BS EN 50546:2024



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Railway applications — Rolling Stock — Three-phase shore (external) supply system for rail vehicles and its connectors

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National foreword

This British Standard is the UK implementation of EN 50546:2024. It supersedes BS EN 50546:2020, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee GEL/9/2, Railway Electrotechnical Applications - Rolling stock.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Applications ferroviaires - Matériel roulant - Système d'alimentation à quai (externe) triphasée des véhicules ferroviaires par connecteurs

Bahnanwendungen - Fahrzeuge - Dreiphasiges Fremdeinspeisungssystem für Schienenfahrzeuge und zugehörige Steckverbinder

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European foreword

This document (EN 50546:2024) has been prepared by CLC/SC 9XB, “Electrical, electronic and electromechanical material on board rolling stock, including associated software”.

The following dates are fixed:

- latest date by which this document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2025-07-29
- latest date by which the national standards conflicting with this document have to be withdrawn (dow) 2027-07-29

This document supersedes EN 50546:2020 and all of its amendments and corrigenda (if any).

EN 50546:2024 includes the following significant technical changes with respect to EN 50546:2020:

a) Revision of Clause 1, Scope;

b) Revision of Clause 2, Normative references;

c) Revision of Clause 3, Terms and definitions, with reorganization of definitions;

d) Introduction of new Clause 4, System overview;

e) Introduction of new Clause 5 (revision and completion of previous Clause 4), General requirements;

f) The previous Clause 5 contents where redistributed among other clauses;

g) Updates of Clause 6, Connector requirements;

h) Updates of Clause 7, Tests;

i) Updates of the following mandatory Annexes:

   1) Annex A, Connector design 63/125 A;

   2) Annex B, Connector design 600 A;

j) New Annex C (Informative), Explanations about some protection features;

k) Bibliography, revised and corrected.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a standardization request addressed to CENELEC by the European Commission. The Standing Committee of the EFTA States subsequently approves these requests for its Member States.

This standardization project was derived from the EU-funded Research project MODTRAIN (MODPOWER). It is part of a series of standards, referring to each other. The hierarchy of the standards is intended to be as set out in Figure 1:

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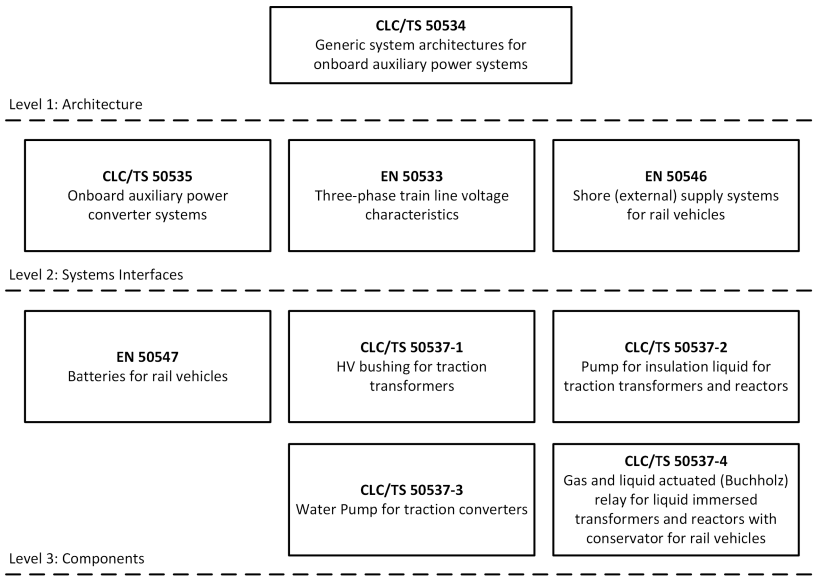


Figure 1 — Overview on the technical framework CLC/TS 50534:2010 defines the basis for other dependent standards

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

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Introduction

This document is part of the technical framework as given in Figure 1 and describes a 63/125 A shore supply system, the safety devices and provides requirements for the connectors. For a 600 A shore supply, this document describes the connector requirements.

The workgroup did take notice from the many technical comments on the final version of the first edition and tried, as best as we could, to address these comments.

While drafting this edition of the document, input was received from various rolling stock manufacturers, infra structure experts, safety experts and operators.

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1 Scope

The shore supply system is used while the rolling stock is standing still within depots and sidings location for providing power to the AC auxiliary loads (which can include battery charging) when the primary power supply (contact line) is not available or used.

This document:

— specifies requirements to the shore supply and to the rolling stock for safe operation on shore supply operation;

— specifies the requirements to ensure compatibility of class C0 and C1 train types as given in CLC/TS 50534:2010 systems and three-phase shore power supply systems;

— provides a complete system design for 63/125 A shore supplies including the interfaces (power and control loop) between shore supply and rolling stock;

— specifies the requirements with regards to interoperability with AC and DC fed traction systems in order to prevent undesired stray currents and adverse interaction with signalling systems when operating on shore supply;

— defines the electrical characteristics of the 63/125 A shore power supply;

— defines the 63/125 A connectors and its intermateability to provide interoperability for rolling stock that is to run across borders;

— defines the 600 A connector and its intermateability;

— can be used for other type of rail vehicles and purposes, if agreed by the manufacturer and customer

— does not apply to shore supplies to move the rolling stock;

— does not describe the 600 A shore supply system.

NOTE 1 The 600 A connector is the existing UK standard three-phase shore supply connector which has a long service history.

NOTE 2 The connectors are dimensioned using standard rolling stock cables as set out in EN 50264-3-1:2008.

NOTE 3 Examples of other usage and rail vehicles are: e.g. light rail vehicles, class A train types, traction battery charging etcetera.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 45545-2:2020+A1:2023, *Railway applications - Fire protection on railway vehicles - Part 2: Requirements for fire behaviour of materials and components*

EN 50124-1:2017, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*

EN 50125-1:2014, *Railway applications - Environmental conditions for equipment - Part 1: Rolling stock and on-board equipment*

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EN 50153:2014,[1] *Railway applications - Rolling stock - Protective provisions relating to electrical hazards*

EN 50264-3-1:2008, *Railway applications - Railway rolling stock power and control cables having special fire performance - Part 3-1: Cables with crosslinked elastomeric insulation with reduced dimensions - Single core cables*

EN 50264-3-2:2008, *Railway applications - Railway rolling stock power and control cables having special fire performance - Part 3-2: Cables with crosslinked elastomeric insulation with reduced dimensions - Multicore cables*

EN 50467:2011, *Railway applications - Rolling stock - Electrical connectors, requirements and test methods*

EN 50533:2011,[2] *Railway applications – Three-phase train line voltage characteristics*

EN 60512-1-4:1997, *Electromechanical components for electronic equipment - Basic testing procedures and measuring methods - Part 1: General - Section 4: Test 1d: Contact protection effectiveness (scoop-proof) (IEC 60512-1-4:1997 + COR1:2000)*

EN 60529:1991,[3] *Degrees of protection provided by enclosures (IP Code) (IEC 60529:1989 + A1:1999 and A2:2013)*

EN 61373:2010, *Railway applications - Rolling stock equipment - Shock and vibration tests (IEC 61373:2010)*

EN ISO 4892-2:2013, *Plastics - Methods of exposure to laboratory light sources - Part 2: Xenon-arc lamps (ISO 4892-2:2013)*

ISO 1431-1:2022, *Rubber, vulcanized or thermoplastic — Resistance to ozone cracking — Part 1: Static and dynamic strain testing*

CLC/TS 50535:2010, *Railway applications - Onboard auxiliary power converter systems*

EN 60947-5-1:2017, *Low-voltage switchgear and controlgear - Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices (IEC 60947-5-1:2016*

3 Terms, definitions and abbreviations

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp/

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1 System

3.1.1.1
shore supply system
system consisting of on-ground equipment and on-board equipment connected to each other

[1] As impacted by EN 50153:2014/A1:2017 and EN 50153:2014/A2:2020.
[2] As impacted by EN 50533:2011/A1:2016.
[3] As impacted by EN 60529:1991/A1:2000, EN 60529:1991/A2:2013 and EN 60529:1991/AC:2016-12.

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3.1.1.2
three-phase shore power supply
three-phase AC voltage system involving three or four wire (including neutral wire) distribution

[SOURCE: CLC/TS 50534:2010, 3.1.18, modified – replaced “3AC voltage system” with “three-phase shore power supply”]

3.1.1.3
3AC train line
<rolling stock> three-phase AC voltage systems involving three or four wire (including neutral wire) distribution

[SOURCE: CLC/TS 50534:2010, 3.1.18, modified – replaced “3AC voltage system” with “3AC train line”]

3.1.1.4
shore supply connection system
system consisting of the fixed connector(s), the free connector(s) and the associated cables

3.1.1.5
shore supply cable
cable with connector(s) connecting the three-phase shore power supply to the rolling stock

Note 1 to entry: The shore supply cable provides connectivity for all contact pins in the connector(s).

3.1.2 Connection

3.1.2.1
connector
device providing connection and disconnection to a suitable mating component

Note 1 to entry: A connector has one or more contact elements

Note 2 to entry: Connectors covered by this document are not intended to be connected and disconnected under electrical load.

[SOURCE: IEC 60050-581:2008,581-26-01 – Note 2 to entry has been added]

3.1.2.2
intermateable
pertaining to each of two components when they feature identical dimensions for electrical and dimensional interfaces

[SOURCE: IEC 60050-581:2008, 581-24-07]

3.1.2.3
mating cycle
cycle of operation of a connector
one connection and one disconnection of the connector mating halves

[SOURCE: IEC 60050-581:2008, 581-21-06, modified – The preferred term “cycle of (connector) operation” has been replaced by “mating cycle” and the admitted term “cycle of operation of a connector” has been added. The word ‘insertion’ has been replaced with ‘connection’ and the word ‘withdrawal’ has been replaced by ‘disconnection’. The word “mating” has been added to “halves” for clarity.]

3.1.2.4
free connector
connector for attachment to a free end of a cable

Note 1 to entry: Is a mobile connector, with male or female contacts, to be coupled to a fixed connector.

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[SOURCE: IEC 60050-581:2008, 581-26-10, modified – ‘of a cable’ and Note 1 to entry added for clarity]

3.1.2.5
fixed connector
connector for attachment to a rigid surface

Note 1 to entry: Is a connector, with male or female contacts, to be mounted on rigid surface.

[SOURCE: IEC 60050-581:2008, 581-26-07, Note 1 to entry added for clarity]

3.1.2.6
shore supply connector
connector dedicated to the shore supply system

3.1.2.7
contact
<in a connector> conductive element in a connector (including means for a cable termination) that mates with a corresponding element to provide an electric path

[SOURCE: EN 50467:2011, 3.8]

3.1.2.8
crimped connection
permanent connection made by the application of pressure inducing the deformation or reshaping of the barrel around the conductor of a cable

Note 1 to entry: In some cases, the deformation or reshaping of the barrel can affect the form of the conductor.

[SOURCE: IEC 60050-461:2008, 461-19-01]

3.1.2.9
male contact
pin contact
contact element intended to make electric engagement on its outer surface for mating with the inner surface of another contact element

[SOURCE: IEC 60050-581:2008, 581-22-08, modified – The preferred term “pin contact” and the admitted term “male contact” have been inverted.]

3.1.2.10
female contact
socket contact
contact element intended to make electric engagement on its inner surface for mating with the outer surface of another contact element

Note 1 to entry: In English, the term “socket contact” does not imply that socket contacts are always mounted in a socket (IEC 60050-151:2001, 151-12-20) nor that sockets have only socket contacts.

[SOURCE: IEC 60050-581:2008, 581-22-06, modified – The preferred term “socket contact” and the admitted term “female contact” have been inverted. “IEC 60050-151:2001” has been added in Note 1 to entry]

3.1.2.11
pilot contact
auxiliary electric contact for use in a control, signalling, monitoring or interlock circuit

[SOURCE: EN-IEC 60309-1:2022, 3.25 modified – replaced the word ”function” with “circuit”]

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3.1.2.12
interlock circuit
circuit linking mechanical, electric or other devices, for example through auxiliary contacts, intended to make the operation of a piece of apparatus dependent on the condition or position of one or more others

[SOURCE: IEC 60050-811:2017, 811-25-13]

3.1.2.13
coding contact
<shore supply system> control contact for the system to know which current is available from the three-phase shore power supply

3.1.2.14
last make first break
contact that is the last to make a connection when the free connector is connected into the fixed connector and the first to break the connection when the free connector is disconnected from the fixed connector

3.1.3 Electrical

3.1.3.1
rated voltage
<of connector> value of voltage assigned to the connector and to which operation and performance characteristics are referred

3.1.3.2
rated impulse voltage
<of connector> impulse voltage value assigned to the connector, characterizing the specified withstand capability of its insulation against transient overvoltages

[SOURCE: IEC 60050-581:2008, 581-21-18, modified – Specific use has been added. In the definition "impulse' has been added. "by the manufacturer" has been deleted.]

3.1.3.3
rated current
<of connector> value of the electric current in a connector used for specification purposes, established for the operating condition in which the electric current is present continuously

[SOURCE: IEC 60050-581:2008, 581-21-05, modified – The specific use has been added. The second part of the definition "and simultaneously in all contacts of the connector being wired with the largest specified conductor, while the ambient temperature near the connector is maintained at 40 °C" has been removed. The Note to entry has been omitted.]

3.1.3.4
Safety Extra-Low Voltage
SELV
AC voltage the RMS value of which does not exceed 50 V or ripple-free DC voltage the value of which does not exceed 120 V, between conductors, or between any conductor and reference earth, in an electric circuit which has galvanic separation from the supplying electric power system by such means as a separate-winding transformer

Note 1 to entry: Maximum voltage lower than 50 V AC or 120 V ripple-free DC can be specified in particular requirements, especially when direct contact with live parts is allowed.

Note 2 to entry: The voltage limit should not be exceeded at any load between full load and no-load when the source is a safety isolating transformer.

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Note 3 to entry: Ripple-free qualifies conventionally an RMS ripple voltage not more than 10 % of the DC component; the maximum peak value does not exceed 140 V for a nominal 120 V ripple-free DC system and 70 V for a nominal 60 V ripple-free DC system.

Note 4 to entry: The values given are according to EN 50153:2014, Table 1 Band II.

[SOURCE: IEC 60050-851:2008, 851-15-08]

3.1.3.5
SELV system
electric system in which the voltage cannot exceed the value of extra-low voltage:

— under normal conditions and

— under single fault conditions, including earth faults in other electric circuits

Note 1 to entry: SELV is the abbreviation for Safety Extra-Low Voltage.

[SOURCE: IEC 60050-195:2021, 195-06-28]

3.1.3.6
phase sequence
order in which the voltages successively reach their maximum positive values between supply conductors

[SOURCE: IEC 60034-8:2007, 3.13]

3.1.3.7
clearance
shortest distance in air between two conductive parts

[SOURCE: IEC 60050-581:2008, 581-27-76]

3.1.3.8
creepage distance
shortest distance along the surface of a solid insulating material between two conductive parts

[SOURCE: IEC 60050-581:2008, 581-21-23]

3.1.3.9
direct contact
electric contact of human beings or livestock with live parts

[SOURCE: IEC 60050-195:2021, 195-06-03]

3.1.3.10
indirect contact
electric contact of human beings or livestock with exposed-conductive-parts that have become live under fault conditions

[SOURCE: IEC 60050-195:2021, 195-06-04]

3.1.3.11
exposed-conductive-part
conductive part of equipment that can be touched and that is not live under normal conditions, but that can become live when basic insulation fails

[SOURCE: IEC 60050-195:2021, 195-06-10]

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3.1.3.12
protective-equipotential-bonding
equipotential bonding for the purposes of electrical safety

[SOURCE: IEC 60050-195:2021, 195-01-15]

3.1.3.13
main equipotential busbar
MEB
busbar where the equipotential conductors terminate

[SOURCE: EN 50122-1:2022, 3.2.7]

3.2 Abbreviations

AC	alternating current
BAT	battery
CP	coding pin
DC	direct current
EFMD	earth fault monitoring device
EMI	electro magnetic interference
FBS	flat battery start
IT	isolation terra
MCB	miniature circuit breaker
MEB	main equipotential busbar
NA	not applicable
PE	protective-equipotential-bonding
PP	pilot pin
RCBO	residual current breaker with overload protection
RCD	residual current device
SELV	Safety Extra-Low Voltage
TCMS	train control and monitoring system
TDR	total distortion ratio
TN	terra neutral
UV	ultra violet
VLD	voltage limiting device

4 System overview

4.1 Introduction

4.1.1 General

This clause describes the complete 63/125 A shore supply system. The functions of different parts are explained briefly in this clause. Specific details are described in later (sub)clauses. Functional examples and further information regarding faults, inrush and personal safety are given in Annex C.

The overall system diagram is given in Figure 2.

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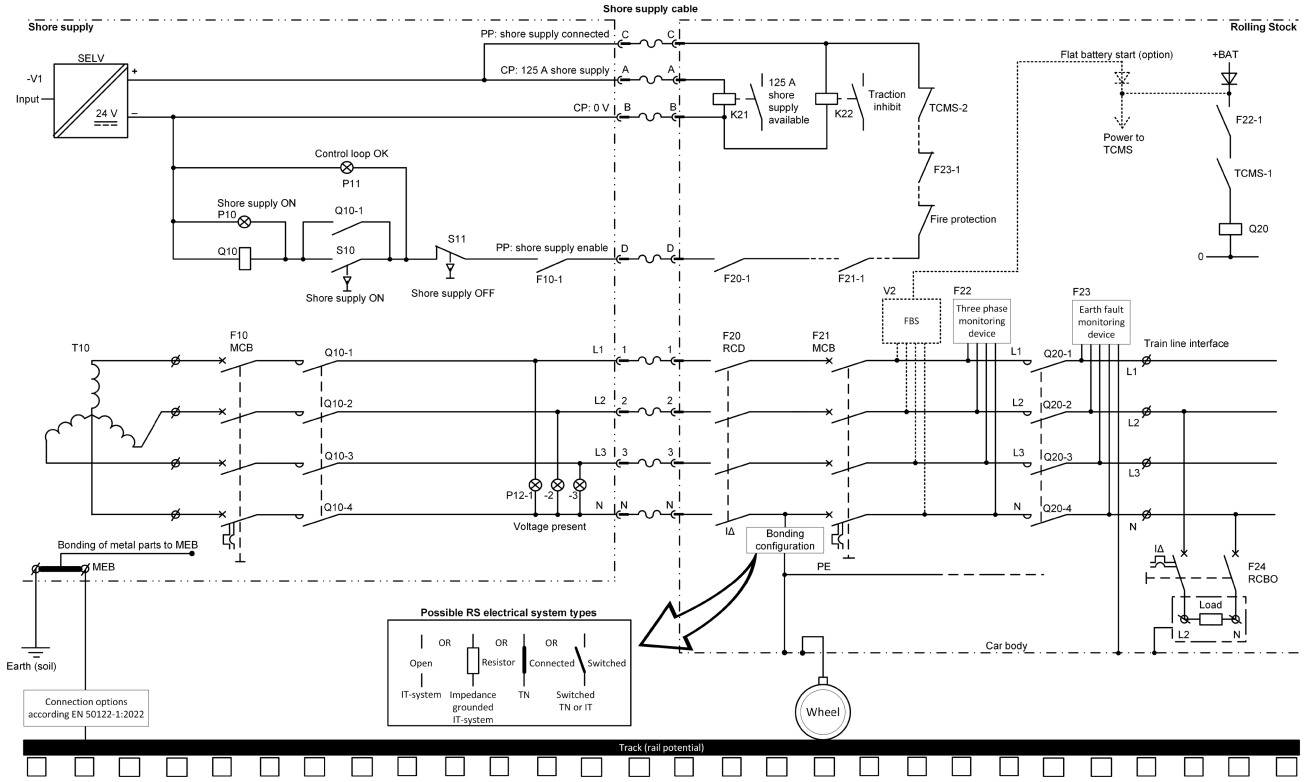


Figure 2 — System overview

4.1.2 Three phase shore power supply

A three-phase shore power supply (with neutral), galvanically isolated to avoid ground loop between shore side and rolling stock, is provided by the shore supply cable to feed the rolling stock.

The system provides a safe way to connect, energize and de-energize the shore supply.

Protection is provided against:

— short circuit and overload;

— indirect contact with an exposed-conductive- part;

— direct contact with an energized defective cable on the shore supply side.

The three-phase shore power supply is compatible with both a TN or a IT rolling stock 3AC train line system. The system can optionally be expanded with a flat battery starting functionality, using the three-phase shore power supply to energize Q20 and / or to provide power for limited TCMS functionality to ensure system start-up.

For alternative implementation requirements refer to 5.1.

NOTE In the infrastructure world a three-phase system is often annotated as “three-phase”, in the rolling stock world it is often annotated as 3AC. In this document 3AC or 3AC+N is used and annotates to the appropriate world.

4.1.3 Safety Extra-Low Voltage (SELV) DC shore power supply

A SELV DC supply, galvanically isolated to avoid ground loop between shore side and rolling stock, is provided to feed the control and safety circuit.

The rolling stock can detect whether a connecting cable is connected to the shore supply and the available current rating (63/125 A system only).

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The shore supply will be de-energized if any of the protection devices in the shore supply (i.e. F10) or in the rolling stock (i.e. F20, F21, F23) is triggered.

The rolling stock can detect an inhibit traction indication using a combination of pilot and coding contacts – even if the shore supply is not yet energized (63/125 A system). An Inhibit traction indication may be used to activate brakes and/or prevent an electrical contact with the main power supply (e.g. contact line, ground level conductor rail).

4.2 Protective devices

4.2.1 General

Due to the interoperability requirements of the system in all European countries for border crossing, different manufacturers of rolling stock, different traction power supply systems and signalling systems, protective devices are placed both on the shore side and on the rolling stock side.

4.2.2 Shore side protective devices

Devices on the shore side provide the following functions:

— overload protection, F10 (mandatory);

— short circuit protection, F10 (mandatory);

— isolation contactor, Q10 (mandatory).

4.2.3 Rolling stock protective devices

Devices on the rolling stock side, between the shore supply connector and the 3AC train line, provide the following functions:

— residual current protection, F20 (mandatory);

— overload protection, F21 (see 5.4.5.3);

— short circuit protection, F21 (see 5.4.5.3);

— phase sequence protection, F22 (mandatory);

— missing phase protection, F22 (mandatory);

— voltage monitoring, F22 (mandatory);

— isolation contactor, Q20 (mandatory);

— earth fault monitoring device, F23 (optional, for IT systems only).

4.2.4 Rail bonding options and PE

4.2.4.1 Shore side

Depending on the traction supply system used and in accordance with EN 50122-1:2022 the main equipotential busbar (MEB) of the shore supply can be bonded to the rail.

4.2.4.2 Rolling stock side

Depending on the design of the rolling stock grid system, the protective earth (PE) can either be a dedicated conductor or a conductive car body frame. The bonding between neutral and the PE can be:

— open (IT system);

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— impedance grounded (IT system);

— fixed connection (TN system);

— switched (TN / IT system).

NOTE In practical conditions, “open” or “open switch” IT systems are actually “high impedance” IT systems. The total earthing impedance can be constituted by one or more elements (e.g. EMI filters) along the 3AC train line.

4.3 Control and monitoring circuitry

4.3.1 Sequence of operation

4.3.1.1 Preparation

The rolling stock is prepared to be connected to the shore supply and parked in accordance with local procedures.

— the rolling stock will be disconnected from the main supply by the operational staff before connecting to the shore supply

— the main supply is disconnected when the shore supply cable is connected to the rolling stock

4.3.1.2 Connecting to shore supply

To prevent the possibility for the rolling stock to drive away with an attached cable (see traction inhibit 5.3.6), the shore supply side of the shore supply cable should be connected first to the shore supply fixed connector.

NOTE Alternatively, a fixed connection to the shore supply side of the shore supply cable can be considered.

Operational staff will attach the shore supply cable with the train shore supply fixed connector.

The SELV of the shore supply informs the rolling stock of:

— the connected status

— the shore supply current rating 63/125 A.

The rolling stock TCMS:

— inhibits traction, K22;

— disconnects from the main supply (if not previously done);

— prepares the control sequence for load limitation if the shore supply current rating is less than the rolling stock current rating.

If the Rolling Stock is ready to be supplied by the shore supply, including the RCD (F20), the overload protection (F21) and the MCB (F10) contacts are in the closed position, the control loop is closed and the “Control loop OK” (P11) lamp lights up.

4.3.1.3 Energized state

The shore supply ON-button (S10) is pressed. The isolation contactor (Q10) is closed. If the MCB (F10) is closed, the “Shore supply ON” (P10), “Voltage present” (P12-1, P12-2 and P12-3) lamps will light up, indicating the presence of the three-phase shore power supply.

If the rolling stock three phase monitoring device (F22) (phase sequence, missing phase detection and voltage monitoring) confirms no faults, two methods of controlling the isolation contactor (Q20) are available:

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— if the TCMS is informed through an auxiliary contact of the phase monitoring device (F22), the TCMS provides the command to close the isolation contactor (Q20);

— if control of isolation contactor (Q20) is required without TCMS involvement, the auxiliary contact (F22-1) of the three phase monitoring device (F22) directly energizes the isolation contactor (Q20), see 5.3.9.

The rolling stock 3AC train line is now connected to the shore power supply.

NOTE When operating on shore supply higher voltages can be generated in other circuits in the rolling stock, depending on the design. Usually this is addressed in the maintenance manual.

4.3.1.4 Fault occurrence

The shore supply is automatically de-energized by any of the following causes:

— disconnection or partial disconnection of the shore supply cable connector at the rolling stock side;

— disconnection or partial disconnection of the shore supply cable connector (if present) at the shore supply;

— detection of a fault by the residual current protection device (F20);

— detection of a fault by the overload and short circuit protection device (F10) on the shore side;

— activation of any optional system opening the control loop (e.g. fire protection, earth fault detection device (F23), TCMS).

4.3.1.5 De-energizing and disconnecting

To deenergise the shore supply OFF-button is pressed. The isolation contactor (Q10) is opened. The “Shore supply ON” (P10) and “Voltage present” (P12-1, P12-2 and P12-3) lamps will turn off, indicating the absence of three-phase shore power supply. The three-phase monitoring device (F22) will detect the absence of the three-phase shore power supply and the isolation contactor Q20 opens, disconnecting the 3AC train line from the shore supply.

The shore supply cable may be disconnected from the rolling stock. As soon as the shore supply cable is disconnected from the rolling stock, the “Control loop OK” (P11) lamp will turn off. After all other shore services (e.g. air supply, water etc.) are disconnected, the rolling stock may be connected to the main supply (e.g. contact line, ground level conductor rail etc.).

4.3.1.6 Feedback

If the “Control loop OK” (P11) lamp lights up when no rolling stock is connected a cable fault is present. The cable should be repaired before use since the rolling stock would be unable to de-energize the shore supply as a result of the causes described in 4.3.1.4.

4.4 Connection diagrams 63/125 A

Figure 3 describes the connection with a fixed cable on the shore side and a free female connector to the rolling stock side.

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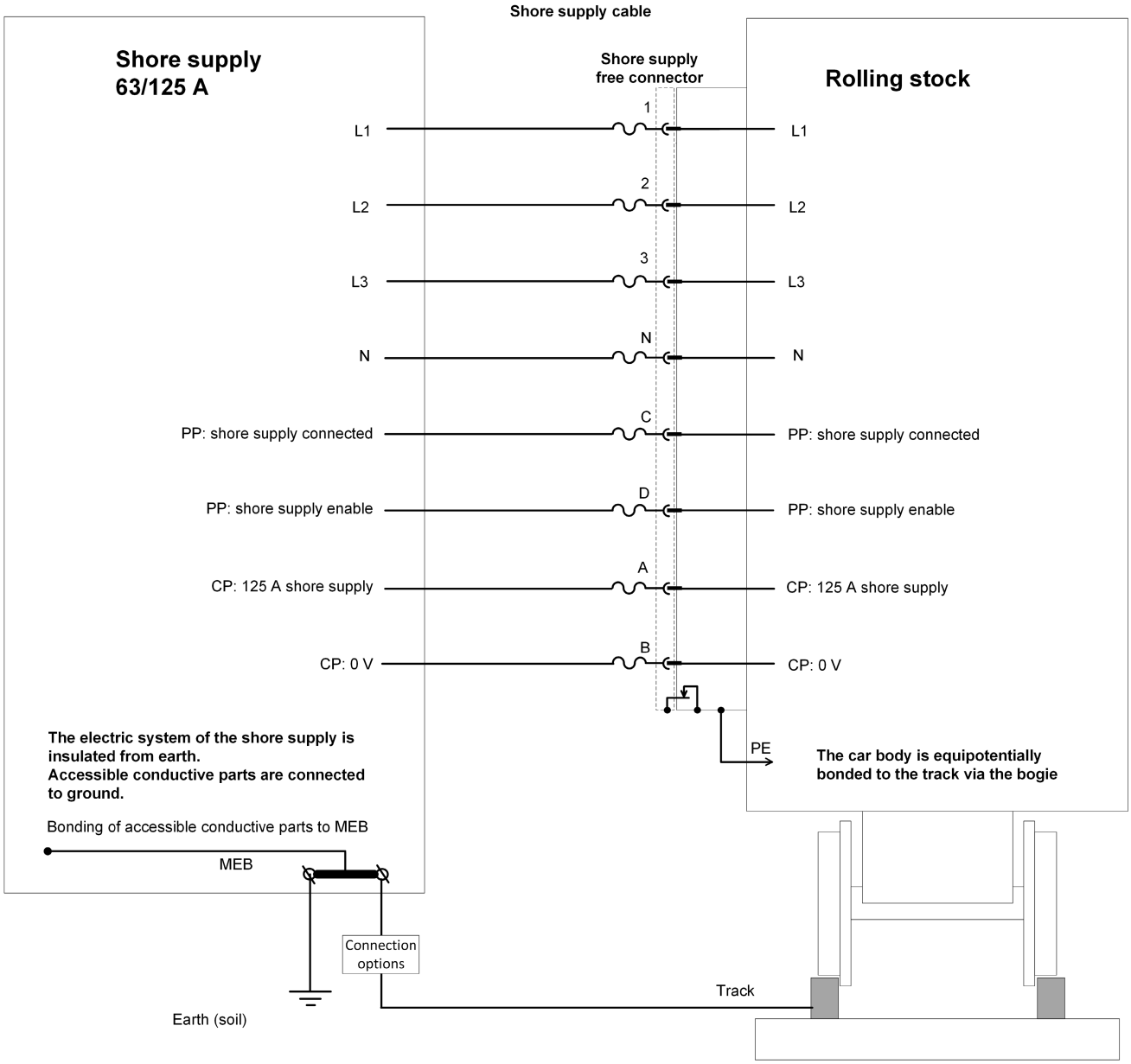


Figure 3 — Connection diagram 63/125 A with fixed cable

Figure 4 describes the connection with a fixed female connector on the shore side and a free cable with one free male connector and one free female connector.

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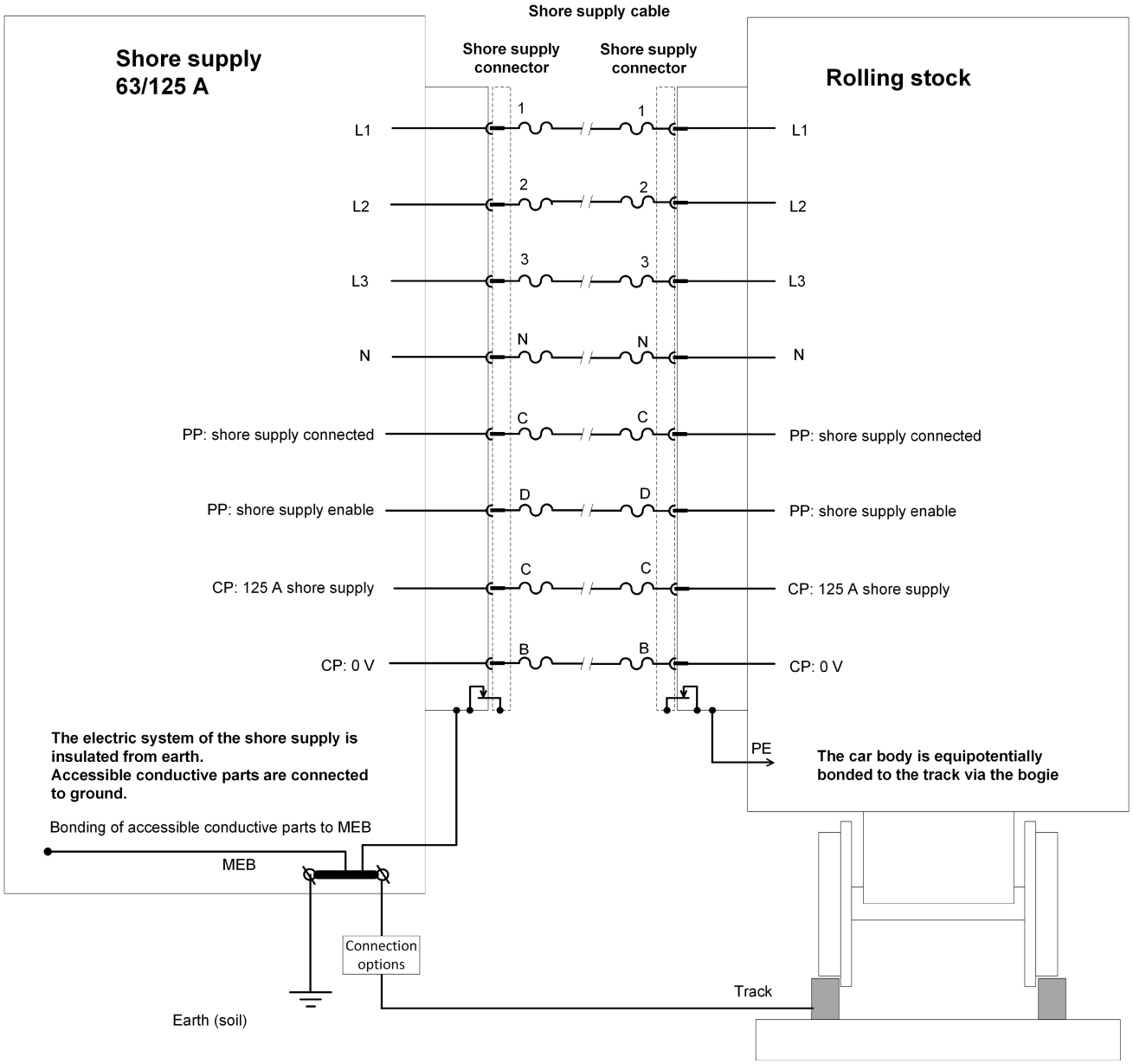


Figure 4 — Connection diagram 63/125 A with a free cable

4.5 Connection diagrams 600 A

Figure 5 describes the connection with a fixed cable on the 600 A shore side and a free male connector on the rolling stock side.

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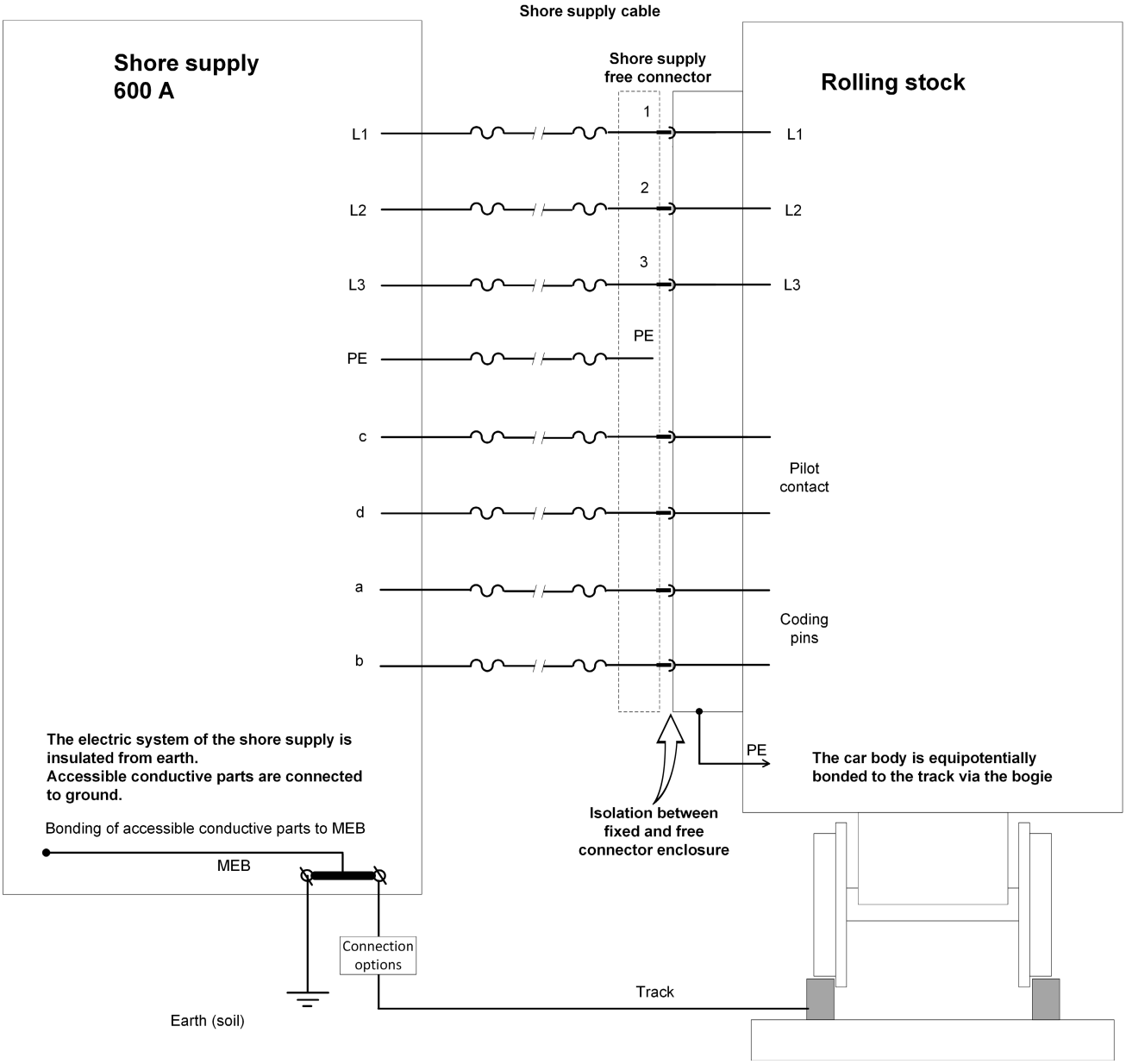


Figure 5 — Connection diagram 600 A system with the PE conductor

5 General requirements

5.1 Alternative implementations

Alternative implementations in technology, combination of functions and additions to Figure 2 are permissible as long as:

— compatibility objective for shore supply and rolling stock shall be achieved;

— all requirements specified in this document shall be fulfilled;

— connector pin functions shall not be changed.

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5.2 Shore supply system power ratings

5.2.1 Three-phase requirements

Table 1 provides an overview of the three-phase power requirements of the 63/125 A and 600 A shore supply and the connector type used.

Table 1 — Shore supply power ratings

Shore supply system	Rated operating current (continuous load at an ambient temperature of 20 °C)	Remarks	Connector type
3-phase AC; 400 V, 50 Hz	600 A per conductor	400 kVA High power system	B
3-phase AC + N; 400 V, 50 Hz	125 A per conductor	86 kVA Medium power system	A
3-phase AC + N; 400 V, 50 Hz	63 A per conductor	44 kVA Low power system	A

The Neutral conductor shall have the same cross section area as per a phase conductor.

5.2.2 Shore supply current rating

The shore supply shall communicate its current rating to the rolling stock by connecting the CP A as given in Table 2.

Table 2 — Current rating identification

Shore supply current rating	CP A voltage against CP B
63 A	0V or CP A not connected
125 A	+24V

5.2.3 Control loop SELV system requirements

The SELV power supply:

— shall be galvanically isolated;

— shall be able to provide a 5 A continuous load current at nominal voltage;

— shall have a current limitation with a maximum current of 10 A in short circuit conditions

— shall be short circuit proof;

— shall have an output voltage of 24 V ± 10 %.

The maximum shoreside current drawn shall not be higher than 2 A, the maximum current consumed by the rolling stock shall not be higher than 3 A.

All contacts in the control loop shall meet DC13 as given EN 60947-5-1:2017

5.3 Interaction between rolling stock and shore supply

5.3.1 Shore supply IT floating (63/125 A)

The shore supply shall be floating and therefore the neutral shall not be connected to the shore supply PE.

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NOTE This requirement follows from the requirement not to interfere with signalling systems and the independence of earthing systems which can be totally different between shore side and rolling stock side. The floating shore side provides compatibility with different train line systems regarding the functionality and the safety provisions addressed in this document.

5.3.2 No connection between shore MEB (PE) and rolling stock PE (63/125 A)

The MEB (PE conductor) of the shore supply shall not be connected to the PE of the rolling stock.

NOTE This requirement follows from the requirement not to interfere with signalling systems and the independence of earthing systems which can be totally different between shore side and rolling stock side. To prevent parallel paths for traction return or neutral return currents. See EN 50122-1:2022, Clause 7 for more information.

5.3.3 Clockwise rotation field

The connections to the phases on the shore and rolling stock sides, shall be made in such a way that their respective voltage correspond to the direct phase sequence as given in Figure 6 and Table 3.

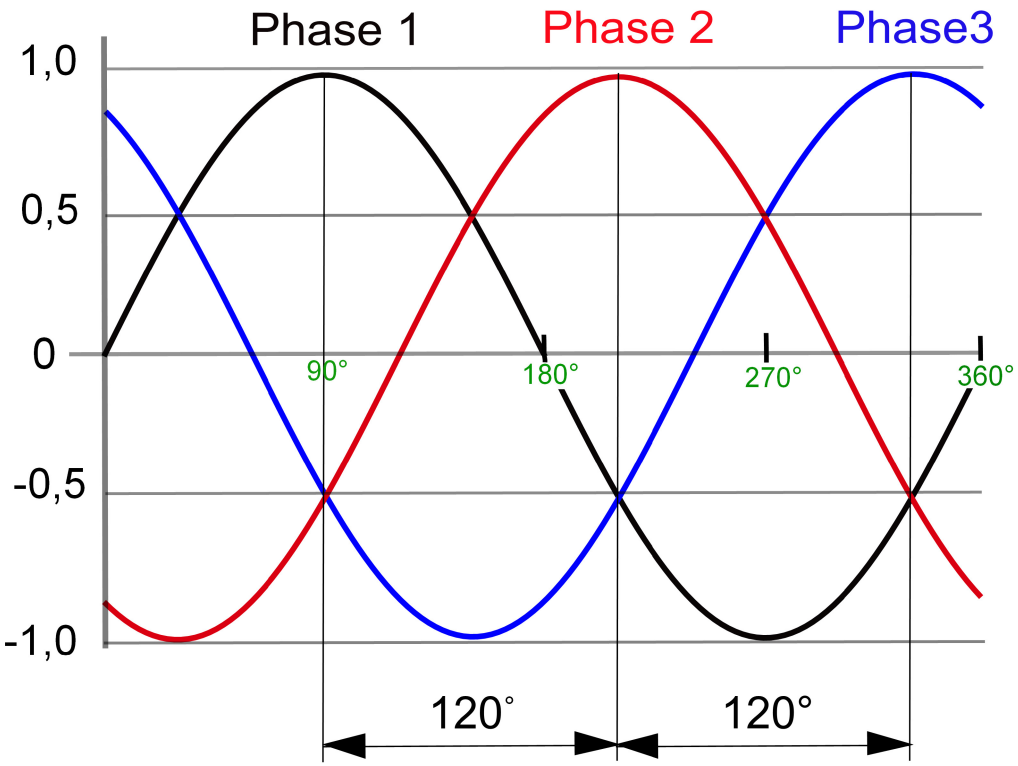


Figure 6 — Direct phase sequence

Table 3 — Pin annotation and phase sequence

Phase according to Figure 6	Annotation according to Figure 2	Pin annotation according to 6.1.3.2 63/125 A connector	Pin annotation according to 6.1.3.3 600 A connector
Phase 1	L1	1	1
Phase 2	L2	2	2
Phase 3	L3	3	3
	Neutral	N	Not present

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NOTE The labelling of the power contacts aligns with the labels used to describe the phases in EN 50533:2011, omitting the 'L' label.

5.3.4 Use of neutral (63/125 A)

The shore supply shall provide the neutral to the rolling stock even if, depending on the rolling stock design, the neutral is not distributed on the 3AC train line.

5.3.5 Use of neutral (600 A)

The neutral is not provided by the shore supply to the rolling stock.

5.3.6 Prevent movement of the rolling stock

The rolling stock shall include an interlock circuit to ensure that traction is inhibited when the three-phase shore power supply is physically connected.

Referring to Figure 2, the interlock circuit can be created by using the combination of pilot pin "C" (+) and coding contact "B" (-): when energized, contactor K22 indicates the physical connection to the shore supply.

This function may also be used to apply parking brakes if required.

NOTE Observe that the traction inhibit indication fails in the absence of the 24 V SELV power. If safe operating procedures are not in place, damage to rolling stock and / or shore system can occur and / or can cause unsafe working conditions.

5.3.7 Rolling stock inrush current limitation

To prevent tripping of the shore supply 63 A MCB (F10) due to the inrush current, the inrush current shall not exceed 315 A during 10 ms maximum.

5.3.8 Exclusive train line supply modes

When a 3AC train line is energized internally, by an auxiliary inverter (usually from the contact line or battery), the shore supply connectors connected to the same 3AC train line shall not be energized. This is achieved by Q20 (see Figure 2) for each shore supply connector.

When a 3AC train line is energized externally, by the shore supply connected to one vehicle fixed connector. It shall not be possible to close another isolation contactor (Q20) connected to the already energized 3AC train line even if another valid shore supply connection is made on the same 3AC train line.

NOTE Due to the scope of this document, this clause provides new / additional requirements in relation to CLC/TS 50534:2010, 5.2.1.7.1.

5.3.9 Shore supply activation when TCMS is unavailable (optional)

If the customer requires to operate the shore supply even when the TCMS functionality isolation contactor (Q20) cannot be energised, a device may be added to the design.

Without TCMS operation some safety functions implemented in TCMS affecting the control loop and Q20 control shall be analysed and agreed between manufacturer and customer.

5.3.10 Flat battery start (optional)

The customer may require to be able to operate on the three-phase shore power supply if the DC battery on the rolling stock (+BAT Figure 2) is flat. A device may be added to the design using the three-phase shore power supply to obtain the energy for supplying the isolation contactor (Q20) and control circuitry.

The design, functions and constraints of the optional Flat Battery Start system are not within the scope of this document, however, the Flat Battery Start system shall be compatible with the requirements of this document.

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5.3.11 Location of shore supply fixed connector on Rolling Stock

The location of the fixed male fixed connector shall be agreed between manufacturer and customer. It is recommended to choose a location which is well accessible from track level. Provisions shall be made to protect the fixed connector against weather influences in accordance with the requirements set out in EN 50467:2011, Table B.1 for location 4. The access may be limited to authorized personnel.

5.4 Electrical safety

5.4.1 Basic safety requirements

Connection cables and connectors shall be inspected regularly. They shall not be mechanically damaged or damaged in such a way providing a risk of electrical shock.

A free connector of the shore supply shall not be energized unless it is properly mated to a fixed connector. This is achieved by the control circuit and the pilot pins in combination with Q10 (see Figure 2). The pilot pins will connect only if the connector is correctly and fully plugged in.

Connecting and disconnecting operations shall take place under conditions of zero voltage. This function is implemented in two ways (see Figure 2):

— the use of the [OFF] and [ON] button;

— the pilot pins. Disconnecting an energised cable causes the pilot pins to disconnect first. The disconnection of the pilot pins causes an immediate de-energisation of Q10. The main contacts are therefore disconnected under the condition of zero current and answers to the requirement as given in EN 50153:2014 to avoid arcing flash.

Electrical parts of the free (infrastructure) connector shall be de-energized when the shore supply system is not in use. This is achieved by the control circuit in combination with Q10 (see Figure 2).

The shore supply shall include a visible indication(s) indicating the system is energized. This is achieved by P10 and P12-1, P12-2, P12-3 (see Figure 2).

NOTE The indication does not need to be on the connector.

5.4.2 Temporary outage of power grid

In case of an interruption in the power grid system supply feeding the shore supply, the reason for interruption is unknown and can invoke an electric safety issue. The design in Figure 2 does not provide automatic function for reenergisation of the three-phase shore power supply. An automatic function for reenergizing the shore supply can be added to the control circuitry.

5.4.3 Insulation safety

The insulation of shore supply installation shall be in accordance with EN 50153:2014 protection against electrical hazards and EN 50124-1:2017.

5.4.4 Touch safety

The electrical installation shall be touch safe. Connectors shall be safe when used in the yard and shed, see the IP rating in 6.4.

The residual current device function (F20, see Figure 2) shall be present in the rolling stock in order to protect persons on the shore side (outside the rolling stock) from direct contact with a damaged cable or connector:

The residual current device (F20, see Figure 2) shall have:

— a rated residual operating current of 30 mA;

— a current rating in accordance with the shore supply rating of the 3AC train line;

— an auxiliary contact opening the control loop.

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The recommended additional requirements for residual current device (F20, see Figure 2) are:

— type B according to IEC 62423:2009;

— immune to current harmonics and transients.

NOTE More details and explanations regarding this RCD on the rolling stock is given in Clause C.2.

5.4.5 Overload and short circuit protection

5.4.5.1 General

Referring to Figure 2 the overload and short circuit protection shall be provided by F10 on the shore side and F21 on the rolling stock side.

5.4.5.2 Shore overload and short circuit protection requirements

The shore supply overload and short circuit protection device (F10) shall:

— have a current rating in accordance with the shore supply current rating and the connector type used;

— have a short circuit capability in accordance with the shore supply current rating;

— be compatible with the inrush current and starting characteristics of the rolling stock auxiliary loads, — particularly on high power auxiliary systems; (63/125 A curve C MCB or 63/125 A Fuse gG);

— have an auxiliary contact to open the control loop.

5.4.5.3 Rolling stock overload and short circuit protection requirements

The presence of F21 is optional unless the rolling stock shore supply interface is designed for 63 A.

In that case overload and short circuit protection device (F21) shall:

— have a current rating of 63 A;

— have a short circuit capability 6 kA;

— be compatible with the inrush current and starting characteristics of the rolling stock auxiliary loads, — particularly on high power auxiliary systems; (63/125 A curve C MCB or 63/125 A Fuse gG);

— have an auxiliary contact to open the control loop.

The functions and requirements of F20 and F21 may be combined in a RCBO device.

5.4.6 Three-phase monitoring device

The three-phase monitoring device (F22, see Figure 2) shall be present in the rolling stock and shall provide the following functions:

— phase sequence protection: phase sequence according to 5.3.3;

— missing phase protection: detection of one or more absent phases;

— voltage monitoring: voltage amplitude within tolerances according to EN 50533:2011.

Detection of any fault condition:

— shall prevent connection of the 3AC train line to the three-phase shore power supply at start-up However, as an alternative implementation as permitted in 5.1, manufacturer of rolling stock may position F22 on

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