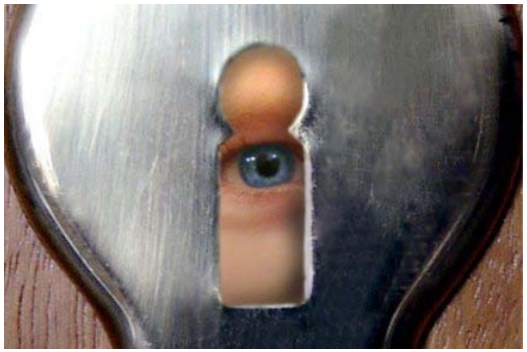
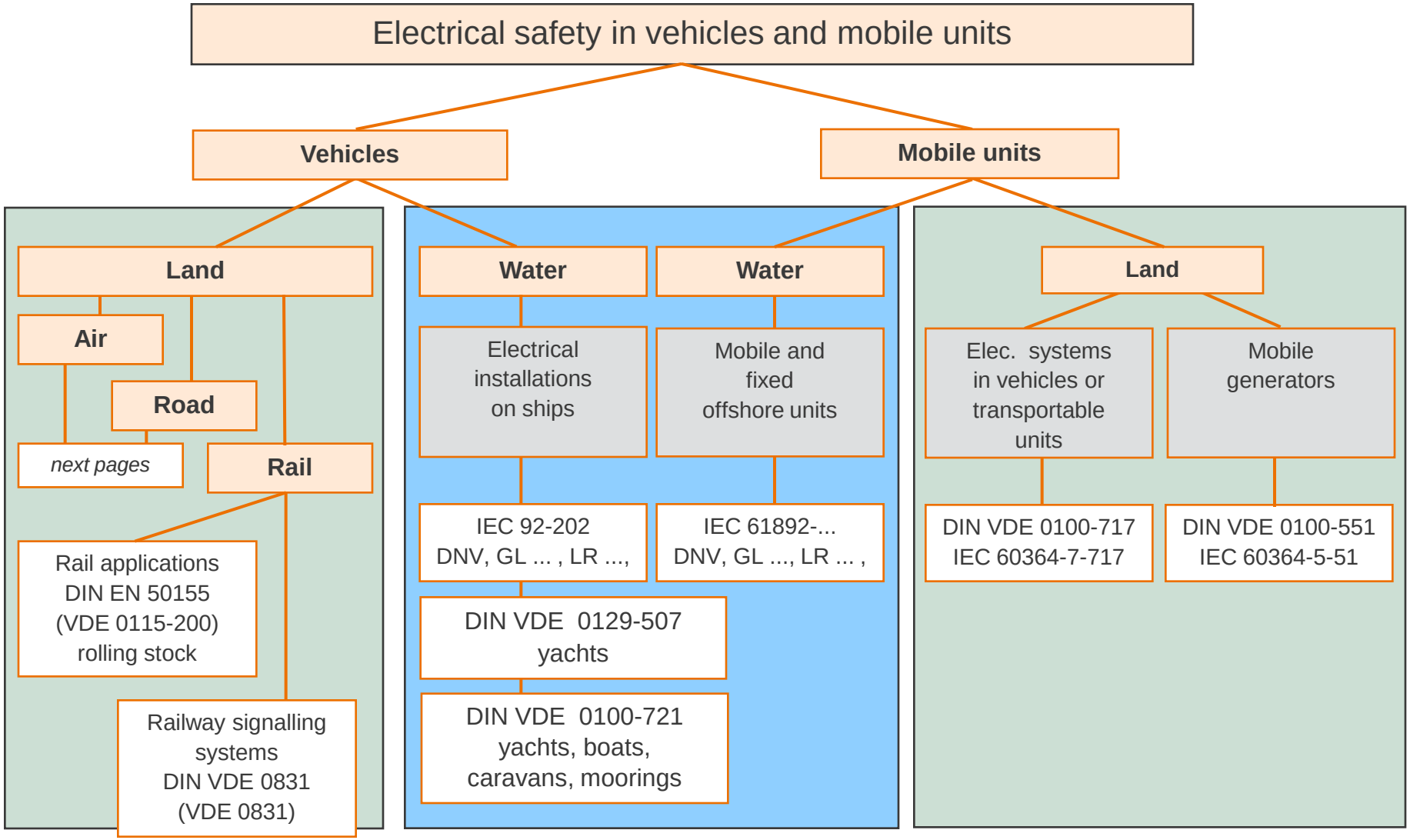
Electrical safety for hybrid and electric vehicles

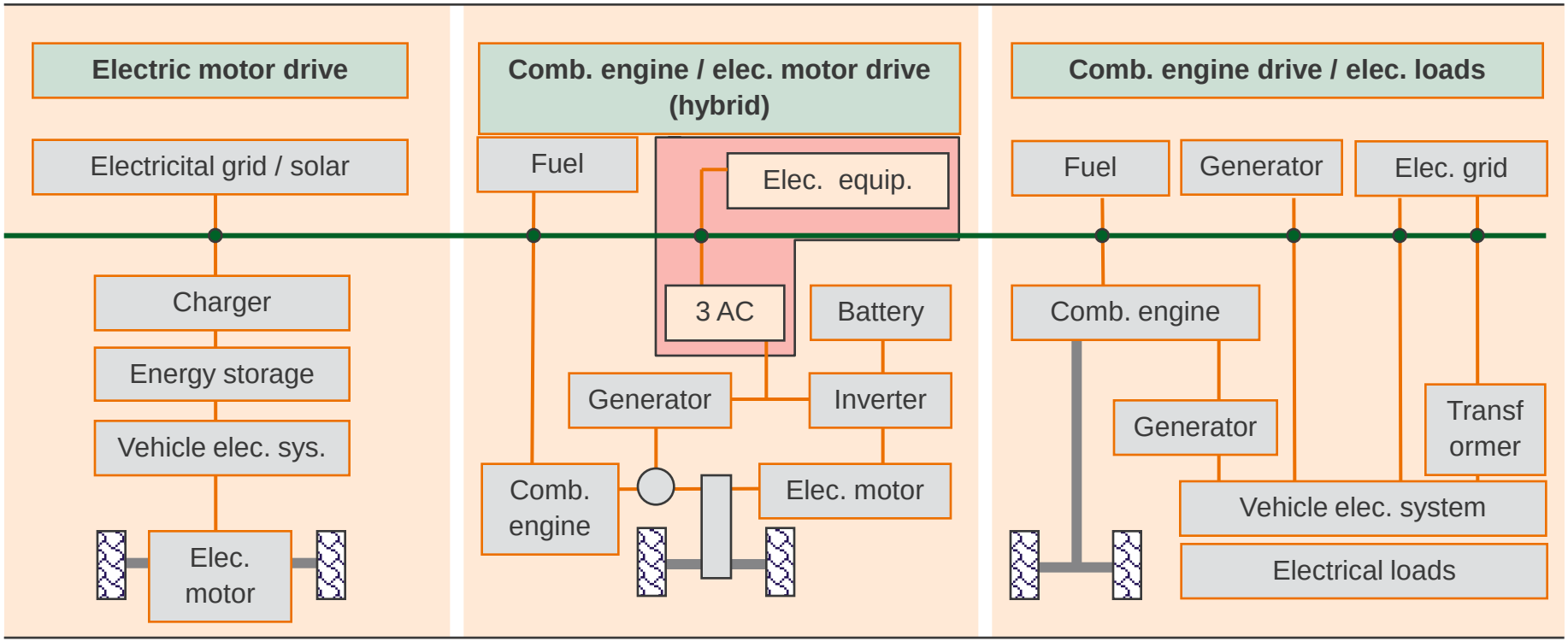
1. General

2. Drive concepts
3. Standards
4. Bender solutions




Electrical safety in vehicles and mobile units
Vehicles
Mobile units
Land
Air
Road
next pages
Rail
Rail applications
DIN EN 50155
(VDE 0115-200)
rolling stock
Railway signalling
systems
DIN VDE 0831
(VDE 0831)
Water
Water
Electrical
installations
on ships
Mobile and
fixed
offshore units
IEC 92-202
DNV, GL ... , LR ...,
IEC 61892-...
DNV, GL ..., LR ... ,
DIN VDE 0129-507
yachts
DIN VDE 0100-721
yachts, boats,
caravans, moorings
Land
Elec. systems
in vehicles or
transportable
units
Mobile
generators
DIN VDE 0100-717
IEC 60364-7-717
DIN VDE 0100-551
IEC 60364-5-51

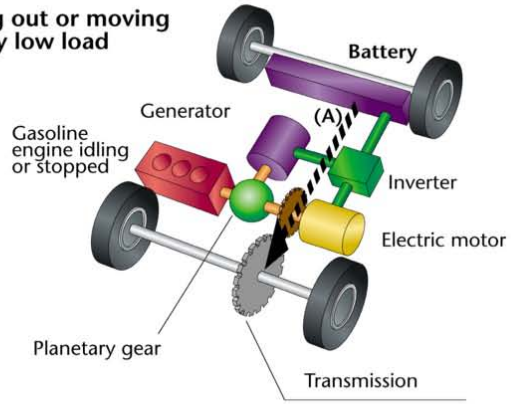
Electrical vehicles with varying drive concepts, requirements and applications



Hybrid principle

THS Operation

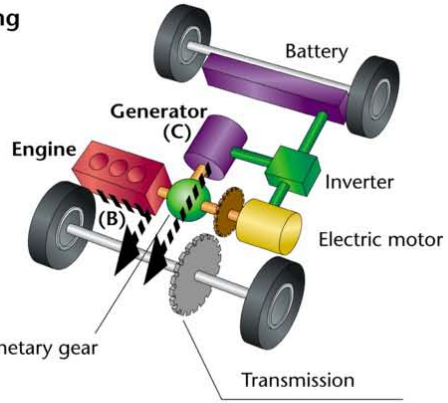
1. Starting out or moving under very low load



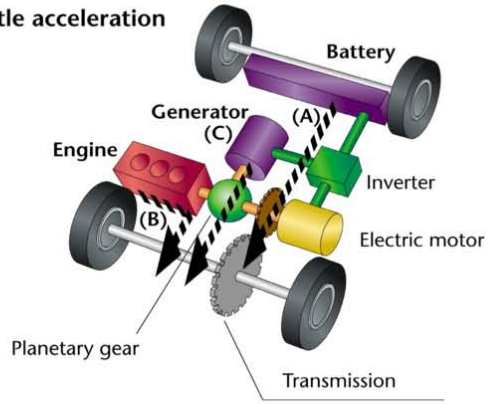
Motive power path

Electrical power path

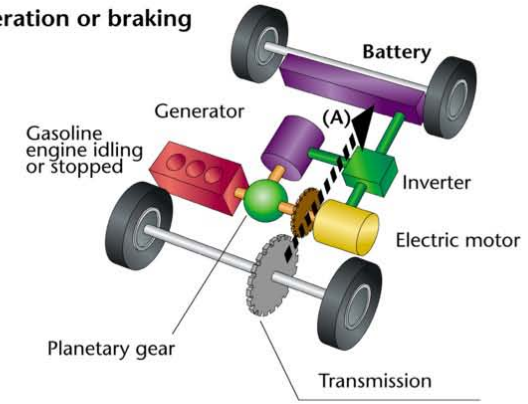
2. Normal driving



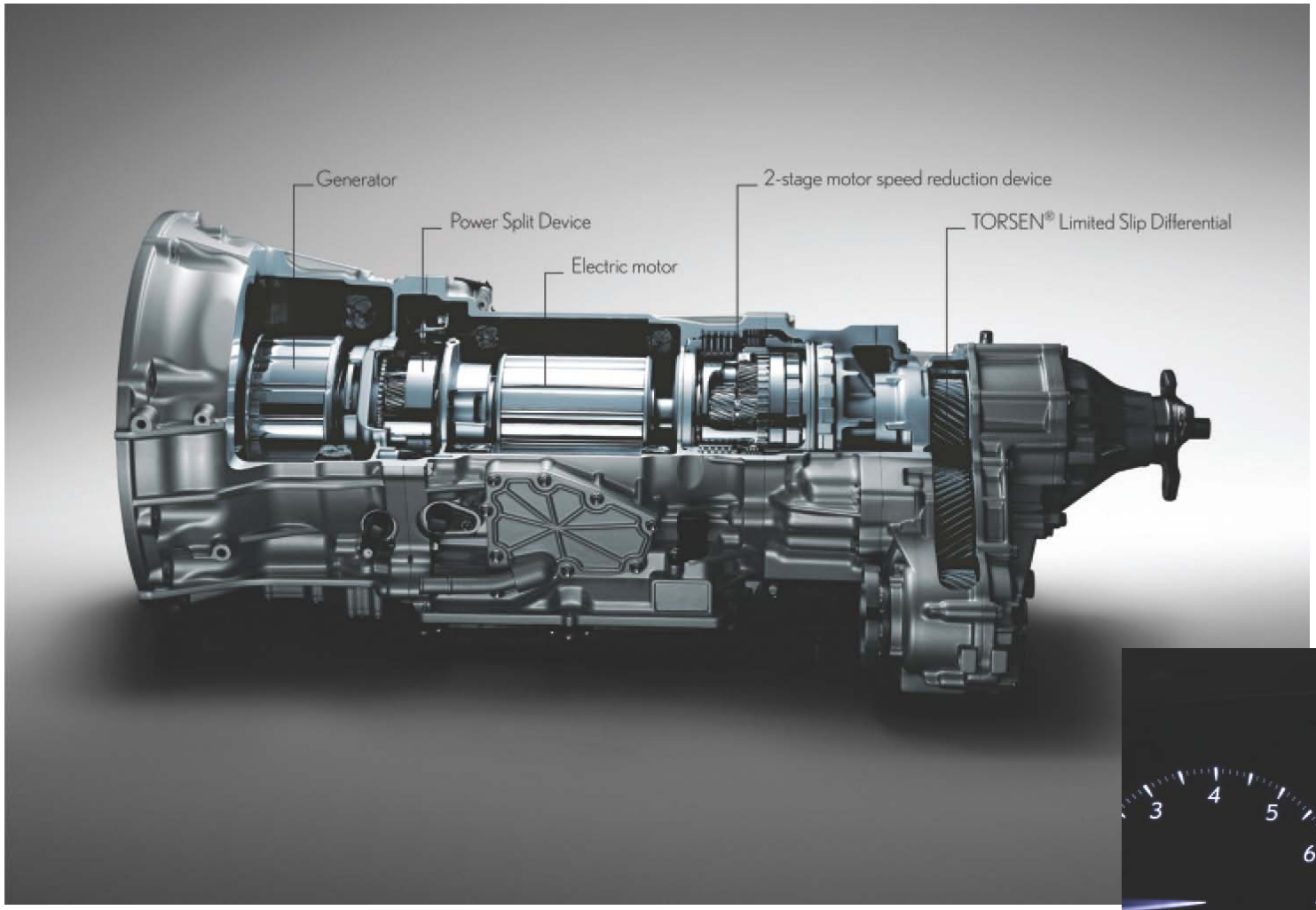
3. Full-throttle acceleration



4. Deceleration or braking



Hybrid unit Toyota Prius



Hybrid variants

Architectural approaches	Micro hybrid	Mild hybrid	Medium hybrid	Full hybrid
Functionality				
Boosting	passive	active	yes	yes
Recuperation	limited / overload	yes	yes	yes
Electric driving	no	no	limited	yes
Start / stop	yes	yes	yes	yes
Vehicle elec. sys.				
Voltage level(s)	12 V	12 - 50 V	12 - 100...400 V	12 - 200...500 V
Elec. machines				
Power rating	≤ 5 kW	≤ 10 kW	≤ 15 kW	≥ 15 kW

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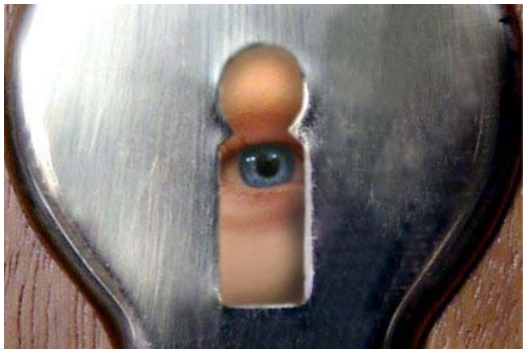
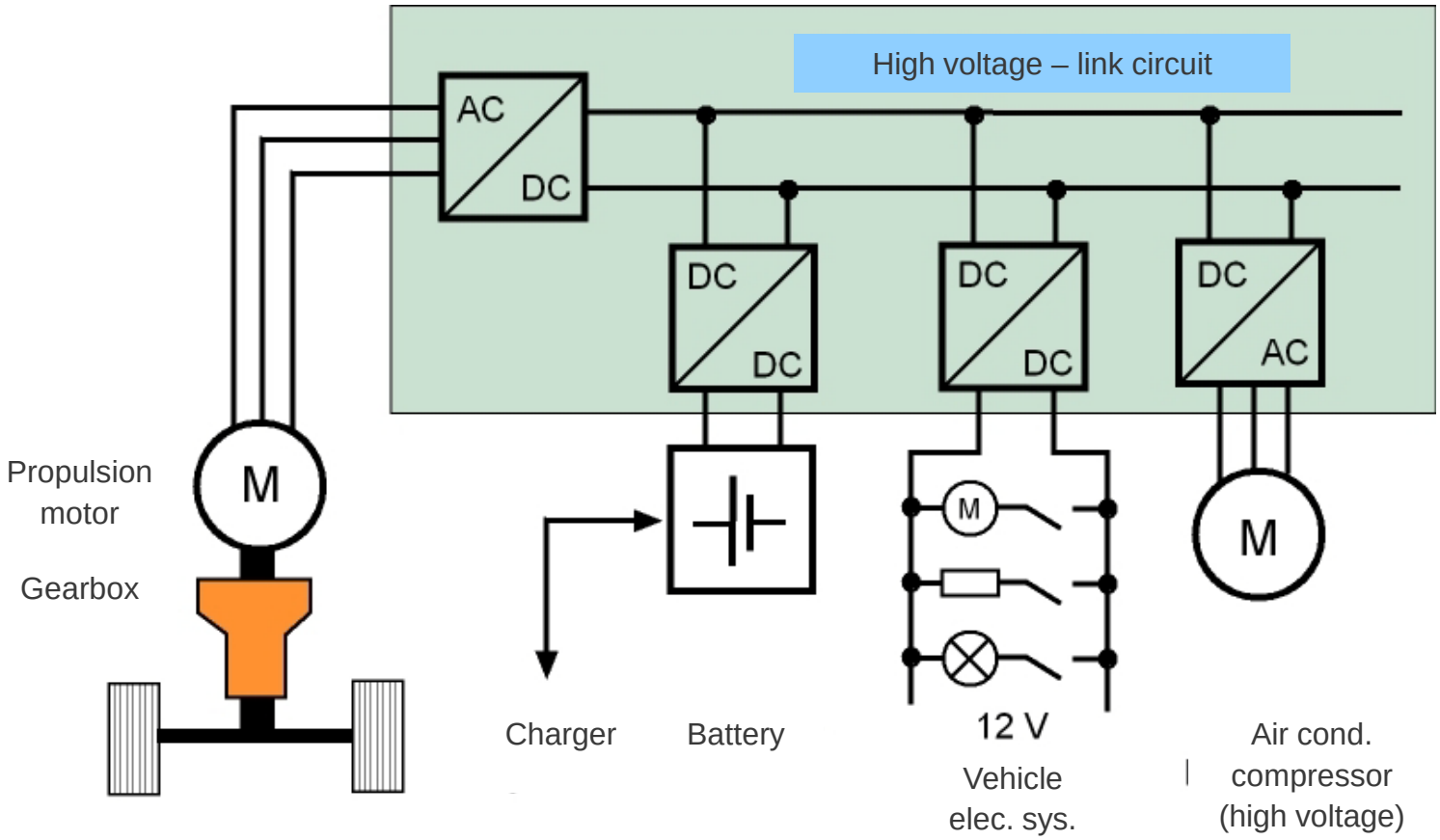
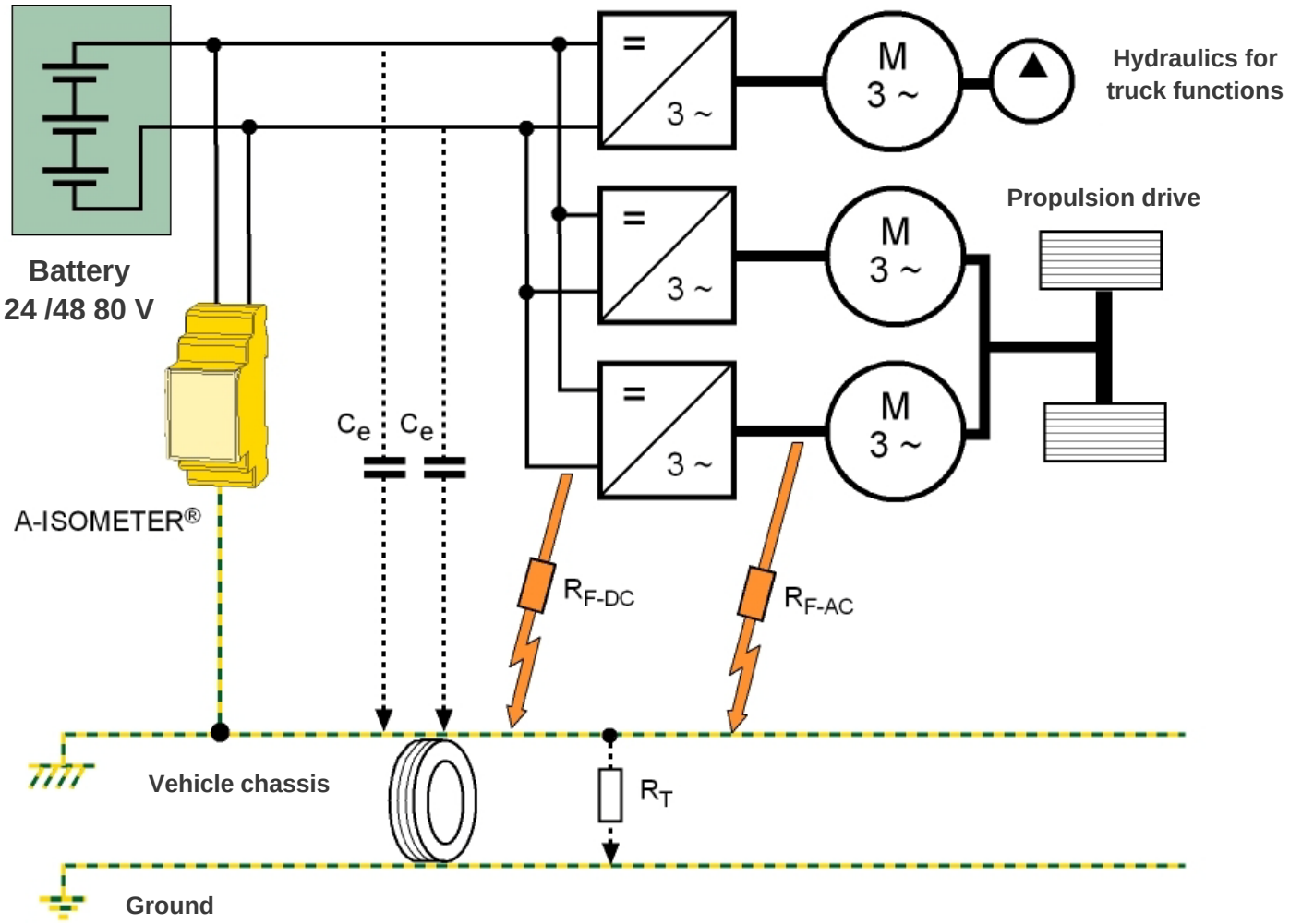


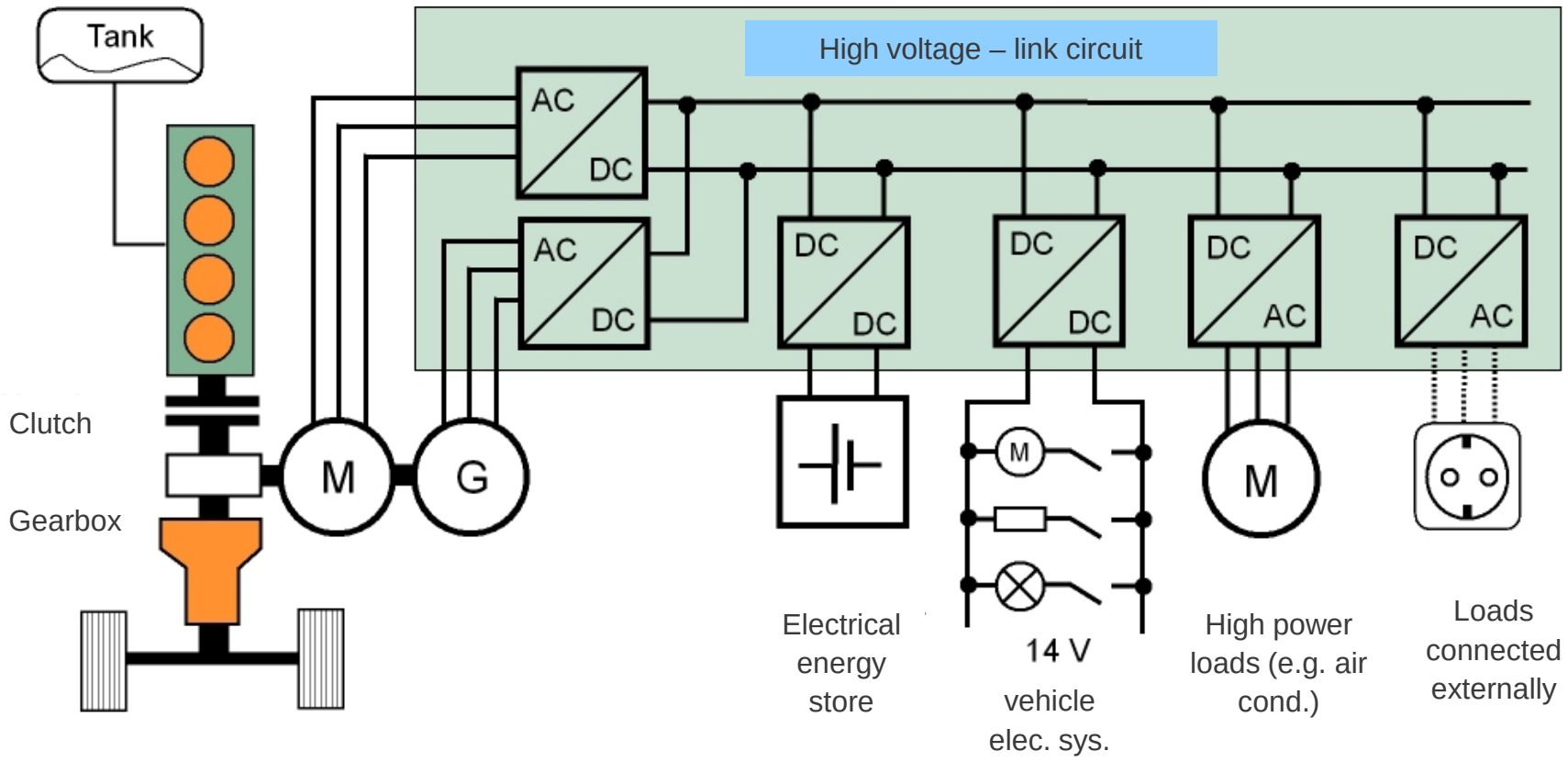
Electric vehicle with traction battery



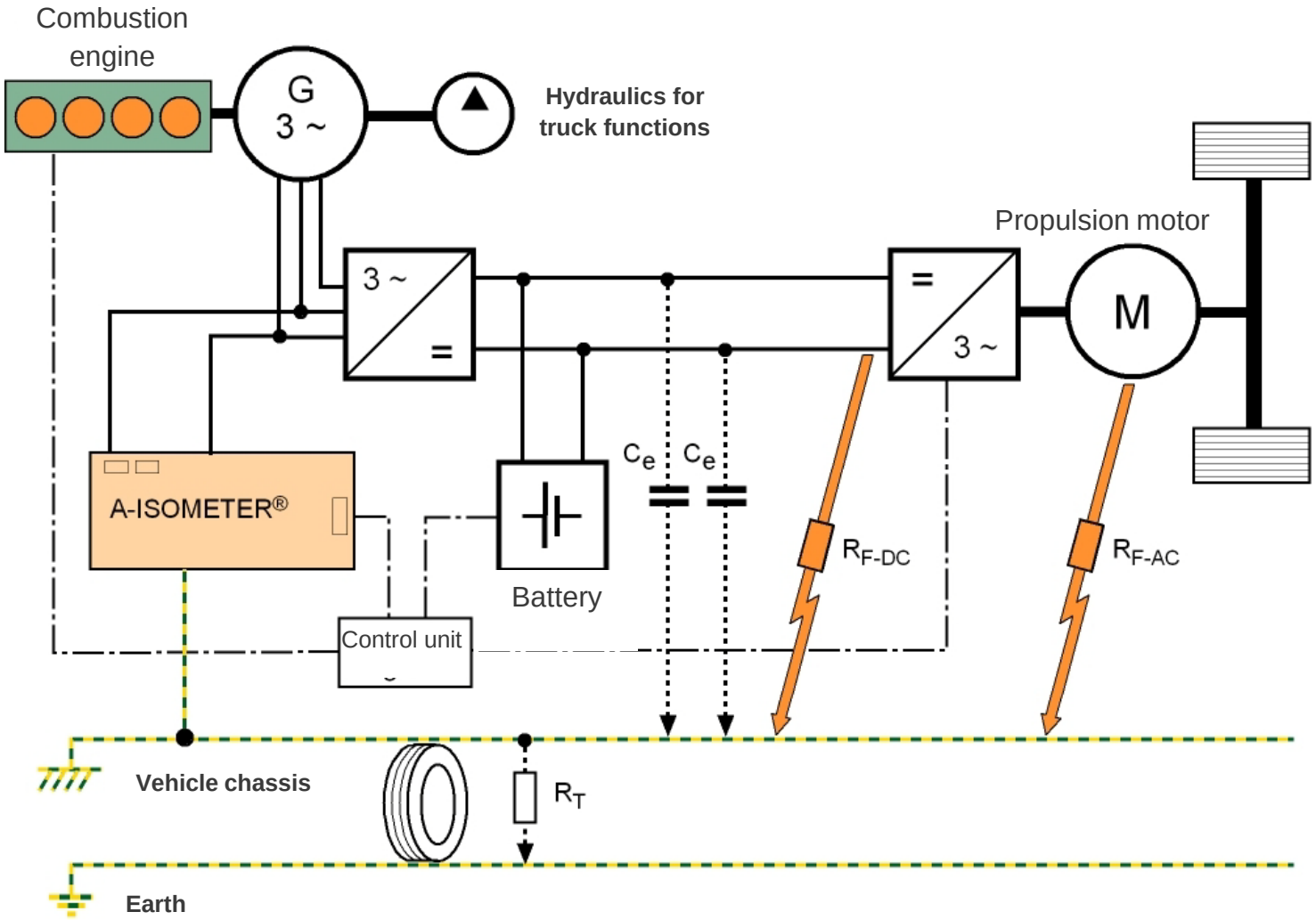
Electrical system (example for electric forklift truck)



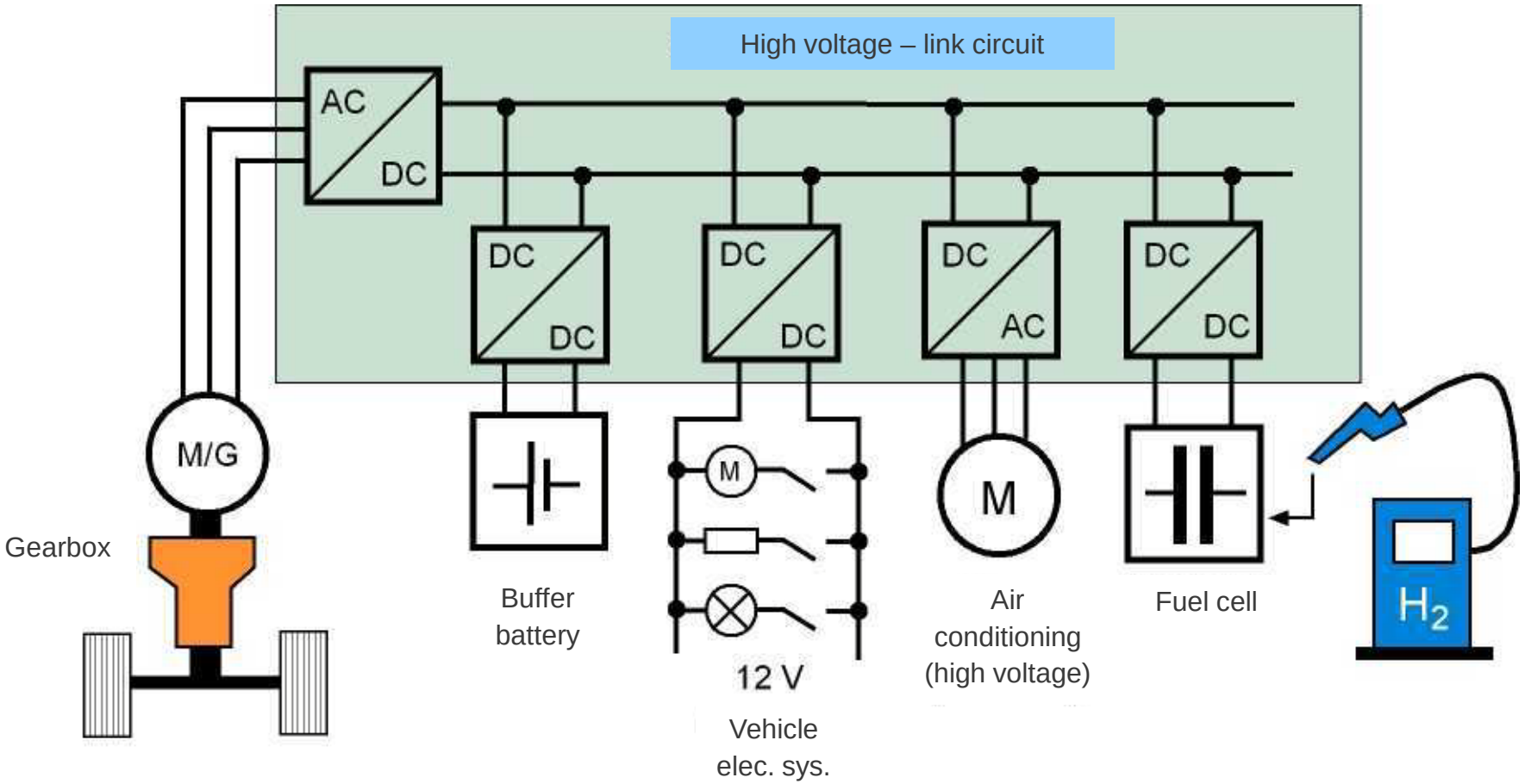
Hybrid vehicle



Electrical system (serial diesel-electric vehicle)



Vehicle with fuel cells

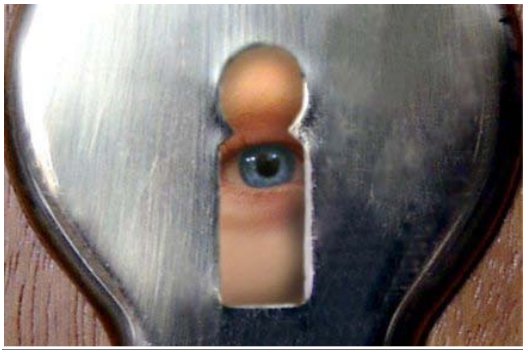


Faults and protective measures

Fault	Reason	Effect	Passive protective measures	Active protective measures
Insulation fault	Thermal or mechanical damage to the insulation, accident	Electric shock, battery discharge	Double insulation, **insulation monitoring**	Disconnection of power sources
Short-circuit	Mechanical fault, accident	Failure of control units	Emergency stopping, compliance with EMC regulations, watchdog for monitoring control unit	Disconnection of power sources
Direct contact with high voltage (vehicle not in operation)	Mechanical fault, maintenance, repair, incorrect operation	Electric shock		Discharge capacitors, disconnection of power sources
Contact with high voltage (vehicle in operation)	Mechanical fault		**Insulation monitoring**	Alarm, disconnection of power sources
Overvoltage	Electrostatic charging, transients during switching, electromagnetic effect	Damage to components	Overvoltage protection	Connection of the vehicle to earth during refuelling and battery charging

Overview

1. General
2. Drive concepts
3. **Standards**
4. Bender solutions



High voltage safety in vehicles

EUROPE
- ECE R 100

USA / CANADA
- FMVSS 305
- CMVSS 305

JAPAN
- Attachment 101
- Attachment 110
- Attachment 111

International standards
- ISO 6469 part 1...3
- ISO 23273

Overview of standards

Germany	International
DIN VDE 0122:1986-08 Elektrische Ausrüstung von Straßenfahrzeugen (Electric equipment of electrical road vehicles)	-
DIN EN 61851-1 (VDE 0122 T1):2001-11 Konduktive Ladesysteme für Elektrofahrzeuge - Teil 1: Allgemeine Anforderungen	**IEC 61851-1:2001-01** Electric vehicle conductive charging system – Part 1: General requirements
DIN EN 61851-21 (VDE 0122 T 2-1):2002-10 Konduktive Ladesysteme für Elektrofahrzeuge – AC/DC-Versorgung	**IEC 61851-21:2001-05** Electric vehicle conductive charging system – Part 21: EV requirements for conductive connection to an ac/dc supply
DIN EN 61851-22 (VDE 0122 Teil 2-2):2002-10 – Konduktive Ladesysteme für Elektrofahrzeuge – AC-Ladestation	**IEC 61851-22:2001-05** Electric vehicle conductive charging system – Part 22: AC electric vehicle charging station
DIN EN 1175-1 (VDE 0117 T1):1998-11 Sicherheit von Flurförderfahrzeugen – Elektrische Anforderungen	**EN 1175-1:1998-01** Safety of industrial trucks – Electrical requirements Part 1: General requirements for batt. powered trucks
DIN EN 1987-3:2000-07 Elektrisch angetriebene Straßenfahrzeuge - Besondere Festlegungen für die Sicherheit Teil 3: Schutz der Benutzer gegen elektrische Gefahren	**EN 1987-3:1998** Electrically propelled road vehicles – Specific requirements for safety – Part 3: Protection of users against electrical hazards
	UL 2231-1:2002-04 Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: General requirements
	UL 2231-2 – Personnel Protection Systems for Electric Vehicle (EV) Supply Circuits: Particular Requirements for Protection Devices for Use in Charging systems

Overview of standards

Germany	International
	SAE J1766:2005-04 Recommended Practice for Electric and Hybrid Electric Vehicle Battery Systems Crash Integrity Testing
	SAE J2578:2009-1 Recommended Practice for General Fuel Cell Vehicle Safety
	SAE J 2344 Guideline for Electrical Vehicle Safety
	SAE J 1772 Electric vehicle Conductive Charger
	ISO 23273-3:2006-11 Fuel cell road vehicles – Safety specifications – Part 3: Protection of persons against electric shock
	ISO 6493-3 Electric road vehicles – Safety specifications – Part 3: Protection of persons against electric hazards
	TP-305-00:2005-12 U.S. Department of Transportation FMVSS305: Electric powered vehicles: Electrolyte Spillage and Electrical shock protection
	Regulation No. 100 Agreement concerning the adoption of uniform conditions technical prescriptions for wheeled vehicles

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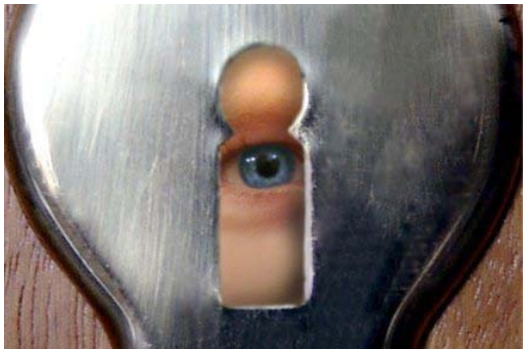
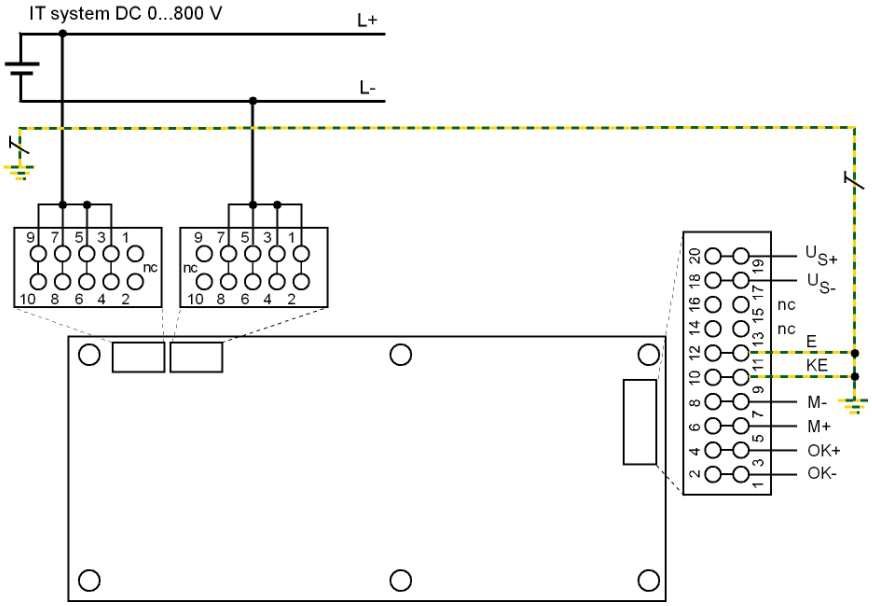
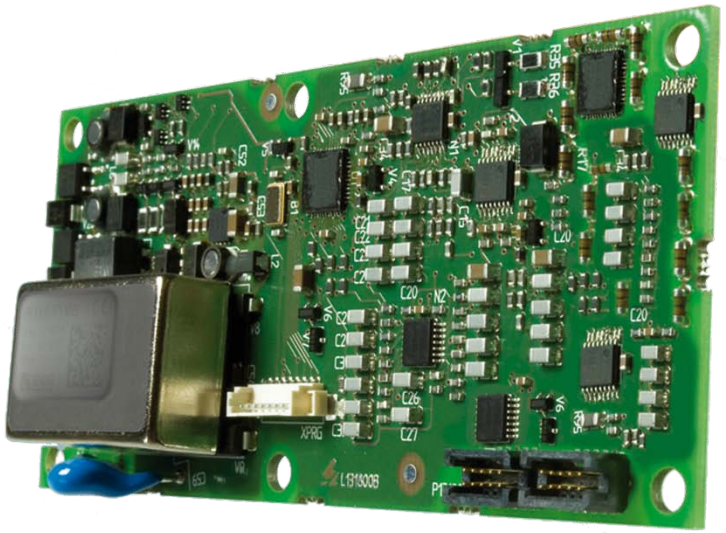
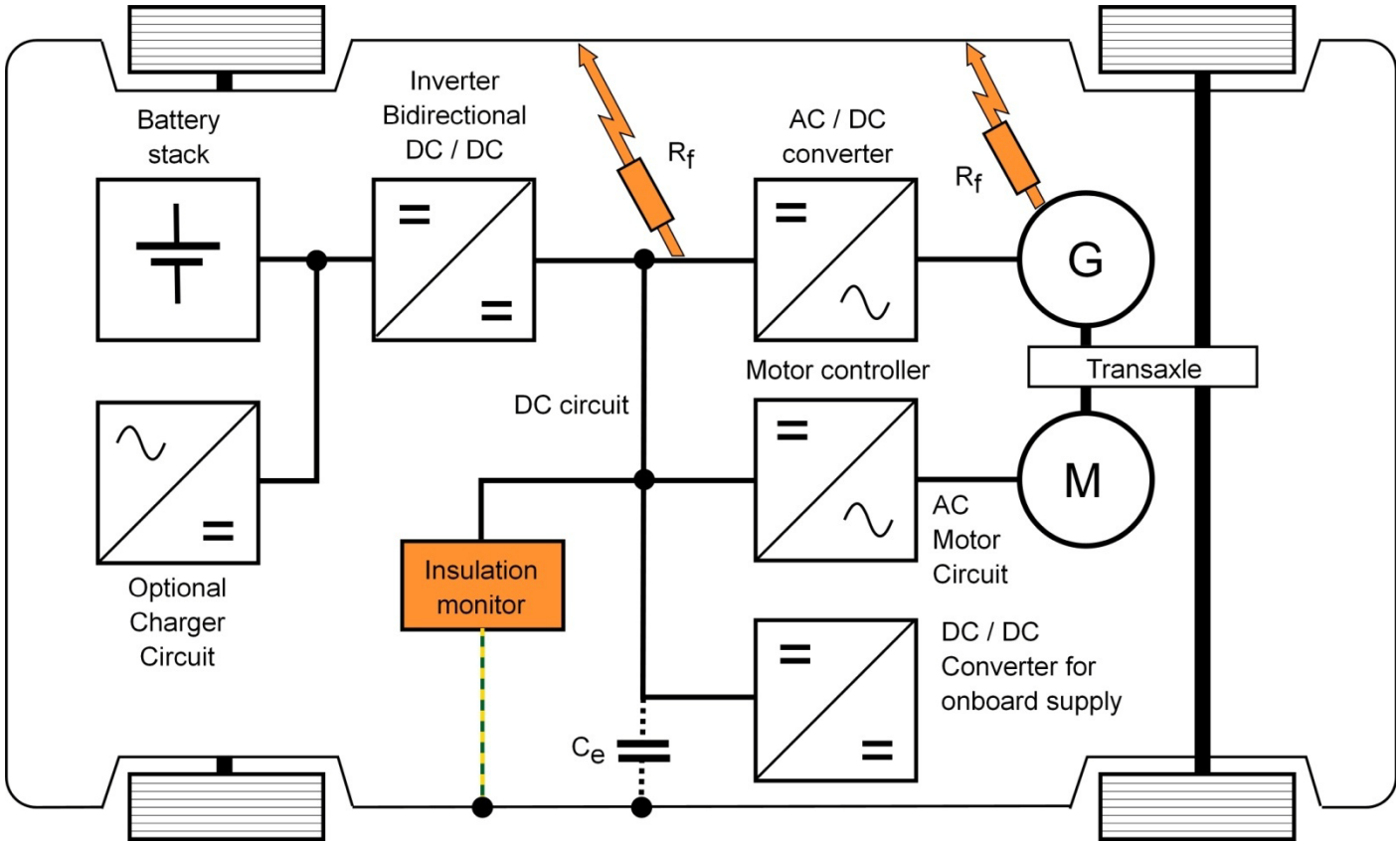



IT system DC 0...800 V
L+
L-
9 7 5 3 1
nc
10 8 6 4 2
20 18 16 14 12 10 8 6 4 2
19 17 15 13 11 9 7 5 3 1
US+
US-
nc
nc
E
KE
M-
M+
OK+
OK-



Example of possible insulation faults in electric/hybrid vehicles



Vielen Dank
Thank you
Merci beaucoup



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