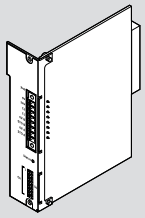
CAMC-G-S1
Safety module



Festo SE & Co. KG
Ruiter Straße 82
73734 Esslingen
Germany
+49 711 347-0

www.festo.com

Brief instruction | Safety function, STO

8219409
2024-07e
[8219411]

8219409

Original instructions

1 Applicable documents

All available documents for the product ➔ www.festo.com/sp.

This documentation refers to the following versions:
- Safety module CAMC-G-S1, from revision 03.
- Motor controller CMMP-AS-...-M3, firmware from version 4.0.1501.1.1.

Specified standards/directives		
EN 61800-5-1:2007 + A1:2017		EN 62061:2005 + AC:2010 + A1:2013 + A2:2015
EN 61800-5-2:2017		EN ISO 13849-1:2015
EN 60204-1:2006+A1:2009+AC:2010		IEC 61508-1/.../-7:2010

Tab. 1

2 Safety

2.1 General safety instructions

- Also always observe the general safety regulations for the motor controller CMMP-AS-...-M3.

The general safety regulations for the CMMP-AS-...-M3 can be found in the hardware documentation GDCP-CMMP-M3-HW-....

NOTICE

Failure of the safety function!
The safety functions might fail if you do not comply with the parameters required for the surroundings and connections.
- Observe the specified environmental and connection conditions, in particular the input voltage tolerances ➔ 13 Technical data.

NOTICE

Incorrect handling may damage the safety module or motor controller.
Incorrect handling may cause damage.
- Switch off the power supply before mounting and installation work. Do not switch on the supply voltages until mounting and installation work is completely finished.
- Never unplug or plug the module from/into the motor controller when powered!
- Observe the handling specifications for electrostatically sensitive devices.

2.2 Intended use

The safety module CAMC-G-S1 is an extension of the motor controller CMMP-AS-...-M3 for implementation of the safety function:
- Safe Torque Off (STO) with SIL 3 in accordance with EN 61800-5-2/EN 62061/IEC 61508 and/or category 4/PL e in accordance with EN ISO 13849-1.

The motor controller CMMP-AS-...-M3 with safety module CAMC-G-S1 is a product with safety-related functions and intended for installation in machines or automation systems and to be used as follows:
- in excellent technical condition,
- in its original condition, without unauthorised modifications,
- within the limits of the product defined by the technical data ➔ 13 Technical data,
- in an industrial environment.

The safety module CAMC-G-S1 can be operated in all motor controllers CMMP-AS-...-M3 that have the Ext3 slot for safety engineering. It cannot be plugged into one of the Ext1 or Ext2 slots for interfaces.

NOTICE

In the event of damage caused by unauthorised manipulation or use other than the intended use, the guarantee will be invalidated and the manufacturer will not be liable for damages.

2.3 Foreseeable misuse

The following are examples of foreseeable misuse and are not approved as intended use:
- use in a device other than the CMMP-AS-...-M3,
- use outdoors,
- use in non-industrial areas (residential areas),
- use in applications where switching off can result in hazardous movements or conditions.

NOTICE

- The STO function must not be used as the sole safety function for drives subject to permanent torque (e.g. suspended loads).
- Safety devices must not be bypassed.
- Repairs on the module are prohibited!

The STO (Safe Torque Off) function does not provide protection against electric shock, only against dangerous movements!
➔ Hardware documentation, GDCP-CMMP-M3-HW-...

2.4 Achievable safety level, safety function in accordance with EN ISO 13849-1/EN 61800-5-2

The safety module fulfils the requirements for
- category 4/PL e in accordance with EN ISO 13849-1,
- SIL CL 3 in accordance with EN 62061,

and can be used in applications up to cat. 4/PL e in accordance with EN ISO 13849-1 and SIL 3 in accordance with EN 61800-5-2/EN 62061/IEC 61508.
The achievable safety level depends on the other components used to implement a safety function.

3 Requirements for product use

- Make this documentation available to the design engineer, installer and personnel responsible for commissioning the machine or system in which this product is used.
- Make sure that the specifications in the documentation are observed at all times. When so doing, also take into account the documentation for the other components and modules (e.g. motor controller, cables etc.).
- Take into account the legal regulations applicable for the location as well as:
  - instructions and standards,
  - regulations of testing organisations and insurers,
  - national specifications.
- If the safety function is required, protection against automatic restart in accordance with the required category must be installed. For example, an external safety relay unit can be used.

3.1 Technical prerequisites

General information on correct and safe use of the product, which must be observed at all times:
- Observe the connection and ambient conditions of the safety module (➔ 13 Technical data), the motor controller and all connected components as specified in the technical data.
  Only compliance with the limit values and/or load limits will enable operation of the product in accordance with the relevant safety directives.
- Observe the notes and warnings in this documentation.

3.2 Qualification of the specialist technicians (requirements for staff)

The device may only be set into operation by a qualified electrical technician who is familiar with:
- the installation and operation of electrical control systems,
- the applicable instructions for operating safety engineering systems,
- the applicable instructions for accident prevention and occupational safety and
- the documentation for the product.

3.3 Diagnostic coverage (DC)

Diagnostic coverage depends on the integration of the motor controller with the safety module into the control loop system as well as the implemented diagnostics measures ➔ 9 Operation and use.
If a potentially dangerous malfunction is recognised during diagnostics, appropriate measures must be taken to maintain the safety level.

NOTICE

Check whether detection of shorts across contacts of the input circuit and the connection wiring is required in your application.
If necessary, use a safety relay unit with detection of shorts across contacts to control the safety module.

3.4 Range of application and approvals

The motor controller with integrated safety module is a safety device. For details of the safety-oriented standards and test values that the product complies with and fulfils, see ➔ 13 Technical data.
The product-relevant directives are listed in the declaration of conformity ➔ www.festo.com/sp.

Product conformity	
CE	in accordance with EU EMC Directive in accordance with EU Machinery Directive in accordance with EU RoHS Directive
UK CA	to UK EMC Regulations to UK Supply of Machinery Regulations to UK RoHS Regulations

Tab. 2: Product conformity

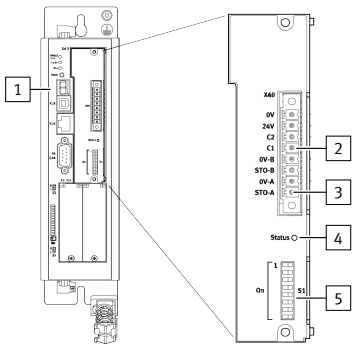
4 Product description

4.1 Supported devices

The safety module CAMC-G-S1 can be used in motor controllers exclusively in accordance with ➔ 2.2 Intended use. The motor controllers CMMP-AS-...-M3 are supplied without a module in slot Ext3 for safety modules.

4.2 Operating elements and connections

The safety module CAMC-G-S1 has the following control components, connections and display components:



1 Motor controller CMMP-AS-...-M3 with slot Ext3 for safety modules
2 Digital I/O interface [X40] for control of the STO function
3 Pin 1 of the interface [X40]
4 LED for display of the operating status (status of functional safety)
5 DIL switch (activation/configuration of fieldbus communications in the motor controller)

Fig. 1: Control section and connections CAMC-G-S1

5 Function and application

The safety module CAMC-G-S1 has the following performance characteristics:
– Achieving the “Safe Torque Off” (STO) function,
– Potential-free feedback contact,
– Execution as plug-in module which can be plugged in from the outside,
– Suitable exclusively for motor controllers of the series CMMP-AS-...-M3.

5.1 Description of the safety function

The power supply to the drive is safely disconnected when the STO “Safe Torque Off” safety function is active. The drive cannot generate torque and so cannot perform any dangerous movements. The standstill position is not monitored. The machine must be brought to a standstill in a safe manner, e.g. with a safety relay unit.

NOTICE

There is a danger that the drive will advance if there are multiple errors in the CMMP-AS-...-M3.
If the power stage of the motor controller fails during the STO state (simultaneous short circuit of 2 power semiconductors in different phases), this can result in a limited detent movement of the rotor. The rotation angle/travel corresponds to one pole pitch. Examples:
- rotary axis, synchronous machine, 8-pole ➔ movement < 45° at the motor shaft.
- linear motor, pole pitch 20 mm ➔ movement < 20 mm at the moving part.

5.2 Control inputs STO-A, 0V_A/STO-B, 0V_B [X40]

The STO safety function is requested exclusively by switching off the control voltage (0 V) at the two digital control inputs STO-A and STO-B. Safety-oriented circuitry of additional interfaces on the basic unit CMMP-AS...-M3 is not required or intended.
➔ The safety module does not detect shorts across contacts of the input circuit. According to the specification of the safety function, both levels at STO-A/B must be identical, otherwise an error message is generated. The state machine in the motor controller internally monitors the driver supply voltages as a result of the control of the control inputs. The level change of both inputs must take place within the discrepancy time (default: 100 ms), otherwise an error message is generated.
Recommendation: always switch STO-A and STO-B simultaneously.
Temporary test pulses from safety controllers are tolerated and thus do not lead to the request of the STO function.

5.3 Feedback contact C1, C2 [X40]

The status of the motor controller is reported back to an external safety relay unit via a potential-free feedback contact (N/O contact).
➔ The feedback contact is single-channel and may be used for diagnostic purposes, but not in the safety circuit.

6 Mounting/removal

The safety module CAMC-G-S1 is suitable exclusively for integration into the motor controller CMMP-AS-...-M3. It cannot be operated outside the motor controller.
The motor controller must be disconnected from any live cables before installing and removing the safety module.

⚠ WARNING

Danger of electric shock if the safety module is not mounted.
Touching live parts causes severe injuries and may cause death.
Before touching live parts during maintenance, repair and cleaning work and when there have been long service interruptions:
1. Switch off power to the electrical equipment at the main switch and lock the switch to prevent reactivation.
2. After switch-off, wait at least 5 minutes discharge time and check that there is no power before accessing the controller.

NOTICE

Incorrect handling may damage the safety module or motor controller.
- Switch off the power supply before mounting and installation work. Do not switch on the supply voltages until mounting and installation work is completely finished.
- Never unplug a module from, or plug a module into, the motor controller when powered!
- Observe the handling specifications for electrostatically sensitive devices. Do not touch the components and conductive tracks on the PCB or the pins on the terminal strip in the motor controller. Hold the safety module only by the front plate or the edge of the PCB.

Mounting the safety module

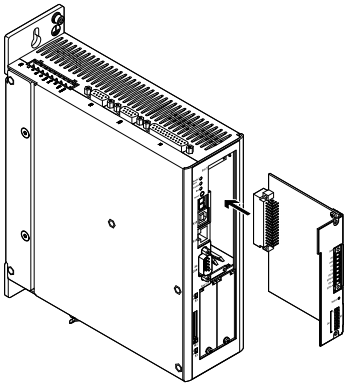


Fig. 2: Mounting/removal

1. Slide the safety module into the guides.
2. Tighten screws. Use a tightening torque of 0.4 Nm ± 20%.

Result: the front plate is in electrical contact with the housing.

Removing the safety module

1. Unscrew screws.
2. Release the safety module a few millimetres by gently levering the front panel or by pulling on the mating plug and pull it out of the slot.

7 Electrical installation

7.1 Safety instructions

The requirements of EN 60204-1 must be fulfilled for the installation.

⚠ WARNING

Danger of electric shock from voltage sources without protective measures.
- Use only PELV circuits in accordance with EN 60204-1 (protective extra-low voltage, PELV) for the electrical logic power supply. Also take into account the general requirements for PELV circuits in accordance with EN 60204-1.
- Use only power sources that guarantee reliable electrical isolation of the operating voltage from the mains in accordance with EN 60204-1.

Protection from electric shock (protection from direct and indirect contact) in accordance with EN 60204-1 (Electrical equipment of machines, General requirements) is guaranteed with the use of PELV circuits. The 24 V fixed power supply used in the system must meet the requirements of EN 60204-1 for DC power supplies (response in the event of voltage interruptions etc.).
➔ Make sure that bridges or the like cannot be inserted parallel to the safety wiring. For example, use the maximum wire cross section of 1.5 mm² or appropriate wire end sleeves with insulating collars.
Use twin wire end sleeves for looping cables between adjacent devices.

ESD protection

Damage may be caused to the device or to other system parts at unassigned plugs as a result of ESD (electrostatic discharge). Earth the system parts prior to installation and use appropriate ESD equipment (e.g. shoes, earthing straps etc.).

7.2 Connection [X40]

The safety module CAMC-G-S1 has a combined interface for control and feedback via the plug [X40].

Plugs	Pin	Designation	Value	Description
8 / 1	8	0V	0 V	Reference potential for auxiliary supply voltage.
	7	24V	+24 V DC	Auxiliary supply voltage (from the 24 V DC logic supply of the motor controller).
	6	C2)	–	Feedback contact for the “STO” status on an external controller.
	5	C1)		
	4	0V-B	0 V	Reference potential for STO-B.
	3	STO-B	0 V / 24 V	Control input B for the STO function.
	2	0V-A	0 V	Reference potential for STO-A.
	1	STO-A	0 V / 24 V	Control input A for the STO function.

Tab. 3: Pin allocation [X40] (diagram of the plug on the module)

The STO-A and STO-B control inputs must be connected in parallel over two channels to ensure the STO “Safe Torque Off” function.
For example, this interface can be part of an emergency stop circuit or a safety door installation.

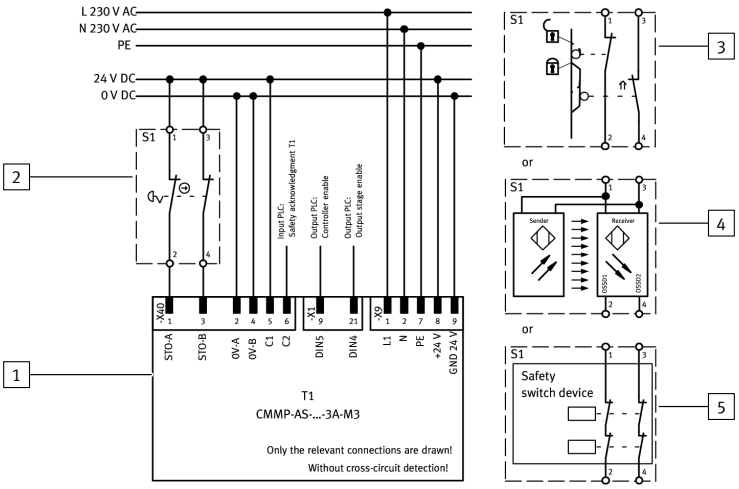


Fig. 3: Connection of the safety module CAMC- G-S1 using the example of a single-phase motor controller CMMP-AS-...-3A-M3

1 Motor controller with safety module (only relevant connections)
2 Emergency stop switch
3 Safety door
4 Light curtain
5 Safety relay unit

If a safety-related interface is not (yet) present, the switch module CAMC-DS-M1 should be used.
If a switch module is not available or for initial commissioning of the motor controller without safety engineering, the motor controller CMMP-AS-...-M3 with the safety module CAMC-G-S1 can be wired with a minimum circuit in accordance with ➔ Fig. 3 with an emergency stop switch [2].
Install the minimum circuits for the STO-A/STO-B and 0V-A/0V-B inputs for initial commissioning in such a way that they must be removed when the final safety circuitry is installed.

NOTICE

Safety functions must never be bypassed.

8 Commissioning

⚠ WARNING

Loss of the safety function!
Absence of safety function can result in serious, irreversible injuries, e.g. due to unintentional movements of the connected actuator technology.
- Operate the safety module only:
  - if it is installed and
  - if all protective measures have been initiated.
- Validate the safety function to complete commissioning.

➔ Incorrect circuitry, use of an incorrect safety module or external components that have not been selected in accordance with the category will result in failure of the safety function.
– Carry out a risk assessment for your application and select the circuitry and components accordingly.

8.1 Prior to commissioning

Carry out the following steps in preparation for commissioning:
1. Make sure that the safety module is correctly mounted.
2. Check the electrical installation (connecting cables, contact assignment ➔ 7 Electrical installation). All PE conductors connected?

8.2 DIP switch setting

Set the DIP switches as described in the hardware documentation GDCP-CMMP-AS-M3-HW-... or the documentation for the fieldbus.

8.3 Parameterisation

A fault that cannot be acknowledged is triggered at initial commissioning or on replacement with a different module type (CAMC-DS-M1 or CAMC-G-S3). The fault is acknowledged by confirming the module change with the parameterisation software. If a module is replaced with an identical type, an entry is generated in the permanent diagnostic memory.

8.4 Function test

NOTICE

The STO function must be validated after installation and after changes to the installation.
This validation must be documented by the person who commissions the device. Examples of check lists as an aid to commissioning are included in the description of the CAMC-G-S1-...

9 Operation and use

9.1 Obligations of the operator

The functionality of the safety device must be tested at appropriate intervals. It is the responsibility of the operator to choose the type and frequency of the checks within the specified time period. The manner in which the test is conducted must make it possible to verify that the safety device is functioning perfectly in interaction with all components.

9.2 Maintenance and care

The safety module is maintenance-free.

10 Diagnostics and fault clearance

10.1 Status display

LED	Identifier	Description
Off	Not safe = STO status not active	Safety module or motor controller has no operating voltage.
Green	Not safe = STO status not active	The power output stage in the motor controller for the power supply to the motor may be active or inactive.
Yellow	Safe = STO status active	The power output stage in the motor controller for the power supply to the motor is safely switched off.

Tab. 4: LED indicators on the safety module

Display	Description
H	“H”: the motor controller is in “safe status”. This does not have the same meaning as the information on the status of the safety function STO (Safe Torque Off). This can only be read from the status LED of the safety module. There is no special display for “unsafe status”; the normal status indicators of the motor controller are displayed.

Tab. 5: 7-segment display on the motor controller

10.2 Malfunction messages

The motor controller displays malfunctions cyclically in the 7-segment display on the front of the motor controller. Error messages are displayed by “E” (for error), a main index (xx) and a sub-index (y), e.g. E 5 1 0. Warnings have the same number, but are shown with bars before and after, e.g. - 1 7 0 -. The error messages relevant for functional safety in combination with the safety module CAMC-G-S1 are listed below.
➔ The complete list of error messages can be found in the hardware documentation GDCP-CMMP-M3-HW-... of the motor controller used.
If error messages cannot be acknowledged, you must first eliminate the cause. Then reset the motor controller, and check whether the cause of the error and thus the error message have been cleared.

Error group 51: safety module/function	
51-0	**No/unknown safety module or driver supply faulty**
	Internal voltage error of the safety module or switch module.
	No safety module detected or unknown module type.
51-2	**Safety module: different module type**
	Type or revision of the module does not match the project engineering.
51-3	**Safety module: different module version**
	Type or revision of the module is not supported.
	The module type is correct but the module revision is not supported by the basic unit.
51-5	**Safety module: brake control error**
	Internal hardware error (brake actuation control signals) of the safety module or switch module.
	Error in brake driver circuit section in the basic unit.

Tab. 6

Error group 52: safety function	
52-1	**Safety function: discrepancy time exceeded**
	Control inputs STO-A and STO-B are not actuated simultaneously.
	Control inputs STO-A and STO-B are not wired in the same direction.
	OS and US supply not switched simultaneously (discrepancy time exceeded), error in control/external circuitry of the safety module. Error in the safety module.

Error group 52: safety function	
52-2	**Safety function: failure of driver supply with active PWM control**
	This error message does not occur with devices supplied from the factory. It can occur when customer-specific device firmware is used.

Tab. 7

11 Replacement of the safety module, repair

Repair or maintenance of the module is not permissible. If necessary, replace the entire module.

12 Decommissioning and disposal

Observe the local regulations for environmentally appropriate disposal of electronic modules.

13 Technical data

Approval information, safety engineering	
CE	
Type-examination	The functional safety engineering of the product has been certified by an independent testing body, see EC-type examination certificate ➔ www.festo.com/sp
Certificate issuing authority	TÜV Rheinland, Certification Body of Machinery, NB 0035
Certificate no.	01/205/5165.03/24

Tab. 8: Approval information, safety engineering

Safety engineering			
Safety reference data			
Safety function		STO	Safe Torque Off (STO) in accordance with EN 61800-5-2
SIL		SIL 3	Safety integrity level in accordance with EN 61800-5-2
		SIL CL 3	SIL Claim Limit for a subsystem in accordance with EN 62061
Category		4	Classification in category in accordance with EN ISO 13849-1
PL		PL e	Performance level (PL) in accordance with EN ISO 13849-1
DCavg	[%]	97	Average diagnostic coverage
HFT		1	Hardware fault tolerance
SFF	[%]	99.2	Safe failure fraction
PFH		1.27 x 10^{-10}	Probability of dangerous failure per hour
PFD		2.54 x 10^{-5}	Probability of dangerous failure on demand
T	[years]	20	Proof test interval Service life in accordance with EN ISO 13849-1
$MTTF_d$	[years]	1370	Mean time to dangerous failure.
Safety specifications			
Well-tried component			Yes

Tab. 9: Safety engineering

General		
Certificates, declaration of conformity		➔ www.festo.com/sp
The device is intended for use in an industrial environment. Measures for interference suppression may be required in residential areas.		
Dimensions (L x W x H)	[mm]	Approx. 112.6 x 87.2 x 28.3
Weight	[g]	approx. 75
Note on materials		RoHS-compliant

Tab. 10: General

Operating and environmental conditions		
Transport		
Permissible temperature range	[°C]	–25 ... +70
Humidity	[%]	0 ... 95, at max. 40 °C ambient temperature
Maximum transportation duration	[weeks]	Maximum 4 in the total product lifecycle
Storage		
Permissible temperature range	[°C]	–25 ... +55
Humidity	[%]	5 ... 95, non-condensing or protected against condensation
Permissible altitude	[m]	< 3000 (above sea level)
Ambient conditions		
Ambient temperature	[°C]	0 ... +40 (outside the motor controller)
Cooling		Via the ambient air in the motor controller, no forced ventilation
Permissible setup altitude	[m]	< 2000 (above sea level)
Degree of protection		IP20 (mounted in the CMMP-AS-...-M3).
Humidity	[%]	Relative humidity up to 90%, non-condensing
Pollution degree in accordance with EN 61800-5-1		2
It must always be ensured by taking appropriate measures, e.g. by installation in a control cabinet.		

Tab. 11: Operating and environmental conditions

Electrical data		
Control inputs STO-A, 0V-A/STO-B, 0V-B [X40]		
Nominal voltage	[V]	24 (related to 0V-A/B)
Voltage range	[V]	19.2 ... 28.8
Permissible residual ripple	[%]	2 (based on nominal voltage 24 V)
Overvoltage shutdown	[V]	31 (shutdown in case of fault)
Nominal current	[mA]	20 (typical; maximum 30)
Starting current	[mA]	450 (typical, duration approx. 2 ms; max. 600 at 28.8 V)
Input voltage threshold		
– Switching on	[V]	approx. 18
– Switching off	[V]	approx. 12.5
Switching time from high to low (STO-A/B_OFF)	[ms]	10 (typical; maximal 20 at 28.8 V)
Switching time from low to high (STO-A/B_ON)	[ms]	5 (typical; maximum 7)
Maximum positive test pulse length with logic 0	[µs]	< 300 (related to nominal voltage 24 V and intervals > 2 s between pulses)
Feedback contact C1, C2 [X40]		
Design		Relay contact, N/O contact
Max. voltage	[V DC]	< 30 (overvoltage-proof up to 60 V DC)
Nominal current	[mA]	< 200 (not short-circuit-proof)
Voltage drop	[V]	≤ 1
Off-state current (contact open)	[µA]	< 10
Switching time for closing (T_C1/C2_ON)	[ms]	< (STO-A/B_OFF + 5 ms)
Switching time for opening (T_C1/C2_OFF)	[ms]	< (STO-A/B_ON + 5 ms)
Service life	[n_{op}]	10 x 10^6 (at 24 V and $I_{contact}$ = 10 mA)
Auxiliary supply 24V, 0V [X40] – output		
Design		Logic supply voltage of the motor controller. Protected against reverse polarity, overvoltage-proof up to 60 VDC
Nominal voltage	[V]	24
Nominal current	[mA]	100 (short-circuit-proof, max. 300 mA)
Voltage drop	[V]	≤ 1 (at nominal current)
Galvanic isolation		
Galvanically isolated potential areas		STO-A/0V-A; STO-B/0V-B; C1/C2; 24V/0V
Wiring		
Max. cable length	[m]	30
Shielding		Use shielded cable for wiring outside the control cabinet. Guide shielding into the control cabinet/attach to the side of the control cabinet.
Conductor cross section (flexible conductors, wire end sleeve with insulating collar)		
– one conductor	mm^2	0.25 ... 0.5
– two conductors	mm^2	2 x 0.25 (with twin wire end sleeves)
Tightening torque M2	[Nm]	0.22 ... 0.25

Tab. 12: Electrical data