SURFACE VEHICLE RECOMMENDED PRACTICE	J3068™	JUL2022
	Issued 2018-04 Revised 2022-07	
	Supersedes J3068 APR2018	
	(R) Electric Vehicle Power Transfer System Using a Three-Phase Capable Coupler	

RATIONALE

This edition of SAE J3068 provides corrections, clarifications, and improvements to the original edition. There are no substantial or incompatible changes.

FORWARD

SAE J3068 is a recommended practice for conductive charging of electric vehicles and supply equipment that utilize 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. DC charging on separate contacts with PLC controls is also described, as is limited three-phase AC charging with PWM controls, providing interoperability with SAE J1772 protocols where possible. SAE J3068's LIN-CP is comparable to IEC 61851-1 Annex D.

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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 recommended practice specifies a three-phase capable AC charging system, while the SAE Standard J1772 specifies single-phase AC charging and DC charging. To avoid duplicated or conflicting requirements, this recommended practice refers to applicable parts of SAE J1772 whenever this is adequate.

This recommended practice also describes options which allow SAE J3068 supply equipment and electric vehicles to be interoperable with SAE J1772 supply equipment and electric vehicles.

All requirements are given level-four section numbers, and appear in the text from Section 5 through Section 10. See 5.2.1.1 as an example of one of the first requirements. Appendix E summarizes only the requirements (with links to explanatory text in context) to assist verification planning.

All defined terms are shown in *italic* font.

2.2 Applicable Documents

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

2.2.1 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 J2847-2	Communication Between Plug-in Vehicles and Off-Board DC Chargers
SAE J2931-1	Digital Communications for Plug-in Electric Vehicles
SAE J2931-4	Broadband PLC Communication for Plug-in Electric Vehicles

2.2.2 ANSI Accredited Publications

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

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

2.2.3 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

2.2.4   Code of Federal Regulations (CFR) Publications

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-1800, www.gpo.gov.

CFR 40	Code of Federal Regulations - Title 40, Part 600, Subchapter Q
CFR 47	Code of Federal Regulations - Title 47, Parts 15A, 15B, and 18C

2.2.5   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 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
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

2.2.6   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

2.2.7   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
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.

2.2.8   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.sinec.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

2.2.9   National Fire Protection Agency Publications

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

National Electrical Code, NFPA 70 , Article 625

2.2.10   UL Publications

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

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

2.3   Related Publications

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

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 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 J2894-1	Power Quality Requirements for Plug-in Electric Vehicle Chargers
SAE J3072	Interconnection Requirements for Onboard, Grid Support Inverter Systems

2.3.2   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 943	Ground-Fault Circuit-Interrupters
UL 1439	Determination of Sharpness of Edges on Equipment

2.3.3   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

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 CASE A

The *EV* connects to the *SE* via a cable permanently attached to the *EV*. (Not supported in SAE J3068.)
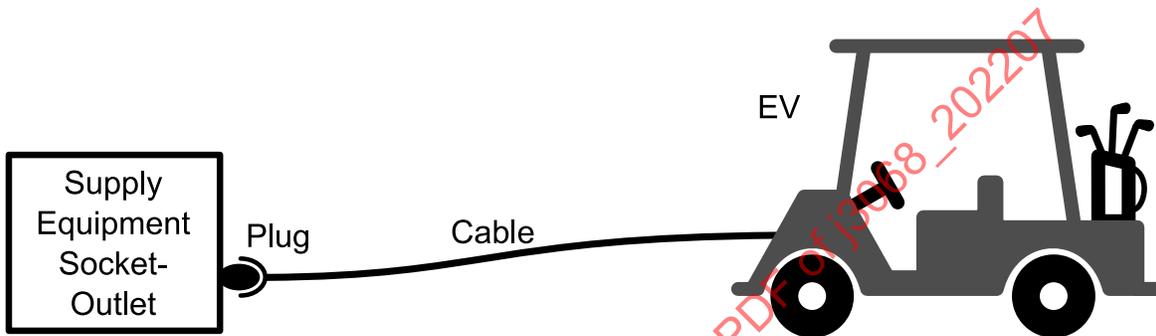
Figure 1 - Case A: Charging cord attached at vehicle

3.4 CASE B

The *EV* connects to the *SE* via a cable that is detachable by the driver at both ends. (Not currently supported in SAE J3068.)
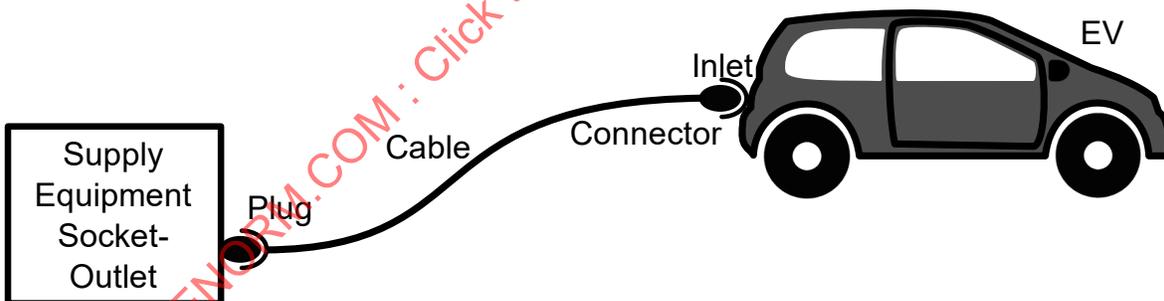
Figure 2 - Case B: Fully removable charging cord

3.5   CASE C

EV connects to the *SE* via a *cordset* permanently attached to the *SE*. This is the primary case supported in this edition of SAE J3068.
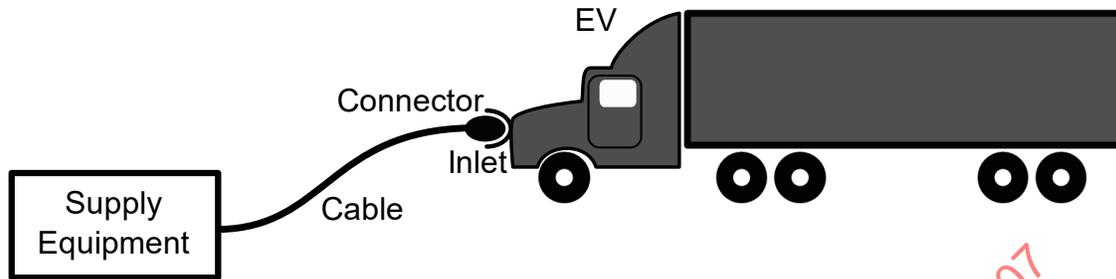
Figure 3 - Case C: Charging cord attached at SE

3.6   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.

3.7   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. (As defined in SAE J1772.)

3.8   CHASSIS GROUND

The *conductor* used to connect the non-current carrying metal parts of the *EV* high voltage system to the *equipment ground*. (As defined in SAE J1772.) Also see 3.24.

3.9   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.

3.10   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.

3.11   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.

3.12   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.

3.13 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*

3.14 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 after a *restart.* See Section 10.

3.15 CORDSET

The *connector* and the flexible cable attaching it to the *EVSE*.

3.16 COUPLER

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*.

3.17 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 S2; see Figure 11. *CP level* is denoted as 12, 9, 6, etc.; see Table 11.

"*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 S2 is supplemented by digital *signals*; see Figure 10.

3.18 DATA LINK

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

3.19 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 3.60.

3.20 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.

3.21 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 EVSE Standard*. It may be permanently wired or connected via a cord to the premises wiring. It may have a permanently attached *cordset* to supply the *EV*, or an *outlet* (see 3.49) for a removable *cordset* (see 3.4) to supply the *EV*. Contrast this with *SE* which does not encompass the *cordset* (see 3.53).

3.22   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*. (As defined in SAE J1772.) Also see 3.24.

3.23   FRAME

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

3.24   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 a circuit protection device such as a fuse or circuit breaker. Also known as Protective Earth outside of North America. See also 3.8 for *EV ground* nomenclature and 3.22 for *SE ground* nomenclature.

3.25   HEADER

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

3.26   INLET

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

3.27   kbps

Thousand bits per second.

3.28   LIN

Local Interconnect Network; refer to ISO 17987.

3.29   LIN-CP

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

3.30   LIN DEFINITION FILE (LDF)

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

3.31   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.

3.32   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.

3.33   LOCK (UNLOCK)

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

3.34   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.

3.35 MCU

Micro Controller Unit.

3.36 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.

3.37 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 3.59.

3.38 ON-BOARD CHARGER

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

3.39 PLUG

A hand-held conductive device at one end of a removable *cordset* which mates into the *SE outlet*; see *case B* (Figure 2), which is not covered in this edition of SAE J3068. Not present on permanently attached *SE* cords (Figure 3), which have only a *connector* on the end of the cable that plugs into the *EV*.

3.40 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*.

3.41 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).

3.42 PUBLISHER

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

3.43 PWM

Pulse-width modulation.

3.44 PWM-CP

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

3.45 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*.

3.46 RESTART

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

3.47 S2

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

3.48   SCHEDULE

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

3.49   SE OUTLET

The device on the *SE* into which the *plug* of a removable *cordset* is inserted. The *SE outlet* only exists in *case B* (Figure 2) applications, which are not covered in this edition of SAE J3068. The *SE* may instead have a permanently attached *cordse*t; see *case C* (Figure 3).

3.50   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 two 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 3.59.

3.51   START VALUE

A value stored internally in a *LIN* node (usually referring to a *signal* from the other node) at the start of a *connection session* 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).

3.52   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*.

3.53   SUPPLY EQUIPMENT (SE)

Supply equipment (also "*Se...*" in *signal* names and *frame* names). In this recommended practice, *supply equipment* does not encompass the *cordset*, which has distinct voltage and current ratings that are not necessarily reflected in the *SE* rating *signals*. Contrast this with *EVSE* (see 3.21) which does encompass the *cordset* ratings in addition to the control box ratings.

3.54   TASK

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

3.55   TRI-NATIONAL CORDSET STANDARD

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

3.56   TRI-NATIONAL EVSE STANDARD

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

3.57   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.

3.58   UART

Universal asynchronous receiver/transmitter.

3.59   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.

3.60   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 3.19).

4.   DOCUMENT AND SYSTEM OVERVIEW

4.1   Document Overview

This document specifies requirements and solutions capable of, but not limited to, three-phase AC charging (constant voltage) using a conductive electrical *coupler* with seven contacts. It also specifies 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.

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 circuit defined in SAE J1772. 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 *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 shows a summary of *LIN signals*, *frames*, and *schedules*.

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

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

Appendix E summarizes requirements and provides links (all of which have four-level section numbers).

The requirements and solutions are designed to facilitate interoperability with existing standards and equipment. This may be done, for example, by allowing the *SE* or the *EV* to fall back to *PWM* signaling (per SAE J1772) when conditions permit.

4.2   System Overview

Signaling and power flow is shown in Figure 4 (informative). The center green box encloses the systems which this recommended practice focuses on.
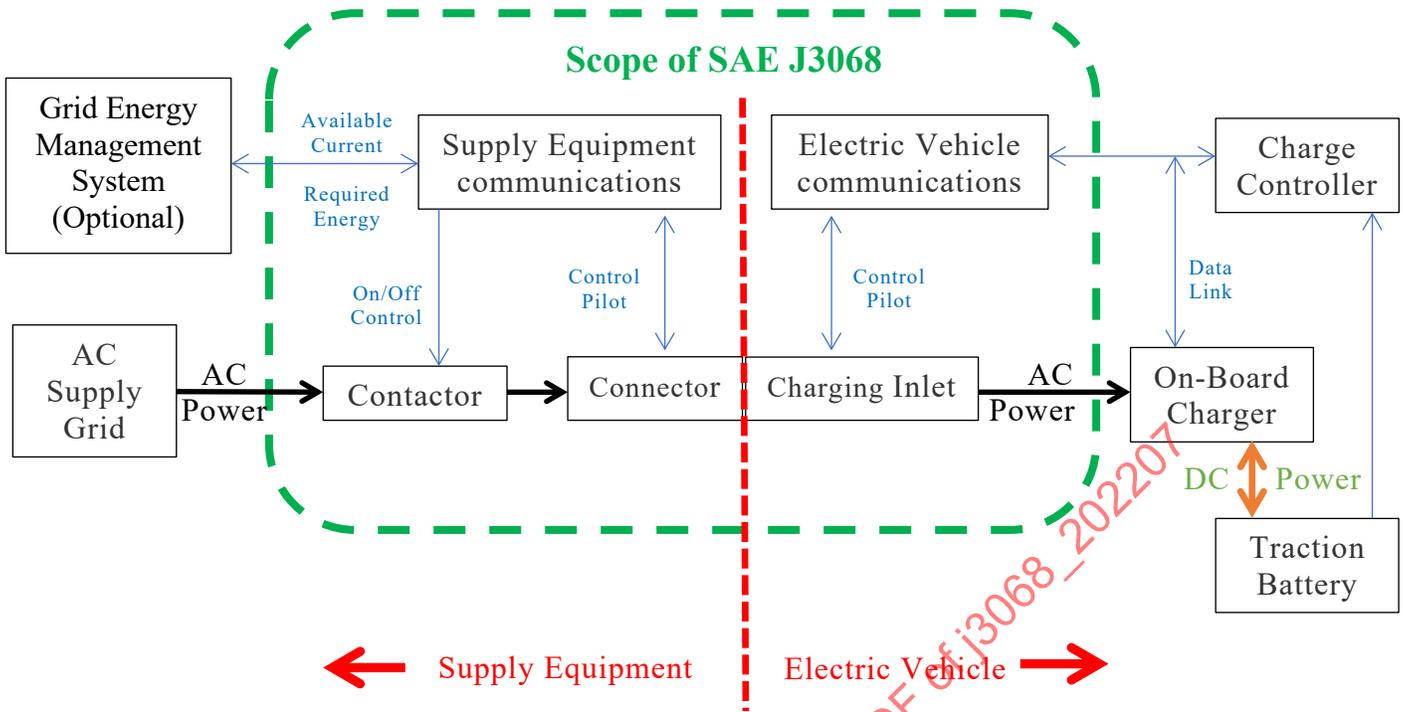
Figure 4 - General conductive charging system topology for typical case C

4.3   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*), similar to analog *PWM* controls in SAE J1772. 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.
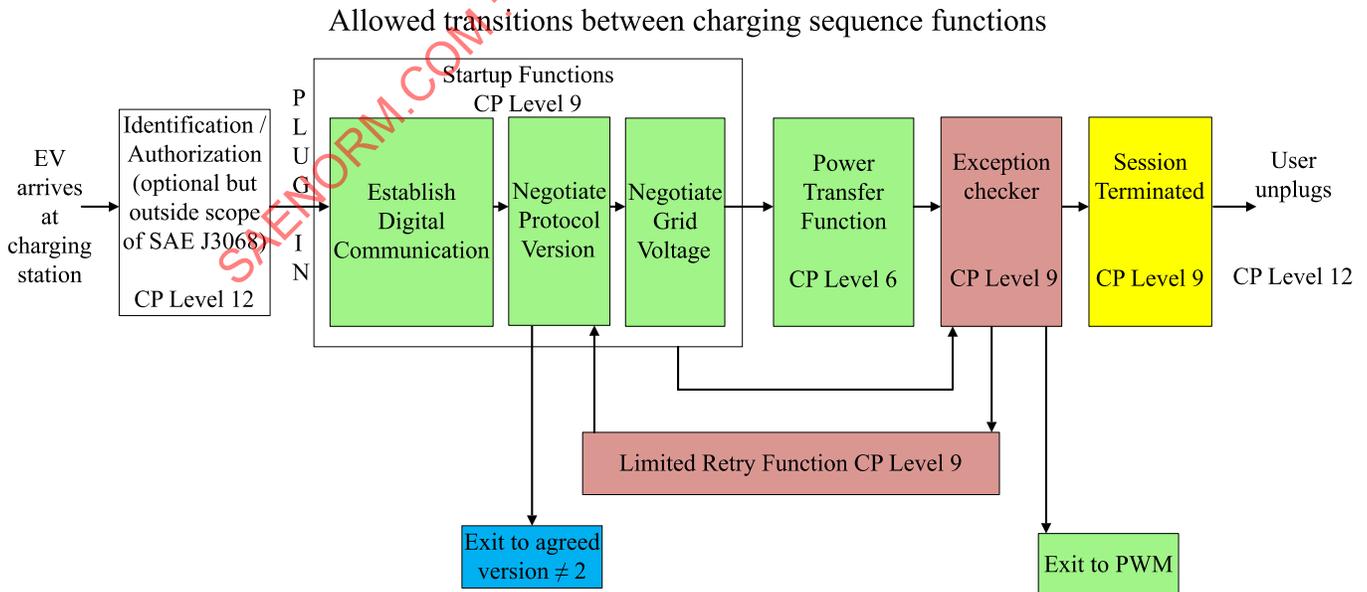
A normal charging session follows the horizontal path from left to right.
Options (in scope) are above the normal path, exception handling is below

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 negotiate a common communications *Protocol Version*. If *LIN-CP* communications cannot be established, the *SE* may fall back to *PWM* control according to SAE J1772 if supplied voltages are within allowable limits. See 6.2.3

After *Protocol Version* negotiation completes successfully, the *EV* signals its highest nominal input voltage. If the *SE* can supply power at a voltage equal to or less than the *EV's* highest 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. Some *SE* may be able to supply more than one voltage. For example, a medium duty truck might only be able to accept up to 240 VAC and the *SE* will supply it with 208 VAC, while a heavy duty truck may be able to accept 480 VAC which the same *SE* can supply by closing a different *contactor*. The same signaling protocol could control an arbitrary AC voltage source, capable of supplying a range of voltages. See *Initialization* (9.6)

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 S2 (which sets the Positive Amplitude of the *control pilot* to 6 V nominal). The *SE* closes the *contactor* only when all three conditions are met.

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 *cordset* node on the *data link* is referred to in 6.2.4. This node can be used to communicate the ratings of the *cordset*; this could be required, for example, in *case B* applications where the *cordset* is rated higher than 415Y/240 VAC. For *case C*, the ratings are alternatively signaled by the *SE* on behalf of the *cordset* when a *cordset* node is not present. See 5.3.2.2.

Temperature monitoring in *couplers* is recommended for derating and required in some situations, see 5.5.1.11.

4.4   Electrical System Topology
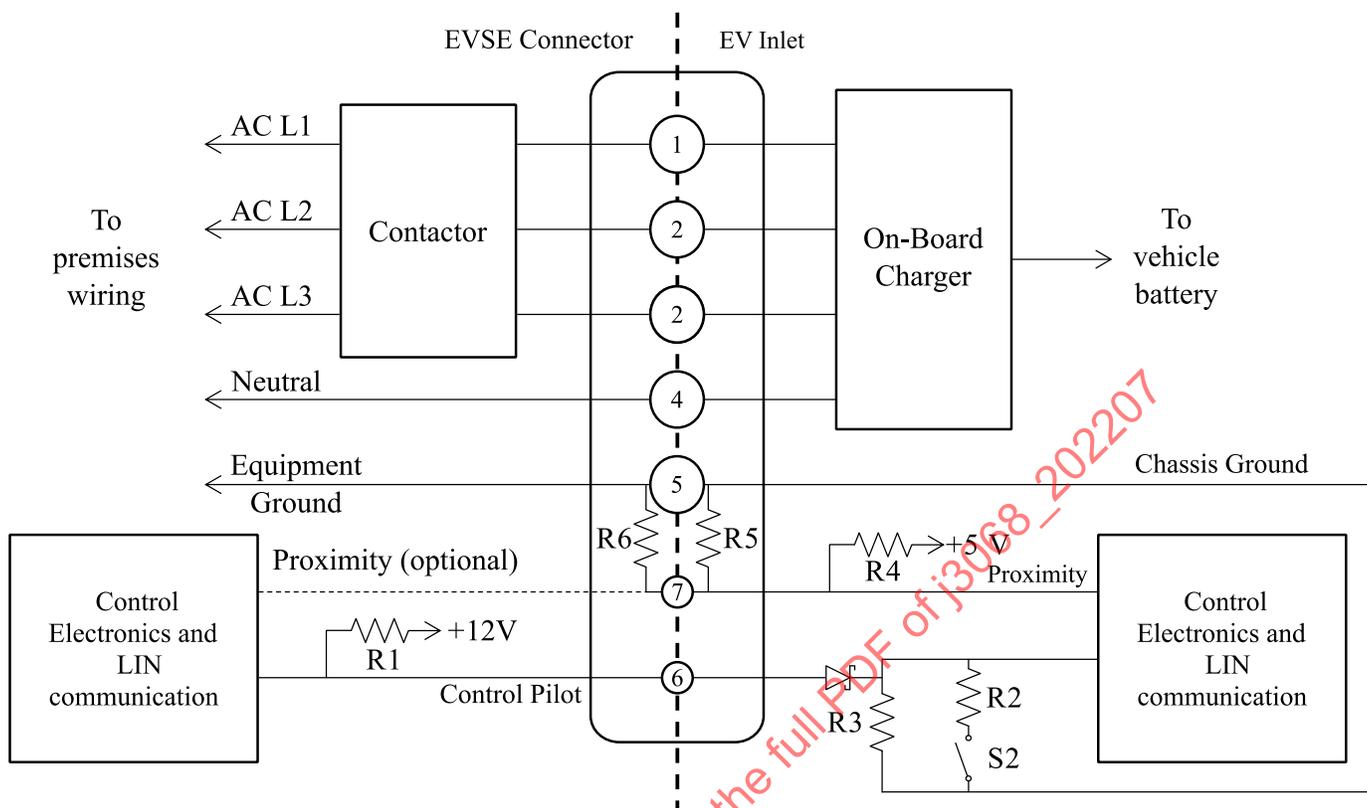
Figure 6 - Electrical system block diagram for three-phase supply
(SE that supports LIN-CP only with EV that supports LIN-CP and PWM-CP shown)

NOTE: Figure 6 is primarily informative and is not intended to dictate system design. However, R5 is required to be part of the *EV inlet* for diagnostic purposes; see 7.1.2.2. For more *control pilot* detail, see Figure 11.

5.   GENERAL REQUIREMENTS

5.1   Coupler Classification

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 6.

5.1.1   Coupler Types

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

SAE J3068 *couplers* are classified as listed in Table 1.

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

5.1.1.2   A SAE J3068 *EV* shall use an *inlet* type defined in Table 1.

Table 1 - Coupler classification

Coupler type	Contact positions used, see Table 6
SAE J3068 AC₆	L1, L2, L3, N, *ground*, *CP*, *proximity*
SAE J3068 DC₈ No AC	*Ground*, *CP*, *proximity*, DC+, DC-
SAE J3068 DC₈/AC₆	L1, L2, L3, N, *ground*, *CP*, *proximity*, DC+, DC-
NOTE 1: The subscripts 6 and 8 denote the diameters in mm of the power pins used. See Table 6.	
NOTE 2: Type *SAE J3068 DC₈/AC₆* is typically used for the *EV inlet*. An *SE* normally supports either DC or AC, but not both.	
NOTE 3: Using 6mm pins for DC is not supported in this edition of SAE J3068.	

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   EVSE and EV Classification Tables

5.2.1.1   An SAE J3068 *EVSE* 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 - EVSE classification

Line	EVSE type	Power capability	Applicable requirements
1	*SAE J3068 AC₆ LIN*	≤600 VAC, nominal, *line*-to-*line* With standard contacts: ≤63 A three-phase, ≤70 A single-phase With advanced contacts: ≤160 A	All requirements in SAE J3068
2	*SAE J3068 AC₆ PWM* Not recommended for new designs	≤250 VAC nominal *line*-to-*neutral* ≤63 A three-phase, ≤70 A single-phase	5.1.1.1, 5.3.2.1, 5.3.2.3, and all applicable requirements in Section 7 and SAE J1772
3	*SAE J3068 AC₆ LIN/PWM*	As in line 1 when *LIN* is used As in line 2 when *PWM* is used	As in line 1 when *LIN* is used. As in line 2 when *PWM* is used
4	*SAE J3068 DC₈ PWM/PLC*	Refer to SAE J1772	5.1.1.1, 5.3.2.1, 5.3.2.3 and all applicable requirements in Section 7 and SAE J1772

Table 3 - EV classification

Line	EV type	Power capability	Applicable requirements
1	*SAE J3068 AC$_6$ LIN*	≤600 VAC nominal *line*-to-*line* With standard contacts: ≤63 A three-phase, ≤70 A single-phase With advanced contacts: ≤160 A	All requirements in SAE J3068
2	*SAE J3068 AC$_6$ PWM* Not recommended for new designs	≤250 VAC nominal *line*-to-*neutral* ≤63 A three-phase, ≤70 A single-phase	5.1.1.2, 9.7.2.1, and all applicable requirements in Section 7 and SAE J1772
3	*SAE J3068 AC$_6$ LIN/PWM*	As in line 1 when *LIN* is used As in line 2 when *PWM* is used	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 J1772	5.1.1.2, 9.7.2.1, and all applicable requirements in Section 7 and 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	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	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 8.3.25 and 8.3.26).

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 range (see 8.3.6, 8.3.7, 8.3.9, and 8.3.10).

It is recommended, if the vehicle transmits its limits according to ANSI C84.1 nominal system voltage, that it 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: 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: 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: 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*.

5.2.3   Supplied AC Power, informative

Table 4 shows examples of maximum supplied power using three-phase AC charging at different voltage and current levels. *LIN-CP* communication can negotiate any voltage and current levels between zero and the maximum levels shown.

Table 4 - Examples of three-phase AC power (informative)

VAC, Three-phase	IEC Standard Contacts 63A Coupler	SAE J3068 Advanced Contacts		
		100A AC$_6$ Coupler	120A AC$_6$ Coupler	160A AC$_6$ Coupler
120/208	22.7 kW	36.0 kW	43.2 kW	57.6 kW
277/480	52.4 kW	83.1 kW	99.7 kW	133 kW
347/600	65.6 kW	104.1 kW	124.9 kW	166 kW

The *LIN-CP* communications specified in this recommended practice could also be used for single-phase charging. Table 5 shows examples of maximum supplied power using single-phase, two-phase, or split-phase AC charging with *LIN-CP* communication and *SAE J3068 AC$_6$ couplers*.

Table 5 - Examples of single-phase AC power (informative)

Supplied voltage VAC	Power with 70A, *SAE J3068 AC$_6$* Coupler (single-phase)
120 single-phase (L-to-N)	8.4 kW
208 two-phase (L-to-L)	14.6 kW
240 split-phase	16.8 kW
277 single-phase	19.4 kW
347 single-phase	24.3 kW
480 two-phase (L-to-L)	33.6 kW

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 EVSE Standard*.

5.3.1.3   The *EVSE* shall incorporate a listed system of personnel protection 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 AC6 LIN/PWM* (see Table 3) shall first attempt *LIN-CP* after plug-in. If *LIN* communication fails, then the *SE* may start *PWM-CP*. See 9.5.4.1 and 9.5.4.2.

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.

5.3.1.5   *Neutral* shall be wired through the *EVSE* to *connector* contact number 4. See Figure 7 and Table 6.

5.3.1.6   At least contact number 1 shall be wired to a *line conductor*. See Figure 7 and Table 6.

NOTE: It is strongly recommended that *EVSE* supply phases are wired in time sequence for clockwise rotation and the *EVSE* is permitted to check for proper phasing as part of its startup self-check. This may be required in future *Protocol Versions* of SAE J3068.

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 Outside Limits Defined in IEC 61851 and IEC 62196

SAE J3068 is designed to interoperate with type 2 *coupler* systems defined in IEC 61851-1 and IEC 62196-2. These standards are designed to support system voltages up to 415Y/240 VAC and currents up to 63 A three-phase or 70 A single-phase. As intelligent *cordsets* are not defined in this edition of SAE J3068 (see 6.2.4), to safely extend type 2 *coupler* systems beyond the aforementioned limits to support North American system voltages and currents beyond 63 A three-phase or 70 A single-phase, certain constraints are imposed on *EVSE:*

5.3.2.1   The *EVSE* shall be designed for *case C* charging; see 3.5.

5.3.2.2   *EVSE* designed to provide more than 63 A three-phase and/or more than 70 A single-phase shall be tested and certified as a unit with their *cordsets*.

NOTE: This implies exact replacement parts are to be used to replace damaged *cordsets* on such *EVSE*.

5.3.2.3   The *EVSE* shall not use *PWM-CP* controls (as defined in the "Control Pilot" section of SAE J1772) when nominal system voltages exceed 415Y/240 VAC. Only *LIN-CP* shall be used when these voltage limits are exceeded.

NOTE: IEC 62196-2 implies compatibility with 480 VAC *line*-to-*line*, but this is in conjunction with a *line*-to-*neutral* voltage rating of 250 VAC. As this is mathematically incongruent (480 divided by the square root of three is 277, but 250 multiplied by the square root of three is approximately 433), the lower rating is taken.

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

5.4   EV Requirements

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 contact numbers 1 and 4 (see Figure 7 and Table 6).

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 operate at a maximum of at least 240 VAC if single-phase and 415Y/240 VAC if three-phase.

EXAMPLE: 415Y/240 VAC is a common configuration outside of North America for IEC 62192 type 2 *couplers* (which can interconnect with SAE *J3068 AC₆*) with *PWM-CP*. An *EV* that is optimized for 208Y/120 VAC but cannot operate up to 415Y/240 VAC, should not support *PWM-CP* and instead should only implement *LIN-CP*.

NOTE: An *EV* of the type described in line 6 of Table 3 is able to distinguish between *LIN-CP* and *PWM-CP*. See 9.5.4.1 and 9.5.4.3.

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 5.5.1.9. 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*; note *case B* is not covered in this edition of SAE J3068 but vehicles may be designed to interoperate with IEC 61851-1). As many of these 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 250ms, 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 *cordset*.

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

5.5.1 Coupler Requirements

5.5.1.1 *Couplers* shall fulfill the requirements defined in the *Tri-National Cordset Standard*.

5.5.1.2 *Couplers* manufactured according to this recommended practice shall be marked on its outer surface in Arial font: "SAE J3068™." Any party providing such identification warrants that the *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.

5.5.1.3 *SAE J3068 AC$_6$ connectors* shall have a mechanical design according to IEC 62196-2:2016, Sheet 2-IIe, Sheet 1 and Sheet 2.

5.5.1.4 *SAE J3068 AC$_6$ inlets* shall have a mechanical design according to IEC 62196-2:2016, Sheet 2-IIf, Sheet 1 and Sheet 2.

5.5.1.5 *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.

5.5.1.6 All SAE J3068 *couplers* shall comply with requirements 26.7, 26.8, and 26.9 (insulating nose cone pull test) from IEC 62196-1:2014.

5.5.1.7   *Couplers* shall have contact functionality according to IEC 62196-2 and 62196-3; see Table 6 for a summary.

IEC 62196-2 specifies maximum rated current 63 A three-phase and 70 A single-phase for type 2 (equivalent to *SAE J3068 AC₆*) *couplers*. *SAE J3068 AC₆* supports higher AC rated current, and higher AC voltages for *case C* assemblies only.

NOTE: An SAE J3068 *EVSE* with ratings beyond those defined in IEC 62196-2 (see 5.3.2.2 and 5.3.2.3), can only be achieved in this edition using a *case C* configuration which is tested and listed as complete assembly to the *Tri-National EVSE Standard*. For an *EV* that operates beyond IEC 62196-2, see 5.4.2.3.

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

5.5.1.8   The socket outlet from IEC 62196-2:2016 Standard Sheet 2-IIa Sheet 1 and Sheet 2, and the *plug* (see Figure 9) from Standard Sheet 2-IIb Sheet 1 and Sheet 2 shall not be implemented with this edition of SAE J3068.

5.5.1.9   *Inlets* shall be equipped with a *locking mechanism* that includes a monitoring function indicating if the *inlet* is *locked* or *unlocked*.

5.5.1.10   *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 5.3.2.2.

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

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

Temperature monitoring is recommended for the *connector* 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)
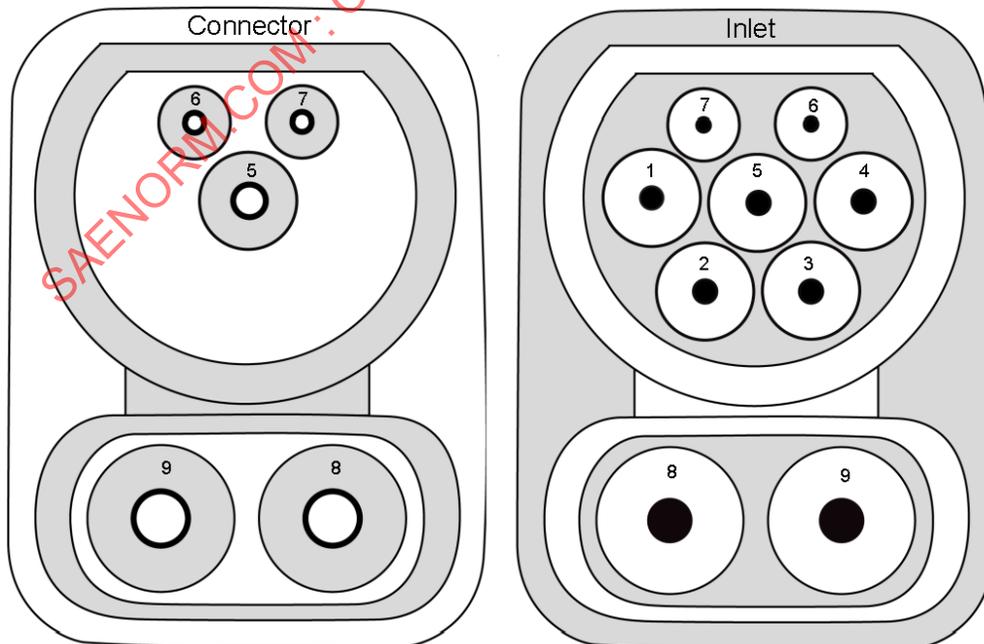
Figure 8 - SAE J3068 DC$_8$ no AC connector and SAE J3068 DC$_8$/AC$_6$ inlet (contact placement as seen by user)

Table 6 - Coupler contact functions

Contact Number	Contact Pin Diameter (mm)	Nominal Contact Function	Description
1	6	L1 AC	Power phase *line* 1 (see 5.3.1.6)
2	6	L2 AC	Power phase *line* 2
3	6	L3 AC	Power phase *line* 3
4	6	Neutral	*Neutral* (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	SAE J1772 DC level 2 charging
9	8	DC positive	SAE J1772 DC level 2 charging

5.5.1.12   The couplers described in IEC 62196-2:2016, 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.
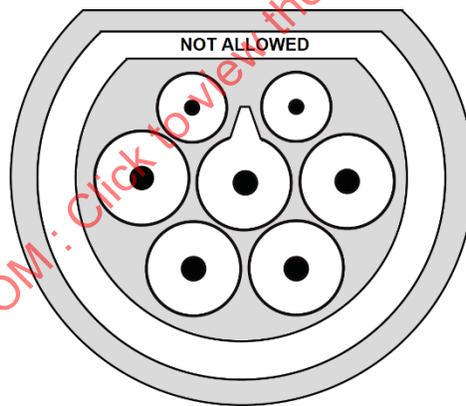
Figure 9 - AC$_6$ keyed couplers, NOT ALLOWED

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 415Y/240 VAC. See 5.3.2.3.

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 also 8.3.15.1 and Figure 15.

5.6.2   DC Charging

5.6.2.1   For control of DC charging, the system shall have:

a.   The *PWM control pilot* (*PWM-CP*) defined in the "Control Pilot" section of SAE J1772 with a 5% duty cycle, and

b.   The PLC communication defined in SAE J2847-2, and

c.   An *EV* that implements *proximity detection* as specified in Section 7.

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

5.6.3   Proximity Function

Upon insertion of the *connector* into the *EV inlet*, the *coupler* 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 5.5.1.3 and 5.5.1.4.

When a charging *cordset* is connected to the *EV*, that *EV* is immobilized even if that *cordset* 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.

See *proximity detection* (Section 7) for implementation 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 up to 20 *kbps* (19.2 *kbps* nominal). At this bit rate, 1 bit duration is 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.
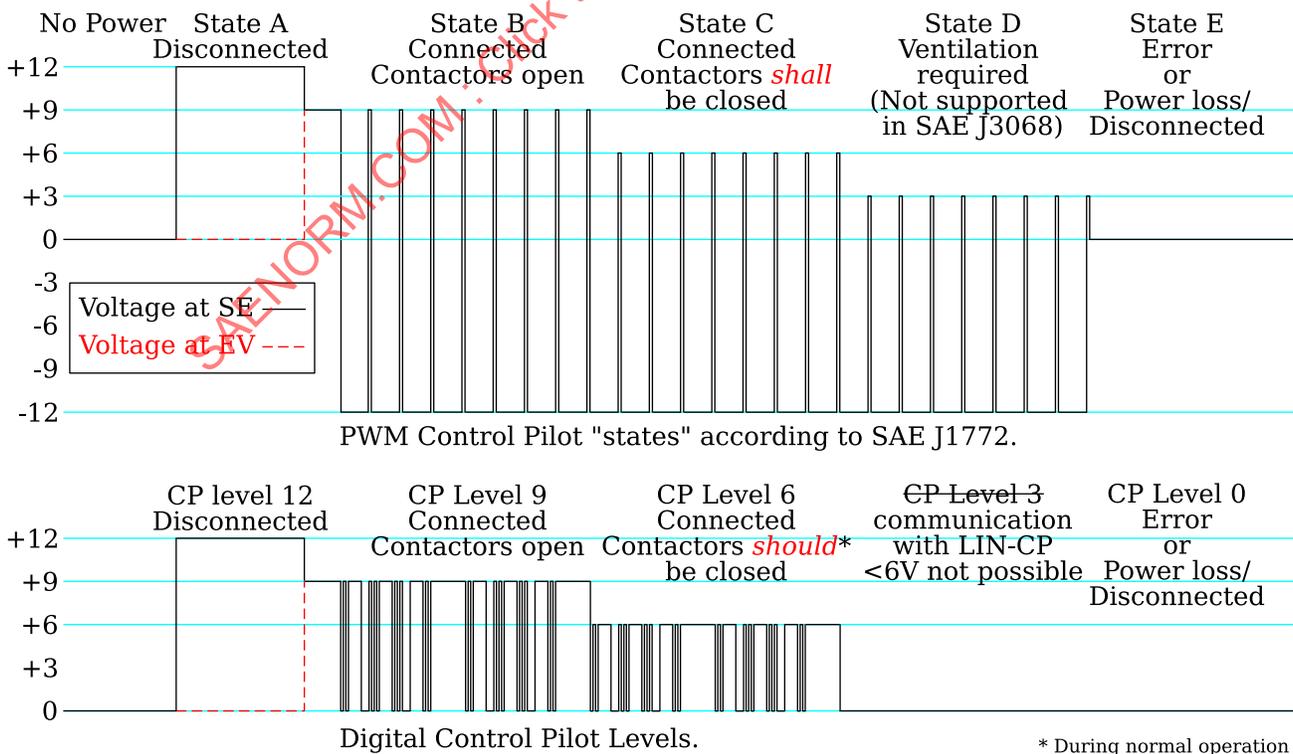
Figure 10 - Comparison of SAE J3068 CP levels to SAE J1772 states (not to scale)

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.
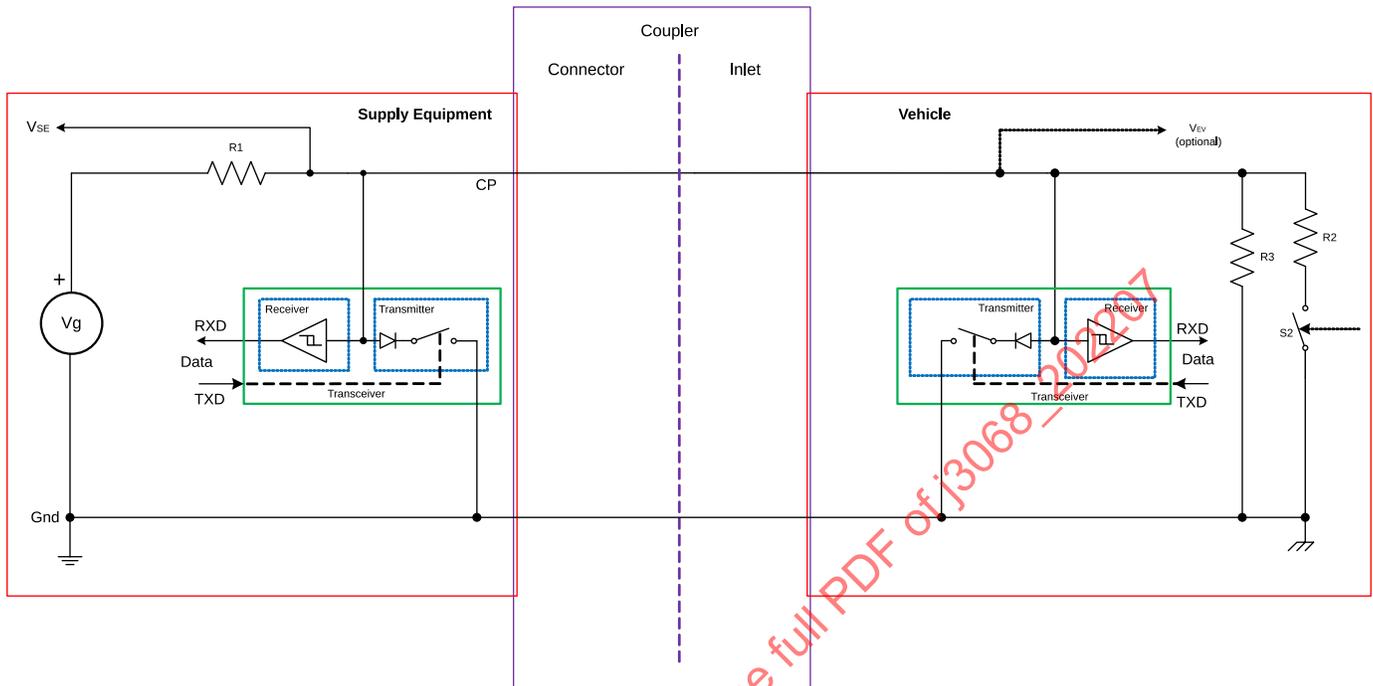
Figure 11A - Configuration without PWM-CP compatibility
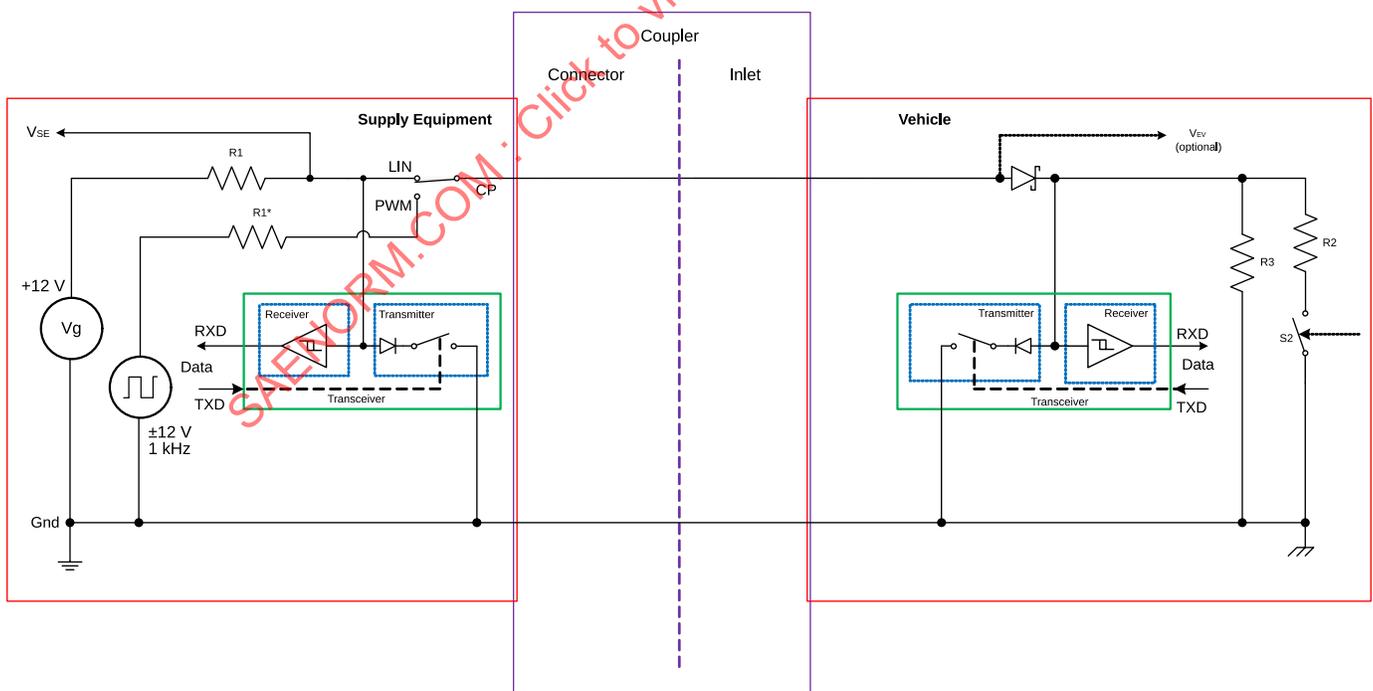
Figure 11B - Configuration with PWM-CP compatibility for SE and EV

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

6.2.1   Control Pilot Tables

Table 7 - 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	R1	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 R1 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 7.

Table 8 - EV control pilot circuit parameters

Parameter	Symbol	Units	Nominal Value	Max Value	Min Value
Resistor always connected[1]	R3	Ω	3000	3090[2]	2910[2]
Resistor, connected when S2 is closed	R2	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 ≥ 15mA, reverse leakage ≤ 100µA.
[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 8.

Table 9 - Transceiver parameters (SE and EV)

Parameter	Symbol	Units	Nominal Value	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 10 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 9.

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: SN65HVDA100, TJA1021T/20, TLE7257, TLIN1021, ATA663211, ATA6664, NCV7329, MCP2003B, MLX80020. 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 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 10 lines 2 and 3 for recessive levels at the *SE*, *CP levels* 9 and 6).

As shown in Figure 11, R1 need not have a diode in series. This is in contrast to ISO 17987-4 where "R$_{master}$" is required to have diode D$_{ser\_master}$ in series. Note that dedicated *LIN* applications differ from SAE J3068 where R1 is also critical to *PWM* operation. In *PWM* mode, a diode in series with R1 could block the negative 12 V portion of the *PWM* waveform. Also note that R1 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 R1 in the *SE* and R2 parallel with R3 in the *EV*.

NOTE: If the series diode is included, the impedance of R1 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*; this allows, for example, the use of a *case C cordset* with an undersized *neutral* to be used. See 8.3.20.

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; refer to SAE J1772.

NOTE: The differences between the *EV control pilot* circuitry recommended in this section (as of SAE J3068 Edition 2) and that described 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 415Y/240 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 Cordset Node

It is intended that a third node may be present in the *cordset*. This node would provide signals relating to its configuration and capabilities to enable *case B* and/or separate certification of *EVSE* and *cordset* when voltages exceed 415Y/240 VAC, and/or currents exceed 63 A three-phase/70 A single-phase. This is, however, not fully defined in this edition of SAE J3068. The *EVSE* and *cordset* are therefore certified as a unit when operating outside these limits in this edition of SAE J3068. See 5.3.2.

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* S2 switch is open or closed. Table 10 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 10 - 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 S2 open	*EV* connected	8.30 to 9.59 at *SE* and *EV*	State B in SAE J1772
3	*CP level* 6	*EV* connected and S2 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 accessory devices (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 11.

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 11. 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 11 - 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, S2 open
3	Vg/12 * 4.5 - Vg/12 * 7.5	*CP level* 6	Normal: *EV* connected, S2 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: 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: *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, 5.5.1.3, and 5.5.1.4.

7.1.2   Immobilization

When a charging *cordset* is connected to the *EV*, that *EV* is immobilized even if that *cordset* is not connected to the *SE*. 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* (3.5), when the *control pilot* leaves *CP level* 12, the mobile *EVSE* shall be immobilized.

7.1.2.2   Resistor R5 in Figures 12 and 6 shall be placed in the *inlet* to enable diagnostics.

NOTE: If an *inlet* is disconnected from the internal *EV* controller, it becomes impossible to detect whether a charging *cordset* is connected to the *SE;* therefore, immobilization cannot be guaranteed. At a minimum in such a case, an *EV* should notify the driver that it cannot detect whether a charging *cordset* is connected to the *inlet* and should receive acknowledgement 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).

Case C using SAE J3068 vehicle *couplers* are covered in 7.2. *Cases A* and *B* are not covered in this edition of SAE J3068.

7.2   Proximity Detection Circuit

7.2.1   Proximity Detection Circuit General Requirements

7.2.1.1   The *EVSE* and the *EV* shall use the *proximity detection* circuit shown in Figure 12.

This circuit is similar to the *proximity detection* circuit found in SAE J1772. 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 *cordset* current capability to the *EV*.

7.2.1.2   The *proximity detection* circuit shall present impedances equivalent to those listed in Table 12.

The *proximity detection* circuit should be designed to tolerate 12 V indefinitely.

7.2.1.3   *EV* supply voltage to R4 shall be 5.0 V ± 5%.

The *EV* may use the R4 supply voltage as reference for the measurement to cancel the tolerance from 7.2.1.3. Alternatively, the R4 supply may be regulated more tightly (recommend 1%) such as to make compensation unnecessary.

NOTE: R4 need not be powered at all times, typically just when charging, when *cordset* ratings need to be checked, or when someone starts the vehicle and immobilization is checked.

7.2.1.4   The *EV* shall detect the voltage between the *proximity* pin and *equipment ground* as specified in Table 13.

The *EV* is immune to temporary *proximity detection* glitches to ensure reliable operation. See 9.7.2.8.
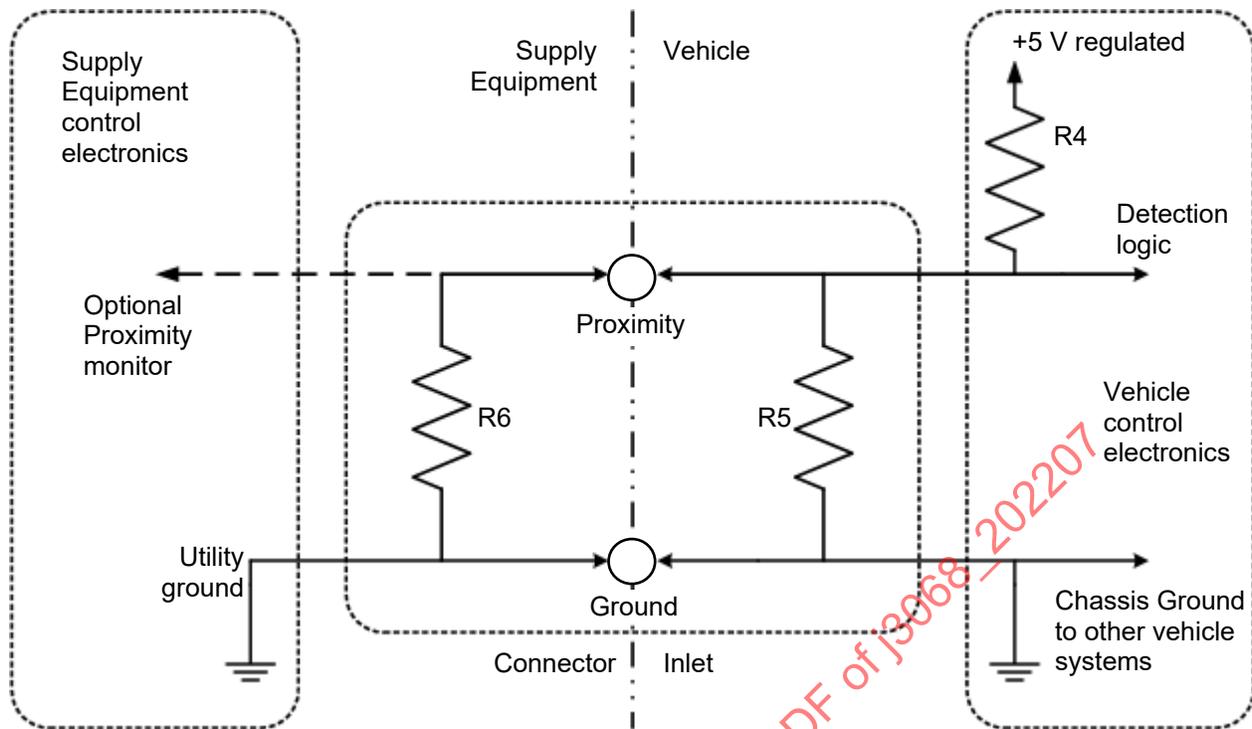
Figure 12 - Equivalent proximity circuit diagram for SAE J3068 coupler

Table 12 - Component values

Cordset Current Capability (each phase)	Resistor R6	Resistor R4	Resistor R5
13 A (or *SAE J3068 DC₈ connector* inserted, DC charging)	1500 Ω ± 3%		
20 A	680 Ω ± 3%		
32 A	220 Ω ± 3%	330 Ω ± 3%	2700 Ω ± 3%
63 A three-phase, 70 A single-phase Or, max 160 A if permitted by *LIN signals*	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 13 - EV detection of proximity voltages

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 - 4.20 V Optional	Reserved for future use	3300 to 3520 Ω
4	3.63 - 3.82 V	13 A (or *SAE J3068 DC$_8$ connector* inserted, DC charging)	R6 = 1500 Ω
5	3.01 - 3.21 V	*SAE J3068 AC$_6$ connector* inserted, max *cordset* current 20 A/phase	R6 = 680 Ω
6	2.58 - 2.93 V Optional	SAE J1772 *connector* connected, S3 pressed	R6 + R7 = 150 Ω ($\pm$ 10%) + 330 Ω ($\pm$ 10%) = 480 Ω ($\pm$ 10%)
7	1.82 - 2.00 V	*SAE J3068 AC$_6$ connector* inserted, max *cordset* current 32 A/phase	R6 = 220 Ω
8	1.36 - 1.65 V Optional	SAE J1772 *connector* connected, S3 not pressed	R6 = 150 Ω ($\pm$ 10%)
9	1.07 - 1.20 V	*SAE J3068 AC$_6$ connector* inserted, max *cordset* current 63 A per phase (three-phase mode) or 70 A single-phase, or up to 160 A if permitted by *LIN signals*	R6 = 100 Ω
10	0.51 - 0.89 V Optional	Reserved for disconnection request button	R8 = 68 Ω (switched in parallel with R6)
11	0.00 - 0.50 V	Error: *proximity* circuit short circuited	

NOTE: 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: The voltage ranges in Table 13 do not take into account variances such as ground shift, chassis resistance, active accessory devices (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: Detection of voltages outside of the ranges defined in Table 13 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 master-slave protocol. The *SE* acts as the *LIN* master 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 B summarizes all *frames*, *signals*, and *schedules*.

Appendix C 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 master node (*SE*). The *response* is sent by a slave node (*EV* or *cordset* node) or in the master 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 master node follows to trigger the *headers*. Slave 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`: *Cordset* 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 8.3.15, 8.3.15.1, 8.3.17, 8.3.28, 8.3.29, 8.3.30) 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:

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

2. 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.

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

4. 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   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	
		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	

8.3.2.1   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.

8.3.3   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 17	*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.

8.3.4   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*)	

8.3.5   EvMaxCurrentX

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

Signal	Bits	Values	Description	Schedule

`EvMaxCurrentL1`
`EvMaxCurrentL2`
`EvMaxCurrentL3`
`EvMaxCurrentN`
	8	0_{10} to 250_{10}	Maximum load current, 1 A per bit
			(*EV start value* is application specific)
				Init

		251_{10} - 254_{10}	Reserved	
		00_{16}	*SE start value*	
		FF_{16}	*Not Available*	

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.

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

8.3.5.2   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*.

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

8.3.6   EvMaxVoltageL1N

`EvMaxVoltageL1N` is used by the *EV* to indicate its highest 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}	Highest nominal voltage, 0.1 V per bit (*EV start value* is application specific)	*Init*
		0000_{16}	*SE start value*	
		$FFFF_{16}$	*Not Available*	

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

8.3.6.2   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 8.3.9.2.

8.3.7   EvMaxVoltageLL

`EvMaxVoltageLL` is used by the *EV* to indicate its highest 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}	Highest nominal voltage, 0.1 V per bit (*EV start value* is application specific)	*Init*
		0000_{16}	*SE start value*	
		$FFFF_{16}$	*Not Available*	

8.3.7.1   If contact numbers 2 and/or 3 are wired (in addition to contact number 1, see 5.3.1.6), a *valid* non-zero `EvMaxVoltageLL` *value* shall be provided by the *EV* to indicate its highest nominal voltage between any of the contact numbers 1, 2, and 3 of the *EV inlet*.

8.3.7.2   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 8.3.10.2.

8.3.8   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*)	

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 inidcate when the vehicle requires at least `EvMinCurrentX` to supply a fixed load application (see Table 17).

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

8.3.9 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*)	

8.3.9.1　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*.

8.3.9.2　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 8.3.6.2.

8.3.10 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*)	

8.3.10.1　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*.

8.3.10.2　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 8.3.7.2.

8.3.11 EvPresentCurrentX

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

Signal	Bits	Values	Description	Schedule
`EvPresentCurrentL1` `EvPresentCurrentL2` `EvPresentCurrentL3` `EvPresentCurrentN`	8	0_{10} to 250_{10}	Measured or estimated current, 1 A per bit (*EV start value* is 0_{10})	*Op*
		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`.

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

8.3.11.2   If the *EV* does not measure or estimate its load current, it shall set the `EvPresentCurrentX` to *Not Available* for each connected contact and to zero for each unconnected contact.

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.

8.3.12   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*.

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

8.3.12.2   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.

8.3.13   EvResponseError

`EvResponseError` is provided by the *EV* (which is a *LIN* slave 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`.

8.3.14 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*)	

8.3.15 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*)	

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

8.3.16 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* S2 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 S2.	
		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.

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

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

8.3.17 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*)	

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

8.3.18 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*; refer to SAE J1772	*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 C	
		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.

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

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

NOTE: 8.3.18.2 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.

8.3.19 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*)	

8.3.20 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*)	

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 attached *cordset*. They may also dynamically track energy management requirements (see 9.7.3.6).

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

8.3.20.2   SeAvailableCurrentX *signal* values shall be *Not Available* for disconnected *conductors*. Also see 8.3.24.2 for SeMaxCurrentX.

8.3.20.3   Unless 5.3.2.2 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*, draw the lowest value on all *line conductors.*

8.3.21   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	
		FF_{16}	*Not Available* (*EV start value*)	
		All Others	Reserved	

8.3.21.1   The *SE* shall provide a *valid* SeFrequency *value* to indicate the nominal frequency of the supply network. This value is static. In this edition of SAE J3068, the *SE* may only advertise support for a single frequency.

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

8.3.22   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 18	*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.

8.3.23 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*)	

8.3.24 SeMaxCurrentX

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

Signal	Bits	Values	Description	Schedule

`SeMaxCurrentL1`
`SeMaxCurrentL2`
`SeMaxCurrentL3`
`SeMaxCurrentN`
	8	0_{10} to 250_{10}	Maximum current, 1 A per bit
			(*SE start value* is application specific)
				Init

		251_{10} - 254_{10}	Reserved	
		00_{16}	*EV start value*	
		FF_{16}	*Not Available*	

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.

8.3.24.1 The *SE* shall provide *valid* `SeMaxCurrentX` *values* for all contacts. *Not Available* is not permitted after startup.

A value of *Not Available* is not allowed to be sent in `SeMaxCurrentX`, zero is used for unconnected *conductors*. 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*.

8.3.24.2 `SeMaxCurrentX` *signal* values shall be zero for disconnected *conductors*. Also see 8.3.20.2 for `SeAvailableCurrentX`.

EXAMPLE: A three-phase *SE* designed to provide the maximum power to a single-phase or three-phase *EV* without 5.3.2.2 being satisfied would signal `SeMaxCurrentL1` = 70 A, `SeMaxCurrentL2` = 63 A, `SeMaxCurrentL3` = 63 A, and `SeMaxCurrentN` = 70 A. See 8.3.20.3.

8.3.25 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 the *SE* can supply only one nominal voltage (application specific)	*Init*
		$FFFF_{16}$	*Not Available* (*EV start value*) *SE start value* is $FFFF_{16}$ if the *SE* can supply more than one nominal voltage; see 9.6.2.2	

8.3.25.1 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.

8.3.25.2   After 8.3.25.1 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.

8.3.25.3   If contact numbers 2 and 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.

8.3.26   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 the *SE* can supply only one nominal voltage (application specific value)	*Init*
		$FFFF_{16}$	*Not Available* (*EV start value*) The *SE start value* is $FFFF_{16}$ if the *SE* can supply more than one nominal voltage; see 9.6.2.2	

8.3.26.1   If the *SE* supplies voltage to only contact number 1, then `SeNomVoltageLL` shall be set to *Not Available* and the subsequent requirements in 8.3.26 do not apply.

8.3.26.2   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 9.6.2.2.

8.3.26.3   After 8.3.26.2 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.

8.3.27   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*)	

8.3.28 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*)	

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

8.3.29 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 S2* switch (nor the *SE contactor*) to be closed (*SE start value*)	*Ver, Init, Op*
		01_2	*Permit_V*: The *SE* permits the *EV S2* 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*)	

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

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

8.3.30 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*)	

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

8.3.31 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*; refer to SAE J1772	*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 C	
		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.

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

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

NOTE: 8.3.31.2 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.

8.3.32 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 14 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`: *Cordset* 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 B 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*.

Also see Appendix B 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 8.3.18 and 8.3.31.

Table 14 - 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 (all 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 (all 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 (all 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 (all FF_{16})
6	SeMaxCurrents	Byte 0: SeSelectedVersion (typically 02_{16}) Byte 1: SeMaxCurrentL1 Byte 2: SeMaxCurrentL2 Byte 3: SeMaxCurrentL3 Byte 4: SeMaxCurrentN Bytes 5-7: reserved (all 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 (all FF_{16})
8	EvMinVoltages	Byte 0: EvSelectedVersion (typically 02_{16}) Bytes 1-2: EvMinVoltageL1N Bytes 3-4: EvMinVoltageLL Bytes 5-7: reserved (all 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

10	CaProperties
	
	Not used in this edition of SAE J3068. Reserved for future implementation of *cordset* nodes
		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

Frame Identifier	Frame Name	Contained Signals
11	SeInfoList	Byte 0: SeSelectedVersion 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 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 15 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 15.

See Appendix B 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 15 - 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 15 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 S2 switch, the *contactor*, and the *inlet locking mechanism*.

LIN communication uses an *API* according to ISO 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* master node (the *SE* node) uses *API* calls to start or stop *LIN schedules*, as described in Sections 9 and 10.
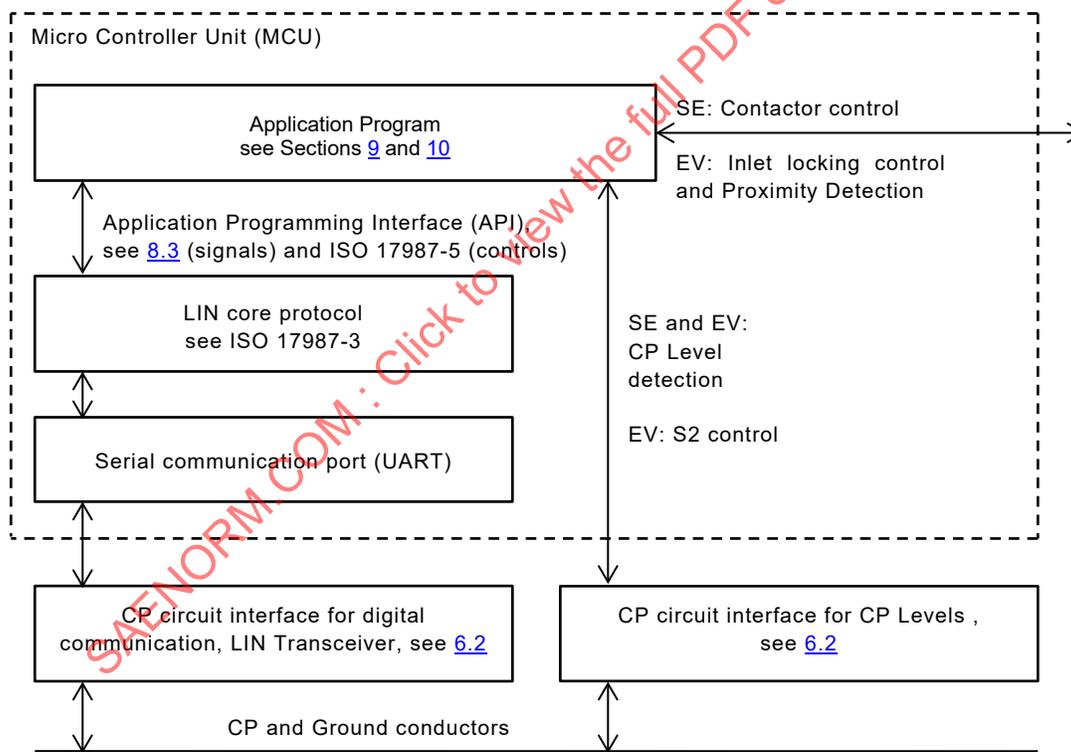
Figure 13 - Typical control pilot controller concept

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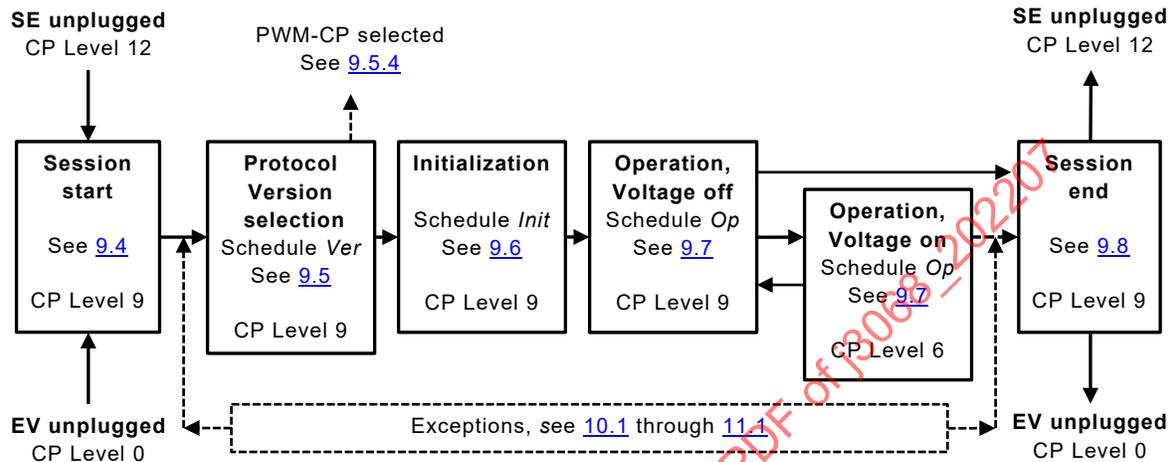
Figure 14 - Overview of typical application program control sequence during a connection session

9.3   Timing Requirements

Table 16 gives a summary of all time limits required in 9.4 through 9.8 and 10.1 through 10.8.

Table 16 - Application program timing limits

Name	Limit (seconds)	Reference	Description
T$_{SEstart}$	0.5	9.4.1.2	*SE* max time to start *LIN schedule*
T$_{EVstart}$	1.0	9.4.1.3	*EV* max time to start responding
T$_{pwm}$	1.1	9.5.4.1	*SE* max time to establish *LIN-CP*
T$_{EVclose}$	3.0	9.7.2.4	*EV* max time to close S2
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 S2
T$_{unlock}$	3.0	9.8.1.1 9.8.2.2	*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 S2, 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 13) to determine the resistance of the current coding resistor R6. 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 *CP level* ≠ 0, 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).

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 15 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 14.

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. If the *SE* supports *PWM-CP* and *valid values* are not detected within T_{pwm} (1.1 seconds), the *SE* shall continue as 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.

9.5.2.2		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.*

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

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 suffucient 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 9.5.4.3 (if *PWM* is supported by the *EV*, and the *EV* detects *PWM* from the *SE*) or else the *EV* shall proceed to 10.3.1.

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

9.5.4.1		If an *SE* that also implements *PWM-CP* detects no valid *LIN responses* from the *EV* within T_{pwm} (1.1 seconds) after detecting a change of *CP level* from 12 to 9, the *SE* shall stop the *schedule Ver* and, when the *SE* is ready to supply power, start sending 10 to 96% *PWM*.

9.5.4.2 If the *SE* detects *CP level* 6 while sending *PWM*, it shall apply *PWM-CP* during the rest of the *connection session*.

If the *SE* does not detect *CP level* 6 within a time limit (application specific), it may retry to establish *LIN-CP* using *schedule Ver*; see 9.4.1.2.

9.5.4.3 If an *EV* that also implements *PWM-CP* detects *PWM*, when the *EV* is ready to receive power, it shall close *S2* and use *PWM-CP* during the rest of the *connection session*.

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* (9.7)

9.6.1.3 The *schedule Init* shall trigger the *frames* listed in Table 15 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 14.

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 level, 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 highest supply power.

9.6.2.2 If SeNomVoltageL1N = *Not Available* and SeNomVoltageLL = *Not Available* (the *SE* can supply more than one nominal voltage), the *SE* shall first read EvMaxVoltageL1N and EvMaxVoltageLL and then write compatible available values for SeNomVoltageL1N and SeNomVoltageLL, if any, that safely allow the highest 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 EvMinCurrentL2 = *Not Available*) AND
(SeMaxCurrentL3 ≥ EvMinCurrentL3 OR EvMinCurrentL3 = *Not Available*) AND
(SeFrequency (bitwise AND) EvFrequencies ≠ 0).

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.

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   When the *EV* reads `SeNomVoltageL1N` ≠ *Not Available* OR `SeNomVoltageLL` ≠ *Not Available*, it shall 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 `EvMinCurrentL2` = *Not Available*) AND
(`SeMaxCurrentL3` ≥ `EvMinCurrentL3`   OR `EvMinCurrentL3` = *Not Available*) AND
(`EvMinCurrentX` ≤ current indicated by R6; see Table 12) AND
(`SeFrequency` (bitwise AND) `EvFrequencies` ≠ 0).

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 15 to allow the *application programs* in the *SE* and the *EV* to exchange the *signals* listed for these *frames* in Table 14.

9.7.2   Operation, Voltage Control

The *EV* closes *S2* 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 *S2* 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 *S2* 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 *S2* or the *contactor* may be opened by internal *EV* or *SE* hardware. SAE J3068 does not specify how to implement such functionality.

```
SeStatusVer = Complete  ────────────▶⟍
SeStatusInit = Complete ────────────▶  ⟍   EV: S2
                                       AND ⟩  closed only
SeStatusOp = Permit_V ──────────────▶  AND ⟩ ──▶ when all
                                       gate⟋   inputs are
EvStatusOp = Permit_V ──────────────▶⟋          true
```

```
                       ┌─────────┐  CP Level = 6 (S2 closed)
Control Pilot ────────▶│CP Level │────────┐
                       │detector │        │
                       └─────────┘        │
                                          ▼
Schedule is Op ──────────────────────▶⟍
                                       ⟍   SE: Contactor
SeStatusOp = Permit_V ───────────────▶ AND ⟩  closed only
                                       AND ⟩ ──▶ when all
EvStatusOp = Permit_V ───────────────▶ gate⟋   inputs are true
```
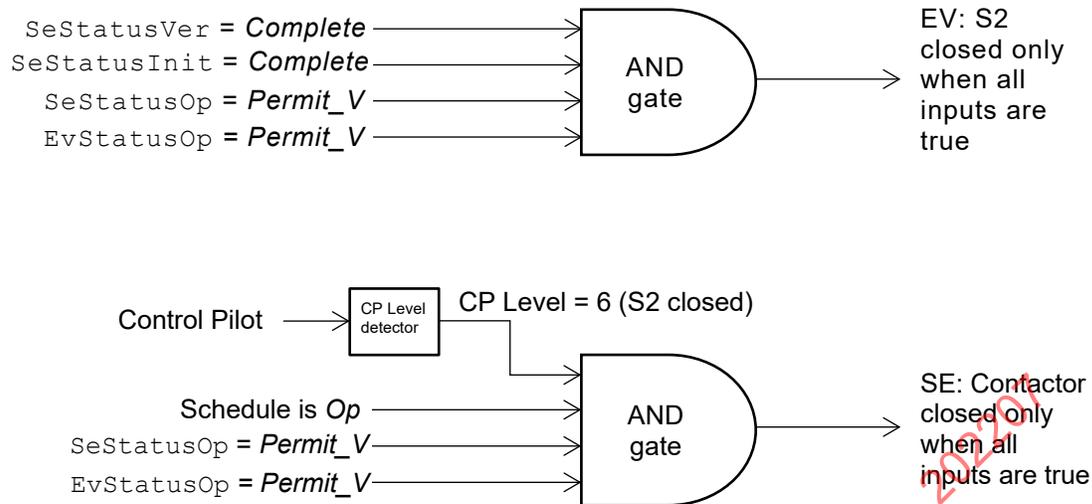
Figure 15 - Control logic concepts for S2 and contactor, informative

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 *S2* 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 ≤ 1 second (T$_{glitch}$) 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 *S2* for conditions lasting ≤ 1 second (T$_{glitch}$).

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 13 lines 1, 2, and 11), it shall not set `EvStatusOp` = *Deny_V* or open *S2* for conditions lasting ≤ 1 second (T_{glitch}).

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 *cordset* connected detects an SAE J1772 *connector* connected, (an adjacent state) or the undefined space between states, for ≤ 1 second (T_{glitch}), 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.

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*. E.g. 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 the current coding resistor R6; see Table 13 and 9.4.1.1.

NOTE: If the current coding resistor R6 indicates a limit of 63 A (three-phase) or 70 A (single-phase), higher load currents are allowed if `SeAvailableCurrentX` allows. See 5.3.2.

9.7.3.5   If the *SE* monitors the *EV's* charge current for purposes of terminating the charge session due to excess current draw, it shall only do so after 1.3 A above `SeAvailableCurrentX` for values under 12 A, or above 111% of `SeAvailableCurrentX` for values above 12 A.

NOTE: Prior to terminating the charge session, the *SE* may initially attempt to mitigate excess current by reducing the `SeAvailableCurrentX` as appropriate. This strategy reduces the risk of a failed charging session.

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 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 *S2*. 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 *S2* 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.

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 it has not already, and open *S2* within T$_{EVopen}$ (3 seconds).

9.7.5.3   The *SE* shall open the *contactor* within T$_{SEopen}$ (3 seconds) of the *EV* opening *S2* (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*). 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 *S2* 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 *S2* 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 *S2* is closed, the *EV* shall request interruption of the supply voltage as specified in 9.7.4.

10.2.1.2   When *S2* 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* negotiation.

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* negotiation.

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   SE Power Outage

A power outage in the *SE* may affect the charging power or the control power or both. Only control power outage is treated here.

10.5.1   SE Power Outage 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) to be ready to *restart* 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 *S2* 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 *S2* 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 to be ready to *restart* the *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 *S2* 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 while *S2* is closed indicates that charging should be stopped, 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 the *connector* being unplugged (the *inlet locking mechanism* has a fault), by the *CP conductor* being interrupted, by 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 17 and 18 show defined values for the *signals* in `EvInfoEntryX` and `SeInfoEntryX`. See 8.3.3 and 8.3.22. 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 does not require the use of these *signals.* It is permissible, but not recommended, to leave all entries set to *Not Available*.

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 3.6.

Table 17 - EvInfoEntryX values

Value	Description	Remark
00_{16} to 10_{16}	Reserved	
11_{16}	*EV* determines that *Protocol Version* selection fails	10.3.1
12_{16}	*EV* determines that *Initialization* fails	10.4.1
13_{16}*	*EV* determines to *restart* the *control sequence* to reselect *Protocol Version*	10.2.1
14_{16}*	[This value is deprecated]	10.2.1
15_{16}*	*EV* needs to *restart* the *control sequence* after an *MCU* reset	10.6.2
16_{16}*	*EV* needs to *restart* the *control sequence* after detecting *CP level* 0 while the *proximity* circuit is connected (e.g., *SE* control power outage)	10.5
17_{16}*	*EV* detects no *LIN headers* for longer than T_{noLIN}	10.7.1
18_{16}*	*EV* determines to *restart* the *control sequence* after detecting a recoverable internal fault	10.7.2
19_{16}	*EV* will terminate charging, an unrecoverable internal fault was detected	10.8.1
$1A_{16}$	Maximum available current is too low	10.4.1
$1B_{16}$	Minimum available voltage is too high	10.4.1
$1C_{16}$	Frequency does not match	10.4.1
$1D_{16}$	Charging delayed due to energy management system	9.7.2.2
$1E_{16}$	*EV* isolation fault	
$1F_{16}$	*EV* is not immediately ready to receive AC voltage	9.7.2.2
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 *S2*	9.7.4
21_{16}	*EV* requests the AC supply voltage to be interrupted by immediately opening *S2*	9.7.4
22_{16}	Maximum available voltage is too low	
23_{16}	Unable to *lock* or latch the charging *inlet*, charging delayed until *lock*/latch succeeds	
24_{16}	Paging error	8.4.2
25_{16}	*EV* requires at least `EvMinCurrentX` to supply a fixed load at the present time	8.3.8
26_{16}-DF_{16}	Reserved	
$E0_{16}$-FE_{16}	Manufacturer specific	
FF_{16}	Empty (default)	

*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.