltage as reference for the measurement to cancel the tolerance from 7.2.1.5. Alternatively, the R_4 supply may be regulated more tightly (recommend 1%) such as to make compensation unnecessary.

NOTE: R_4 need not be powered at all times, typically just when charging, when cable ratings need to be checked, or when someone starts the vehicle and immobilization is checked.

7.2.1.6 The *EV* shall detect the voltage between the *proximity* pin and *equipment ground* as specified in Table 11.

The *EV* is immune to temporary *proximity detection* glitches to ensure reliable operation. See 9.7.2.8.

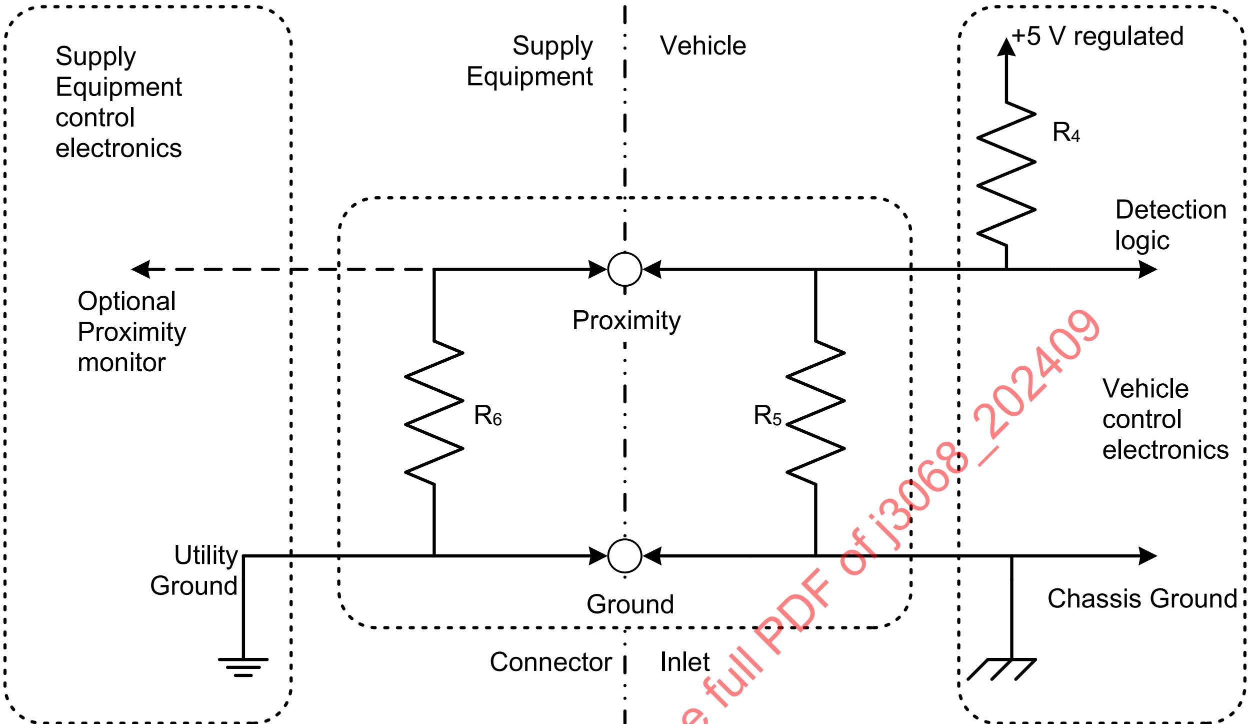

Figure 12 - Equivalent proximity circuit diagram for SAE J3068 coupler under case C

Table 10 - Component values for SAE J3068 connector

Cable Current Capability (each phase)	Resistor R_6	Resistor R_4	Resistor R_5
13 A (or SAE J3068 DC_8 *connector* inserted, DC charging)	1500 Ω ±3%		
20 A	680 Ω ±3%		
32 A Or higher if permitted by *LIN signals* (see 9.7.3.5)	220 Ω ±3%	330 Ω ±3%	2700 Ω ±3%
63 A three-phase, 70 A single-phase Or higher if permitted by *LIN signals* (see 9.7.3.5)	100 Ω ±3%		

Note 1: Resistors used should preferably fail in open circuit mode. Metal film resistors commonly show acceptable properties for this application.
Note 2: Tolerances to be maintained over the full useful life and under environmental conditions as specified by the manufacturer.

Table 11 - EV detection of proximity voltages for SAE J3068 inlet

Line #	Voltage Range (at 1% supply tolerance)	Proximity Circuit Status	Connected Resistors Inside the Connector
1	4.95-5.05 V	Error: *proximity* circuit internally interrupted in *EV*	
2	4.38-4.53 V	No *connector* inserted	
3	4.00-4.18 V Optional	Reserved for use in SAE J3068/2 for 12 VDC powered *cable assembly* nodes and/or adapters	R_6 = 3300 Ω
4	3.63-3.82 V	13 A (or SAE J3068 DC_8 *connector* inserted, DC charging)	R_6 = 1500 Ω
5	3.01-3.21 V	SAE J3068 AC_6 *connector* inserted, max cable current 20 A/phase	R_6 = 680 Ω
6	2.58-2.93 V	0 A SAE J1772 *connector* inserted – S_3 pressed SAE J3400 *connector* inserted – S_{3B} pressed	$R_6 + R_7$ = 150 Ω (± 10%) + 330 Ω (± 10%) = 480 Ω (± 10%)
7	1.82-2.00 V	SAE J3068 AC_6 *connector* inserted, max cable current 32 A/phase, or higher if permitted by *LIN signals* (see 9.7.3.4)	R_6 = 220 Ω
8	1.36-1.65 V	SAE J1772/SAE J3400 *connector* inserted AC or DC charging allowed	R_6 = 150 Ω (± 10%)
9	1.07-1.20 V	SAE J3068 AC_6 *connector* inserted, max cable current 63 A per phase (three-phase mode) or 70 A single-phase, or higher if permitted by *LIN signals* (see 9.7.3.4) Also, see DC thermal warning as described in SAE J3400	R_6 = 100 Ω
10	0.51-0.89 V Optional	Reserved for disconnection request button Also, see DC thermal shutdown as described in SAE J3400	R_8 = 68 Ω (switched in parallel with R_6)
11	0.00-0.50 V	Error: *proximity* circuit short circuited	

Note 1: In the case of line 1 or line 11, it is not possible to detect whether a *connector* is inserted, making it impossible to immobilize the *EV* as required in 9.4.1.1. This problem is mitigated by requirement 7.1.2.2.

Note 2: In the case of line 1, 2, 6, 10, and 11; during AC power transfer, the *EV* shall ramp-down to <1 A within 100 ms (faster recommended; see 9.7.2.8 for S_2 behavior). During DC power transfer, these shall be treated as an emergency shutdown as per SAE J3400.

Note 3: The voltage ranges in Table 11 do not take into account variances such as *ground* shift, chassis resistance, active accessories (air conditioning, rear defog, etc.), or other factors that may shift these values. These values do not include *EVSE* cable or vehicle *inlet*-to-vehicle charge controller cable resistance. *EVSE*/*EV* manufacturers should minimize these factors in their design. It is up to the manufacturer to widen the acceptable voltage range of their *proximity detection* interface.

Note 4: Detection of voltages outside of the ranges defined in Table 11 may be considered to fall into the nearest defined range, depending on the implementation.

8. DIGITAL COMMUNICATION PROTOCOL

8.1 General

The *LIN* protocol is a commander-responder protocol. The *SE* acts as the *LIN* commander and controls the *LIN* communication using *signals*, *frames*, and *schedules*. The *signals* are defined in 8.3. *Signal* packaging into *frames* is defined in 8.4. How the *frames* are used in *schedules* is defined in 8.5.

8.1.1 LIN General Requirements

8.1.1.1 The *SE* and the *EV* shall implement the *LIN* protocol according to ISO 17987-2 Section 5 and ISO 17987-3 Sections 1 through 5. Exceptions are detailed in this recommended practice.

Appendix D summarizes all *frames*, *signals*, and *schedules*.

Appendix E links to a reference implementation of SAE J3068 including an *LDF*.

8.2 LIN Protocol Introduction

A *signal* is the smallest data entity. *Signals* are identified by their defined bit positions within *frames*.

All *signals* have *start values*. See 8.4.1.3.

Signals should contain their *start values* as defined in 8.3 until a *valid value* is written by the *signal's publisher* or read by the *signal's subscriber*.

A *frame* contains a *header* and a *response*. The *header* contains a *frame* ID which identifies the *frame*. The *header* is sent by the commander node (*SE*). The *response* is sent by a responder node (*EV* or *cable assembly* node) or in the commander node (*SE*). The *response* contains *signals* packaged into 8 data bytes. It is sent by one *LIN* node, called the *publisher*, and received by one or more *LIN* nodes, called the *subscribers*.

Frame headers contain two parity bits. If a parity error is detected, no *response* is sent. *Frame responses* contain a checksum byte. If a checksum error is detected, receiving nodes disregard the data.

A *schedule* is a timed list which the commander node follows to trigger the *headers*. Responder nodes do not control *schedules*, but just respond (or listen) to *headers*.

Signal names, *frame* names, and *schedule* names are used in this document to facilitate the description. The names are not communicated over the *data link*.

8.3 LIN Signals

All *signal* names are shown in `monospace` font, and *signal* values are shown in *italic* font.

All *signal* names have a prefix indicating its *publisher*, as follows:

`Ca`: *Cable Assembly* (CA)
`Ev`: *Electric Vehicle* (*EV*)
`Se`: *Supply Equipment* (*SE*)

Start values are defined for all *signals*.

Start values are set internally in the *application program* (see 9.1) when *LIN* communication is started or *restarted* (see 9.4 and 10.1 through 10.7). *Start values* for *subscribed signals* are used until other values are received via the *LIN* bus.

Status *signals* (see 8.3.16, 8.3.16.1, 8.3.18, 8.3.30, 8.3.31, and 8.3.32) are included in every *schedule*. The value *Error* may rarely be set in status *signals* for several reasons. A summary of possible root causes is as follows:

a. Incompatible communication *Protocol Versions*, in which case it is appropriate to abort. This would be detected in *schedule Ver*. See 9.5.

b. Incompatible power (voltage too high, current too low, mismatched frequency), in which case it is appropriate to abort. This would be detected in *schedule Init*. See 9.6.

c. Internal fault, in which case it is appropriate to abort. See 10.8.

d. The *EV* or *SE* has determined that the other side is not performing as required. It may be appropriate to *restart* a limited number of times, or abort.

Future editions of SAE J3068 may add additional *signals* and *frames*.

NOTE: It is not recommended to interpret reserved *signals* or reserved bit positions within *signals*.

8.3.1 EvAwake

Signal	Bits	Values	Description	Schedule
`EvAwake`	1	0_2	*EV* requests to go to sleep	*Ver, Init, Op*
		1_2	*EV* does not request to go to sleep (*EV* and *SE start value*)	

8.3.1.1 The *EV* shall provide a value of 1_2 in `EvAwake` when it wants to stay awake.

The *EV* may clear this *signal* when it wishes to save power; see *LIN* sleep (10.1).

8.3.2 EvConnectionType

The *EV* may use this *signal* to specify its *inlet* type, or that the *EV* is *case A*. This information may be used to detect *coupler* adapters and may influence *inlet* and/or *socket-outlet locking*. Use of this *signal* is highly recommended.

Signal	Bits	Values	Description	Schedule
`EvConnectionType`	8	0_{10}	SAE J3068 AC_6 (IEC 62196-2) *case A plug* (no *inlet*)	*Init*
		1_{10}	SAE J1772 (IEC 62196-2 type 1) *inlet*	
		2_{10}	SAE J3068 AC_6 (IEC 62196-2 type 2) *inlet*	
		3_{10}	*CCS1 inlet*	
		4_{10}	*CCS2* (SAE J3068 DC_8/AC_6) *inlet*	
		5_{10}	SAE J3400 *inlet*	
		6_{10}	GB/T 20234.2 *inlet*	
		FE_{16}	*Error*	
		FF_{16}	*Not Available*/Not Specified (*SE start value*)	
		All Others	Reserved	

In conjunction with `SeConnectionType` (see 8.3.22), this *signal* may be used to detect potentially incompatible configurations and/or the presence of *coupler* adapters. This determination is manufacturer-specific.

8.3.2.1 If the *EV* determines it is incompatible with connected *SE* in a given configuration via `EvConnectionType` and `SeConnectionType` (see 8.3.22), it shall write "*EV* determines connection with *SE* is incompatible" [29_{16}] to an `EvInfoEntryX` (see 8.3.4).

8.3.2.2 If the *EV* uses a connection type not listed, it shall set `EvConnectionType` to *Not Available*.

NOTE 1: Presence or absence of AC contacts on *CCS couplers* is signaled via *LIN-CP*. See `EvMaxCurrentX` (see 8.3.6.3) and `SeMaxCurrentX` (see 8.3.26.2).

NOTE 2: Previous editions of this document did not define this *signal*; therefore, some implementations may transmit *Not Available.*

8.3.3 EvFrequencies

Signal	Bits	Values	Description	Schedule
`EvFrequencies`	8	00000001_2	The *EV* can operate at 50 Hz supply frequency	*Init*
		00000010_2	The *EV* can operate at 60 Hz supply frequency	
		00000100_2	The *EV* can operate at 400 Hz supply frequency	
		Any bitwise 'or' of the above	The descriptions of the values ored together are all true	
		FF_{16}	*Not Available* (*SE start value*)	
		All Others	Reserved	

8.3.3.1 The *EV* shall provide a *valid* `EvFrequencies` *value* to indicate its rated frequencies. The *EV* may be rated for one or more frequencies. See 9.6.2.3 and 9.6.3.1.

NOTE: To maintain future compatibility, it is recommended to only check defined bit positions.

8.3.4 EvInfoEntryX

`EvInfoEntryX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule

`EvInfoEntry1`
`EvInfoEntry2`
`EvInfoEntry3`
`EvInfoEntry4`
`EvInfoEntry5`
`EvInfoEntry6`
	8	00_{16} - FE_{16}	See Table 15	*Ver, Init, Op*

		FF_{16}	*Not Available* (*EV* and *SE start value*)	

`EvInfoEntry6` is set to *Not Available* on the last page, and only the last page. *Valid values* may be provided by the *EV* to communicate information about exceptional conditions or events detected by the *EV*; see 11.1. If more than five info codes are active, multiple pages are required. See 8.4.2.

8.3.5 EvInfoPageNumber

`EvInfoPageNumber` is an enumerator for *frames* that can provide several pages of *signals*. `EvInfoPageNumber` starts at page number zero (0_{10}) and is incremented each time the *frame* is sent. After the *frame* with the last page has been sent, `EvInfoPageNumber` rolls over and the next *frame* will contain the zeroth page. See 8.4.2.

Signal	Bits	Values	Description	Schedule
`EvInfoPageNumber`	8	0_{10} to 42_{10}	Page number	*Ver, Init, Op*
		FF_{16}	*Not Available* (*SE start value*)	

8.3.6 EvMaxCurrentX

`EvMaxCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule

`EvMaxCurrentL1`
`EvMaxCurrentL2`
`EvMaxCurrentL3`
`EvMaxCurrentN`
	8	00_{16}	*SE start value*	*Init*

		0_{10} to 250_{10}	Maximum load current, 1 A per bit (*EV start value* is application-specific)	
		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available*/Contact not provided (see 8.3.6.3)	

The *EV* uses these *signals* to indicate the maximum current it is designed to draw. The information given for each relevant contact of the *EV inlet*, e.g., *for* `EvMaxCurrentL1`, this is the contact number 1.

8.3.6.1 `EvMaxCurrentX` shall be provided by the *EV* to indicate its maximum rated current at each corresponding contact of the *EV inlet*.

8.3.6.2 If the *EV* is designed to draw only single-phase current between L1 and N, the *EV* shall set both `EvMaxCurrentL1` and `EvMaxCurrentN` to the same value, and the other values to *Not Available*.

8.3.6.3 If a contact is not wired, the corresponding `EvMaxCurrentX` shall be set to *Not Available*.

8.3.7 EvMaxVoltageL1N

`EvMaxVoltageL1N` is used by the *EV* to indicate its maximum nominal voltage (see 5.2.2) between the contacts number 1 and number 4 of the *EV inlet*. If the *EV* operates over a range of nominal voltages, this *signal* is used to indicate the maximum of these voltages. This *signal* will be compared against the *SE's* nominal voltage (see 9.6.2.3 and 9.6.3.1) to complete *Init*.

Signal	Bits	Values	Description	Schedule
`EvMaxVoltageL1N`	16	0_{10} to 10000_{10}	Maximum nominal voltage, 0.1 V per bit (*EV start value* is application-specific)	*Init*
		0000_{16}	*SE start value*	
		$FFFF_{16}$	*Not Available*/Contact number 4 not wired (see 8.3.7.2)	

8.3.7.1 If contact number 4 is wired, a *valid* non-zero `EvMaxVoltageL1N` *value* shall be provided by the *EV* to indicate its maximum nominal voltage between contact numbers 1 and 4.

8.3.7.2 If this value is not applicable, as in the case of an *EV* where the *neutral* contact (number 4) is not wired, the *EV* shall set `EvMaxVoltageL1N` to *Not Available*. See 8.3.10.2.

8.3.8 EvMaxVoltageLL

`EvMaxVoltageLL` is used by the *EV* to indicate its maximum nominal voltage (see 5.2.2) between contacts number 1 and 2, 1 and 3, and between 2 and 3 (or some subset thereof if not all contacts are populated) of the *EV inlet*. If the *EV* operates over a range of nominal voltages, this *signal* is used to indicate the maximum of these voltages. This *signal* will be compared against the *SE's* nominal voltage (see 9.6.2.3 and 9.6.3.1) to complete *Init*.

Signal	Bits	Values	Description	Schedule
`EvMaxVoltageLL`	16	0_{10} to 10000_{10}	Maximum nominal voltage, 0.1 V per bit (*EV start value* is application-specific)	*Init*
		0000_{16}	*SE start value*	
		$FFFF_{16}$	*Not Available*/Contact numbers 2 and 3 not wired (see 8.3.8.2)	

8.3.8.1 If contact numbers 2 and/or 3 are wired (in addition to contact number 1, see 5.3.1.7), a *valid* non-zero `EvMaxVoltageLL` *value* shall be provided by the *EV* to indicate its maximum nominal voltage between the contact numbers 1, 2, and 3 of the *EV inlet*.

8.3.8.2 If this value is not applicable, as in the case of an *EV* where contact numbers 2 and 3 are not wired, the *EV* shall set `EvMaxVoltageLL` to *Not Available*. See 8.3.11.2.

8.3.9 EvMinCurrentX

`EvMinCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule

`EvMinCurrentL1`
`EvMinCurrentL2`
`EvMinCurrentL3`
	8	0_{10} to 250_{10}	Minimum operating current, 1 A per bit
			(*EV start value* is application-specific)
				Init

		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available* (*SE start value*)/Contact not wired (see 8.3.9.1)	

These *signals* are used by the *EV* to indicate the minimum current where it is operable. The information is given for each relevant contact of the *EV inlet*; e.g., for `EvMinCurrentL1`, this is the contact number 1.

NOTE: An *EV* would set `EvMinCurrentX` to the lowest current (given the currently connected *SE* configuration) needed by the vehicle to operate its *on-board charger* and any fixed auxiliary loads such as a compressor for a refrigerated trailer. An `EvInfoEntryX` value is provided to indicate when the vehicle requires at least `EvMinCurrentX` to supply a fixed-load application (see Table 15).

8.3.9.1 If a contact is not wired, the corresponding `EvMinCurrentX` shall be set to *Not Available*.

8.3.10 EvMinVoltageL1N

Signal	Bits	Values	Description	Schedule
`EvMinVoltageL1N`	16	0_{10} to 10000_{10}	Lowest nominal voltage from *line*-to-*neutral*, 0.1 V per bit (*EV start value* is application-specific)	*Init*
		$FFFF_{16}$	*Not Available* (*SE start value*)/Contact number 4 not wired (see 8.3.10.2)	

8.3.10.1 If contact number 4 is wired, a *valid* non-zero `EvMinVoltageL1N` *value* shall be provided by the *EV* to indicate its lowest nominal voltage (see 5.2.2) between contact number 4 and any of the contact numbers 1, 2, or 3 of the *EV inlet*. This *signal* will be compared against the *SE's* nominal voltage (see 9.6.2.3 and 9.6.3.1) to complete *Init*.

8.3.10.2 If this value is not applicable, as in the case where the *neutral* contact (number 4) is not wired, the *EV* shall set `EvMinVoltageL1N` to *Not Available*. See 8.3.7.2.

8.3.11 EvMinVoltageLL

Signal	Bits	Values	Description	Schedule
`EvMinVoltageLL`	16	0_{10} to 10000_{10}	Lowest nominal voltage from *line*-to-*line*, 0.1 V per bit (*EV start value* is application specific)	*Init*
		$FFFF_{16}$	*Not Available* (*SE start value*)/Contact numbers 2 and 3 not wired (see 8.3.11.2)	

8.3.11.1 If the *EV* loads from *line*-to-*line*, a non-zero `EvMinVoltageLL` shall be provided by the *EV* to indicate its lowest nominal voltage (see 5.2.2) between any two of the contact numbers 1, 2, and 3 of the *EV inlet*. This *signal* will be compared against the *SE's* nominal voltage (see 9.6.2.3 and 9.6.3.1) to complete *Init*.

8.3.11.2 If this value is not applicable, as in the case of an *EV* where contact numbers 2 and 3 are not wired, the *EV* shall set `EvMinVoltageLL` to *Not Available*. See 8.3.8.2.

8.3.12 EvPresentCurrentX

`EvPresentCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
`EvPresentCurrentL1` `EvPresentCurrentL2` `EvPresentCurrentL3` `EvPresentCurrentN`	8	00_{16}	Contact not wired (see 8.3.12.3)	*Op*
		0_{10} to 250_{10}	Measured or estimated current, 1 A per bit (*EV start value* is 0_{10})	
		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available* (*SE start value*)	

The *EV* may use these *signals* to report the instantaneous measured or estimated load current that is drawn by the *EV* at the corresponding contact of the *EV inlet*. For example, contact number 1 relates to `EvPresentCurrentL1`.

8.3.12.1 If supported, the *EV* shall adjust `EvPresentCurrentX` dynamically in accordance with the current that it is drawing.

8.3.12.2 If the *EV* does not measure or estimate its load current, it shall set the `EvPresentCurrentX` to *Not Available*.

8.3.12.3 If a contact is not wired, the corresponding `EvPresentCurrentX` shall be set to zero.

EXAMPLE: An *EV* with a single-phase *on-board charger* which does not measure or estimate its load current will set `EvPresentCurrentL1` and `EvPresentCurrentN` to *Not Available* and `EvPresentCurrentL2` and `EvPresentCurrentL3` to zero.

A non-zero value in `EvPresentCurrentN` indicates asymmetric current drawn by the *EV*. If this value is set to zero, the *EV* may be operating as a *delta connected load*, or a balanced three-phase *wye connected load*. When drawing only single-phase power between L1 and *neutral*, the *EV* should set the values for `EvPresentCurrentL1` and `EvPresentCurrentN` approximately the same.

8.3.13 EvRequestedCurrentX

`EvRequestedCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
`EvRequestedCurrentL1` `EvRequestedCurrentL2` `EvRequestedCurrentL3` `EvRequestedCurrentN`	8	0_{10} to 250_{10}	Requested current, 1 A per bit (*EV start value* is 0_{10})	*Init, Op*
		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available* (*SE start value*)	

The *EV* may provide these *signals* to indicate the current that it would like to draw at the corresponding contact of the *EV inlet*. For example, for `EvRequestedCurrentL1`, the corresponding contact is number 1. These *signals* are intended for an optional energy management system.

To indicate that the *EV* could use more current, the *signal* values of `EvRequestedCurrentX` may be higher than the limits indicated by the corresponding `SeAvailableCurrentX` *signals*. The *EV* should adjust these values as needed to follow the actual current needed by *EV* loads (for example, requested current typically tapers down as battery state of charge approaches 100%). This *signal* may be used by the *SE* to dynamically adjust the corresponding `SeAvailableCurrentX` *signals*.

8.3.13.1 If the *EV* does not support this function, values for *conductors* that can draw current shall be set to *Not Available*.

8.3.13.2 Values for *conductors* that cannot draw current shall be set to zero, even if the *EV* does not support this function. For example, an *EV* that loads single-phase-only from L1 to N would signal zero for L2 and L3.

8.3.14 EvResponseError

`EvResponseError` is provided by the *EV* (which is a *LIN* responder node) to report if a *frame* that is transmitted or received by the node contains an error in the *frame response*.

Signal	Bits	Values	Description	Schedule
`EvResponseError`	1	0_2	*Signal* cleared (No error detected) *EV* and *SE start values* are 0_2	*Ver, Init, Op*
		1_2	*Signal* set (error detected)	

NOTE: Refer to the "Status management" section of ISO 17987-3 for the *LIN* specification of `response_error`.

8.3.15 EvSelectedVersion

`EvSelectedVersion` is used by the *EV* to uniquely identify the *Protocol Version*. Future editions of SAE J3068 may define new *Protocol Versions*. See 9.5.

Signal	Bits	Values	Description	Schedule
`EvSelectedVersion`	8	0_{10} - 254_{10}	Selected *Protocol Version*	*Ver, Init, Op*
		FF_{16}	*Not Available* (*EV* and *SE start value*)	

8.3.16 EvStatusInit

`EvStatusInit` is provided by the *EV* to indicate the system *Initialization* status. See 9.6.

Signal	Bits	Values	Description	Schedule
`EvStatusInit`	2	00_2	*Incomplete*: *Initialization* incomplete (*EV start value*)	*Ver, Init, Op*
		01_2	*Complete*: *Initialization* complete (see 9.6.3.1)	
		10_2	*Error*: The *EV* determines *Initialization* fails	
		11_2	*Not Available* (*SE start value*)	

8.3.16.1 The *EV* shall not set `EvStatusInit` to *Not Available* during normal operation.

8.3.17 EvStatusOp

`EvStatusOp` is provided by the *EV* to indicate its *Operation* status. See 9.7.

Signal	Bits	Values	Description	Schedule
`EvStatusOp`	2	00_2	*Deny_V*: The *EV* does not permit the *SE contactor* nor the *EV* S_2 switch to close (*EV start value*)	*Ver, Init, Op*
		01_2	*Permit_V*: The *EV* permits the *SE contactor* to close and requests permission to close S_2.	
		10_2	*Error*: The *EV* has detected an *Operation* error.	
		11_2	*Not Available* (*SE start value*)	

`EvStatusOp` is not set to *Permit_V* unless the *inlet* is *locked*. See 9.7.2.1 and 10.8.5.1.

8.3.17.1 The *EV* shall not set `EvStatusOp` to *Not Available* during normal operation.

8.3.17.2 The *EV* shall not set `EvStatusOp` to *Permit_V* unless `SeStatusVer` = *Complete* and `SeStatusInit` = *Complete* (i.e., the *schedule* is *Op*).

8.3.18 EvStatusVer

`EvStatusVer` is provided by the *EV* to indicate the *Protocol Version* selection status. See 9.5.

Signal	Bits	Values	Description	Schedule
`EvStatusVer`	2	00_2	*Incomplete*: *Protocol Version* selection incomplete (*EV start value*)	*Ver, Init, Op*
		01_2	*Complete*: *Protocol Version* selection complete	
		10_2	*Error*: The *EV* determines *Protocol Version* selection fails	
		11_2	*Not Available* (*SE start value*)	

8.3.18.1 The *EV* shall not set `EvStatusVer` to *Not Available* during normal operation.

8.3.19 EvSupportedVersionX

`EvSupportedVersionX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
`EvSupportedVersion1` `EvSupportedVersion2` `EvSupportedVersion3` `EvSupportedVersion4` `EvSupportedVersion5`	8	0_{10}	*PWM-CP*	*Ver*
		1_{10}	*LIN-CP* as defined in IEC 61851-1:2017, Annex D	
		2_{10}	*LIN-CP* as defined in this edition of SAE J3068	
		3_{10} - 239_{10}	Reserved	
		240_{10} - 253_{10}	Reserved for proprietary/experimental implementations. See Appendix E.	
		254_{10}	Reserved	
		FF_{16}	*Not Available* (*SE start value*) Any other unused *signals* are FF_{16}	

These *signals* are used by the *EV* to indicate which *Protocol Versions* are supported.

8.3.19.1 At least one `EvSupportedVersionX` entry shall contain a *valid* non-zero *value*.

8.3.19.2 If the *EV* supports *PWM-CP*, it shall list *Protocol Version* 0_{10} in an `EvSupportedVersionX`.

NOTE: Requirement 8.3.19.2 was not required in the first edition of SAE J3068.

`EvSupportedVersion5` is set to *Not Available* on the last page, and only the last page. `EvSupportedVersion2`, `3`, and `4` may be set to *Not Available* or may be *valid values*. `EvSupportedVersion5` contains a *valid value* on every page except the last. These *signals* are provided by the *EV* to indicate which communication *Protocol Versions* are supported. See 8.4.2.

8.3.20 EvVersionPageNumber

`EvVersionPageNumber` is an enumerator for *frames* that can provide several pages of *signals*. If more than four *Protocol Versions* are supported, `EvVersionPageNumber` may start at page number zero (0_{10}) and increment each time the *frame* is sent. After the *frame* with the last page has been sent, `EvVersionPageNumber` rolls over and the next *frame* will contain the zeroth page. See 8.4.2.

Signal	Bits	Values	Description	Schedule
`EvVersionPageNumber`	8	0_{10} to 51_{10}	Page number	*Ver*
		FF_{16}	*Not Available* (*SE start value*)	

8.3.21 SeAvailableCurrentX

`SeAvailableCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
`SeAvailableCurrentL1` `SeAvailableCurrentL2` `SeAvailableCurrentL3` `SeAvailableCurrentN`	8	0_{10} to 250_{10}	Available current, 1 A per bit (*SE start value* is 0_{10})	*Init, Op*
		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available* (*EV start value*)/Contact not provided (see 8.3.21.2)	

These *signals* are used by the *SE* to indicate the current the *EV* may draw at any given time. These *signals* are analogous to the *PWM-CP* duty cycle. The *EV* should anticipate these *signals* may change at any time and may change continuously. The information is given for each relevant contact of the *EVSE's connector*; e.g., for `SeAvailableCurrentL1` this is contact number 1. These *signals* are present during *Initialization* but are only used in *Operation* (see 8.4 and 8.5). The *signals* encompass the *EVSE* electrical limits, including premises wiring and the ampacity of the attached *connector* or *plug*. They may also dynamically track energy management requirements (see 9.7.3.6). *SE* signals `SeAvailableCurrentX` in relation to R_6 in accordance with 9.7.3.5. The *EV* interprets `SeAvailableCurrentX` in relation to R_6 in accordance with 9.7.3.4.

8.3.21.1 The *SE* shall provide *valid* `SeAvailableCurrentX` *values* for every connected contact.

8.3.21.2 `SeAvailableCurrentX` *signal* values shall be *Not Available* when the contact is not provided. See 8.3.26.2 for `SeMaxCurrentX`.

8.3.21.3 Unless 5.3.2.1 is satisfied, `SeAvailableCurrentX` shall not be greater than 63 A. `SeAvailableCurrentL1` and `SeAvailableCurrentN` may be up to 70 A if and only if `SeAvailableCurrentL2` AND `SeAvailableCurrentL3` are zero or *Not Available*.

The *EV* load does not exceed the `SeAvailableCurrentX` for any *conductors*. See 9.7.3.3.

The *signal* `SeAvailableCurrentN` limits asymmetric current drawn by the *EV*. If this value is set to zero, it will not be possible to operate single-phase *chargers* connected between L1 and *neutral*. Note that if an *SE* provides only single-phase power from L1 to *neutral*, the *SE* typically sets `SeAvailableCurrentL1` and `SeAvailableCurrentN` to the same value.

EXAMPLE: An *EV* that cannot adjust loads asymmetrically and receives different current limits on one of more *line conductors*, draws the lowest value on all *line conductors*.

8.3.22 SeConnectionType

The *SE* may use this *signal* to specify its *connector* type, or that it has a *socket-outlet*. This information may be used to detect *coupler* adapters and may influence *inlet* and/or *socket-outlet locking*. Use of this *signal* is highly recommended.

Signal	Bits	Values	Description	Schedule
`SeConnectionType`	8	0_{10}	SAE universal AC_6 *socket-outlet* (IEC 62196-2 type 2 or GB/T 20234.2)	*Init*
		1_{10}	SAE J1772 (IEC 62196-2 type 1) *connector*	
		2_{10}	SAE J3068 AC_6 (IEC 62196-2 type 2) *connector*	
		3_{10}	*CCS1 connector*	
		4_{10}	*CCS2* (SAE J3068 DC_8) *connector*	
		5_{10}	SAE J3400 *connector*	
		6_{10}	GB/T 20234.2 *connector*	
		FE_{16}	*Error*	
		FF_{16}	*Not Available*/Not Specified (*EV start value*)	
		All Others	Reserved	

In conjunction with `EvConnectionType` (see 8.3.2), this *signal* may be used to detect potentially incompatible configurations and/or the presence of *coupler* adapters. This determination is manufacturer-specific. Generally, the SAE universal AC_6 *socket-outlet* [0_{10}] is compatible with all *EV* that otherwise pass the initialization process in 9.6.2.

8.3.22.1 If the *SE* determines it is incompatible with connected *EV* in a given configuration via `SeConnectionType` and `EvConnectionType` (see 8.3.2), it shall write "*SE* determines connection with *EV* is incompatible" [35_{16}] to an `SeInfoEntryX` (see 8.3.24).

8.3.22.2 If the *SE* uses a connection type not listed, it shall set `SeConnectionType` to *Not Available*.

NOTE 1: Presence or absence of AC contacts on *CCS couplers* is signaled via *LIN-CP*. See `EvMaxCurrentX` (see 8.3.6.3) and `SeMaxCurrentX` (see 8.3.26.2).

NOTE 2: Previous editions of this document did not define this *signal*; therefore, some implementations may transmit *Not Available.*

8.3.23 SeFrequency

Signal	Bits	Values	Description	Schedule
`SeFrequency`	8	00000001_2	The *SE* provides 50 Hz supply frequency	*Init*
		00000010_2	The *SE* provides 60 Hz supply frequency	
		00000100_2	The *SE* provides 400 Hz supply frequency	
		FF_{16}	*Not Available* (*EV start value*) *SE start value* is FF_{16} if 8.3.23.1 is applicable.	
		All Others	Reserved	

8.3.23.1 If the *SE* can supply more than one frequency, then the *start value* of `SeFrequency` shall be set to *Not Available* until the *SE* reads the `EvFrequencies`. See 9.6.2.

8.3.23.2 After 8.3.23.1 is satisfied, the *SE* shall provide a *valid* `SeFrequency` *value* to indicate the frequency of the supply network.

NOTE: To maintain future compatibility, it is recommended to only check defined bit positions.

8.3.24 SeInfoEntryX

`SeInfoEntryX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule

`SeInfoEntry1`
`SeInfoEntry2`
`SeInfoEntry3`
`SeInfoEntry4`
`SeInfoEntry5`
`SeInfoEntry6`
	8	00_{16} - FE_{16}	See Table 16	*Ver, Init, Op*

		FF_{16}	*Not Available* (*EV* and *SE start value* is FF_{16})	

`SeInfoEntry6` is set to *Not Available* on the last page, and only the last page. *Valid values* may be provided by the *SE* to communicate information about exceptional conditions or events detected by the *SE*; see 11.1. If more than five info codes are active, multiple pages are required. See 8.4.2.

8.3.25 SeInfoPageNumber

`SeInfoPageNumber` is an enumerator for *frames* that can provide several pages of `SeInfoEntryX` values. Typically, `SeInfoPageNumber` starts at page number zero (0_{10}) and is incremented each time the *frame* is sent. After the *frame* with the last page has been sent, `SeInfoPageNumber` rolls over and the next *frame* will contain the zeroth page. See 8.4.2.

Signal	Bits	Values	Description	Schedule
SeInfoPageNumber	8	0_{10} to 42_{10}	Page number	*Ver, Init, Op*
		FF_{16}	*Not Available* (*EV start value*)	

8.3.26 SeMaxCurrentX

`SeMaxCurrentX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
SeMaxCurrentL1 SeMaxCurrentL2 SeMaxCurrentL3 SeMaxCurrentN	8	00_{16}	Contact not provided (see 8.3.26.2)	*Init*
		0_{10} to 250_{10}	Maximum current, 1 A per bit (*SE start value* is application-specific)	
		251_{10} - 254_{10}	Reserved	
		FF_{16}	*Not Available* (*EV start value*)	

These *signals* are used by the *SE* to indicate the maximum current the *SE* can provide. This value includes the design limits of the *SE* and electrical infrastructure to which it is attached. They should be the highest value `SeAvailableCurrentX` may take. The information is given for each relevant contact of the *EVSE's connector*; e.g., for `SeMaxCurrentL1`, this is the contact number 1.

8.3.26.1 The *SE* shall provide *valid* `SeMaxCurrentX` *values* for all contacts.

A value of *Not Available* is not allowed to be sent in `SeMaxCurrentX`. The *EV* uses *Not Available* as an internal *start value* for `SeMaxCurrentX` which only indicates that *a valid value* has not yet been received from the *SE*.

8.3.26.2 `SeMaxCurrentX` *signal* values shall be zero when the contact is not provided to the *EV* during the *control sequence*. See 8.3.21.2 for `SeAvailableCurrentX`.

EXAMPLE: A three-phase *SE* designed to provide the maximum power to a single-phase or three-phase *EV* without 5.3.2.1 being satisfied would signal `SeMaxCurrentL1` = 70 A, `SeMaxCurrentL2` = 63 A, `SeMaxCurrentL3` = 63 A, and `SeMaxCurrentN` = 70 A. See 8.3.21.3.

8.3.27 SeNomVoltageL1N

`SeNomVoltageL1N` is used to provide the nominal *line*-to-*neutral* voltage provided by the supply network. See 5.2.2.

Signal	Bits	Values	Description	Schedule
SeNomVoltageL1N	16	0_{10} to 10000_{10}	Nominal voltage, 0.1 V per bit The *SE start value* is in this range if 8.3.27.1 is not applicable.	*Init*
		$FFFF_{16}$	*Not Available* (*EV start value*) *SE start value* is $FFFF_{16}$ if 8.3.27.1 is applicable.	

8.3.27.1 If the *SE* can supply more than one nominal voltage, then the *start value* of `SeNomVoltageL1N` shall be set to *Not Available* until the *SE* reads the `EvMaxVoltageL1N`. See 9.6.2.

8.3.27.2 After 8.3.27.1 is satisfied, the *SE* shall provide a *valid* `SeNomVoltageL1N` *value* to indicate the nominal voltage between the contact numbers 1 and 4 of the *connector*.

Typical *wye line*-to-*neutral* voltages in North America for three-phase power distribution are 120.0 VAC, 277.0 VAC, and 347.0 VAC. See 5.2.2.

8.3.27.3 If contact numbers 2 and/or 3 are supplied with voltage, the nominal voltages from these contacts to contact number 4 shall be the same as from contact number 1 to contact number 4. See 5.3.1.5.

8.3.28 SeNomVoltageLL

This is the nominal *line*-to-*line* voltage provided by the supply network. See 5.2.2.

Signal	Bits	Values	Description	Schedule
`SeNomVoltageLL`	16	0_{10} to 10000_{10}	Nominal voltage, 0.1 V per bit The *SE start value* is in this range if 8.3.28.2 is not applicable.	*Init*
		$FFFF_{16}$	*Not Available* (*EV start value*) *SE start value* is $FFFF_{16}$ if 8.3.28.2 is applicable.	

8.3.28.1 If the *SE* supplies voltage to only contact number 1, then `SeNomVoltageLL` shall be set to *Not Available* and the subsequent requirements in 8.3.28 do not apply.

8.3.28.2 If the *SE* can supply more than one nominal voltage, then the *start value* of `SeNomVoltageL1N` shall be set to *Not Available* until the *SE* reads the `EvMaxVoltageLL`. See 9.6.2.

8.3.28.3 After 8.3.28.2 is satisfied, the *SE* shall provide a *valid* `SeNomVoltageL1N` *value* to indicate the nominal voltage between any of the contact numbers 1, 2, 3 of the *connector* to which voltage is supplied.

NOTE: A two-phase or a split-phase supply is possible. For example, contact numbers 1 and 2 are supplied with voltage, but contact number 3 is not connected. In this example, `SeNomVoltageLL` indicates the voltage between contact numbers 1 and 2, while `SeMaxCurrentL3` would be zero.

Typical *wye line*-to-*line* voltages in North America for three-phase power distribution are 208.0 VAC, 480.0 VAC, and 600.0 VAC. See 5.2.2.

8.3.29 SeSelectedVersion

`SeSelectedVersion` is used by the *SE* to uniquely identify the *Protocol Version* chosen by the *EV*. Future editions of SAE J3068 may define new *Protocol Versions*. See 9.5.

Signal	Bits	Values	Description	Schedule
`SeSelectedVersion`	8	0_{10} - 254_{10}	Selected *Protocol Version*	*Ver, Init, Op*
		FF_{16}	*Not Available* (*EV* and *SE start value*)	

8.3.30 SeStatusInit

`SeStatusInit` is used by the *SE* to indicate the *Initialization* status. See 9.6.

Signal	Bits	Values	Description	Schedule
`SeStatusInit`	2	00_2	*Incomplete*: *Initialization* incomplete (*SE start value*)	*Ver, Init, Op*
		01_2	*Complete*: *Initialization* complete (see 9.6.2.3)	
		10_2	*Error*: The *SE* determines that *Initialization* fails	
		11_2	*Not Available* (*EV start value*)	

8.3.30.1 The *SE* shall not set `SeStatusInit` to *Not Available* during normal operation.

8.3.31 SeStatusOp

`SeStatusOp` is used by the *SE* to indicate its *Operation* status. See 9.7.

Signal	Bits	Values	Description	Schedule
`SeStatusOp`	2	00_2	*Deny_V*: The *SE* does not permit the *EV* S_2 switch (nor the *SE contactor*) to be closed (*SE start value*)	*Ver, Init, Op*
		01_2	*Permit_V*: The *SE* permits the *EV* S_2 switch (and the *SE contactor*) to be closed	
		10_2	*Error*: The *SE* has detected an *Operation* error	
		11_2	*Not Available* (*EV start value*)	

8.3.31.1 The *SE* shall not set `SeStatusOp` to *Not Available* during normal operation.

8.3.31.2 The *SE* shall not set `SeStatusOp` to *Permit_V* unless the *schedule* is *Op*.

8.3.32 SeStatusVer

`SeStatusVer` is used by the *SE* to indicate the *Protocol Version* selection status. See 9.5.

Signal	Bits	Values	Description	Schedule
`SeStatusVer`	2	00_2	*Incomplete*: *Protocol Version* selection incomplete (*SE start value*)	*Ver, Init, Op*
		01_2	*Complete*: *Protocol Version* selection complete	
		10_2	*Error*: The *SE* determines that *Protocol Version* selection fails	
		11_2	*Not Available* (*EV start value*)	

8.3.32.1 The *SE* shall not set `SeStatusVer` to *Not Available* during normal operation.

8.3.33 SeSupportedVersionX

`SeSupportedVersionX` refers to one or more of the *signals* in the following table:

Signal	Bits	Values	Description	Schedule
SeSupportedVersion1 SeSupportedVersion2 SeSupportedVersion3 SeSupportedVersion4 SeSupportedVersion5	8	0_{10}	*PWM-CP*	*Ver*
		1_{10}	*LIN-CP* as defined in IEC 61851-1:2017, Annex D	
		2_{10}	*LIN-CP* as defined in this edition of SAE J3068	
		3_{10} - 239_{10}	Reserved	
		240_{10} - 253_{10}	Reserved for proprietary/experimental implementations. See Appendix E.	
		254_{10}	Reserved	
		FF_{16}	*Not Available* (*EV start value*) Any other unused *signals* are FF_{16}	

These *signals* are used by the *SE* to indicate which *Protocol Versions* are supported.

8.3.33.1 At least one `SeSupportedVersionX` entry shall be a *valid* non-zero *value*.

8.3.33.2 If the *SE* supports *PWM-CP*, it shall list *Protocol Version* 0_{10} in an `SeSupportedVersionX`.

NOTE: Requirement 8.3.33.2 was not required in the first edition of SAE J3068.

`SeSupportedVersion5` is set to *Not Available* on the last page, and only the last page. `SeSupportedVersion2`, `3`, and `4` may be set to *Not Available* or may be *valid values*. `SeSupportedVersion5` contains a *valid value* on every page except the last. These *signals* are provided by the *SE* to indicate which communication *Protocol Versions* are supported. See 8.4.2.

8.3.34 SeVersionPageNumber

`SeVersionPageNumber` is an enumerator for *frames* that can provide several pages of *signals*. If more than four *Protocol Versions* are supported, `SeVersionPageNumber` may start at page number zero (0_{10}) and increment each time the *frame* is sent. After the *frame* with the last page has been sent, `SeVersionPageNumber` rolls over and the next *frame* will contain the zeroth page. See 8.4.2.

Signal	Bits	Values	Description	Schedule
SeVersionPageNumber	8	0_{10} to 51_{10}	Page number	*Ver*
		FF_{16}	*Not Available* (*EV start value*)	

8.4 LIN Frames

8.4.1 List of Defined Frames

Table 12 shows a list of all defined *LIN frames* and the contained *signals*.

All *frame* and *signal* names are shown in `monospace` font.

All *frame* names have a prefix that indicates the *publisher* of the *frame*:

`Ca`: *Cable Assembly* (CA)
`Ev`: *Electric Vehicle* (*EV*)
`Se`: *Supply Equipment* (*SE*)

8.4.1.1 The *frame* type of all *frames* shall be "unconditional Frame"; refer to ISO 17987-3.

The *LIN* protocol uses 6 bits for the *frame* identifier (*frame* ID). *Frame* identifiers between 0_{10} and 59_{10} are available for unconditional *frames*.

8.4.1.2 *Signal* positions with respect to *frame* boundaries shall be as given in Appendix D column five, "Bits within Frame."

8.4.1.3 All nodes shall *publish* the *frame responses* that are assigned to their node, providing at least *start values* (which may be *Not Available* in some cases) for all contained *signals*.

See Appendix D for a summary of *signals*, *frames*, and *schedules*.

Manufacturers may construct additional optional *frames* using *frame* ID 50_{10} - 59_{10} for their own purposes; however, it is recommended to use proprietary/experimental *Protocol Versions*. See 8.3.19 and 8.3.33.

Table 12 - Frames

Frame Identifier	Frame Name	Contained Signals
0	SeVersionList	Byte 0: SeSelectedVersion Byte 1: Bit 0: reserved (= 1) Bits 1-2: SeStatusVer Bits 3-4: SeStatusInit Bits 5-6: SeStatusOp Bit 7: reserved (= 1) Byte 2: SeVersionPageNumber (typically 00_{16}) Byte 3: SeSupportedVersion1 (typically 02_{16}) Byte 4: SeSupportedVersion2 (typically FF_{16}) Byte 5: SeSupportedVersion3 (typically FF_{16}) Byte 6: SeSupportedVersion4 (typically FF_{16}) Byte 7: SeSupportedVersion5 (typically FF_{16})
1	EvVersionList	Byte 0: EvSelectedVersion (typically 02_{16}) Byte 1: Bit 0: EvResponseError Bits 1-2: EvStatusVer Bits 3-4: EvStatusInit Bits 5-6: EvStatusOp Bit 7: EvAwake Byte 2: EvVersionPageNumber (typically 00_{16}) Byte 3: EvSupportedVersion1 (typically 02_{16}) Byte 4: EvSupportedVersion2 (typically FF_{16}) Byte 5: EvSupportedVersion3 (typically FF_{16}) Byte 6: EvSupportedVersion4 (typically FF_{16}) Byte 7: EvSupportedVersion5 (typically FF_{16})
2	SeStatus	Byte 0: SeSelectedVersion (typically 02_{16}) Byte 1: Bit 0: reserved (= 1) Bits 1-2: SeStatusVer Bits 3-4: SeStatusInit Bits 5-6: SeStatusOp Bit 7: reserved (= 1) Byte 2: SeAvailableCurrentL1 Byte 3: SeAvailableCurrentL2 Byte 4: SeAvailableCurrentL3 Byte 5: SeAvailableCurrentN Bytes 6-7: reserved (typically FF_{16})

Frame Identifier	Frame Name	Contained Signals
3	EvStatus	Byte 0: EvSelectedVersion (typically 02_{16}) Byte 1: Bit 0: EvResponseError Bits 1-2: EvStatusVer Bits 3-4: EvStatusInit Bits 5-6: EvStatusOp Bit 7: EvAwake Byte 2: EvRequestedCurrentL1 Byte 3: EvRequestedCurrentL2 Byte 4: EvRequestedCurrentL3 Byte 5: EvRequestedCurrentN Bytes 6-7: reserved (typically FF_{16})
4	EvPresentCurrents	Byte 0: EvSelectedVersion (typically 02_{16}) Byte 1: EvPresentCurrentL1 Byte 2: EvPresentCurrentL2 Byte 3: EvPresentCurrentL3 Byte 4: EvPresentCurrentN Bytes 5-7: reserved (typically FF_{16})
5	SeNomVoltages	Byte 0: SeSelectedVersion (typically 02_{16}) Bytes 1-2: SeNomVoltageL1N Bytes 3-4: SeNomVoltageLL Byte 5: SeFrequency Bytes 6-7: reserved (typically FF_{16})
6	SeMaxCurrents	Byte 0: SeSelectedVersion (typically 02_{16}) Byte 1: SeMaxCurrentL1 Byte 2: SeMaxCurrentL2 Byte 3: SeMaxCurrentL3 Byte 4: SeMaxCurrentN Byte 5: SeConnectionType Bytes 6-7: reserved (typically FF_{16})
7	EvMaxVoltages	Byte 0: EvSelectedVersion (typically 02_{16}) Bytes 1-2: EvMaxVoltageL1N Bytes 3-4: EvMaxVoltageLL Byte 5: EvFrequencies Bytes 6-7: reserved (typically FF_{16})
8	EvMinVoltages	Byte 0: EvSelectedVersion (typically 02_{16}) Bytes 1-2: EvMinVoltageL1N Bytes 3-4: EvMinVoltageLL Byte 5: EvConnectionType Bytes 6-7: reserved (typically FF_{16})
9	EvMaxMinCurrents	Byte 0: EvSelectedVersion (typically 02_{16}) Byte 1: EvMaxCurrentL1 Byte 2: EvMaxCurrentL2 Byte 3: EvMaxCurrentL3 Byte 4: EvMaxCurrentN Byte 5: EvMinCurrentL1 Byte 6: EvMinCurrentL2 Byte 7: EvMinCurrentL3

Frame Identifier	Frame Name	Contained Signals
10	CaProperties Reserved for future implementation of *cable assembly* nodes (see 6.2.4).	Byte 0: CaVersion (typically 01_{16}) Byte 1: Bit 0: CaResponseError Bits 1-7: reserved (= all ones) Byte 2-3: CaMaxVoltage Byte 4: CaMaxCurrentL1 Byte 5: CaMaxCurrentL2 Byte 6: CaMaxCurrentL3 Byte 7: CaMaxCurrentN
11	SeInfoList	Byte 0: SeSelectedVersion (typically 02_{16}) Byte 1: SeInfoPageNumber Byte 2: SeInfoEntry1 Byte 3: SeInfoEntry2 Byte 4: SeInfoEntry3 Byte 5: SeInfoEntry4 Byte 6: SeInfoEntry5 Byte 7: SeInfoEntry6
12	EvInfoList	Byte 0: EvSelectedVersion (typically 02_{16}) Byte 1: EvInfoPageNumber Byte 2: EvInfoEntry1 Byte 3: EvInfoEntry2 Byte 4: EvInfoEntry3 Byte 5: EvInfoEntry4 Byte 6: EvInfoEntry5 Byte 7: EvInfoEntry6
13	SeErrorList	Reserved; used in *Protocol Version* 1
14	EvErrorList	Reserved; used in *Protocol Version* 1
15 to 49	Reserved	
50 to 59	Available for application-specific *frames*	
60	Refer to ISO 17987, used in SAE J3068 for the *LIN* go-to-sleep command. See 10.1.	
61 to 63	Refer to ISO 17987, not used in SAE J3068	

8.4.2 Paged Frames

The *frames* SeVersionList, EvVersionList, SeInfoList, and EvInfoList contain lists of values. To allow longer lists than can be contained in one *frame*, these *frames* can *publish* a long list as several pages. The *frames* contain a page enumerator (SeVersionPageNumber, EvVersionPageNumber, SeInfoPageNumber, EvInfoPageNumber) that identifies what page is *published*. Each time the *frame* is triggered (i.e., each *schedule* cycle) the enumerator and the data content are changed. Paging allows long lists to be *published* without using many *frame* IDs. The first edition of SAE J3068 did not require implementation of paging.

The paging technique can be used to transmit information that is organized in several pages as follows:

- The pages of `SeVersionList` and `EvInfoList` contain *Protocol Versions*.

- The pages of `SeInfoList` contain `SeInfoEntryX` values. The pages of `EvInfoList` contain `EvInfoEntryX` values.

- The first time each of the *frames* is triggered, the *publisher* responds with the respective page number *signal* set to zero (0_{10}) and provides the corresponding page. Each time the *frame* is triggered again, the page number *signal* is incremented and the corresponding page is provided. After the last page, the process repeats with the page number *signal* set to zero (0_{10}).

- It is recommended that *Protocol Version* 2_{10} (and *Protocol Versions* 0_{10} and 1_{10} if supported) be listed in `SeSupportedVersionX` and `EvSupportedVersionX` on the zeroth (0_{10}) page to ensure compatibility with devices that do not implement paging.

- It is recommended that the most important `SeInfoEntryX` and `EvInfoEntryX` values be on the zeroth (0_{10}) page to ensure compatibility with devices that do not implement paging.

- For all *frames* of this type, the unused entries of their last page are filled with the value *Not Available* such that at least `SeSupportedVersion5`, `EvSupportedVersion5`, `SeInfoEntry6`, or `EvInfoEntry6` contains this value. This allows the receiving side to confirm that all pages have been received. If the number of list elements is divisible by the number of entries per page (five for `SeVersionList` and `EvInfoList` and six for `SeInfoList` and `EvInfoList`), an entire page of *Not Available* is sent after the last page with *valid values*.

- If a paging error is detected, the data from that cycle should be discarded. Paging errors include: the cycle not starting on page zero, an out-of-sequence page number, and the last value on the last page not being set to *Not Available*. The appropriate value may be written to an `EvInfoEntryX` or `SeInfoEntryX` *signal*. Paging errors should not be considered fatal, i.e., charging should not be stopped and the *control sequence* should not be *restarted*. It may be appropriate to *restart* the *control sequence* if no error-free paging cycles are received for an extended period of time.

8.5 LIN Schedules

Three different *schedules* are defined to allow short *schedule* cycle times.

Table 13 lists the required *schedules* and the *frames* contained in each *schedule*. The table also shows the normal status *signal* values for each *control sequence* step, and *signal* positions with respect to byte boundaries.

All *schedule* names and values are shown in *italic* font. *Frame* names and *signal* names are shown in `monospace` font.

8.5.1 LIN Schedules Table

8.5.1.1 The *SE* shall use the *schedules* as defined in Table 13.

See Appendix D for a summary of *signals*, *frames*, and *schedules*.

Manufacturers may construct additional optional *schedules* for their own purposes.

8.5.1.2 All *schedules* shall have a repetition period which is not an integer multiple of the period of the power line frequency.

8.5.1.3 In *schedule Op*, the *frames* `SeStatus` and `EvStatus` shall have a repetition rate of at least nine times per second.

Table 13 - Chain of control: status, task, schedule, frame

Present SE Status Signal Values			Required Task (see Figure 14)	Required Schedule	Required Frames (Frame ID)
`SeStatusVer`	`SeStatusInit`	`SeStatusOp`			
Incomplete or *Error*	*Incomplete*	*Deny_V*	**Protocol Version selection** *SE* and *EV* establish *LIN* communication *SE* and *EV* exchange information about supported communication *Protocol Versions* until a *Protocol Version* is selected	*Ver*	`SeVersionList` (0) `EvVersionList` (1) `SeInfoList` (11) `EvInfoList` (12)
Complete	*Incomplete* or *Error*	*Deny_V*	**Initialization** *SE* and *EV* exchange information about the power supply and about the *EV* load until compatibility is verified	*Init*	`SeStatus` (2) `EvStatus` (3) `SeNomVoltages` (5) `SeMaxCurrents` (6) `EvMaxVoltages` (7) `EvMinVoltages` (8) `EvMaxMinCurrents` (9) `SeInfoList` (11) `EvInfoList` (12)
Complete	*Complete*	Any value except *Not Available*	**Operation** *SE* and *EV* exchange *frames* to control the *SE* supply voltage and the *EV* load current	*Op*	`SeStatus` (2) `EvStatus` (3) `EvPresentCurrents` (4) `SeInfoList` (11) `EvInfoList` (12)

NOTE: The *tasks* described in Table 13 are SAE J3068 concepts while general *LIN* concepts include *signals*, *schedules*, and *frames*.

If a *LIN* core software with an *API* following ISO/TR 17987-5 is used, a predefined *schedule*, `L_NULL_SCHEDULE`, is used to stop all transfers on the *LIN* cluster. See 9.1 for a discussion of the *API*.

9. APPLICATION PROGRAM, NORMAL SEQUENCE

9.1 Typical CP Controller Implementation Concept

Figure 13 shows a typical implementation concept for an *SE* or *EV CP* controller. The system behavior is controlled by an *application program* which controls the *LIN* communication as well as the required hardware functions, e.g., *CP level* detection, *proximity detection* circuit and control of the S_2 switch, the *contactor*, and the *inlet locking mechanism*.

LIN communication uses an *API* according to ISO/TR 17987-5. The *API* interfaces to *LIN* protocol software which accesses the *LIN* bus through a serial port (*UART*) and a *LIN* transceiver.

The *API* is a network software layer that hides the details of a *LIN* network configuration (e.g., how *signals* are mapped into certain *frames*) from the implementer of the *application program*. The *API* is focused on the *signals* transported on the *LIN* network. A *LIN* development tool may be used to take care of the step from network configuration to ready-made program code.

The *application program* in the *SE* and the *EV* writes and reads *LIN signal* values with the *API*. The *LIN* protocol software takes care of the actual communication.

The *application program* in the *LIN* commander node (the *SE* node) uses *API* calls to start or stop *LIN schedules*, as described in Sections 9 and 10.

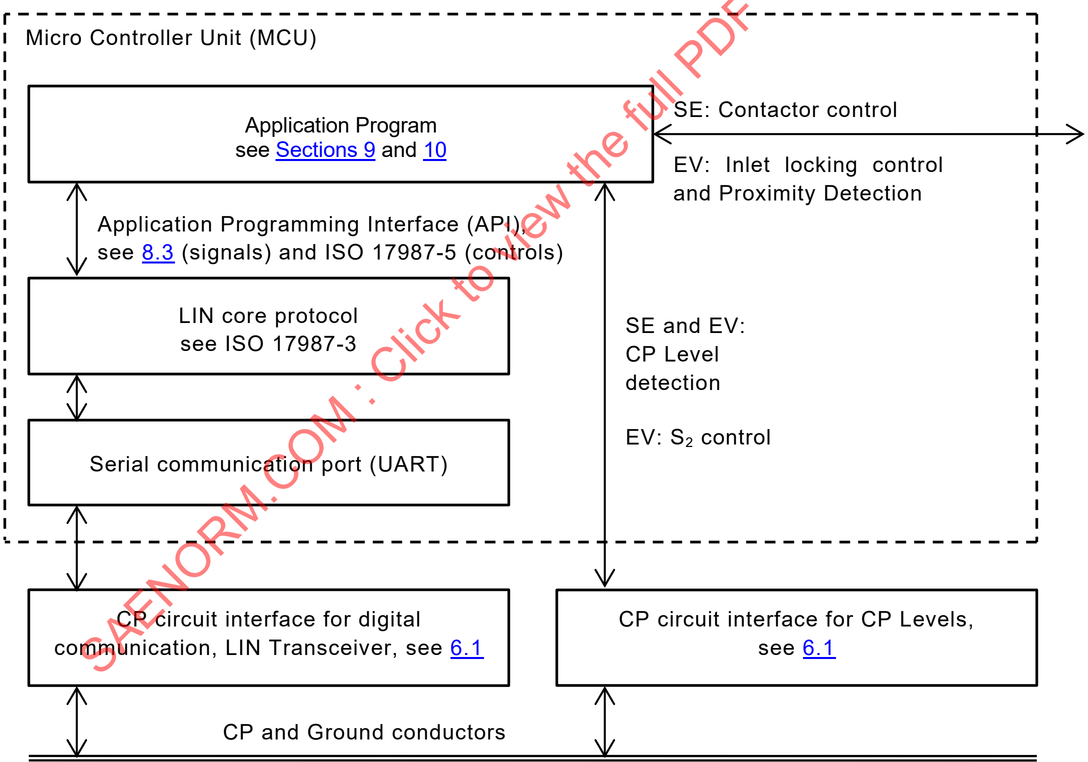

Figure 13 - Typical control pilot controller concept

9.2 Application Program Overview

Figure 14 and Appendix A give an overview of a typical *application program* structure in an *SE* or an *EV CP* controller. A *connection session* starts at the left, when the *connector* is inserted into the *inlet*, and ends at the right, when the *connector* is removed.

A normal *control sequence*, with no exceptional events, follows the solid line arrows in Figure 14. See 9.4 through 9.8. A *control sequence* with exceptions also follows at least some of the dashed arrows in Figure 14. See 10.1 through 10.8.

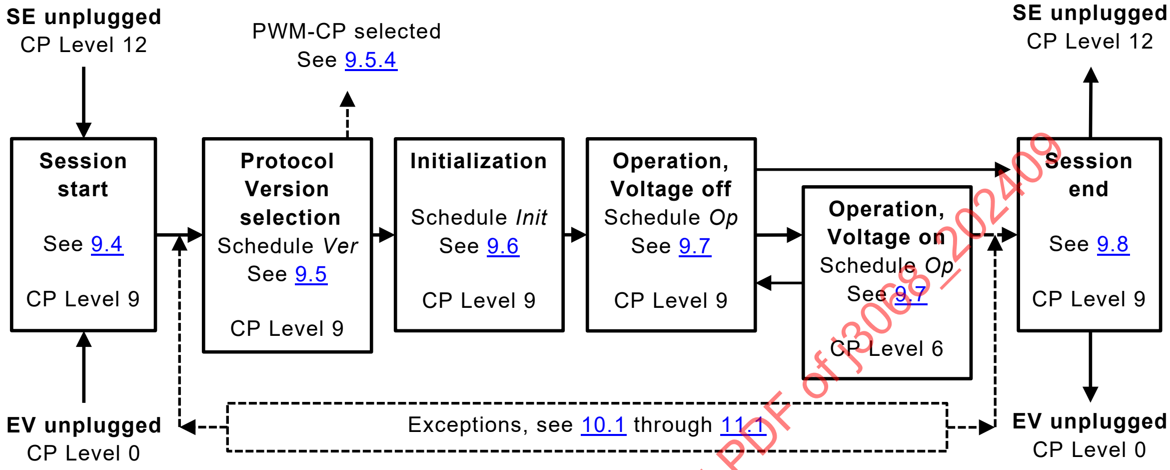

Figure 14 - Overview of typical application program control sequence during a connection session

9.3 Timing Requirements

Table 14 gives a summary of all time limits required in 9.4 through 9.8 and 10.1 through 10.8.

Table 14 - Application program timing limits

Name	Limit (seconds)	Reference	Description
$T_{SEstart}$	0.5	9.4.1.2	*SE* max time to start *LIN Ver schedule*
$T_{EVstart}$	1.0	9.4.1.3	*EV* max time to start responding (0.5 second recommended)
T_{pwm_max}	1.5	9.5.2.2	*SE* max time to attempt *LIN-CP* before switching to *PWM-CP*
T_{pwm_min}	1.3	9.5.2.2	*SE* min time to attempt *LIN-CP* before switching to *PWM-CP*
$T_{EVclose}$	3.0	9.7.2.4	*EV* max time to close S_2
$T_{SEclose}$	3.0	9.7.2.5	*SE* max time to close the *contactor*
T_{glitch}	1.0	9.7.2.6 9.7.2.7 9.7.2.8 10.8.5.2	*SE* time to ignore *CP level* glitch *EV* time to ignore *CP level* glitch *EV* time to ignore *prox* voltage glitch *EV* time to ignore *lock* glitch
$T_{SEadapt}$	10	9.7.3.2	*SE* max time to adapt `SeAvailableCurrentX` to external limit (for example, energy management system)
$T_{EVadapt}$	5.0	9.7.3.6	*EV* max time to adapt load current to `SeAvailableCurrentX`
T_{SEopen}	3.0	9.7.4.2 10.7.2.2	*SE* max time to open the *contactor*
$T_{rampdown}$	6.0	9.7.5.1 10.2.1.1	*SE* min time to wait before interrupting supply
T_{EVopen}	3.0	9.7.5.2 10.7.1.1	*EV* max time to open S_2
T_{unlock}	3.0	9.8.1.1	*EV* max time to *unlock inlet*
T_{ver}	5.0	10.3.1.1 10.3.2.1	*SE* and *EV* timeout before *Protocol Version* selection fails
T_{init}	5.0	10.4.1.1 10.4.2.1	*SE* and *EV* timeout before *Initialization* fails
T_{noLIN}	2.0	10.7.1.1 10.7.1.2 10.7.2.1 10.7.2.2	*EV* min time to wait before opening S_2, no *LIN headers* *SE* min time to wait before opening the *contactor*, no *LIN responses*
T_{SE_12}	0.10	10.8.4.1	*SE* max time to open the *contactor*, *SE* detects *CP level* 12
$T_{EV\_unlocked}$	0.10	10.8.5.1	*EV* max time to stop drawing current if unexpectedly *unlocked*. Refer to SAE J1772 "EVSE and EV/PHEV response time specifications" table.

9.4 Control Sequence

9.4.1 Control Sequence Start

9.4.1.1 When the *EV* detects that the *proximity* circuit is connected, it shall immobilize the *EV* if it is safe to do so, and measure the *proximity* circuit voltage (see Table 11) to determine the resistance of the current coding resistor R_6. This value shall be used to limit the *EV* load current, as described in 9.7.3.4.

9.4.1.2 When the *SE* detects a change from *CP level* 12 to 9, or in exceptional situations described in Section 10, the *SE* shall set all its *published* and *subscribed signals* to *start values* (see 8.3) and begin *schedule Ver* within $T_{SEstart}$ (0.5 second).

9.4.1.3 When the *EV* detects a change from *CP level* = 0 to *CP level* ≠ 0 (as described in 6.3.2), or in exceptional situations described in Section 10, the *EV* shall set all its *published* and *subscribed signals* to *start values* (see 8.3) and be ready to respond to *LIN headers* within $T_{EVstart}$ (1.0 second).

NOTE: It is recommended to be ready to respond to *LIN headers* within 0.5 second; this will improve the reliability of establishing a *LIN-CP connection session*.

9.4.1.4 The *SE* shall communicate at a bit rate of 19.2 *kbps* nominal.

9.5 Protocol Version Selection

9.5.1 Protocol Version Selection Sequence

9.5.1.1 While `SeStatusVer` = (*Incomplete* OR *Error*), the *SE* and the *EV* shall perform the *Protocol Version* selection *task* as specified in this section.

9.5.1.2 During *Protocol Version* selection, the *SE* shall use *schedule Ver* to establish *LIN* communication and to enable the *EV* to select a preferred *Protocol Version*.

9.5.1.3 The *schedule Ver* shall trigger the *frames* listed in Table 13 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 12.

9.5.1.4 The *SE* and the *EV* shall support *Protocol Version* 2.

EXCEPTION: This requirement does not apply for application-specific *EVSE* installations designed to serve a limited set of vehicles which are not intended for use by the general public, including specialized and commercialized industrial vehicles, and where otherwise noted.

This section references paged *frames*. See 8.4.2.

If *Protocol Version* selection fails, see 10.3.

9.5.2 Protocol Version Selection, Normal SE Sequence

9.5.2.1 The *SE* shall wait until it reads `EvStatusVer` = *Incomplete*, `EvStatusInit` = *Incomplete*, and `EvStatusOp` = *Deny_V*, before continuing with 9.5.2.3.

9.5.2.2 If the *SE* is able and willing to offer *PWM-CP* upon plug-in, it shall continue as in 9.5.2.1 at least T_{pwm_min} (1.3 seconds) and no more than T_{pwm_max} (1.5 seconds) after sending the first *LIN header*. Then, it shall continue as described in 9.5.4.

Reading *valid values* from the *EV* is how the *SE* determines that *LIN* communication is successfully established and that the *EV* has initialized its *LIN* node.

9.5.2.3 When the *SE* reads `EvStatusVer` = *Complete* and reads a *valid value* in `EvSelectedVersion` and the value in `EvSelectedVersion` is in an `SeSupportedVersionX`, it shall set `SeSelectedVersion` to `EvSelectedVersion` and write `SeStatusVer` = *Complete.*

9.5.2.4 Once `SeStatusVer` = *Complete*, it shall remain *Complete* for the remainder of the *control sequence*.

9.5.2.5 If `EvSelectedVersion` = *Protocol Version* 0_{10} (*PWM-CP*), the *SE* shall continue as in 9.5.4.

This would only typically occur in the absence of a shared (non-zero) *Protocol Version*. Under this version of SAE J3068, AC stations always at least support *Protocol Version* 2 (see 9.5.1.4).

9.5.3 Protocol Version Selection, EV Normal Sequence

9.5.3.1 The *EV* shall wait until it reads `SeStatusVer` = *Incomplete*, `SeStatusInit` = *Incomplete,* and `SeStatusOp` = *Deny_V*, before continuing.

The *EV* has thus determined that *LIN* communication is successfully established and that the *SE* has initialized its *LIN* node.

9.5.3.2 The *EV* shall read the values of `SeSupportedVersionX` in all pages of `SeVersionList`, select one of the values, write `EvSelectedVersion` = its chosen value, and write `EvStatusVer` = *Complete*.

NOTE: In some circumstances (e.g., the *EV* only supports one *Protocol Version*), it may be sufficient for the *EV* to read the `SeSupportedVersionX` values every time `SeVersionList` is received until it finds a match, ignoring the page number.

9.5.3.3 Once `EvStatusVer` = *Complete*, it shall remain *Complete* for the remainder of the *control sequence*.

If no match is found after all pages are read, the *EV* may continue as in 9.5.4 (if *PWM* is supported by the *EV*, and the *EV* detects *PWM* from the *SE*), or else the *EV* proceeds to 10.3.1.

9.5.4 Protocol Version Selection, Optional Sequence to Start PWM-CP

9.5.4.1 If the *EV* selected *PWM-CP* as described in 9.5.2.5, it shall ensure that `SeSelectedVersion` = *Protocol Version* 0_{10} (*PWM-CP*) is transmitted for at least one cycle through the *schedule Ver frames*.

NOTE: This is also recommended if the *SE* chooses *PWM-CP* as described in 9.5.2.2.

9.5.4.2 An *SE* then shall stop the *schedule Ver* and when willing and able to supply power, start sending 10 to 96% *PWM*.

If the *SE* detects *CP level* 6, after switching to *PWM-CP* as described in 9.5.2.2, it typically applies *PWM-CP* during the rest of the *connection session*; otherwise, if the *SE* does not detect *CP level* 6 within a time limit (application-specific), it may retry establishing *LIN-CP* using *schedule Ver*; see 9.4.1.2.

9.6 Initialization

NOTE: The use of AND and OR (in all caps) are the Boolean logical operators, where OR is inclusive.

9.6.1 Initialization Sequence

9.6.1.1 While `SeStatusVer` = *Complete* and `SeStatusInit` = (*Incomplete* OR *Error*), the *SE* and the *EV* shall perform the *Initialization task* as specified in this section.

9.6.1.2 During *Initialization*, the *SE* shall use *schedule Init* to enable the *SE* and the *EV* to exchange information about their AC voltage, current, and frequency limits. Both the *SE* and the *EV* determine that they are compatible to allow the *control sequence* to continue to *Operation* (see 9.7).

9.6.1.3 The *schedule Init* shall trigger the *frames* listed in Table 13 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 12.

If *Initialization* fails, see 10.4.

9.6.2 Initialization, Normal SE Sequence

9.6.2.1 If the *SE* can supply more than one nominal voltage, frequency, or phase configuration, then `SeNomVoltageL1N` and `SeNomVoltageLL` shall be *Not Available* at the beginning of *Initialization*, and the *SE* waits to indicate its supplied voltage until it has read the *EV* limits.

Then the *SE* selects and writes the *SE* limits that safely allow the optimal supply voltage or phase configuration (e.g., to accommodate two-wire single-phase vehicles).

9.6.2.2 If `SeNomVoltageL1N` = *Not Available* and `SeNomVoltageLL` = *Not Available* (the *SE* can supply more than one nominal voltage, frequency, or phase configuration), the *SE* shall first read `EvMaxVoltageL1N`, `EvMaxVoltageLL`, `EvMinCurrentX`, and `EvFrequencies`; and if compatible, then write appropriate values for `SeNomVoltageL1N` and `SeNomVoltageLL`, and set `SeMaxCurrentX` and `SeFrequency` appropriately to safely/optimally supply power.

9.6.2.3 Once the *SE* has read all *EV frames* in the *Init schedule*, and the *SE* reads `EvStatusInit` = *Complete*, it shall verify that the *EV* and the *SE* are compatible and then write `SeStatusInit` = *Complete.*

Compatibility is verified if:

((`SeNomVoltageL1N` AND `EvMaxVoltageL1N` are *valid values*) OR
(`SeNomVoltageLL` AND `EvMaxVoltageLL` are *valid values*)) AND
(`SeNomVoltageL1N` ≤ `EvMaxVoltageL1N` OR either side = *Not Available*) AND
(`SeNomVoltageL1N` ≥ `EvMinVoltageL1N` OR either side = *Not Available*) AND
(`SeNomVoltageLL` ≤ `EvMaxVoltageLL` OR either side = *Not Available*) AND
(`SeNomVoltageLL` ≥ `EvMinVoltageLL` OR either side = *Not Available*) AND
(`SeMaxCurrentL1` ≥ `EvMinCurrentL1` OR `EvMinCurrentL1` = *Not Available*) AND
(`SeMaxCurrentL2` ≥ `EvMinCurrentL2` OR
(`SeMaxCurrentL2` = 0 OR `EvMinCurrentL2` = *Not Available*)) AND
(`SeMaxCurrentL3` ≥ `EvMinCurrentL3` OR
(`SeMaxCurrentL3` = 0 OR `EvMinCurrentL3` = *Not Available*)) AND
(`EvMinCurrentX` ≤ current indicated by R_C; see Table B1)* AND
(`SeFrequency` (bitwise AND) `EvFrequencies` ≠ 0).

* This check is for *EVSE* with *socket-outlets* only.

9.6.2.4 The *SE* shall not set `SeStatusInit` = *Complete* unless it can continuously supply at least `EvMinCurrentX` while power is available.

9.6.2.5 If the *SE* does signal `SeStatusInit` = *Complete*, then during the *Op schedule*, the *SE* shall not reduce `SeAvailableCurrentX` below `EvMinCurrentX` while power is available. See 9.7.5.1.

NOTE: This requirement has special consideration for single-phase-only vehicles. As discussed in 8.3.21, both `SeAvailableCurrentL1` and `SeAvailableCurrentN` need to be set appropriately given `EvMinCurrentL1`.

9.6.2.6 Once `SeStatusInit` = *Complete*, it shall remain *Complete* for the remainder of the *control sequence*.

The *SE* continues as in 9.7.

9.6.3 Initialization, Normal EV Sequence

9.6.3.1 Only when the *EV* reads `SeNomVoltageL1N` ≠ *Not Available* OR `SeNomVoltageLL` ≠ *Not Available* (as described in 9.6.2.2), it shall then verify that the *EV* and the *SE* are compatible and then write `EvStatusInit` = *Complete.*

Compatibility is verified if:

((`SeNomVoltageL1N` AND `EvMaxVoltageL1N` are *valid values*) OR
(`SeNomVoltageLL` AND `EvMaxVoltageLL` are *valid values*)) AND
(`SeNomVoltageL1N` ≤ `EvMaxVoltageL1N` OR either side = *Not Available*) AND
(`SeNomVoltageL1N` ≥ `EvMinVoltageL1N` OR either side = *Not Available*) AND
(`SeNomVoltageLL` ≤ `EvMaxVoltageLL` OR either side = *Not Available*) AND
(`SeNomVoltageLL` ≥ `EvMinVoltageLL` OR either side = *Not Available*) AND
(`SeMaxCurrentL1` ≥ `EvMinCurrentL1` OR `EvMinCurrentL1` = *Not Available*) AND
(`SeMaxCurrentL2` ≥ `EvMinCurrentL2` OR
(`SeMaxCurrentL2` = 0 OR `EvMinCurrentL2` = *Not Available*)) AND
(`SeMaxCurrentL3` ≥ `EvMinCurrentL3` OR
(`SeMaxCurrentL3` = 0 OR `EvMinCurrentL3` = *Not Available*)) AND
(`EvMinCurrentX` ≤ current indicated by R_6; see Table 10)* AND
(`SeFrequency` (bitwise AND) `EvFrequencies` ≠ 0).

*This check is for *coupler* types with current coding resistors only.

9.6.3.2 Once `EvStatusInit` = *Complete*, it shall remain *Complete* for the remainder of the *control sequence*.

9.7 Operation

9.7.1 Operation Sequence Start

9.7.1.1 While `SeStatusVer` = *Complete* AND `SeStatusInit` = *Complete*, the *SE* and the *EV* shall perform the *Operation task* as specified in this section.

9.7.1.2 During *Operation*, the *SE* shall use *schedule Op* to enable the *SE* and the *EV* to exchange *signals* to control the AC voltage and current.

9.7.1.3 The *schedule Op* shall trigger the *frames* listed in Table 13 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 12.

9.7.2 Operation, Voltage Control

The *EV* closes S_2 only when permitted by both the *EV* and the *SE*. See 9.7.2.4. Permission from the *EV* (`EvStatusOp` = *Permit_V*) should be interpreted by the *SE* as a desire to charge. The *SE* closes the *contactor* when the *EV* closes S_2 if permitted by both the *EV* and the *SE*. At this point, voltage is supplied. See 9.7.2.5.

The logic for normal control of S_2 in the *EV* and the *contactor* in the *SE* is illustrated by the equivalent logic diagrams in Figure 15.

In exceptional cases (e.g., *ground* fault or isolation fault), the S_2 or the *contactor* may be opened by internal *EV* or *SE* hardware. SAE J3068 does not specify how to implement such functionality.

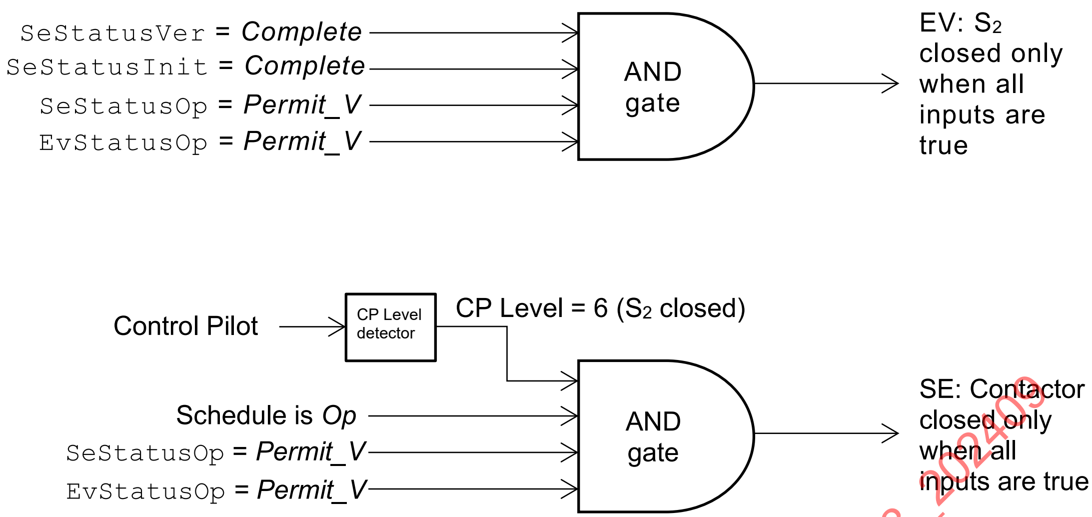

Figure 15 - Control logic concepts for S_2 and contactor, informative

If the *inlet locking mechanism* is electronically controlled, and the *inlet* is not *locked*, it is *locked* before the *EV* sets `EvStatusOp` = *Permit_V*. See 5.4.3.

9.7.2.1 Before the *EV* sets `EvStatusOp` = *Permit_V*, it shall verify the *inlet* is *locked*. See 5.4.3.

9.7.2.2 When the *EV* wants to receive AC voltage, it shall write `EvStatusOp` = *Permit_V*.

NOTE: The *EV* may write `EvStatusOp` = *Permit_V* regardless of the value in `SeStatusOp`.

If the *EV* does not want to receive AC voltage while in *schedule Op*, the *EV* may write an applicable value to an `EvInfoEntryX` *signal* to indicate why it indicates `EvStatusOp` = *Deny_V*.

9.7.2.3 When the *SE* is willing to supply AC voltage, it shall write `SeStatusOp` = *Permit_V*.

If the *SE* is not immediately willing to supply AC voltage, the *SE* may write an applicable value to an `SeInfoEntryX` *signal* to indicate why it indicates `SeStatusOp` = *Deny_V*.

9.7.2.4 When `EvStatusOp` = *Permit_V* AND the *EV* reads `SeStatusOp` = *Permit_V* (AND `SeStatusVer` and `SeStatusInit` = *Complete*), the *EV* shall close S_2 within $T_{EVclose}$ (3 seconds).

9.7.2.5 When `SeStatusOp` = *Permit_V* AND the *SE* reads `EvStatusOp` = *Permit_V* AND the *SE* detects *CP level* 6 (AND the *schedule* is *Op*), the *SE* shall close the *contactor* within $T_{SEclose}$ (3 seconds).

To ensure reliable operation, measurement of the *CP level* is fault tolerant:

9.7.2.6 If the *SE* detects *CP level* 9 (or *CP level* 3) for T_{glitch} (≤1 second) while `EvStatusOp` = *Permit_V* (and all other conditions for closing the *contactor* are still met), the *SE* shall not open the *contactor*.

9.7.2.7 If the *EV* measures *CP levels* for fault detection that would result in an interruption of charging, it shall not set `EvStatusOp` = *Deny_V* or open S_2 for conditions lasting T_{glitch} (≤1 second).

To ensure reliable operation, measurement of the *prox* voltage is fault tolerant:

9.7.2.8 If the *EV* detects an unexpected *prox* voltage (other than error or no *connector* inserted; see Table 11 lines 1, 2, and 11), it shall not set `EvStatusOp` = *Deny_V* or open S_2 for conditions lasting T_{glitch} ≤ (1 second).

EXAMPLE: The preceding requirement is meant to reduce interruptions to the *control sequence* caused by noise on the *prox*. For example, if during *Operation*, an *EV* with a 32 A cable connected detects an SAE J1772/SAE J3400 *connector* connected (an adjacent *proximity* circuit status), or the undefined space between statuses for T_{glitch} ≤ (1 second); charging is not interrupted.

NOTE: The requirements 9.7.2.7 and 9.7.2.8 do not preclude a temporary ramp-down of load current as required by Table 11.

9.7.3 Operation, Current Control

Current control uses static limits determined during *Initialization* and other information (static or dynamic) exchanged with a grid energy management system, the *electric vehicle* charging control, vehicle climate system, other external systems, etc.

The *EV* may use `EvRequestedCurrentX` to inform an energy management system. These values may be lower or higher than the corresponding `SeAvailableCurrentX` *signals*. For example, the *EV* may inform the *SE* that the *EV* goes to a standby state by writing a very low value (e.g., 1 A) to `EvRequestedCurrentX` when the battery is fully charged or when the tariff is high.

The *EV* may use `EvPresentCurrentX` to inform the *SE*. The *SE* may use this information to confirm load current, etc.

9.7.3.1 While the *contactor* is closed, the *SE* shall write values to `SeAvailableCurrentX` to indicate the maximum allowed *EV* load current. The values may be constant or may vary during *Operation*.

9.7.3.2 If an external energy management system reduces the available supply current, the *SE* shall adapt `SeAvailableCurrentX` to the new values within $T_{SEadapt}$ (10 seconds). However, it is recommended that the *SE* adapt as quickly as possible.

9.7.3.3 The *EV* shall not draw load current exceeding the `SeAvailableCurrentX` values.

9.7.3.4 The *EV* shall not draw load current exceeding the value indicated by a current coding resistor (if present in that *coupler* type) unless it confirms the absence of *EV cable assemblies* (*case B*) and the absence of dumb *coupler* adapters (those without cable nodes) via `SeConnectionType` and `EvConnectionType`; see Table 11 and 9.4.1.1.

9.7.3.5 *SE* shall only signal `SeAvailableCurrentX` greater than their current coding resistor (if present) indicates, unless it is *case C* and has confirmed the absence of dumb *coupler* adapters (those without cable nodes) via `SeConnectionType` and `EvConnectionType`. See 5.3.2.1.

If the *SE* monitors the *EV's* charge current for purposes of terminating charging due to excess current draw, it is recommended to only do so after 1.3 A above `SeAvailableCurrentX` for values under 12 A, or above 111% of `SeAvailableCurrentX` for values above 12 A. Prior to terminating charging, the *SE* should initially attempt to mitigate minor excess current by reducing the `SeAvailableCurrentX` as appropriate. This strategy reduces the risk of a charging failure.

9.7.3.6 If the *SE* reduces `SeAvailableCurrentX` to values lower than the present load current, the *EV* shall adapt to the new values within $T_{EVadapt}$ (5 seconds). However, it is strongly recommended that the *EV* adapt as quickly as possible.

9.7.4 EV Commands Interruption of the AC Supply Voltage

The *EV* may, at any time, command interruption of the AC supply voltage by writing `EvStatusOp` = *Deny_V* and opening S_2. The *EV* may write an applicable value to an `EvInfoEntryX` *signal* to indicate why the supply was interrupted.

9.7.4.1 Before interrupting the AC supply voltage, the *EV* shall normally reduce the load current to ≤1 A.

In exceptional cases, the *EV* may write `EvStatusOp` = *Deny_V* and/or open S_2 at any load current.

9.7.4.2 When the *SE* reads `EvStatusOp` = *Deny_V* or detects *CP level* 9, it shall open the *contactor* within T_{SEopen} (3 seconds). See 9.7.2.6.

NOTE: To improve noise immunity, the timing in this requirement is based on SAE J1772, not IEC 61851-1, Annex A.

9.7.4.3 If the *EV* again becomes ready to receive voltage, it shall write `EvStatusOp` = *Permit_V*. If the *EV* also reads `SeStatusOp` = *Permit_V*, the *control sequence* shall then proceed as specified in 9.7.2.4.

9.7.5 SE Interrupting the AC Supply Voltage

The *SE* may, at any time, interrupt the AC supply voltage by writing `SeStatusOp` = *Deny_V* and opening the *contactor*. The *SE* may write an applicable value to an `SeInfoEntryX` *signal* to indicate why the supply was interrupted.

9.7.5.1 Before interrupting the AC supply voltage, the *SE* shall normally write all `SeAvailableCurrentX` = 0 and wait $T_{rampdown}$ (6 seconds) to allow the *EV* to stop the load current before signaling `SeStatusOp` = *Deny_V*. The *SE* may signal `SeStatusOp` = *Deny_V* sooner if it reads all `EvPresentCurrentX` ≤ 1.

In exceptional cases (e.g., if the *EV* does not reduce the load current as required by the *SE*), the *SE* may open the *contactor* and write `SeStatusOp` = *Deny_V* at any load current.

9.7.5.2 When the *EV* reads `SeStatusOp` = *Deny_V*, it shall stop drawing current if possible, and if it has not done so already, open S_2 within T_{EVopen} (3 seconds).

9.7.5.3 The *SE* shall open the *contactor* within T_{SEopen} (3 seconds) of the *EV* opening S_2 (see 9.7.4.2) and may open the *contactor* after $T_{rampdown}$ (6 seconds) of signaling `SeAvailableCurrentX` = 0 if the *EV* has not responded appropriately.

9.7.5.4 If the *SE* again becomes ready to supply voltage, it shall write `SeStatusOp` = *Permit_V*. If the *SE* also reads `EvStatusOp` = *Permit_V* and detects *CP level* 6, the *control sequence* shall then proceed as specified in 9.7.2.5.

9.8 Connection Session End, Initiated by the User

The *connection session* ends when the user removes the *connector* from the *inlet*.

SAE J3068 does not specify how a user can initiate a *connection session* end. This is up to the *EV* manufacturer (for example, when to *unlock* the *inlet* after a *control sequence*). Only a *connection session* ended by the *EV* is considered here. If the *SE* wishes to end a *connection session*, it may command interruption of the AC supply as described in 9.7.5 but it cannot guarantee the *inlet* will be *unlocked*. See 5.4.3.

9.8.1 Connection Session End While AC Voltage Is Not Supplied

9.8.1.1 When the user requests the *connection session* to end while the *contactor* is open, the *EV* shall *unlock* the *inlet* within T_{unlock} (3 seconds) if the *locking mechanism* is electronically controlled and not already *unlocked*.

9.8.1.2 When the *EV* detects that the *proximity* circuit is no longer connected (the *connector* is removed), the *EV* shall no longer be immobilized.

9.8.2 Connection Session End While AC Voltage Is Supplied

9.8.2.1 When the user requests the *EV* to end the *connection session*, the *EV* shall command interruption of the AC supply as described in 9.7.4.

9.8.2.2 After T_{SEopen} or sooner if the *EV* reads all `SeAvailableCurrentX` = 0 (see 9.7.4.2), the *EV* shall proceed from 9.8.1.1.

10. APPLICATION PROGRAM, EXCEPTIONAL EVENTS

10.1 LIN Sleep

While S_2 is open and the *CP level* is 9 (AC voltage is not supplied), the *EV* and the *SE* may interrupt the *LIN* communication and set their *LIN* transceivers to *LIN* sleep mode. *LIN* sleep is specified in ISO 17987-2. All *LIN* transceivers have a control input which the *MCU* can use to control the sleep mode (disable or enable the transceiver).

To safely start communication again after *LIN* sleep, the system always *restarts* with *schedule Ver* and all *signals* reset to *start values*.

10.1.1 Going to LIN Sleep

10.1.1.1 If S_2 is open and the *EV* determines to request to go to *LIN* sleep, it shall write `EvAwake` = 0.

10.1.1.2 If the *SE* supports sleep, then when the *SE* reads `EvAwake` = 0, the *SE* shall stop the present *schedule*, send go-to-sleep commands, set all of its *published* and *subscribed signals* to *start values* (see 8.3), and go to *LIN* sleep.

10.1.1.3 When the *EV* receives a go-to-sleep command, the *EV* shall set all of its *published* and *subscribed signals* to *start values* (see 8.3) and go to *LIN* sleep.

10.1.1.4 If the user requests the *connection session* to end, while the *EV* is in *LIN* sleep, the *EV* shall proceed as specified in 9.8.1.

10.1.2 EV Wakes Up the SE

10.1.2.1 If the *EV* determines to wake up from *LIN* sleep, it shall send wake-up *signals* (refer to ISO 17987-2).

10.1.2.2 When the *SE* detects *LIN* wake-up *signals*, it shall wake up, start *schedule Ver*, and then proceed as specified in 9.5, *Protocol Version* selection.

10.1.3 SE Wakes Up the EV

10.1.3.1 If the *SE* determines to wake up from *LIN* sleep, it shall start *schedule Ver* and then proceed as specified in 9.5, *Protocol Version* selection.

10.1.3.2 If the *EV* detects *LIN headers* from the *SE*, it shall wake up and proceed as specified in 9.5, *Protocol Version* selection.

10.2 Intentional Restart of the Control Sequence During Initialization or Operation

During *Initialization* or *Operation*, the *EV* or the *SE* may request to *restart* the *control sequence* from *Protocol Version* selection by following the steps below. This can be used to renegotiate *Protocol Version*, for example.

10.2.1 EV Determines to Request a Restart

10.2.1.1 Before requesting a *restart* while S_2 is closed, the *EV* shall request interruption of the supply voltage as specified in 9.7.4.

10.2.1.2 When S_2 is open, the *EV* may request a *restart* by resetting all *published* and *subscribed signals* to *start values* in the *EV* (see 8.3). In this case, the *SE* shall respond to `EvSelectedVersion` = *Not Available* by *restarting*.

10.2.1.3 If the *SE* reads `EvSelectedVersion` = *Not Available* AND `SeStatusVer` = *Complete*, it shall stop the present *schedule*, reset all *published* and *subscribed signals* to *start values* in the *SE* (see 8.3) and start *schedule Ver* to *restart* the *Protocol Version* selection.

10.2.1.4 The *control sequence* shall continue as in 9.5.

10.2.2 SE Determines to Request a Restart

10.2.2.1 Before requesting a *restart* while the *contactor* is closed, the *SE* shall interrupt the supply voltage as specified in 9.7.5.

10.2.2.2 When the *contactor* is open, the *SE* may trigger a *restart*. In this case, the *SE* shall reset all *published* and *subscribed signals* to *start values* in the *SE* (see 8.3).

10.2.2.3 If the *EV* reads `SeSelectedVersion` = *Not Available* AND `EvStatusVer` = *Complete*, the *EV* shall stop drawing current, the *EV* shall reset all *published* and *subscribed signals* to *start values* (see 8.3) and wait for the *SE* to start *schedule Ver* to *restart* the *Protocol Version* selection.

10.2.2.4 The sequence shall continue as in 9.5.

10.3 Protocol Version Selection Fails

10.3.1 EV Determines That Protocol Version Selection Fails

10.3.1.1 If the *EV* determines that *Protocol Version* selection is not successful within T_{ver} (5 seconds) (e.g., *SE* and *EV* have no common *Protocol Version*), the *EV* shall write `EvStatusVer` = *Error* and the *EV* may write an applicable value to an `EvInfoEntryX` *signal* to indicate that *Protocol Version* selection failed. The communication may continue for a limited time using *schedule Ver.* The *EV* may request to go to *LIN* sleep as specified in 10.1.1.

10.3.2 SE Determines That Protocol Version Selection Fails

10.3.2.1 If the *SE* determines that *Protocol Version* selection is not successful within T_{ver} (5 seconds) (e.g., *SE* and *EV* have no common *Protocol Version*, or the *EV* selects a version that the *SE* does not support), the *SE* shall write `SeStatusVer` = *Error* and the *SE* may write an applicable value to an `SeInfoEntryX` *signal* to indicate that *Protocol Version* selection failed. The communication may continue for a limited time using *schedule Ver.* The *EV* may request to go to *LIN* sleep as specified in 10.1.1.

10.4 Initialization Fails

10.4.1 EV Determines That Initialization Fails

If the *EV* determines that *Initialization* cannot be performed correctly, the *EV* may (for a limited number of retries) request a *restart* as described in 10.2.1.

10.4.1.1 If the *EV* determines that *Initialization* is not successful within T_{init} (5 seconds) (e.g., *SE* and *EV* are not compatible), the *EV* shall write `EvStatusInit` = *Error* and the *EV* may write an applicable value to an `EvInfoEntryX` *signal* to indicate that *Initialization* failed. The communication may continue for a limited time using *schedule Init* or the *EV* may request to go to *LIN* sleep as specified in 10.1.1.

10.4.2 SE Determines That Initialization Fails

If the *SE* determines that *Initialization* cannot be performed correctly, the *SE* may (for a limited number of retries) request a *restart* as described in 10.2.2.

10.4.2.1 If the *SE* determines that *Initialization* is not successful within T_{init} (5 seconds) (e.g., *SE* and *EV* are not compatible), the *SE* shall write `SeStatusInit` = *Error* and the *SE* may write an applicable value to an `SeInfoEntryX` *signal* to indicate that *Initialization* failed. The communication may continue for a limited time using *schedule Init* or the *EV* may request to go to *LIN* sleep as specified in 10.1.1.

10.5 Loss of SE Communication/Control Power

A power outage in the *SE* may affect the AC power provided to the vehicle or the power to the communication/control electronics, or both. Only control power outage is treated here.

10.5.1 Loss of SE Communication/Control Power Requirements

10.5.1.1 If the *SE* has a control power outage during charging and the *EV* detects this as *CP level* 0 while the *proximity* circuit is still connected, the *EV* shall prepare for *restart* (as described in relevant sections of 10.2.1) the *control sequence*. The *EV* may go to *LIN* sleep to save power. When the *EV* detects *CP level* ≠ 0 (*SE* control power returns), the *EV* shall wake up its *LIN* transceiver and proceed as in 9.4.

10.5.1.2 If control power returns to the *SE* and the *SE* detects *CP level* 9, it shall *restart* the *control sequence* from 9.4.1.2.

10.5.1.3 If the user requests the *connection session* to end while there is an *SE* control power outage, the *EV* shall proceed as specified in 9.8.1.

10.6 SE or EV MCU Watchdog Reset

10.6.1 SE MCU Watchdog Reset

10.6.1.1 If the *SE MCU* is reset by a watchdog circuit, it shall *restart* the *control sequence* from 9.4.1.2.

10.6.1.2 The *EV* shall continue as in 10.2.2.3.

10.6.2 EV MCU Watchdog Reset

10.6.2.1 If the *EV MCU* is reset by a watchdog circuit, it shall *restart* the *control sequence* from 9.4.1.3.

10.6.2.2 The *SE* shall continue as in 10.2.1.3.

10.7 LIN Communication Interrupted

10.7.1 EV Detects No LIN Headers

10.7.1.1 If the *EV* detects no *LIN headers* for more than T_{noLIN} (2 seconds) while S_2 is closed, the *EV* shall command interruption of the AC supply voltage within T_{EVopen} (3 seconds) after reception of the last *LIN header*. See 9.7.4 for AC interruption procedure.

10.7.1.2 If the *EV* detects no *LIN headers* for more than T_{noLIN} (2 seconds) while S_2 is open and *LIN* sleep has not been agreed (see 10.1.1), the *EV* shall *restart* as described in 9.4.1.3, to be ready to *restart* the *control sequence* if the *SE* resumes sending *headers*.

After the *EV* has requested a *restart*, it may write an applicable value to an `EvInfoEntryX` *signal* to indicate that it did not detect *LIN headers*.

10.7.2 SE Detects No LIN Responses

10.7.2.1 If the *SE* detects no *LIN responses* for more than T_{noLIN} (2 seconds) while the *contactor* is closed, it shall interrupt the AC supply voltage within T_{SEopen} (3 seconds) of the last *response*. See 9.7.5 for AC interruption procedure.

10.7.2.2 If the *SE* detects no *LIN responses* for more than T_{noLIN} (2 seconds), while the *contactor* is open, it shall trigger a *restart* as described in 9.4.1.2 and be ready to continue the new *control sequence* if the *EV* resumes sending *responses*.

After the *SE* has triggered a *restart*, it may write an applicable value to an `SeInfoEntryX` *signal* to indicate that it did not detect *LIN responses*.

10.8 Faults

10.8.1 EV Detects an Internal Fault

10.8.1.1 If internal *EV* testing indicates that charging is not possible while S_2 is open, the *EV* shall write the value *Error* to the appropriate status *signal*, depending on the present *task* and *schedule*.

EXAMPLE: `EvStatusVer` = *Error*, `EvStatusInit` = *Error*, or `EvStatusOp` = *Error*. The *EV* may also write an applicable value to an `EvInfoEntryX` *signal* to indicate why charging is not possible. The *EV* and the *SE* may go to *LIN* sleep.

10.8.1.2 If internal *EV* testing indicates that charging should be stopped while S_2 is closed, the *EV* shall command interruption of the AC voltage supply as described in 9.7.4, and then perform as specified in 10.8.1.1.

10.8.2 SE Detects Internal Fault

10.8.2.1 If internal *SE* hardware testing indicates that charging is not possible while the *contactor* is open, the *SE* shall write the value *Error* to the appropriate status *signal*, depending on the present *task* and *schedule*.

EXAMPLE: `SeStatusVer` = *Error*, or `SeStatusInit` = *Error*, or `SeStatusOp` = *Error*. The *SE* may also write an applicable value to an `SeInfoEntryX` *signal* to indicate why charging is not possible. The *EV* and the *SE* may go to *LIN* sleep.

10.8.2.2 If internal *SE* hardware testing indicates that charging should be stopped while the *contactor* is closed, the *SE* shall interrupt the AC voltage supply as described in 9.7.5, and then perform as specified in 10.8.2.1.

10.8.3 SE Detects CP Level 0

10.8.3.1 If the *SE* detects *CP level* 0 while the *contactor* is closed, it shall interrupt the AC voltage supply as described in 9.7.5, and then *restart* according to 9.4.

CP level 0 may be caused by a short circuit between the *CP conductor* and the *ground conductor*, or by a hardware fault in the *SE* or *EV control pilot* interfaces.

10.8.4 SE Detects CP Level 12

10.8.4.1 If the *SE* detects *CP level* 12 while the *contactor* is closed, it shall open the *contactor* within T_{SE_12} (100 ms) and write `SeStatusOp` = *Deny_V*.

CP level 12 may be caused by either the *connector* being unplugged (the *inlet locking mechanism* has a fault), the *CP conductor* being interrupted, the *ground conductor* being interrupted, or by a hardware fault in the *SE* or *EV control pilot* interfaces.

10.8.5 EV Detects Unexpected Inlet Unlock

10.8.5.1 If the *locking mechanism* is of the manually actuated type or the manual override is readily accessible, and while voltage is being supplied, the *EV* detects the *inlet* is *unlocked*; the *EV* shall stop drawing current within $T_{EV\_unlocked}$ (100 ms). See 5.4.3.

10.8.5.2 If, while voltage is being supplied, the *EV* detects the *inlet* is *unlocked* for more that T_{glitch} (1 second), it shall request the interruption of supply voltage as specified in 9.7.4.

11. RECOMMENDED DIAGNOSTIC INFORMATION EXCHANGE

This *Protocol Version* defines two paged *frames* which are used to exchange information about faults and other conditions about the current or previous *control sequence.* See 8.4.2.

11.1 EvInfoEntryX and SeInfoEntryX Signal Values

Tables 15 and 16 show defined values for the *signals* in `EvInfoEntryX` and `SeInfoEntryX`. See 8.3.4 and 8.3.24. It is intended that the *SE* be aware of conditions affecting the *EV*, and vice versa. Values should be sent every paging cycle while the condition is active, and cease being sent once the condition is no longer active. Values marked with an asterisk (*) may also be sent during *schedule Ver* in the *control sequence* after they occur within a *connection session* to indicate why the *control sequence* was *restarted*.

SAE J3068 *Protocol Version* 2 does not require the use of these *signals.* It is permissible, but not recommended, to leave all entries set to *Not Available*. Other *Protocol Versions* may require the use of these *signals*.

EXAMPLE: If the *SE*'s *CCID* trips, it should set the appropriate value ($2B_{16}$ or $2C_{16}$) in an `SeInfoEntryX` *signal*; the *EV* will then be aware of why charging was interrupted. This information could be used by an *EV* technician to diagnose a no-charge condition. See 3.7.

Table 15 - EvInfoEntryX values

Value	Description	Reference	Introduced
00_{16} to 10_{16}	Reserved		
11_{16}	*EV* determines that *Protocol Version* selection fails	10.3.1	SAE J3068
12_{16}	*EV* determines that *Initialization* fails	10.4.1	SAE J3068
13_{16}*	*EV* determines to *restart* the *control sequence* to reselect *Protocol Version*	10.2.1	SAE J3068
14_{16}	[This value is deprecated]		
15_{16}*	*EV* needs to *restart* the *control sequence* after an *MCU* reset	10.6.2	SAE J3068
16_{16}*	*EV* needs to *restart* the *control sequence* after detecting *CP* level 0 while the *proximity* circuit is connected (e.g., loss of *SE* communication/control power)	10.5	SAE J3068
17_{16}*	*EV* detects no *LIN headers* for longer than T_{noLIN}	10.7.1	SAE J3068
18_{16}*	*EV* determines to *restart* the *control sequence* after detecting a recoverable internal fault	10.7.2	SAE J3068
19_{16}	*EV* will terminate charging, an unrecoverable internal fault was detected	10.8.1	SAE J3068
$1A_{16}$	Maximum available current is too low	10.4.1	SAE J3068
$1B_{16}$	Minimum available voltage is too high	10.4.1	SAE J3068
$1C_{16}$	Frequency does not match	10.4.1	SAE J3068
$1D_{16}$	Charging delayed due to energy management system	9.7.2.2	SAE J3068
$1E_{16}$	*EV* isolation fault		SAE J3068
$1F_{16}$	*EV* is not immediately ready to receive AC voltage	9.7.2.2	SAE J3068
20_{16}	*EV* requests the AC supply voltage to be interrupted by reducing the load current to <1 A, writing `EvStatusOp` = *Deny_V* and opening S_2	9.7.4	SAE J3068
21_{16}	*EV* requests the AC supply voltage to be interrupted by immediately opening S_2	9.7.4	SAE J3068
22_{16}	Maximum available voltage is too low		SAE J3068
23_{16}	Unable to *lock* the charging *inlet*, charging delayed until *lock* succeeds		SAE J3068
24_{16}	Paging error	8.4.2	SAE J3068
25_{16}	*EV* requires at least `EvMinCurrentX` to supply a fixed load at the present time	8.3.9	SAE J3068
26_{16}	*EV* requires no additional energy during this *connection session* (e.g., HVESS full)		SAE J3068/1
27_{16}	Temporary conditions preventing charging exist (e.g., HVESS under temperature)		SAE J3068/1
28_{16}	Fatal error prevents charging – *EV* may require service		SAE J3068/1
29_{16}	*EV* determines connection with *SE* is incompatible		SAE J3068/1
$2A_{16}$	Charging delayed for identification or affiliation		SAE J3068/1
$2B_{16}$	Charging disallowed due to missing or invalid identity		SAE J3068/1
$2C_{16}$	*Proximity* power requested		SAE J3068/2
$2D_{16}$	*EV* detects *inlet* overtemperature		SAE J3068
$2F_{16}$	*EV* detects *proximity* out of range		SAE J3068
30_{16}-DF_{16}	Reserved		
$E0_{16}$-FE_{16}	Manufacturer-specific		SAE J3068
FF_{16}	Empty (default)		SAE J3068

* These codes may appear in *schedule Ver* to signify a fault in a previous *control sequence*. In this context, they are informational and should not be construed to mean the current *control sequence* cannot continue normally.

Table 16 - SeInfoEntryX values

Value	Description	Reference	Introduced
00_{16} to 10_{16}	Reserved		
11_{16}	*SE* determines that *Protocol Version* selection fails	10.3.2	SAE J3068
12_{16}	*SE* determines that *Initialization* fails	10.4.2	SAE J3068
13_{16}*	*SE* determines to *restart* the *control sequence* to reselect *Protocol Version*	10.2.2	SAE J3068
14_{16}	[This value is deprecated]		
15_{16}*	*SE* needs to *restart* the *control sequence* after an *MCU* reset	10.6.1	SAE J3068
16_{16}*	*SE* needs to *restart* the *control sequence* after a loss of *SE* communication/control power	10.5	SAE J3068
17_{16}*	*SE* detects no *LIN responses* for longer than T_{noLIN}	10.7.2	SAE J3068
18_{16}*	*SE* needs to *restart* the *control sequence* after detecting an internal fault	10.8.2	SAE J3068
19_{16}	Charging delayed due to energy management system	9.7.2.3	SAE J3068
$1A_{16}$	Charging stopped by user, for example the stop button on the charging station is pressed		SAE J3068
$1B_{16}$	Maximum available current is too low (`SeMaxCurrentX` < `EvMinCurrentX`)	10.4.2	SAE J3068
$1C_{16}$	Minimum available voltage is too high (lowest `SeNomVoltage` > `EvMaxVoltage`)	10.4.2	SAE J3068
$1D_{16}$	Frequency does not match	10.4.2	SAE J3068
$1E_{16}$	*Initialization* timeout at *EVSE*	10.4.2	SAE J3068
$1F_{16}$	Overtemperature in *connector*		SAE J3068
20_{16}	Overtemperature internally		SAE J3068
21_{16}	Temperature sensor irrational		SAE J3068
22_{16}	Overcurrent (*EV* load current is too high)		SAE J3068
23_{16}	Current sensor irrational		SAE J3068
24_{16}	Voltage sensor irrational		SAE J3068
25_{16}	Pilot voltage fault		SAE J3068
26_{16}	AC supply *contactor* fault		SAE J3068
27_{16}	Input AC supply miswired		SAE J3068
28_{16}	Measured AC supply input is over voltage		SAE J3068
29_{16}	Measured AC supply input is under voltage		SAE J3068
$2A_{16}$	*CCID* self-test fault		SAE J3068
$2B_{16}$	*CCID* tripped – *SE* will auto-retry		SAE J3068
$2C_{16}$	*CCID* tripped – retry limit exceeded/no auto-retry allowed		SAE J3068
$2D_{16}$	Breaker tripped		SAE J3068
$2E_{16}$	*Ground* monitor circuit fault		SAE J3068
$2F_{16}$	*EVSE* configuration error		SAE J3068
30_{16}	Improper *grounding* or *ground* is not present		SAE J3068
31_{16}	Problem with *EV* communications - Disconnect and *restart*		SAE J3068
32_{16}	Internal *EVSE* fault - Call for service		SAE J3068
33_{16}	Maximum available voltage is too low		SAE J3068
34_{16}	Paging error	8.4.2	SAE J3068
35_{16}	*SE* determines connection with *EV* is incompatible		SAE J3068/1
36_{16}	Charging delayed for identification or affiliation		SAE J3068/1
37_{16}	Charging delayed for payment (external or plug-&-charge)		SAE J3068/1
38_{16}	Charging disallowed due to missing or invalid identity		SAE J3068/1
39_{16}	*SE* determines the requested energy or range cannot be achieved by the departure time: Charging will continue at maximum rate		SAE J3068/1
$3A_{16}$	*SE* requests the *EV unlock* its *inlet* (non-binding)		SAE J3068/1
$3B_{16}$	*Proximity* power requested		SAE J3068/2
$3C_{16}$	*SE* detects *proximity* out of range		SAE J3068
$3D_{16}$-DF_{16}	Reserved		
$E0_{16}$-FE_{16}	Manufacturer-specific		SAE J3068
FF_{16}	Empty (default)		SAE J3068

* These codes may appear in *schedule Ver* to signify a fault in a previous *control sequence*. In this context, they are informational and should not be construed to mean the current *control sequence* cannot continue normally.

12. NOTES

12.1 Revision Indicator

A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

PREPARED BY SAE TRUCK AND BUS ELECTRICAL SYSTEMS COMMITTEE

APPENDIX A - OVERVIEW OF HARDWARE STATUS, LIN COMMUNICATION SIGNAL VALUES, AND TIMINGS DURING A REPRESENTATIVE (CASE C) CONNECTION SESSION

Table A1 - Representative connection session flow (Informative)

Hardware Status:	**Before Connection Session**	**Connection Session Start** 9.4	**Protocol Version Selection** 9.5	**Initialization** 9.6	**Operation, Contactor Open** 9.7.2	**Operation, Contactor Closed - Current Allowed** 9.7.3	**SE Commanded Shutdown** 9.7.5	**Operation, Current Allowed** 9.7.3	**Connection Session End** 9.7.4/9.8	**After Connection Session**
Plug-in status	unplugged	plugged in								unplugged
SE CP level	12	9			6		9	6	9	12
EV CP level	0	9			6		9	6	9	0
EV proximity circuit	disconnected	connected								disconnected
EV inlet locking mechanism	*unlocked*	Application-dependent			*locked*				*unlocked*	
EV S_2 switch*	open				closed		open	closed	open	
SE contactor	open					closed	open	closed	open	
EV load current	0					≥ 0	0	≥ 0	0	
LIN Signals:										
`EvStatusVer`		*Incomplete*		*Complete*						
`SeStatusVer`		*Incomplete*		*Complete*						
`EvStatusInit`		*Incomplete*			*Complete*					
`SeStatusInit`		*Incomplete*			*Complete*					
`EvStatusOp`*		*Deny_V*			*Permit_V*				*Deny_V*	
`SeStatusOp`*		*Deny_V*			*Permit_V*		*Deny_V*	*Permit_V*		
`SeAvailableCurrentX`		0			≥ 0		0	≥ 0	0	
`EvRequestedCurrentX`		0			≥ 0				0	
`EvPresentCurrentX`		0				≥ 0	0	≥ 0	0	
SE LIN Schedules:		***Ver***		***Init***	***Op***					
Timings of Interest:		1, 2	3	4	5, 6		7, 8	5, 6	9, 10	

Note: Not all changes shown to be simultaneous are required to be. In some cases, one occurs no later than its counterparts; in others, no specific sequence is expected. See Section 9 for details.

* For relationship between `EvStatusOp`, `SeStatusOp`, and S_2 see 9.7.2.

Timings (see Table 14 for limits)

1. $T_{SEstart}$ Maximum time for *SE* to start *LIN schedule*
2. $T_{EVstart}$ Maximum time (after the *LIN schedule* begins) for *EV* to respond to *LIN signals*
3. Time to complete *Protocol Version* selection. Typically, <50 ms unless one or both devices support substantially more than four *Protocol Versions.*
4. Time to complete *Initialization*. Typically, <200 ms.
5. $T_{EVclose}$ Maximum time for *EV* to close S_2
6. $T_{SEclose}$ Maximum time for *SE* to close *contactor*
7. $T_{rampdown}$ Minimum time for *SE* to wait for *EV* to stop drawing current before opening *contactor*
8. T_{EVopen} Maximum time for *EV* to open S_2 when *SE* disallows charging
9. T_{SEopen} Maximum time for *SE* to open *contactor* under normal conditions
10. T_{unlock} Maximum time for *EV* to *unlock* the *inlet*

APPENDIX B - UNIVERSAL SOCKET-OUTLET AC POWER TRANSFER

This edition of SAE J3068 introduces charging with a user-detachable *EV cable assembly* from a *socket-outlet* that is defined internationally and is widely deployed. This appendix can be used to achieve AC charging with different vehicle *inlets* which share the same infrastructure without adapters, because an *EV cable assembly* can be fitted with the vehicle *connector* appropriate for the *inlet* (SAE J1772, SAE J3068 AC_6, or SAE J3400).

Universal plug <-> SAE J1772 *connector* provides single-phase power (32 A, 48 A, 70 A)

Universal plug <-> SAE J3068 *connector* provides single or multi-phase power (32 A, 63/70 A)

Universal plug <-> SAE J3400 *connector* provides single-phase power (32 A, 48 A, 70 A)

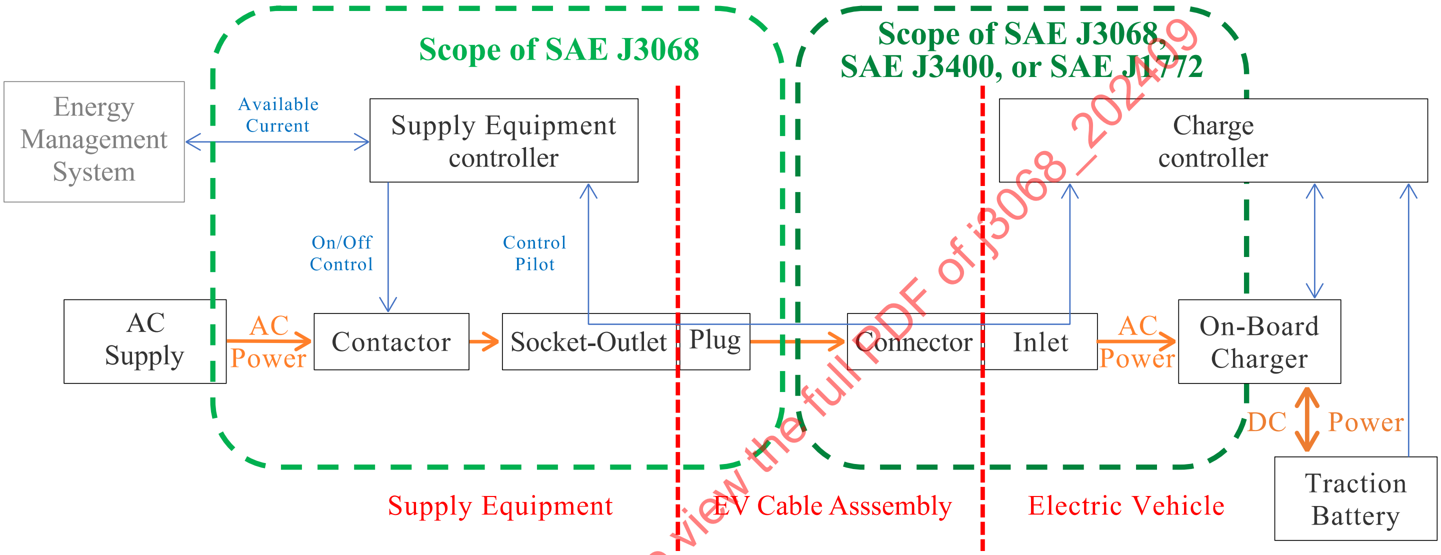

Figure B1 - General AC conductive charging system topology for case B

B.1 UNIVERSAL AC POWER TRANSFER

B.1.1 Mechanicals for Socket-Outlet and Plugs

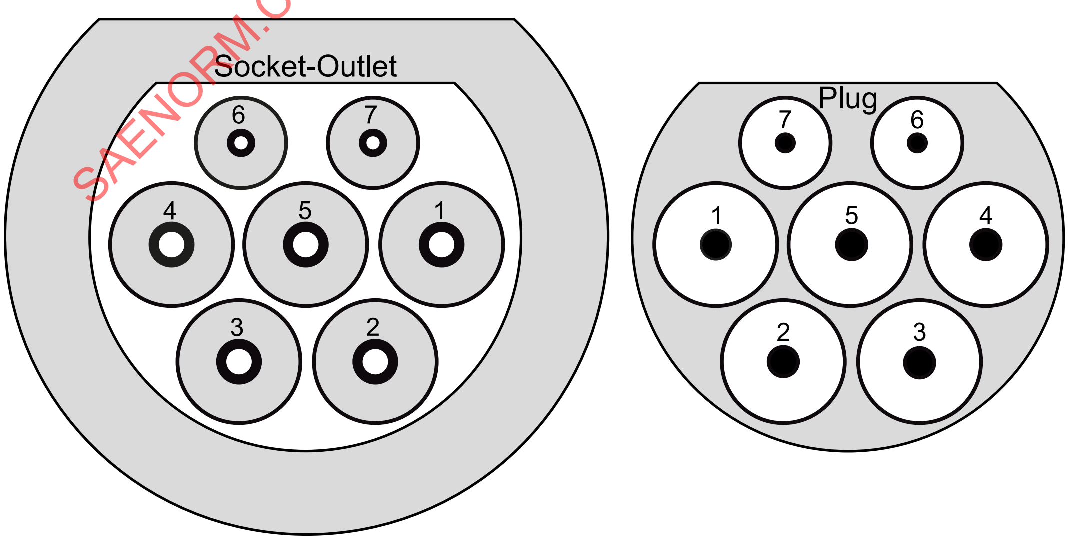

Figure B2 - SAE universal AC socket-outlet (left) and plug of the EV cable assembly (right)

B.1.1.1 Mechanical Socket-Outlet Specification

B.1.1.1.1 Universal *socket-outlets* shall have a mechanical design according to IEC 62196-2:2022, Sheet 2-IIb, Sheet 1 and Sheet 2.

B.1.1.2 Mechanical Plug Specification

B.1.1.2.1 Universal *plugs* shall have a mechanical design according to IEC 62196-2:2022, Sheet 2-IIa, Sheet 1 and Sheet 2.

B.1.1.2.2 Universal *socket-outlets* shall provide packaging room for the universal *plug* according to IEC 62196-2:2022, Sheet 2-IIg.

B.1.2 EV Cable Assemblies

B.1.2.1 EV Cable Assemblies – General Requirements

B.1.2.1.1 *EV cable assemblies* shall be rated, at minimum, 277 VAC single-phase and 480Y/277 VAC if multi-phase-capable and an ampacity of at least 32 A.

B.1.2.1.2 Single-phase two-wire *EV cable assemblies* shall be wired from *plug* position number 1 (refer to IEC 62196-2 Table 202) and *plug* position number 4 (refer to IEC 62196-2 Table 202) for single-phase two-wire power transfer. See Table C1.

B.1.2.2 EV Cable Assembly Thermal Protection

EV cable assemblies may employ *plug*-side *prox*-based thermal reduction. In the example shown in Figure B4, both the *connector* and *plug* have thermal warning cut-outs, either of which when triggered increases the effective *plug* coding resistor to 680 Ω; and reduces the current to 20 A as required in B.1.4.1.1. This decreases the power dissipated in the *EV cable assembly* approximately 60%. The exact method and implementation details are determined by the manufacturer; for example, a 63/70 A to 48 A reduction could be achieved using an identical circuit with different coding resistor values. If the effective *plug* coding resistor is 480 Ω (see Table B1), then the current limit is reduced to 0 A.

B.1.3 EV Requirements

EVSE under SAE J3068 (and SAE J3400) can provide single-phase voltage up to 277 VAC nominal using *PWM-CP*, therefore:

B.1.3.1.1 SAE J1772 vehicles in North America which are designed to be fully interoperable with EV cable assemblies and/or are designed to be fully interoperable with non-SAE J1772 AC EVSE (via adapters) shall be designed to support single-phase charging as specified in SAE J3068 and SAE J3400.

The *EV inlet locking* behavior is typically configurable/controllable to allow continuous retention of the *EV cable assembly* (*case B*) until the operator explicitly requests an *unlock*. This mechanism is also used to prevent tampering with the *connector* when mated to the *inlet*, when used under *case B* or *case C*. See 5.4.3.

B.1.4 Socket-Outlet EVSE

B.1.4.1.1 *EVSE* shall continuously detect the current coding by measurement of the R_C and dynamically update the maximum available current provided on the *control pilot* (*PWM-CP* w/wo *PLC*, *LIN-CP*) during a *control sequence* to not exceed the ratings as specified in Table B1.

B.1.4.1.2 *EVSE* equipped with a *socket-outlet* which provides output greater than 32 A, shall provide automatic supplementary overcurrent protection based on the ampacity of the *EV cable assembly* as detected by the measurement of the *plug* R_C, as specified by the values in Table B1.

NOTE: Prior to terminating the *connection session*, the *SE* may initially attempt to mitigate minor excess *EV* current draw by reducing the maximum available current as appropriate. This strategy reduces the risk of a charging failure.

EXAMPLE: Consider *EVSE* with a 48 A *socket-outlet* output with a 32 A *EV cable assembly* mated. The overcurrent protection upstream is based on the 48 A continuous output rating (e.g., 60 A breaker in North America), but as required by B.1.4.1.1, when a 32 A *EV cable assembly* is connected to the *EVSE*, it will lower its maximum available current (signaled via *PWM-CP*, *LIN-CP*, SW-CAN-*CP*, *PLC-CP* etc..) to 32 A or lower depending on the availability of energy. As required by B.1.4.1.2, if during the *connection session*, a vehicle draws more than 32 A, the *EVSE* automatic supplementary overcurrent protection will interrupt the AC supply to protect the *EV cable assembly*.

EVSE equipped with a *socket-outlet* typically *lock* their *socket-outlet* if they detect a transition from *CP Level* 12 to *CP Level* 9.

B.1.4.1.3 *EVSE* equipped with a *socket-outlet* shall confirm its *socket-outlet* is *locked* before closing its *contactor*.

B.1.4.1.4 *EVSE* equipped with a *socket-outlet* shall not *unlock* its *socket-outlet* while its *contactor* is closed.

B.1.4.1.5 *EVSE* equipped with a *socket-outlet* shall *unlock* its *socket-outlet* when *CP Level* 12 is detected or alternatively by user interaction.

EXCEPTION: If the *EV cable assembly* is owned by the *EVSE* operator, this requirement does not apply and the *socket-outlet* can be *locked* to retain its *cable assembly* between *connection sessions*.

B.1.4.1.6 *EVSE* equipped with a *socket-outlet* shall use temperature monitoring at current levels >32 A. It is recommended at all levels.

NOTE: Thermal cutouts installed on *socket-outlet* contacts could fulfill temperature monitoring requirements; however, this limits derating and may increase operational risk while charging.

Single-phase *EVSE* equipped with a *socket-outlet* (or a three-phase *EVSE* presently only providing a single-phase two-wire output) detecting R_C = 100 Ω may signal an available current up 70 A whether operating under *PWM-CP* or *LIN-CP*.

B.1.4.1.7 A *socket-outlet EVSE* presently providing more than two current-carrying conductors to the vehicle detecting R_C = 100 Ω shall only signal an available current greater than 63 A and up 70 A if:

- *EVSE* receives *LIN-CP* that the *EV* is single-phase-only (`EvMaxCurrentL2` = FF and `EvMaxCurrentL2`=FF) OR
- *EVSE* reads an *EV* cable node indicating the *EV cable assembly* is single-phase-only

NOTE 1: This implies, if none of the above apply, when providing three-phase power to the *EV*, *EVSE* shall only signal available current up 63 A (*PWM-CP* or *LIN-CP*).

NOTE 2: In North America, *EVSE* would need to be supplied from a 90 A branch circuit device, to provide single-phase charging at 70 A, while *EVSE* that provides three-phase and single-phase charging but limits all outputs to 63 A could be supplied from an 80 A breaker per *local electrical codes.*