Prüfbericht-Nr.: *Test report no.:*	CN23NLZW 001	**Auftrags-Nr.:** *Order no.*:	244552483 P01225666	**Seite 1 von 32** *Page 1 of 32*
Kunden-Referenz-Nr.: *Client reference no.:*	2083350	**Auftragsdatum:** *Order date:*	2023-10-16	
Auftraggeber: *Client:*	**Pylon Technologies Co., Ltd.** No. 73, Lane 887, Zu Chongzhi Road, Zhangjiang Hi-Tech Park Pudong, Shanghai, 201203, P. R. China.			
Prüfgegenstand: *Test item:*	Rechargeable Li-ion Battery			
Bezeichnung / Typ-Nr.: *Identification / Type no.:*	Pelio-L-5.12			
Auftrags-Inhalt: *Order content*:	Test report			
Prüfgrundlage: *Test specification:*	IEC 60730-1:2022 Annex H UL 60730-1:2016 Annex H			

Wareneingangsdatum: *Date of sample receipt:*	2023-10-17
Prüfmuster-Nr.: *Test sample no:*	Engineering sample
Prüfzeitraum: *Testing period:*	2023-10-18 - 2023-10-20
Ort der Prüfung: *Place of testing:*	Pylon Technologies Co., Ltd.
Prüflaboratorium: *Testing laboratory:*	TÜV Rheinland (Shanghai) Co., Ltd.
Prüfergebnis*: *Test result*:*	Pass

geprüft von: *tested by:*	Ding Guan	**genehmigt von:** *authorized by:*	
Datum: *Date:* 2023-10-24	Ding Guan	**Ausstellungsdatum:** *Issue date:* 2023-10-24	Bowen Dong
Stellung / *Position:*	Engineer	**Stellung** / *Position:*	Reviewer

Sonstiges / *Other:* See the following pages for general product information and comment for details.

Zustand des Prüfgegenstandes bei Anlieferung: Prüfmuster vollständig und unbeschädigt
Condition of the test item at delivery: *Test item complete and undamaged*

* Legende:	P(ass) = entspricht o.g. Prüfgrundlage(n)	F(ail) = entspricht nicht o.g. Prüfgrundlage(n)	N/A = nicht anwendbar	N/T = nicht getestet
* *Legend:*	*P(ass) = passed a.m. test specification(s)*	*F(ail) = failed a.m. test specification(s)*	*N/A = not applicable*	*N/T = not tested*

Absatz *Clause*	**Anforderungen - Prüfungen /** *Requirements - Tests*	**Messergebnisse – Bemerkungen/** *Measuring results - Remarks*	**Ergebnis** *Result*

1	Alle eingesetzten Prüfmittel waren zum angegebenen Prüfzeitraum gemäß eines festgelegten Kalibrierungsprogramms unseres Prüfhauses kalibriert. Sie entsprechen den in den Prüfprogrammen hinterlegten Anforderungen. Die Rückverfolgbarkeit der eingesetzten Prüfmittel ist durch die Einhaltung der Regelungen unseres Managementsystems gegeben. Detaillierte Informationen bezüglich Prüfkonditionen, Prüfequipment und Messunsicherheiten sind im Prüflabor vorhanden und können auf Wunsch bereitgestellt werden. *The equipment used during the specified testing period was calibrated according to our test laboratory calibration program. The equipment fulfils the requirements included in the relevant standards. The traceability of the test equipment used is ensured by compliance with the regulations of our management system.* *Detailed information regarding test conditions, equipment and measurement uncertainty is available in the test laboratory and could be provided on request.*
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4	Die Entscheidungsregel für Konformitätserklärungen basierend auf numerischen Messergebnisen in diesem Prüfbericht basiert auf der "Null-Grenzwert-Regel" und der "Einfachen Akzeptanz" gemäß ILAC G8:2019 und IEC Guide 115:2021, es sei denn, in der auf Seite 1 dieses Berichts genannten angewandten Norm ist etwas anderes festgelegt oder vom Kunden gewünscht. Dies bedeutet, dass die Messunsicherheit nicht berücksichtigt wird und daher auch nicht im Prüfbericht angegeben wird. Zu weiteren Informationen bezueglich des Risikos durch diese Entscheidungsregel siehe ILAC G8:2019. *The decision rule for statements of conformity, based on numerical measurement results, in this test report is based on the "Zero Guard Band Rule" and "Simple Acceptance" in accordance with ILAC G8:2019 and IEC Guide 115:2021, unless otherwise specified in the applied standard mentioned on Page 1 of this report or requested by the customer. This means that measurement uncertainty is not taken in account and hence also not declared in the test report. For additional information to the resulting risk based of this decision rule please refer to ILAC G8:2019.*

Test Report issued under the responsibility of:

TÜVRheinland®

TEST REPORT

IEC 60730-1
Automatic electrical controls for household and similar use
Controls using software

Report Number. .....:	**CN23NLZW 001**
Date of issue .....:	**See cover page**
Total number of pages.....:	**See cover page**
Name of Testing Laboratory preparing the Report.....:	**See cover page**
Applicant's name.....:	**See cover page**
Address .....:	**See cover page**
Test specification:	
Standard .....:	**See cover page**
Test procedure.....:	**See cover page**
Non-standard test method.....:	N/A
Test Report Form No.....:	IEC60730_1i_SOFTWARE
Test Report Form(s) Originator.....:	UL(US)
Master TRF .....:	2018-05

If this Test Report Form is used by non-IECEE members, the IECEE/IEC logo and the reference to the CB Scheme procedure shall be removed.

This report is not valid as a CB Test Report unless signed by an approved CB Testing Laboratory and appended to a CB Test Certificate issued by an NCB in accordance with IECEE 02.

General disclaimer:

The test results presented in this report relate only to the object tested.
This report shall not be reproduced, except in full, without the written approval of the Issuing CB Testing Laboratory. The authenticity of this Test Report and its contents can be verified by contacting the NCB, responsible for this Test Report.

Test Item description	Rechargeable Li-ion Battery
Trade Mark	PYLONTECH
Manufacturer	See cover page
Model/Type reference	See cover page
Ratings	See copy of marking label and model list
Software module(s) and associated version(s)	MCU Version: STM32H723ZGT6 Software Version: Raybow_A_B70.3.0

Responsible Testing Laboratory (as applicable), testing procedure and testing location(s):			
☐	**CB Testing Laboratory:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 1:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 2:**		
Testing location/ address.....:			
Tested by (name + signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature)...:			
☐	**Testing procedure: CTF Stage 3:**		
☐	**Testing procedure: CTF Stage 4:**		
Testing location/ address.....:			
Tested by (name, function, signature).....:			
Witnessed by (name, function, signature) .:			
Approved by (name, function, signature)...:			
Supervised by (name, function, signature) :			

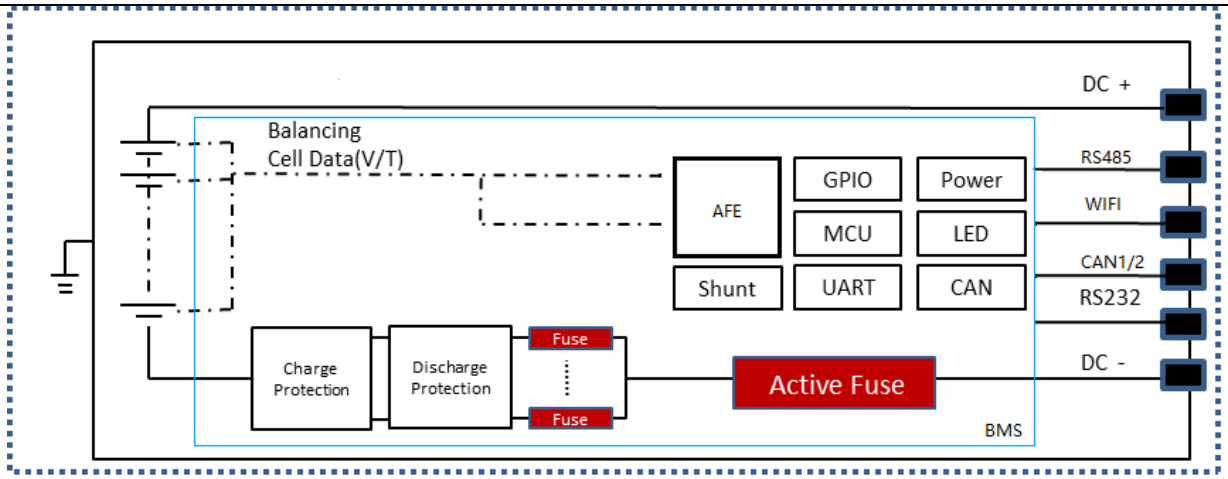
List of Attachments (including a total number of pages in each attachment): - Attachment 1 - FMEA and fault insert testing - Attachment 2 - Clearance and Creepage documents
Summary of compliance with National Differences (List of countries addressed): N/A

Copy of marking plate:

The artwork below may be only a draft. The use of certification marks on a product must be authorized by the respective NCBs that own these marks.

Label of Battery:

TEST ITEM PARTICULARS:	
Manufacturer's specified maxium operating ambient :	55°C
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..... :	See cover page
Date (s) of performance of tests..... :	See cover page
GENERAL REMARKS:	
"(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 5.1 Test Report.** **Throughout this report a ☐ comma / ☒ point is used as the decimal separator.**	
When differences exist; they shall be identified in the General product information section.	
Name and address of factory (ies) ..... :	**Pylon Technologies Co., Ltd.** No. 73, Lane 887, Zu Chongzhi Road, Zhangjiang Hi-Tech Park Pudong, Shanghai, 201203, P. R. China.
GENERAL PRODUCT INFORMATION:	
Product Description: This product is used for Energy Storage System. The battery is constructed with 16 battery cells in 16S, and has overcharge, over-discharge, over current and short-circuits proof circuit. The function safety has been evaluated in accordance with IEC 60730-1 Annex H and UL 60730-1 Annex H. Block diagram as below:	



Model list:

Product name	Rechargeable Li-ion Battery
Type/model	Pelio-L-5.12
Nominal voltage	51.2 V
Rated capacity	100 Ah
Total Storage Energy	5120 Wh
Connecting type	16S/1P
Upper limit charging voltage	57.6 Vdc
Final discharge voltage	44.8 Vdc
Nominal Current	25 Adc
Recommend Current	50 Adc
Maximum charging current	100 Adc
Pulse Charge Current	DC 120~200A(≤15S)
Nominal Discharge Current	25Adc
Recommend Discharge Current	50Adc
Maximum discharging current	100 Adc
Pulse Discharge Current	DC 120~200A(≤15S)
Over voltage category	OVC II
Charging temp. upper limit	55 °C
Charging temp. lower limit	-10 °C
Dsicharging temp. upper limit	55°C
Dsicharging temp. lower limit	-10 °C
Dimension	395mm*578mm*165mm
Weight	43 kg
Overcharge protected voltage supply by battery system	≥3.65 V /Cell
Protective Class	I
Installation Type	Ground mounting
Enclosure Protection (IP)	IP65
Enclosure Material	DC51D+ZF
Enclosure Thickness	1 mm
Pollution degree (PD)	3 (Inside 2)
Cooling type	Natural

Altitude	4000m

*: An adequate circuit breaker (with consideration of the max. short circuit current) shall be equipped per each DC string of connection.

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

N/A

DESCRIPTION OF SAFETY FUNCTION(S)

	Safety function 1 – Voltage protection function	
	Software protection	Hardware protection
Description	The MCU reads the voltage of cells periodically. If any of the cell voltage exceeds the threshold value, the MCU will switch off the MOS.	-
Input	Cell voltage	-
threshold value	Overvoltage: 3.65V Low voltage: 2.8V	-
Response time	2s	-
Output	Switch off MOS	-

	Safety function 2 – Temperature protection function	
	Software protection	Hardware protection
Description	The MCU reads the temperature of cells periodically. If any of the cell temperature exceeds the threshold value, the MCU will switch off the MOS.	-
Input	Cell temperature	-
threshold value	Over temperature: 60°C Low temperature: -10°C	-
Response time	2s	-
Output	Switch off the MOS	-

	Safety function 3 – Current protection function	
	Software protection	Hardware protection
Description	The MCU reads the current of cells periodically. If any of the current exceeds the threshold value, the MCU will switch off the MOS.	
Input	Charge/discharge current	
threshold value	Charge/discharge current: 100A/900s 120A/15s 200A/0.5s	
Response time	See above	
Output	Switch off the MOS	

	Safety function 4 – Communication protection function	
	Software protection	Hardware protection
Description	The MCU monitors the communication between the pack and BMS periodically. If communication missed, the MCU will switch off the MOS.	-
Input	Charge/discharge current	-
threshold value	-	-
Response time	10s	-
Output	Switch off the MOS	-

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
H.5	Information in addition to Table 1 provided:		P
	H.3 - Software sequence documentation; clause: H.9.12.2.9; method: X .....:		P
	H.4 - Program documentation; clause: H.9.12.2.9, H.9.12.2.11; method: X .....:		P
	H.5 - Software fault analysis; clause: H.9.1.2, 13.1.3; method: X.....:		P
	H.6 - Software class(es) and structure; This information is not required for class A controls; clause: H.9.12.2, H.9.12.3, H.13.2.2.1, H.13.2.3.1; method: D.....:		P
	H.7 - Analytical measures and fault/error control techniques employed; clause: H.3.17.10 H.9.12.2.6; method: X .....:		P
	H.8 - 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
	H.9 - Control response(s) in case of detected fault/error; clause: H.9.12.2.7; method: X .....:		P
	H.10 – Controls subjected to a second fault analysis and declared condition as a result of the second fault; clause H.13.2.3; method: X .....:		P
	H.11 - Fault reaction time; clause H.3.22.2, H.13.2.2.2, H.13.2.2.3, H.13.2.3.2, H.13.2.3.3, H.13.2.4.2, H.13.2.4.3; method: X.....:		P
	H.12 - Class or classes of control function(s), clause H.13.2.2, H.13.2.3; method: X.....:		
	a – For controls declared as entirely class A, the requirements H.3, H.4, H.5, H.7, H.8 and H.9 of Table H.1 are exempted. For controls with software classes B or C, information shall be provided only for the safety-related segments of the software. Information on the non-safety related segments shall be sufficient to establish that they do not influence the safety-related segments.....:		P

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	b – The software sequence shall be documented and, together with the operating sequence of table requirement 46, shall include a description of the control system philosophy, the control flow, data flow and the timings. .....:		P
	c - Safety-related data and safety-related segments of the software sequence, the malfunction of which could result in non-compliance with the requirements of Clause 13, 19, 24 and H.25 shall be identified. This identification shall:. .....:		P
	– Included the operating sequence .....:		P
	– Software fault analysis was related to the hardware fault analysis in Clause H.13.2.....:		P
	e - Programming documentation was supplied in a programming design language declared by the manufacturer .....:		P
	f – Different software classes applied to different control functions .....:		P
	g - 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.9	Constructional requirements		P
H.9.12	Controls using software		P
	Controls using software were so constructed that the software did not impair control compliance with the requirements of this standard		P
H.9.12.1	Requirements for the architecture		P
H.9.12.1.1	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.9.12.1.2 to H.9.12.3 inclusive.	Class B considered	P
H.9.12.1.2	Structure for control functions with software class B or C		
H.9.12.1.2.1	Control functions with software class C have one of the following structures:		N/A
	– single channel with periodic self-test and monitoring (H.3.16.7)	Class B	N/A

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	– dual channel (homogenous) with comparison (H.3.16.3)		N/A
	– dual channel (diverse) with comparison (H.3.16.2)		N/A
H.9.12.1.2.2	Control functions with software class B have one of the following structures:		P
	– single channel with functional test (H.3.16.5)	Used	P
	– single channel with periodic self-test (H.3.16.6)	Used	P
	– dual channel without comparison (H.3.16.1)	Not used	N/A
H.9.12.1.3	Other structure permitted with equivalent level of safety to those in H.9.12.1.2 ..... :		P
H.9.12.2	Measures to control faults/errors		P
H.9.12.2.1	Redundant memory with comparison provided on two areas of the same component: data stored in different formats		P
H.9.12.2.2	Software class C using dual channel structures with comparison: additional fault/error detection means		N/A
H.9.12.2.3	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.9.12.2.4	For control with software class B or C, the manufacturer shall provide, within the control, measures to address the fault/errors in safety-related segments and data indicated in Table H.2 and declared in Table H.1, requirement H.5.		P
H.9.12.2.5	Measures others than those specified in H.9.12.2.4 are permitted if they can be shown to satisfy the requirements listed in Table H.2.		P
H.9.12.2.6	Software fault/error detection:		P
	– occur not later than declared time(s), Table H.1, requirement H.8		P

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	– acceptability of declared time(s): evaluated during fault analysis of the control		P
H.9.12.2.7	For controls with functions, classified as Class B or C, detection of fault/error:		P
	– results in the response declared in Table H.1, requirement H.9		P
	– for Class C: independent means capable of performing this response provided		N/A
H.9.12.2.8	Class C, dual channel structure, loss of dual channel capability: deemed to be an error		N/A
H.9.12.2.9	Software referenced:		P
	– to relevant parts of the operating sequence		P
	– to the associated hardware functions		P
H.9.12.2.10	Labels used for memory locations are unique		N/A
H.9.12.2.11	Software protected from user alteration of safety-related segments and data		P
H.9.12.2.12	Software and safety-related hardware under its control is initialized to and terminates at a declared state, Table H.1, requirement H.4 .....:		P
H.9.12.3	Measures to avoid errors		P
H.9.12.3.1	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.9.12.3.2	Specification		P
H.9.12.3.2.1	Software safety requirements		P
H.9.12.3.2.1.1	The specification of the software safety requirements includes:		P

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	• A description of each safety related function to be implemented, including its response time(s): - functions related to the application including their related software classes - functions related to the detection, annunciation and management of software or hardware faults		P
	• A description of interfaces between software and hardware		P
	• A description of interfaces between any safety and non-safety related functions		P
H.9.12.3.2.2	Software architecture		P
H.9.12.3.2.2.1	The description of software architecture include the following aspects:		P
	• Techniques and measures to control software faults/errors (refer to H.9.12.2)		P
	• Interactions between hardware and software		P
	• Partitioning into modules and their allocation to the specified safety functions		P
	• Hierarchy and call structure of the modules (control flow)		P
	• Interrupt handling		P
	• Data flow and restrictions on data access		P
	• Architecture and storage of data		P
	• Time based dependencies of sequences and data		P
H.9.12.3.2.2.2	The architecture specification is verified against the specification of the software safety requirements by static analysis		P
H.9.12.3.2.3	Module design and coding		P
H.9.12.3.2.3.1	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

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	– function(s)		P
	– interfaces to other modules		P
	– data		P
H.9.12.3.2.3.2	Software code is structured		P
H.9.12.3.2.3.3	Coded software is verified against the module specification, and the module specification is verified against the architecture specification by static analysis		P
H.9.12.3.2.4	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.9.12.3.3	Testing		P
H.9.12.3.3.1	Module design (software system design, software module design and coding)		P
H.9.12.3.3.1.1	A test concept with suitable test cases is defined based on the module design specification.		P
H.9.12.3.3.1.2	Each software module is tested as specified within the test concept		P
H.9.12.3.3.1.3	Test cases, test data and test results are documented		P
H.9.12.3.3.1.4	Code verification of a software module by static means includes such techniques as software inspections, walk-throughs, static analysis and formal proof		P

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	Code verification of a software module by dynamic means includes functional testing, white-box testing and statistical testing		P
H.9.12.3.3.2	Software integration testing		P
H.9.12.3.3.2.1	A test concept with suitable test cases is defined based on the architecture design specification		P
H.9.12.3.3.2.2	The software is tested as specified within the test concept		P
H.9.12.3.3.2.3	Test cases, test data and test results are documented		P
H.9.12.3.3.3	Software validation		P
H.9.12.3.3.3.1	A validation concept with suitable test cases is defined based on the software safety requirements specification		P
H.9.12.3.3.3.2	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.9.12.3.3.3.3	Test cases, test data and test results are documented		P
H.9.12.3.4	Other Items		P
H.9.12.3.4.1	Equipment used for software design, verification and maintenance was qualified appropriately and demonstrated to be suitable for purpose in manifold applications		P
H.9.12.3.4.2	Management of software versions: All versions are uniquely identified for traceability		P
H.9.12.3.4.3	Software modification		P

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
H.9.12.3.4.3.1	Software modifications are based on a modification request which details the following:		P
	• the hazards which may be affected		P
	• the proposed change		P
	• the reasons for change		P
H.9.12.3.4.3.2	An analysis is carried out to determine the impact of the proposed modification on functional safety.		P
H.9.12.3.4.3.3	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.9.12.3.4.3.4	The modification is carried out as planned		P
H.9.12.3.4.3.5	The assessment of the modification is carried out based on the specified verification and validation activities.		P
H.9.12.3.4.3.6	All details of modification activities are documented		P
H.9.12.3.5	For class C control functions: One of the combinations (a–p) of analytical measures given in the columns of table H.10 is used during hardware development.....:	Class B	N/A
H.9.12.4	Remotely actuated control functions		N/A
H.9.12.4.2.3.1	Communication of Safety Related Data – Transmission – Safety relevant data is transmitted authentically concerning:		N/A
	– data corruption		N/A
	– 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

IEC/UL 60730-1 Annex H			
Clause	Requirement + Test	Result - Remark	Verdict
	The following failure modes are addressed .....:		—
	– permanent “auto-sending” or repetition,		N/A
	– interruption of data transfer		N/A
H.9.12.4.2.3.2	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.9.12.4.2.3.3	For class B and class C software revisions the requirements of H.9.12.3 and hardware configuration management are applied and the control maintains its protective functions		N/A
H.9.12.4.5	Software Download and Installation		N/A
	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
	The software which performs the above mentioned checks had measures to control the fault/error conditions specified in H.9.12.2.		N/A
H.9.12.4.5.2	In case of software download via remote communication, the cryptographic techniques in H.9.12.4.6 were provided. In addition to the requirements in H.9.12.4.6, identification procedures were provided for the software packages.		N/A

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Clause	Requirement + Test	Result - Remark	Verdict
	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.9.12.4.5.3	Each update of software had provisions for authorization by the user and a version ID number which were accessible.		N/A
H.9.12.4.5.4	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.9.12.4.6	Cryptographic 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.13	Fault assessment on electronic circuits		P
H.13.2	Protection against internal faults to ensure functional safety		P
H.13.2.1	Design and construction requirements		P
H.13.2.1.1	Fault avoidance and fault tolerance		P
	Controls incorporating control functions of class B or C are designed according to H.13.2 taking into account the failure modes of Table 14 and H.9.12 for software		P
	Systematic errors are avoided		P
	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

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Clause	Requirement + Test	Result - Remark	Verdict
	– 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.9.12 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.13.2.3.		P
H.13.2.1.2	Documentation		P
	The documentation was based on H.9.12.3		P
H.13.2.2	Class B control function		P
H.13.2.2.1	Design and construction requirements		P
	Software complies with software class B		P
H.13.2.3	Class C control function		N/A
H.13.2.3.1	Design and construction requirements		N/A
	Software complies with software class C		N/A
H.13.2.5	Circuit and construction evaluation		P
H.13.2.5.3	Assessment		P

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Clause	Requirement + Test	Result - Remark	Verdict
	Only the safety related software (software class B and C) as identified according to H.13.2.1.2 were subjected to further assessment		P
H.25	Electromagnetic compatibility (EMC) requirements – Immunity		P
H.25.1	General requirements	Refer to report CN22JGJ7 001 for details.	P
	Electronic controls shall be so constructed as to: - withstand the effects of mains-borne perturbations		P
	- electromagnetic phenomena which can occur in normal use		P
H.25.2	Particular requirements for integrated and incorporated controls with type 2 action		N/A
	For integrated and incorporated controls with type 2 action, compliance is checked by H.25.5 and any other tests of Clause H.25 which are declared in Table H.1, requirement H.1.		N/A
H.25.3	Sample requirement		P
	A separate sample, as submitted, may be used for each test. At the option of the control manufacturer, multiple tests can be performed on a single sample.		P
H.25.4	Harmonics and interharmonics including mains signalling at AC power port, low frequency immunity tests		P
	The control is subjected to mains signals in accordance with IEC 61000-4-13, test level class 2 being applicable.		P
	During the test, the control is supplied with rated voltage. The test levels for Class 2 environment according to IEC 61000-4-13:2002, IEC 61000-4-13/AMD1:2009 and IEC 61000-4-13/AMD2:2015, Tables 1 to 4 shall be applied at the AC power port of the EUT. The control is tested under the test conditions as specified in the specific control standard.		P
	The following tests are performed in accordance with IEC 61000-4-13:2002, IEC 61000-4-13/AMD1:2009 and IEC 61000-4-13/AMD2:2015, Figure 1a for Class 2 environment:		P

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Clause	Requirement + Test	Result - Remark	Verdict
	- "Harmonic combination" (IEC 61000-4-13:2002, IEC 61000-4-13/AMD1:2009 and IEC 61000-4-13/AMD2:2015, 8.2.1);		P
	- "Meister curve" (IEC 61000-4-13:2002, IEC 61000-4-13/AMD1:2009 and IEC 61000-4-13/AMD2:2015, 8.2.4).		P
H.25.5	Voltage dips, voltage interruptions and voltage variations in the power supply network		P
	The control shall tolerate voltage dips voltage interruptions and voltage variations in the power supply network.		P
H.25.5.1	Voltage dips and interruptions		P
H.25.5.1.1	Test levels for voltage dips and interruptions		P
	The test values in Table H.13 shall be applied to all the test levels		P
H.25.5.1.2	Test procedure for voltage dips and interruptions		P
	The test apparatus and procedures shall be as described in IEC 61000-4-11. During the test, the control shall be initially operated at its rated voltage.		P
H.25.5.2	Voltage variation test		P
	- verify the immunity of the control against voltage change taking place over a short period which can occur due to a change of load or stored energy in local power networks.		P
H.25.5.2.1	Test levels for voltage variations		P
	The test values in Table H.14 shall be applied to all the test levels.		P
H.25.5.2.2	Test procedure		P
	The test apparatus and procedures shall be as described in IEC 61000-4-11.		P
H.25.6	Test of influence of voltage unbalance		P
H.25.6.1	The influence of unbalance in a three-phase voltage system on equipment sensitive to this kind of interference shall be investigated.		P

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Clause	Requirement + Test	Result - Remark	Verdict
H.25.6.2	Test voltage characteristics		P
	A power frequency three-phase voltage shall be applied to the control with the specified unbalance factor.		P
H.25.6.3	Test equipment/test generator		P
	The test arrangement shall consist of three single-phase auto-transformers, whose outputs are regulated individually, or the like.		P
H.25.6.4	Test level		P
	The test shall be carried out with an unbalance factor of 2 %.		P
H.25.7	Test of the influence of DC in AC networks		P
H.25.8	Surge immunity test		P
	The control shall tolerate voltage surges on the mains supply and relevant signal terminals.		P
	The tests as detailed in Table H.15 shall be applied.		P
	The test apparatus and procedure shall be as described in IEC 61000-4-5.		P
H.25.9	Electrical fast transient/burst immunity test		P
	The control shall tolerate fast transient bursts on the mains supply and on the signal lines.		P
	The tests shall be applied as specified in Table H.16.		P
	The test apparatus and test procedures shall be as described in IEC 61000-4-4.		P
H.25.10	Electrostatic discharge test		P
	This test is carried out in accordance with IEC 61000-4-2.		P
	The test values shall be applied to test level 3.		P
H.25.11	Radio-frequency electromagnetic field immunity		P

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Clause	Requirement + Test	Result - Remark	Verdict
H.25.11.2.1	At minimum, the test levels in Table H.17 shall be applied.		P
H.25.11.2.2	This test shall be carried out in accordance with IEC 61000-4-6.		P
H.25.11.3	The control shall tolerate high-frequency signals on the mains supply and relevant signal terminals.		P
H.25.11.3.1	Test levels for immunity to radiated electromagnetic fields shall be applied in accordance with Table H.18.		P
H.25.11.3.2	This test shall be carried out in accordance with IEC 61000-4-3.		P
H.25.12	Test of influence of supply frequency variations		P
	The test values in Table H.20 shall be applied.		P
	The test apparatus and procedures shall be as described in IEC 61000-4-28.		P
H.25.13	Power frequency magnetic field immunity test		
H.25.13.1	The controls which are susceptible to magnetic field such as controls which use Hall-effect devices shall tolerate power-frequency magnetic fields.		P
H.25.13.2	The test levels shall be applied in accordance with Table H.21.		P
H.25.13.3	The control is supplied at rated voltage. Test equipment, test set-up and test procedure shall be in accordance with IEC 61000-4-8. The control is tested under the test conditions as specified in the relevant part 2.		P
H.25.14	Evaluation of compliance		
H.25.14.1	After completion of all the tests of H.25.4 through H.25.13, the sample(s) shall meet the requirements of Clause 6, Clause 11 and 19.5.		P
H.25.14.2	The control shall meet the following:		P
	- the requirements of 19.14 or		P
	- the output(s) and functions shall be as declared in Table H.1, requirements H.1 and H.2.		P

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Clause	Requirement + Test	Result - Remark	Verdict
H.25.14.3	Different outputs and functions can be declared by the manufacturer after testing at test level 2, or test level 3, if relevant. Part 2 may specify particular criteria after each of these tests.		P
H.25.14.4	In cases where the compliance criteria is not specified for the control, the control shall comply with one of the following criteria:		P
	a) normal performance with no loss of protective functions and control is within specification or declared limits;		P
	b) loss of protective function within declared limits;		P
	c) loss of protective function with safety shut-down.		P

TABLE H.1 – MEASURES TO ADDRESS FAULT/ERRORS (Software Class B) Software of MCU			
Component	Fault / Error	Declared measures	Verdict
1. CPU	-	-	-
1.1 Registers	Stuck at	Checking one register each operating cycle First, write 0xAAAAAAAA to the register, read the value of the register written, and compare with the value written; Next, write 0x55555555 to the register, read the value of the register written, and compare with the value written; The total period is 1000ms In error condition, set system Error, and send to String controller MCU	Pass
1.3 Program counter	Stuck at	Covered by Clock detection	Pass
2. Interrupt handling and execution	No interrupt	Enable the time interrupter whose interval time is 1s. Count all interrupts in one interrupt service process. If the count number is equal to 0, the system set system Error, and send to String controller MCU	Pass
	Too frequent interrupt	Enable the time interrupter whose interval time is 1s. Count all interrupts in one interrupt service process. If the count number is more than 1000, the system set system Error, and send to String controller MCU	Pass

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3. Clock	Wrong frequency (for quartz synchronized clock: harmonics/ sub-harmonics only)	Internal low speed clock LSI is enabled to count in 10ms cycle. External high speed clock HSE is enable to count in 10ms cycle. Then compare the count between LSI and HSE. If the result has ±25% deviation from the normal value, the system sets system Error, and send to String controller MCU	Pass
4. Memory	-	-	-
4.1 Invariable memory	All single bit faults	Total flash is 512KB. 1024 bytes are checked each cycle of 1s. The CRC checksum for the entire Flash is calculated at compile time and stored at the start of Flash. The CRC checksum for the entire Flash (not including the CRC stored at the start of Flash) is calculated at run time and compared with the CRC stored in Flash In error condition, set system Error, and send to String controller MCU	Pass

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4.2 Variable memory	DC fault	First, write 0x55555555 to the address according to the direction of address increase, read the data in the written address, and compare whether the written data is consistent with the read data; Secondly, write 0xAAAAAAAA to the address according to the direction of address increase, read the data in the written address, and compare whether the written data is consistent with the read data; Then repeat the above two steps according to the direction of address decrease. In error condition, set system Error, and send to String controller MCU	Pass
4.3. Addressing (relevant to variable and invariable memory)	Stuck at	For flash, same to clause 4.1 For ram, same to clause 4.2	Pass
5. Internal data path	-	-	-
5.1 Data	Stuck at	When data is stored, a byte of parity data is added at the end of the packet. This byte is the sum in bytes of all the data in the previous packet without carrying the carry. When data is read, the sum and check of the read data are performed and the check results are compared with the stored results. In error condition, set system Error, and send to String controller MCU	Pass

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5.2 Addressing	Wrong address	1. Address and data bus detection: If errors occur during the self-test of Flash and RAM, it will result in the disconnection of the MOS (Metal-Oxide-Semiconductor). See 5.1 for more details. 2. The LTC acquisition chip adopts SPI communication with PEC verification. The communication includes a Packet Error Checking code (PEC), which is a 15-bit cyclic redundancy check (CRC). The characteristic polynomial is: x15 + x14 + x10 + x8 + x7 + x4 + x3 + 1.	Pass
6. External communication	-	-	-
6.1 Data	Hamming distance 3	CRC is used in the data transmission process, and the received data is calculated in the same way to compare the data's CRC checksum with the received CRC checksum. In error condition, set system Error, and send to String controller MCU	Pass
6.2 Addressing	Wrong address	CRC is used in the data transmission process, and the received data is calculated in the same way to compare the data's CRC checksum with the received CRC checksum. In error condition, set system Error, and send to String controller MCU	Pass
6.3 Timing	Wrong point in time	CRC is used in the data transmission process, and the received data is calculated in the same way to compare the data's CRC checksum with the received CRC checksum. In error condition, MOS will operate.	Pass

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	Wrong sequence	CRC is used in the data transmission process, and the received data is calculated in the same way to compare the data's CRC checksum with the received CRC checksum In error condition, MOS will operate.	Pass
7. Input/output periphery	-	-	-
7.1 Digital I/O	Fault conditions specified in Cl.H.27	Periodic self-test. The cycle is 1s. First, Set IO port output low level and read IO level signal. Then Set IO port output high. level, read IO level signal In error condition, set system Error, and send to String controller MCU	Pass
7.2 Analog I/O	-	-	-
7.2.1 A/D and D/A-convertor	Fault conditions specified in Cl. H.27	Compare the ADC sample values of the reference voltages periodically. In error condition, set system Error, and send to String controller MCU	Pass
7.2.2 Analog multiplexer	Wrong addressing	N/A No such part	N/A
9. Custom chips e.g. ASIC, GAL, gate array	Any output outside the static and dynamic functional specification	N/A No such part	N/A

- End of Test Report -