


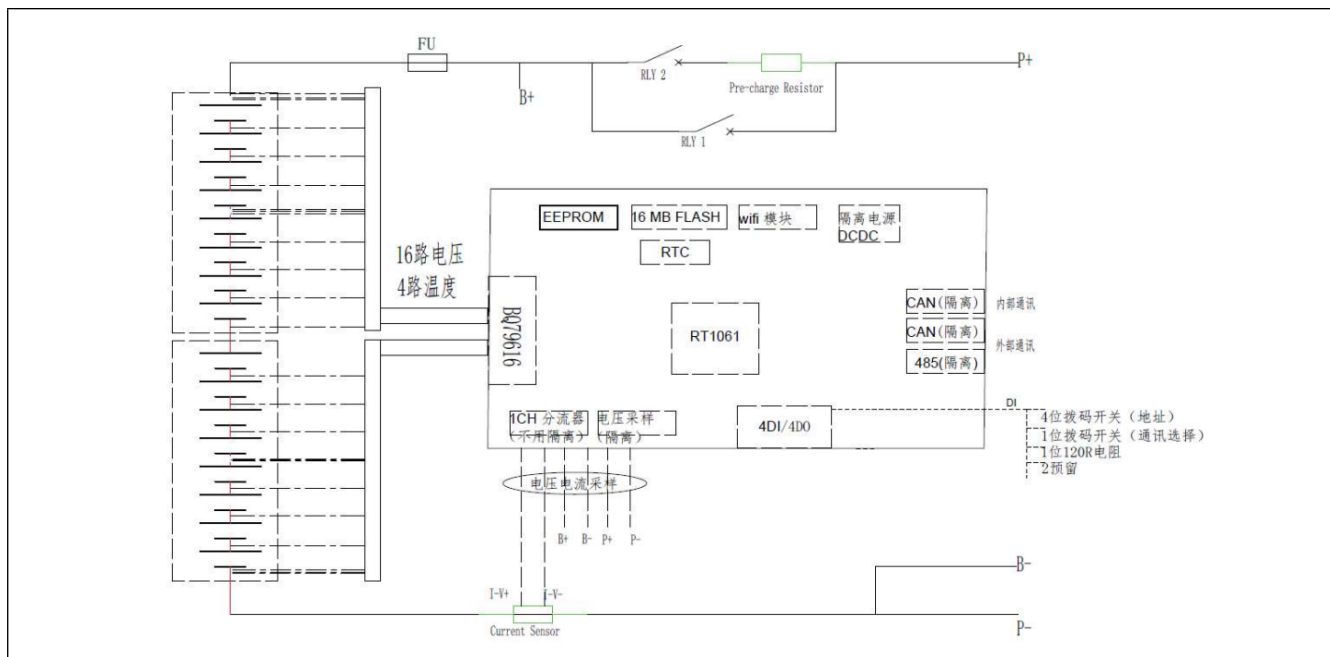


TEST REPORT IEC 60730-1 Automatic electrical controls for household and similar use (Controls using software)	
Report Number	5061723021301-00 FS
Date of issue	2023-07-25
Total number of pages	27
Name of Testing Laboratory preparing the Report	TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.
Applicant's name	Jiangsu SolarEast Energy Storage Technology Co., Ltd
Address	No. 199, Yingzhou South Road Haizhou District 222243 Lianyungang City, Jiangsu Province PEOPLE'S REPUBLIC OF CHINA
Test specification:	
Standard	IEC 60730-1:2013, AMD1:2015, AMD2:2020
Test procedure	Test Report
Non-standard test method	N/A
TRF template used	IECEE OD-2020-F1:2020, Ed.1.3
Test Report Form No.	IEC60730_1KSOF
Test Report Form(s) Originator	UL(US)
Master TRF	2020-08-14
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Test Item description	Battery management system	
Trade Mark(s)	N/A	
Manufacturer	Hangzhou LiDe Communications., Ltd	
Model/Type reference	IBMS-16-M	
Ratings	See General product information Hardware identification: IBMS-16-M Hardware version: IBMS-16-M-1.0.0.1	
Software module(s) and associated version(s)	Software version: SDK_2_13_0 Type of MCU: MIMXRT1051	
Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):		
Testing Laboratory:	TÜV SÜD New Energy Vehicle Testing (Jiangsu) Co., Ltd.	
Testing location/ address	No.15 Factory Building A, Jintong International Industrial Park, No.8 Xihu Road, Changzhou, Jiangsu, 213164, P. R. China	
Tested by (name, function, signature)	Haiyang Liu (Project Handler)	
Approved by (name, function, signature)	Xiaohang Chen (Designated Reviewer)	

List of Attachments (including a total number of pages in each attachment): Attachment 1 – Critical component documentation (CDF), 11 pages. Attachment 2 – Photo documentation, 11 pages. Attachment 3 –TDS for fault insert, 36 pages.	
Summary of testing/evaluation:	
Tests performed (name of test and test clause): The battery management system, model IBMS-16-M. Functional safety evaluation for this battery management system is combined with a Rechargeable Li-ion Battery System, model PowerCool-LFP5000.	Testing location: Jiangsu Solareast Energy Storage Technology Co., Ltd No. 199, Yingzhou South Road Haizhou District 222243 Lianyungang City, Jiangsu Province PEOPLE'S REPUBLIC OF CHINA
Summary of compliance with National Differences (List of countries addressed): N/A	
Statement concerning the uncertainty of the measurement systems used for the tests: N/A (may be required by the product standard or client)	
Copy of marking plate: N/A	

Test Item Particulars	
Classification of installation and use	Rechargeable Li-ion Battery System
Supply Connection	Supply by terminals
Possible test case verdicts	
- test case does not apply to the test object	N/A
- test object does meet the requirement.....	P (Pass)
- test object does not meet the requirement	F (Fail)
Testing	
Date of receipt of test item	2023-04-23
Date (s) of performance of tests	2023-06-20
General remarks:	
<p>"(See Enclosure #)" refers to additional information appended to the report. "(See appended table)" refers to a table appended to the report. This Test Report is only applicable to controls using software. This TRF is to be used in conjunction with the IEC 60730-1, Edition 5.2 Test Report. Throughout this report a <input type="checkbox"/> comma / <input checked="" type="checkbox"/> point is used as the decimal separator.</p>	
Manufacturer's Declaration per sub-clause 4.2.5 of IEC 60730-1:	
The application for obtaining a CB Test Certificate includes more than one factory location and a declaration from the Manufacturer stating that the sample(s) submitted for evaluation is (are) representative of the products from each factory has been provided	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> Not applicable
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies)	Hangzhou LiDe Communications., Ltd Room 208, Building 3, Fashion Wantong City, Cangqian Street, Yuhang District, Hangzhou, Zhejiang Province
General product information and other remarks:	
Product Description– The battery management system, model IBMS-16-M is used in Rechargeable Li-ion Battery System, the maximum voltage is 57.6V Its functions include battery system voltage sampling, battery system current sampling, cell voltage and temperature sampling, contact control, SOH/SOC calculation, cell voltage balance etc. The communication output with CAN. All items are analysed with the battery system, model PowerCool-LFP5000, produced by Jiangsu SolarEast Energy Storage Technology Co., Ltd The result may be changed if this battery management system is used in different battery system.	
Diagram Block	



Model Differences –

Additional application considerations – (Considerations used to test a component) –

N/A

DESCRIPTION OF SAFETY FUNCTION(S)

Safety function 1: Over-voltage protection function		
	Hardware protection	Software protection
Description	-	During charging, voltage of each cell and system are monitored. If any voltages exceed the maximum charge voltage, the MCU (U16) will stop charging by controlling the power Relay to disconnect the battery.
Input	-	Cell voltage Battery system voltage
Threshold value	-	Cell voltage: adjustable, 3.65V Battery System voltage: adjustable, 58.4V
Response time	-	2s
Output	-	Switch off the contactors

Safety function 2: Over-current protection function		
	Hardware protection	Software protection

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Description	-	During charging, the charge current is monitored by IC (U19). If the charge current exceeds the upper limit, the MCU (U16) will stop charging by the Relay (DC Contactor) to disconnect the battery.
Input	-	Charge current
Threshold value	-	Adjustable, 55A
Response time	-	2ms
Output	-	Switch off the contactors

Safety function 3: Over-temperature protection function		
	Hardware protection	Software protection
Description	-	The battery temperature is monitored by temperature sensor (NTC). When the temp is out of operation range, system will disconnect the battery. By the mean of that MCU (U16) control the Relay (DC Contactor) in series to disconnect the battery and load or charger.
Input	-	Cell temperature
Threshold value	-	Adjustable, 52°C
Response time	-	3s
Output	-	Switch off the contactors

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
H.6	Classification, additions		
H.6.18	Class of control function (A, B,C).....	Class B	—
H.7	Information in addition to Table 1 provided:		P
	66 - Software sequence documentation; clause: H.11.12.2.9; method: X.....		P
	67 - Programme documentation; clause: H.11.12.2.9, H.11.12.2.12; method: X.....		P
	68 - Software fault analysis; clause: H.11.12, H.27.1.1.4; method: X.....		P
	69 - Software class(es) and structure; clause: H.11.12.2, H.11.12.3, H.27.1.2.2.1, H.27.1.2.3.1; method: D		P
	70 - Analytical measures and fault/error control techniques employed; clause: H.11.12.1.2, H.11.12.2.2, H.11.12.2.4; method: X.....		P
	71 - Software fault/error detection time(s) for controls with software Classes B or C; clause: H.2.17.10, H.11.12.2.6; method: X		P
	72 - Control response(s) in case of detected fault/error; clause: H.11.12.2.7; method: X		P
	93 – Maximum number of reset actions within a time period; clause H.11.12.4.3.6, H.11.12.4.3.4; method: D		P
	94 – Number of remote reset actions; clause H.17.1.4.3; method: X.....		P
	m – Controls with software classes B or C had information provided for safety-related segments of the software. Information on the non-safety related segments was sufficient to establish that they did not influence safety-related segments		P
	n – Software sequence was documented and, together with the operating sequence, included a description of the control system philosophy, the control flow, data flow and the timings		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	o - Safety-related data and safety-related segments of the software sequence, the malfunction of which could result in non-compliance with the requirements of Clauses 17, 25, 26 and 27, are identified		P
	– Included the operating sequence		P
	– Software fault analysis was related to the hardware fault analysis in Clause H.27		P
	q - Programming documentation was supplied in a programming design language declared by the manufacturer.....		P
	r – Different software classes applied to different control functions		P
	s - Measures declared are chosen by manufacturer from the requirements of Clauses H.11.12.1.2 to H.11.12.2.4 inclusive		P
H.11	Constructional requirements		P
H.11.12	Controls using software		P
	Controls using software were so constructed that the software did not impair control compliance with the requirements of this standard		
H.11.12.1	Requirements for the architecture		P
H.11.12.1.1	Control functions with software class B or C use measures to control and avoid software-related faults/errors in safety-related data and safety-related segments of the software, as detailed in H.11.12.1.2 to H.11.12.3 inclusive	Class B	P
H.11.12.1.2	Control functions with software class C have one of the following structures:		N/A
	– single channel with periodic self-test and monitoring (H.2.16.7)		N/A
	– dual channel (homogenous) with comparison (H.2.16.3)		N/A
	– dual channel (diverse) with comparison (H.2.16.2)		N/A

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	Control functions with software class B have one of the following structures:		P
	– single channel with functional test (H.2.16.5)	Used	P
	– single channel with periodic self-test (H.2.16.6)	Used	P
	– dual channel without comparison (H.2.16.1)		N/A
H.11.12.1.3	Other structure permitted with equivalent level of safety to those in H.11.12.1.2		P
H.11.12.2	Measures to control faults/errors		P
H.11.12.2.1	Redundant memory with comparison provided on two areas of the same component: data stored in different formats		P
H.11.12.2.2	Software class C using dual channel structures with comparison: additional fault/error detection means		N/A
H.11.12.2.3	Software class B or C: means for recognition and control of errors in transmission to external safety-related data paths: Means took into account errors of data, addressing, transmission timing and sequence of protocol		P
H.11.12.2.4	Software class B or C: within the control, measures are taken to address the fault/errors in safety-related segments and data indicated in Table H.1 and identified in Table 1 requirement 68.		P
H.11.12.2.5	Measures others than those specified in H.11.12.2.4 utilized to satisfy the requirements listed in Table H.1		P
H.11.12.2.6	Software fault/error detection:		P
	– occur not later than declared time(s), Table 1, requirement 71		P
	– acceptability of declared time(s): evaluated during fault analysis of the control		P
H.11.12.2.7	For controls with functions, classified as Class B or C, detection of fault/error:		P
	– results in the response declared in Table 1, requirement 72		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	– for Class C: independent means capable of performing this response provided		N/A
H.11.12.2.8	Class C, dual channel structure, loss of dual channel capability: deemed to be an error		N/A
H.11.12.2.9	Software referenced:		P
	– to relevant parts of the operating sequence		P
	– to the associated hardware functions		P
H.11.12.2.1 0	Labels used for memory locations are unique		N/A
H.11.12.2.1 1	Software protected from user alteration of safety-related segments and data		P
H.11.12.2.1 2	Software and safety-related hardware under its control is initialized to and terminates at a declared state, Table 1, requirement 66		P
H.11.12.3	Measures to avoid errors		P
H.11.12.3.1	For controls with software class B or C the measures shown in Figure H.1 to avoid systematic faults are applied		P
	Other methods utilized that incorporate disciplined and structured processes including design and test phases		P
H.11.12.3.2	Specification		P
H.11.12.3.2 .1	Software safety requirements		P
H.11.12.3.2 .1.1	The specification of the software safety requirements includes:		P
	<ul style="list-style-type: none"> • A description of each safety related function to be implemented, including its response time(s): <ul style="list-style-type: none"> - functions related to the application including their related software classes - functions related to the detection, annunciation and management of software or hardware faults 		P
	<ul style="list-style-type: none"> • A description of interfaces between software and hardware 		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> A description of interfaces between any safety and non-safety related functions 		P
H.11.12.3.2.2	Software architecture		P
H.11.12.3.2.2.1	The description of software architecture include the following aspects:		P
	<ul style="list-style-type: none"> Techniques and measures to control software faults/errors (refer to H.11.12.2) 		P
	<ul style="list-style-type: none"> Interactions between hardware and software 		P
	<ul style="list-style-type: none"> Partitioning into modules and their allocation to the specified safety functions 		P
	<ul style="list-style-type: none"> Hierarchy and call structure of the modules (control flow) 		P
	<ul style="list-style-type: none"> Interrupt handling 		P
	<ul style="list-style-type: none"> Data flow and restrictions on data access 		P
	<ul style="list-style-type: none"> Architecture and storage of data 		P
	<ul style="list-style-type: none"> Time based dependencies of sequences and data 		P
H.11.12.3.2.2.2	The architecture specification is verified against the specification of the software safety requirements by static analysis		P
H.11.12.3.2.3	Module design and coding		P
H.11.12.3.2.3.1	Software is suitably refined into modules. Software module design and coding are implemented in a way that is traceable to the software architecture and requirements. The module design specified:		P
	– function(s)		P
	– interfaces to other modules		P
	– data		P
H.11.12.3.2.3.2	Software code is structured		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
H.11.12.3.2 .3.3	Coded software is verified against the module specification, and the module specification is verified against the architecture specification by static analysis		P
H.11.12.3.2 .4	Design and coding standards		P
	Program design and coding standards is used during software design and maintenance		P
	Coding standards		—
	– specified programming practice		P
	– proscribed unsafe language features		P
	– specify procedures for source code documentation		P
	– specify data naming conventions		P
H.11.12.3.3	Testing		P
H.11.12.3.3 .1	Module design (software system design, software module design and coding)		P
H.11.12.3.3 .1.1	A test concept with suitable test cases is defined based on the module design specification.		P
H.11.12.3.3 .1.2	Each software module is tested as specified within the test concept		P
H.11.12.3.3 .1.3	Test cases, test data and test results are documented		P
H.11.12.3.3 .1.4	Code verification of a software module by static means includes such techniques as software inspections, walk-throughs, static analysis and formal proof		P
	Code verification of a software module by dynamic means includes functional testing, white-box testing and statistical testing		P
H.11.12.3.3 .2	Software integration testing		P
H.11.12.3.3 .2.1	A test concept with suitable test cases is defined based on the architecture design specification		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
H.11.12.3.3 .2.2	The software is tested as specified within the test concept		P
H.11.12.3.3 .2.3	Test cases, test data and test results are documented		P
H.11.12.3.3 .3	Software validation		P
H.11.12.3.3 .3.1	A validation concept with suitable test cases is defined based on the software safety requirements specification		P
H.11.12.3.3 .3.2	The software is validated with reference to the requirements of the software safety requirements specification as specified within the validation concept		P
	The software is exercised by simulation or stimulation of:		P
	• input signals present during normal operation		P
	• anticipated occurrences		P
	• undesired conditions requiring system action		P
H.11.12.3.3 .3.3	Test cases, test data and test results are documented		P
H.11.12.3.4	Other Items		P
H.11.12.3.4 .1	Equipment used for software design, verification and maintenance was qualified appropriately and demonstrated to be suitable for purpose in manifold applications		P
H.11.12.3.4 .2	Management of software versions: All versions are uniquely identified for traceability		P
H.11.12.3.4 .3	Software modification		P
H.11.12.3.4 .3.1	Software modifications are based on a modification request which details the following:		P
	• the hazards which may be affected		P
	• the proposed change		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	<ul style="list-style-type: none"> the reasons for change 		P
H.11.12.3.4 .3.2	An analysis is carried out to determine the impact of the proposed modification on functional safety.		P
H.11.12.3.4 .3.3	A detailed specification for the modification is generated including the necessary activities for verification and validation, such as a definition of suitable test cases		P
H.11.12.3.4 .3.4	The modification is carried out as planned		P
H.11.12.3.4 .3.5	The assessment of the modification is carried out based on the specified verification and validation activities.		P
H.11.12.3.4 .3.6	All details of modification activities are documented		P
H.11.12.3.5	For class C control functions: One of the combinations (a–p) of analytical measures given in the columns of table H.9 is used during hardware development		N/A
H.11.12.4	Remotely actuated control functions		N/A
H.11.12.4.1 .1	Data Exchange – General – Remotely actuated control functions are connected to separate, independent devices, which may themselves contain control functions or provide other information and any data exchange between these devices does not compromise the integrity of class B control function or class C control function.		N/A
H.11.12.4.1 .2	Type of data - Message types for data exchange in a control function or functions are allocated to class A control function, class B control function or class C control function. The safety or protective relevance or influence, message types or data exchange are allocated only to class B control function or class C control functions, see Table H.10.		N/A
H.11.12.4.1 .3.1	Communication of Safety Related Data – Transmission – Safety relevant data is transmitted authentically concerning:		N/A
	– data corruption		N/A

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	– address corruption		N/A
	– wrong timing or sequence		N/A
	Data variation or corrupted data did not lead to an unsafe state		N/A
	Before transmitted data was used it was ensured that data corruption, address corruption and wrong timing or sequence are addressed using the measures as given in Annex H.		N/A
	The following failure modes are addressed		—
	– permanent “auto-sending” or repetition,		N/A
	– interruption of data transfer		N/A
H.11.12.4.1 .3.2	Access to data exchange -		N/A
	Adequate hardware/software measures are taken to prevent unauthorized access to the control functions (class B and C; operating data, configuration parameters and/or software modules)		N/A
	Access to data exchange of class B control function or class C control function related operating data through public networks, has appropriate cryptographic techniques implemented.		N/A
H.11.12.4.1 .3.3	For class B and class C software revisions the requirements of H.11.12.3 and hardware configuration management are applied and the control maintains its protective functions		N/A
H.11.12.4.1 .4	Remotely actuated control function operation have the duration or limits set before switching on except when automatic switching off is realized at the end of a cycle or the system is designed for permanent operation.		N/A
H.11.12.4.2	Priority of remotely actuated control functions over control functions does not lead to a hazardous condition.		N/A
H.11.12.4.3 .1	Remote reset action is manually initiated.		N/A

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	Reset functionality initiated by a hand-held device required at least two manual actions to activate		N/A
H.11.12.4.3.2	Reset functions are capable of resetting the system as intended		N/A
H.11.12.4.3.3	Unintended resets from safe state do not occur.		N/A
H.11.12.4.3.4	Any fault of the reset function does not cause the control or controlled function to result in a hazardous condition, and was evaluated for its Class B classification		N/A
H.11.12.4.3.5	For reset functions initiated by manual action not in visible sight of the appliance, the following additional requirements apply:		N/A
	– the actual status and relevant information of the process under control is visible to the user before, during and after the reset action;		N/A
	– the maximum number of reset actions within a time period is declared. Following this, any further reset is denied unless the appliance is physically checked		N/A
H.11.12.4.3.6	The reset function is evaluated on the final application.		N/A
	Manual switching of a thermostat or device with similar function that activates a reset is declared by the manufacturer and is suitable in the final application.....		N/A
H.11.12.4.4	Software Download and Installation		N/A
H.11.12.4.4.1	Software updates provided by the manufacturer and transmitted to the control via remote communication were checked prior to its use:		N/A
	– against corruption through communication ensuring Hamming distance 3 for software class B, or Hamming distance 4 for software class C;		N/A
	– that the software version is compatible with the hardware version of the control according to the version management documentation.		N/A

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	The software which performs the above mentioned checks had measures to control the fault/error conditions specified in H.11.12.2.		N/A
H.11.12.4.4.2	In case of software download via remote communication, the cryptographic techniques in H.11.12.4.5 were provided. In addition to the requirements in H.11.12.4.5, identification procedures were provided for the software packages.		N/A
	The cryptographic techniques employed were part of the control, did not rely upon part of the router or similar data transmission device itself, and were performed prior to transmission.		N/A
H.11.12.4.4.3	Each update of software had provisions for authorization by the user and a version ID number which were accessible.		N/A
H.11.12.4.4.4	The installation of class B software or class C software was permitted during and after which the software installation process the control remained in compliance with the requirements of this standard.		N/A
H.11.12.4.5	Cryptographical techniques		N/A
	In cases where class B control function or class C control function related operating data, configuration parameters and/or software modules were transmitted over a public network, and/or where software updates were provided by the manufacturer via remote communication, cryptographic techniques were employed.		N/A
H.27.1.2	Protection against internal faults to ensure functional safety		P
H.27.1.2.1	Design and construction requirements		P
H.27.1.2.1.1	Fault avoidance and fault tolerance		P
	Controls incorporating control functions of class B or C are designed according to H.27.1.2 taking into account the failure modes of Cl. H.11.12 for software		P
	Systematic errors are avoided		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	Random faults are dealt with by a proper system configuration		P
	Functional analysis of the application resulted in a structured design with:		P
	– Control flow		P
	– Data flow		P
	– Time related functions required by the application		P
	For custom-chips special attention was made to minimize systematic errors		P
	System configuration was failsafe or:		P
	Incorporated components with direct safety-critical functions guarded by safeguards that cause a completely independent safety shut-down in accordance to H.11.12 software class B or C		P
	- safeguards are built into hardware and,		P
	- safeguards are supplemented by software		P
	Time slot monitoring is sensitive to both an upper and a lower limit of the time interval.		P
	Faults resulting in a shift of the upper and/or lower limit are taken into account.		P
	In a class C control function when a single fault in a primary safeguard can render the safeguard inoperative, a secondary safeguard is provided		N/A
	The reaction time of the secondary safeguard is in accordance with Clause H.27.1.2.3.		P
H.27.1.2.1.2	Documentation		P
	The documentation was based on H.11.12.3.2		P
	The functional analysis of the control and the safety related programs under its control are documented in a clear hierarchical way in accordance with the safety philosophy and the program requirements.		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
	Documentation provided for assessment included:		—
	<ul style="list-style-type: none"> A description of the system philosophy, the control flow, data flow and timings. 		P
	<ul style="list-style-type: none"> A clear description of the safety philosophy of the system with all safeguards and safety functions clearly indicated. Sufficient design information is provided to enable the safety functions or safeguards to be assessed 		P
	<ul style="list-style-type: none"> Documentation for any software within the system 		P
	Programming documentation is supplied in a programming design language declared by the manufacturer.....:		P
	Safety related data and safety related segments of the operating sequence are identified and classified according to H.11.12.3		P
	There is a clear relationship between the various parts of the documentation		P
H.27.1.2.2	Class B control function		P
H.27.1.2.2.1	Design and construction requirements		P
	Software complies with software class B		P
H.27.1.2.3	Class C control function		N/A
H.27.1.2.3.1	Design and construction requirements		N/A
	Software complies with software class C		N/A
H.27.1.2.5	Circuit and construction evaluation		P
H.27.1.2.5.3	Assessment		P
	Only the safety related software (software class B and C) as identified according to H.27.1.2.1.2 were subjected to further assessment		P

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE H.1 – MEASURES TO ADDRESS FAULT/ERRORS (Software Class B)			
Component	Fault/error	Declared measures	Verdict
1. CPU	-	-	-
1.1 Registers	Stuck at	Time-slot monitoring	P
1.3 Program counter	Stuck at	Time-slot monitoring	P
2. Interrupt handling and execution	No interrupt	Time-slot monitoring	P
	Too frequent interrupt	Time-slot monitoring	P
3. Clock	Wrong frequency (for quartz synchronized clock: harmonics/ sub-harmonics only)	Time-slot monitoring Timer B is checked by Timer A.	P
4. Memory	-	-	-
4.1 Invariable memory	All single bit faults	CRC (Cyclic Redundancy Check)	P
4.2 Variable memory	DC fault	March C test	P
4.3. Addressing (relevant to variable and invariable memory)	Stuck at	Word protection with multi-bit redundancy	P
5. Internal data path	-	-	-
5.1 Data	Stuck at	Word protection with multi-bit redundancy	P
5.2 Addressing	Wrong address	Word protection with multi-bit redundancy	P
6. External communication	-	-	-
6.1 Data	Hamming distance 3	CRC (Cyclic Redundancy Check)	p
6.2 Addressing	Wrong address	CRC (Cyclic Redundancy Check)	p
6.3 Timing	Wrong point in time	Time-slot monitoring	p
	Wrong sequence	Time-slot monitoring	P
7. Input/output periphery	-	-	-
7.1 Digital I/O	Fault conditions specified in Cl.H.27	Plausibility check	P
7.2 Analog I/O	-	-	-

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
7.2.1 A/D and D/A-convertor	Fault conditions specified in Cl. H.27	No such part	N/A
7.2.2 Analog multiplexer	Wrong addressing	No such part	N/A
9. Custom chips e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	No such chip used.	N/A

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict

TABLE H.1 – MEASURES TO ADDRESS FAULT/ERRORS (Software Class C): N/A			
Component	Fault/error	Declared measures	Verdict
1. CPU	-	-	-
1.1 Registers	DC fault		
1.2 Instruction decoding and execution	Wrong decoding and execution		
1.3 Program counter	DC fault		
1.4 Addressing	DC fault		
1.5 Data paths instruction decoding	DC fault		
	execution		
2. Interrupt handling and execution	No interrupt		
	Too frequent interrupt related to different sources		
3. Clock	Wrong frequency (for quartz synchronized clock: harmonics/ sub-harmonics only)		
4. Memory	-	-	-
4.1 Invariable memory	99,6 % coverage of all information errors		
4.2 Variable memory	DC fault		
	Dynamic cross links		
4.3 Addressing (relevant to variable and invariable memory)	DC fault		
5. Internal data path	-	-	-
5.1 Data	DC fault		
5.2 Addressing	Wrong address		
	Multiple addressing		
6 External communication	-	-	-
6.1 Data	Hamming distance 4		
6.2 Addressing	Wrong address		
	Multiple addressing		

IEC 60730-1 (Software)			
Clause	Requirement + Test	Result - Remark	Verdict
6.3 Timing	Wrong point in time		
	Wrong sequence		
7. Input/output periphery	-	-	-
7.1 Digital I/O	Fault conditions specified in Cl.H.27		
7.2 Analog I/O	-	-	-
7.2.1 A/D and D/A-convertor	Fault conditions specified in Cl. H.27		
7.2.2 Analog multiplexer	Wrong addressing		
8. Monitoring devices and comparators	Any output outside the static and dynamic functional specification		
9 Custom chips e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification		

IEC 60730-1 (Software)													
Clause	Requirement + Test											Result - Remark	Verdict
H27.1	TABLE: Electrical / electronic component fault modes												
Component	short circuiting	open circuit	a) No flames	b) 1.5 x max temp. of Cl. 14	c) as declared (H57)	d) protect. against el. shock	d) electric strength, basic insulation	e) creepage and clearance	f) no rupture of ext. fuses or	f) complies with a), b) and d)	g) as declared in H58	Observations	
P3 (Pin1 and Pin2) on the power board		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3 (Pin1 and Pin2) on the power board	Reverse		P	P	P	P	P	P	N/A	N/A	N/A	The system doesn't work. No hazard.	
P5V		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P5V	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3V3	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3V3		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3V3_AD		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3V3_AD	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	
P3V3_SYS		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.	

IEC 60730-1 (Software)												
Clause	Requirement + Test								Result - Remark			Verdict
P3V3_SYS	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
Current sense line	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
Current sense line		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
CAN of U2,U18,U37	x		P	P	P	P	P	P	N/A	N/A	N/A	Communication time out. The power relay switched off. No hazard.
CAN of U2,U18,U37		x	P	P	P	P	P	P	N/A	N/A	N/A	Communication time out. The power relay switched off. No hazard.
Cell voltage sense line	x		P	P	P	P	P	P	N/A	N/A	N/A	The voltage value is abnormal. Communication time out. The power relay switched off. No hazard.
Cell voltage sense line		x	P	P	P	P	P	P	N/A	N/A	N/A	The voltage value is abnormal. Communication time out. The power relay switched off. No hazard.
NTC resistor	x		P	P	P	P	P	P	N/A	N/A	N/A	The temperature value is abnormal. Communication time out. The power relay switched off. No hazard.
NTC resistor		x	P	P	P	P	P	P	N/A	N/A	N/A	The temperature value is abnormal. Communication time out. The power relay switched off. No hazard.

IEC 60730-1 (Software)												
Clause	Requirement + Test								Result - Remark			Verdict
TVS	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
Fuse		x	P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
Relay	x		P	P	P	P	P	P	N/A	N/A	N/A	The power relay switched off. Cease to output. No hazard.
Supplementary information: N/A												

Table: Manufacturer's Documentation Referenced in this TRF (informative)

Title	Revision	Date
System Requirements Specification (SRS)	A0	2023-04-20
User manual	A0	2023-04-20
Safety Architecture	A0	2023-04-20
Code standard	A0	2023-04-20
Hardware Specification	A0	2023-04-20
Software system design Specification	A0	2023-04-20
Component single fault analysis	A0	2023-04-20
Hazard analyses and risk assessment for system	A0	2023-04-20
FEMA for Hardware	A0	2023-04-20
Battery system safety test report	Report No: 5061723021301-00	2023-07-25

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