



IECEX Test Report Cover

ATEX Assessment Report Cover



IECEX ExTR Reference Number.....	See Report No. above.	
ATEX Assessment Report Number.....	See Report No. above.	
Free Reference Number.....	228412900	
Compiled by + signature (ExTL)	A. Hadak	
Reviewed by + signature (ExTL).....	B.P.O. Meijer (Ex i part) H.J.G. de Wild (Ex d part)	
Approved by + signature..... on behalf of the bodies listed below	R. Schuller	
Date of issue (yyyy-mm-dd).....	2024-06-19	
Ex Testing Laboratory (ExTL).....	DEKRA Certification B.V.	
Address.....	Meander 1051, 6825 MJ Arnhem, The Netherlands	
IECEX Certification Body (ExCB)	DEKRA Certification B.V.	
Address.....	Meander 1051, 6825 MJ Arnhem, The Netherlands	
ATEX Notified Body (0344).....	DEKRA Certification B.V.	
Per Annex III (EU-Type Examination) or Annex IX (Unit Verification)		
Address	Meander 1051, 6825 MJ Arnhem, The Netherlands	
Applicant's name.....	RIKEN KEIKI Co., Ltd.	
Address	2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan	
Standards associated with this report package	IEC 60079-0 : 2017 (Ed. 7.0) IEC 60079-1 : 2014 (Ed. 7.0) IEC 60079-11 : 2011 (Ed. 6.0)	
Clauses considered.....	All clauses considered	
Test Report Form Number.....	DEKRA form 256, based on ExTR Cover_9 (released 2021-09)	
Related Amendments, Corrigenda or ISHs.....	For ExTAG Decision Sheets see the individual report parts For IEC and ISO Corrigenda, Amendments and Interpretation Sheets see the overview in this IECEX Test Report Cover For EN Corrigenda, Amendments and Interpretation Sheets see the ATEX Assessment Report of National Differences EU (ATEX)	
Test item description	Portable gas monitor	
Model/type reference.....	GX-6000 and GX-6100	
Code (e.g. Ex __ II__ T__)	Ex ia IIB T4...T3 Ga Ex da ia IIB T4...T3 Ga See General Product Information for details.	
Rating	Battery operated. BUL-6000/6100 (rechargeable Li-ion battery unit) or BUD-6000/6100 (Alkaline battery unit). For BUD- 6000/6100: use only Toshiba LR6T(JE) or Duracell MN1500 AA- batteries. Both battery units can be installed into GX-6000 and GX-6100.	

Report Package Contents

Assembled Report parts and additional reference material:

Report No. NL/DEK/ExTR24.0017/00 Cover
Report No. NL/DEK/ExTR24.0017/00 IEC 60079-0
Report No. NL/DEK/ExTR24.0017/00 IEC 60079-1
Report No. NL/DEK/ExTR24.0017/00 IEC 60079-11 including Appendix A and Appendix B to F
Report No. NL/DEK/ExTR24.0017/00 National Differences EU (ATEX)
Report No. NL/DEK/ExTR24.0017/00 Appendix A; Description of the Test item
Annex 1 to Report No. NL/DEK/ExTR24.0017/00; Electrical data, Type designation and Ex code
Report No. NL/DEK/ExTR24.0019/00 Appendix B; Description of the Tests
Report No. NL/DEK/ExTR17.0047/01 Appendix B; Description of the Tests
Report No. NO/PRE/ExTR15.0012/06

Note: An * is included before the title of documents that are new or revised at an up- issue of the report.

Manufacturer's name..... : Same as Applicant
 Address..... : Same as Applicant
 Trademark..... :

**Particulars: Test item vs. Test requirements**

Equipment classification of installation and use : Portable (Hand-held)
 Ingress protection : IP20
 Rated ambient temperature range (°C) : -20 °C to +50 °C

General remarks:

The test results presented in this report package relate only to the item or product tested.

- "(See Attachment #)" refers to additional information appended to this report package.
- "(See appended table)" refers to a table appended to the report package.
- Throughout this report package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of a report package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an report Cover.*

The technical content of this report package shall not be reproduced except in full without the written approval of the issuing Body and Ex Testing Laboratory.

Use of uncertainty of measurement for decisions on conformity (Decision rule):

No decision rule is specified by the standards associated with this ExTR package, when comparing the measurement result with the applicable limit according to the specification in these standards. The decisions on conformity are made without applying the measurement uncertainty as described in IECEx OD 012 (i.e. "simple acceptance" decision rule, previously known as "accuracy method").

General product information:

The portable battery-operated handheld gas monitors GX-6000 and GX-6100 are used for measuring flammable gas concentration in hazardous location.

Different battery units may be used, BUL-6000/6100 (rechargeable Li-ion battery) and BUD-6000/6100 (alkaline dry battery). Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas.

Following parts are also included in the investigation, charger module BC-6000 or SDM-6000, Combustible gas sensor, Toxic gas sensor and Oxygen sensor, Smart sensor type DES, ESS, PIS, SHS & OSS.

Ambient temperature range for use: -20 °C to +50 °C

Ambient temperature range during charging: 0 °C to +40 °C (Non-hazardous area only)

For more information about Type designation and Ex code see Annex 1 to this report.

The examination of the portable gas monitor does not include a judgment of the functional performance of the equipment.

Report history:

Report	Free Reference Number
NL/DEK/ExTR24.0017/00	228412900

Copy of Marking Plate:

See technical documents M4-4777-33-05K and M4-4777-33-07K.

GX-6000 and 6100, label A, B, C and D

GX-6000(LABEL A)

MODEL GX-6000

INST.No.

RIKEN KEIKI Co., Ltd.

2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

BUL-□(LABEL B)

MODEL BUL-□

INST.NO.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,

Itabashi-ku, Tokyo, 174-8744, Japan

WARNING

Do not charge battery in haz.loc.

BUD-□(LABEL C) □:6000 OR 6100

MODEL BUD-□

INST.NO.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,

Itabashi-ku, Tokyo, 174-8744, Japan

WARNING Use only battery types

LR6T(JE) TOSHIBA or MN1500 DURACELL

GX-6100(LABEL A)

MODEL GX-6100

INST.No.

RIKEN KEIKI Co., Ltd.

2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

BUL-□(LABEL B) □:6000 OR 6100

MODEL BUL-□

INST.NO.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,

Itabashi-ku, Tokyo, 174-8744, Japan

WARNING

Do not charge battery in haz.loc.

BUD-□(LABEL C) □:6000 OR 6100

MODEL BUD-□

INST.NO.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,

Itabashi-ku, Tokyo, 174-8744, Japan

WARNING Use only battery types

LR6T(JE) TOSHIBA or MN1500 DURACELL

GX-6000 and 6100, label D



II 1 G Ex ia IIB T4...T3 Gd

DEKRA 24 ATEX 0016

IECEx DEK 24.0014

-20°C ≤ T_a ≤ +50°C

WARNING

Read manual for safety info.

Do not open in haz.loc.



II 1 G Ex da IIB T4...T3 Gd
(with NCR-6309)

II 1 G Ex ia IIB T4...T3 Gd
(without NCR-6309)

-20°C ≤ T_a ≤ +50°C

WARNING Do not open in haz.loc.

Read manual for safety info.

DEKRA 24 ATEX 0016 IECEx DEK 24.0014

Details regarding 'trade agent' / 'local assembler' application in accordance with OD 203:

N/A, no 'trade agent' / 'local assembler'.

Testing not fully performed by ExTL staff at the above ExTL address:

This project is transfer project from NO/PRE/ExTR15.0012/06. No new tests have been performed as part of this project. Old performed tests have been assessed and accepted by different IECEx Test reports, references are made in Appendix B (to F) of relevant reports.

National differences considered as part of this evaluation:

For the EU, ATEX: National differences from directive 2014/34/EU and national differences between the applied IEC and EN standards were assessed and reported in the part "National differences for ATEX" of this report.

Specific Conditions of Use:

None.

Routine tests:

N/A

Date(s) of performance for all testing:

See all 3 reports Appendix B for dates of performed tests (part IEC 60079-11 has Appendix B to F).

Copyright © 2021 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Technical Documents

No.	(*)	Title:	Document No.:	Rev.	Date:
1.		INDEX GX-6000 (documents 1 up to 53).	E3-6991-5470-70-01K	16	2024.6.13
2.		INDEX GX-6100 (documents 1 up to 58).	E3-6991-5470-70-02K	10	2024.6.13

Note: An * is included before the title of documents that are new or revised at an up- issue of the report.

Corrigenda, Amendments and Interpretation Sheets			
Decision	Requirement – Test	Result – Remark	Verdict

IEC 60079-0: 2017 (Edition 7.0)			
IEC 60079-0 : 2017 COR1 : 2020	cl. 26.5.1.1 Temperature tests shall be done in still ambient air and shall be linearly corrected for the rated ambient temperature	Temperature tests are not done for this project. Previous performed test are done in still ambient air and final results, ΔT , was linearly corrected for the rated ambient temperature. See report part 60079-0.	Pass
IEC 60079-0 : 2017 ISH1 : 2019	cl. 16.6. internal air temperature may represent other temperatures of electrical machines	The internal air temperature is not taken as a representation of other temperatures.	N/A
IEC 60079-0 : 2017 ISH2 : 2019	cl.29. marking of Equipment which includes both an electrical part and a non-electrical part shall have combined marking	The Equipment includes only electrical parts	N/A

IEC 60079-1 : 2014 (Edition 7.0)			
IEC 60079-1 : 2014 / COR1 : 2018	C.2.3.3 the text at bullet point d) is deleted, bullet point e) is renumbered to bullet point d)	No NPT threaded flameproof entry devices in the scope.	N/A
IEC 60079-1 : 2014 / ISH1 : 2020	cl. 13.1: The restriction to NPT and M threaded entries is a major technical change	No entries provided	N/A
	Annex C: a thread adapter fitted and assessed as factory assembled part may use other thread than NPT and M	No factory assembled thread adapter with other thread than NPT and M applied	N/A
	cl. 13: blanking elements may be installed in factory assembled thread adapter(s)	The equipment has no blanking elements mounted in factory assembled thread adapter(s).	N/A
	cl. 13 when factory assembled thread adapter are applied, the thread of the field wiring side shall be identified	No factory assembled thread adapter applied	N/A

IEC 60079-11 : 2011 (Edition 6.0)			
IEC 60079-11 : 2011 C1 : 2012	Table 1 cl. 26.4.4 changed Table 3 8 th footnote changed Fig 1b changed cl. 8.2.3 4 th paragraph changed cl. 12.1 5 th , 6 th and 8 th paragraph changed Fig. D.3a changed Fig. G.1 changed	Corrigendum taken into account. For details see EXTR 60079-11	Pass
IEC 60079-11 : 2011 / I-SH 01 : 2014	Significant changes compared to Edition 5	This overview of changes is not used for a gap analysis. The reported assessment covers all actual requirements in the standard.	N/A
IEC 60079-11 : 2011 ISH2 : 2016	clause 6.2.5 clarified. IEC 60079-11 is not applicable for voltage limitation to guarantee U_m .	This interpretation sheet is mainly for the end user and not for the assessment of the product.	N/A

Corrigenda, Amendments and Interpretation Sheets			
Decision	Requirement – Test	Result – Remark	Verdict
IEC 60079-11 : 2011 ISH3 : 2016	guide for level of protection "ic" evaluations	"ic" not applied	N/A
IEC 60079-11 : 2011 / ISH4 : 2019	cl. 6.1.3. group III enclosures	Not group III	N/A
IEC 60079-11 : 2011 / ISH5 : 2019	Table 4 - group III with component(s) immersed in dust	Not group III	N/A
IEC 60079-11 : 2011 / ISH6 : 2019	cl. 10.5.3 b) current limiting devices to be disabled at the determination of the surface temperature of cells.	Only cells are used for testing. See Report Part 60079-11, Appendix C.	Pass



Report
IEC 60079-0
Explosive atmospheres –
Part 0: Equipment – General requirements



Report Number	See Report No. above.
Free Reference Number.....	See report cover. <i>Aya Hadak</i>
Compiled by + signature (ExTL)	A. Hadak
Reviewed by + signature (ExTL).....	B.P.O. Meijer (Ex i part) <i>[Signature]</i> H.J.G. de Wild (Ex d part) <i>[Signature]</i>
Date of issue (yyyy-mm-dd)	2024-06-19
Ex Testing Laboratory (ExTL).....	DEKRA Certification B.V.
Address	Meander 1051, 6825 MJ Arnhem, The Netherlands
Applicant's name.....	See report cover.
Address	See report cover.
Standard	IEC 60079-0 : 2017, Edition 7.0
Test procedure.....	IECEX System
Test Report Form Number.....	See footer, based on ExTR60079-0_7D_DS (released 2021-12)

Copyright © 2021 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEX System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEX System is acknowledged as copyright owner and source of the material. The IECEX system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item..... : N/A
- test item does meet the requirement : Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Report shall not be reproduced except in full without the written approval of the Issuing Body and Ex Testing Laboratory.

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
1 DS 2021/004	Scope	<p>The equipment is intended for standard atmospheric conditions.</p> <p>See Appendix A from report IEC 60079-11 for a detailed description of the Ex i safety concept.</p> <p>See Appendix A for a detailed description of Gas Sensor, Type NCR-6309, "Ex da" type of protection.</p> <p>Gas sensor is tested in previous projects and results are reported in Appendix B of reports: NL/DEK/ExTR24.0019/00 and NL/DEK/ExTR17.0047/01. Relevant reports are listed in Report Package Contents.</p>	Pass
2	Normative references		
3 DS 2020/002	Terms and definitions		
4	Equipment grouping		
4.1	General	The equipment is intended for group II.	Pass
4.2	Group I	This equipment is not intended for group I.	N/A
4.3	Group II	This equipment is intended for use in group II, subdivision IIB.	Pass
4.4	Group III	This equipment is not intended for group III.	N/A
4.5	Equipment for a particular explosive atmosphere	This equipment is not intended for use in a particular explosion atmosphere.	N/A
5 DS 2016/002 DS 2015/011A	Temperatures		
5.1	Environmental influences		
5.1.1	Ambient temperature	The ambient temperature range of -20 °C to +50 °C is marked. See drawings M4-4777-33-05K and M4-4777-33-07K.	Pass
5.1.2	External source of heating or cooling	No external source of heating or cooling considered.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
5.2 DS 2020/006	Service temperature	Not required due to exclusion of cl. 7.2 by Table 1 of IEC 60079-11: 2011. For Model GX-6100: Stand by 150 mA / 4.5 V / 675 mW When gas is detected 170 mA / 4.5 V / 810 mW (maximum power). $\Delta T = 8 \text{ K}$, $T_{\text{service sensor}} = 58 \text{ }^{\circ}\text{C}$ For tests see B.3.1 in report part IEC 60079-11.	Pass

5.3	Maximum surface temperature		
5.3.1	Determination of maximum surface temperature	Maximum surface temperature is considered taken into account requirements of thermal ignition compliance of cl. 5.6 of IEC 60079-11. Evaluation documented in Appendix A.3 & B.3 of associated IEC 60079-11. Maximum surface temperature for Ex da Gas Sensor taking into the consideration results of thermal tests of IEC 60079-1 and $\Delta T = 8 \text{ K}$. $T_{\text{max surface}} = 58 + 10.1 = 68.1 \text{ }^{\circ}\text{C}$ ($< 130 \text{ }^{\circ}\text{C}$ for T4) See report part 60079-1, cl. 15.4.3.2.	Pass
5.3.2	Limitation of maximum surface temperature		
5.3.2.1	Group I electrical equipment	This equipment is not intended for group I.	N/A
5.3.2.2	Group II electrical equipment	$T_{\text{max surface}}$ does not exceed the limit for temperature class T4... T3 per table 2 with the 5 K margin per cl. 26.5.1.3 taken into account.	Pass
5.3.2.3	Group III electrical equipment	This equipment is not intended for group III.	N/A
5.3.3	Small component temperature for Group I or Group II electrical equipment	See Appendix A.3 in part IEC 60079-11 for details.	Pass
5.3.4	Component temperature of smooth surfaces for Group I or Group II electrical equipment	Not applied.	N/A

6	Requirements for all electrical equipment		
---	-------------------------------------------	--	--

6.1	General	The equipment complies with the requirements of this standard and IEC 60079-1 and IEC 60079-11. Compliance with the relevant industrial standards is the manufacturer responsibility.	Pass
-----	---------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------

6.2	Mechanical strength of equipment	For "ia": Excluded by table 1 of IEC 60079-11. The gas sensor, Type NCR-6309, is protected from impact by enclosure parts which are considered as "guard".	Pass
-----	----------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------	------

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
6.3	Opening times	For “ia”: Excluded by table 1 of IEC 60079-11. Sensor, Type NCR-6309, cannot be opened.	N/A
6.4	Circulating currents in enclosures (e.g. of large electric machines)	This equipment is not a large electric machine.	N/A
6.5	Gasket retention	For “ia”: Excluded by table 1 of IEC 60079-11. Sensor, Type NCR-6309, cannot be opened, Ex protection doesn't rely on the gasket.	N/A
6.6	Electromagnetic and ultrasonic energy radiating equipment		
6.6.1	General	Energy levels do not exceed the levels as stated in the standard, see remarks below.	Pass
6.6.2	Radio frequency sources	The equipment does not contain radio frequency sources.	N/A
6.6.3	Ultrasonic sources	The equipment does not contain ultrasonic sources.	N/A
6.6.4 DS 2018/004	Lasers, luminaires, and other non-divergent continuous wave optical sources	The lamp OL-8270BPA is separately Ex certified, assessment is documented in test report NL/DEK/ExTR12.0033. See Appendix D in associated IEC60079-11 test report.	Pass
7	Non-metallic enclosures and non-metallic parts of enclosures		
7.1	General		
7.1.1	Applicability	For “ia”: Excluded by table 1 of IEC 60079-11. (plastic materials from gas detector are relevant only for electrostatic) Enclosure of the gas sensor, Type NCR-6309, made from two plastic parts with - cemented joint (in between).	Pass
7.1.2	Specification of materials		
7.1.2.1	General	The materials are specified see technical document M2-4777-33-01K for gas detector and M3-4463-10-02K for gas sensor.	Pass
7.1.2.2	Plastic materials	Gas Sensor, Type NCR-6309, enclosure: a) DIC Corporation b) PPS FZ1130-D5 (PPS GF30%), natural color. c) no surface treatment d) RTI: +130 °C e) N/A (not exposed to UV)	Pass
7.1.2.3	Elastomers	There are no elastomers relevant for the type of protection.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
7.1.2.4	Materials used for cementing	<p>Sensor, Type NCR-6309:</p> <p>The joints between the in-casted breather and the Cap and between the electrical contacts and Base are cemented joints.</p> <p>Since the joints are formed by injection molding (from the same material as enclosure) the molding parameters are relevant (specified in drawing M3-4463-10-02K). See 7.1.2 for details.</p> <p>Cementing is not used for the external enclosure.</p>	Pass

7.2	Thermal endurance	See cl. 7.1.1.	Pass
7.2.1	Tests for thermal endurance	See cl. 26.8 and 26.9	Pass
7.2.2	Material selection	All materials used for the sensor (plastic and cement) are rated for the minimum service temperature and the maximum service temperature +20 K or better.	Pass
7.2.3	Alternative qualification of elastomeric sealing O-rings	The alternative qualification is not used.	N/A

7.3	Resistance to ultraviolet light	<p>For “Ia”: Excluded by table 1 of IEC 60079-11.</p> <p>Sensor, Type NCR-6309, protected from UV by detectors enclosure.</p>	Pass
-----	---------------------------------	-------------------------------------------------------------------------------------------------------------------------------	------

7.4	Electrostatic charges on external non-metallic materials		
7.4.1	Applicability	Applicable non-metallic materials: - enclosure	Pass
7.4.2	Avoidance of a build-up of electrostatic charge for Group I or Group II	<p>Electrostatic charging is avoided by selection of the material and limitation of the surface.</p> <p>Material ESC9448N & LCD panel sheet PET 300R or PET84. Sensor cover made of PC LNP STAT-LOY D3000IEU6-4G7B1971. All material have surface resistance of less than 1 GΩ. See measurement section of this report and cl. 26.13. All smaller parts of regular plastic material have surface area less than 400 mm².</p> <p>Refer to drawing M2-4777-01-01K.</p>	Pass
7.4.3	Avoidance of a build-up of electrostatic charge for Group III	This equipment is not intended for group III.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
7.5	Attached external conductive parts	Small accessible metal parts exist but enclosure's conductive plastic materials are used so the mentioned parts are not isolated. However small metallic parts are considered to represent not more than 3 pF. Clip: To attach the EUT to person s clothes. The clip itself is mounted to conductive plastic material. Discharges to approaching earthed objects are not expected as it is attached to a person.	Pass
8	Metallic enclosures and metallic parts of enclosures		
8.1	Material composition	The manufacturers documents specify the materials.	Pass
8.2	Group I	This equipment is not intended as group I equipment.	N/A
8.3	Group II	Small parts of stainless steel material used such as air inlets. Less than 10 % in total of Al, Mg, Ti & Zr and less than 7.5% in total of Mg, Ti & Zr.	Pass
8.4	Group III	Not Group III equipment.	N/A
8.5	Copper Alloys	No copper alloy enclosure applied.	N/A
9	Fasteners	No fasteners applied.	N/A
10	Interlocking devices	This equipment does not contain interlocking devices.	N/A
11	Bushings	This equipment does not contain bushings.	N/A
12	(Reserved for future use)		
13 DS 2014/001 DS 2021/006	Ex Components	No Ex Components included	N/A
14	Connection facilities	For "ia": Excluded by table 1 of IEC 60079-11. No external connections to gas sensor, Type NCR-6309.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
15	Connection facilities for earthing or bonding conductors	For "ia": Excluded by table 1 of IEC 60079-11. Battery powered equipment.	N/A
16 DS 2017/001	Entries into enclosures	For "ia": Excluded by table 1 of IEC 60079-11. No entries to gas sensor, Type NCR-6309.	N/A
17	Supplementary requirements for electric machines	The equipment is no rotating machine.	N/A
18	Supplementary requirements for switchgear	The equipment does not contain switchgear.	N/A
19	Reserved for future use		
20 DS 2020/007	Supplementary requirements for external plugs, socket outlets and connectors for field wiring connection	The equipment does not contain external plugs, socket outlets or connectors for field wiring connection.	N/A
21	Supplementary requirements for luminaires	The equipment is no and does not contain luminaires.	N/A
22	Supplementary requirements for cap lights and hand lights	The equipment is no and does not contain cap lights and hand lights.	N/A
23	Equipment incorporating cells and batteries		
23.1	General	Refer to associated IEC 60079-11 test report for detailed assessments and testing of battery units. Back-up secondary battery (Seiko SSI MS421R): 1.5 mAh, $R_{int} = 600 \Omega$. The physical dimensions are 4.8 mm (diameter), 2.1 mm (height) and 0.11 g (standard mass). Accepted by evaluation. The cell Panasonic NCR18650GA is tested in NO/PRE/ExTR20.0043/00. Surface temperature measurement tests and electrolyte tests are performed, due to parallel coupling and that the cells are encapsulated. See B.3.5. in report IEC 60079-11.	Pass
23.2	Interconnection of cells to form batteries	BUD-6000 & BUL-6000 units & SR616 button cell assessed. See 23.1 The cell Panasonic NCR18650GA are parallel coupled according to IEC 60079-11.	Pass

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
23.3 DS 2019/002	Cell types	Refer also to associated IEC 60079-11 test report Panasonic NCR18650GA According to table 14: Type system: Lithium ion Positive electrode: (NCA) Li(NiCoAl)O ₂ Electrolyte: Liquid solution Negative electrode: Carbon Voltage: 3.6 V Maximum open circuit voltage: 4.2 V Rated capacity: 2 x3300 mA = 6.6 Ah.	Pass
23.4	Cells in a battery	Refer to associated IEC 60079-11 test report Two identical cells.	Pass
23.5	Ratings of batteries	Refer to associated IEC 60079-11 test report Back-up secondary battery (Seiko SSI MS421R): Charging voltage is 3.1 V. 3.3 V-D3, Vf (0.2V). It charges through 3.1 V and the internal switch of IC5. The battery is protected by the serial resistor RS10 (3 kΩ). Maximum discharge, $I = 3.3 \text{ V} / 3 \text{ k} = 1.1 \text{ mA}$ Charging voltage from datasheet: 2.9 to 3.3 V Maximum discharge from datasheet: 10 mA Range of temperature: -20 °C to +60 °C. Panasonic NCR18650GA: Amb. Temp. discharge: -20 °C to + 60 °C Ambient temperature charge: +10 °C to + 45 °C Ambient temperature for EUT: -20 °C to + 50 °C Max discharge current for the battery is 8 A. Nominal discharge for EUT is: 150 mA Discharge when alarm is activated: 170 mA	Pass
23.6	Interchangeability	Warnings provided. See General product information and Copy of marking plates. For alkaline batteries only Toshiba LR6T(JE) or MN1500 by Duracell (AA size) are allowed to be used. See also 29.13. No other batteries are interchangeable. For BUL-6100 the cells are encapsulated. Interchangeability is not possible.	Pass
23.7	Charging of primary batteries	No charging circuits for dry battery unit BUD-6000.	Pass
23.8	Leakage	Refer to associated IEC 60079-11 test report	Pass
23.9	Connections	Refer to associated IEC 60079-11 test report	Pass

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
23.10	Orientation	Refer to associated IEC 60079-11 test report	N/A
23.11	Replacement of cells or batteries	Warnings provided. See 29.13 and Copy of marking plates and associated IEC 60079-11 test report.	Pass
23.12	Replaceable battery pack	BUL- battery pack.	Pass
24	Documentation	The documents listed in the report Cover give a full and correct specification of the explosion safety aspects.	Pass
25	Compliance of prototype or sample with documents	The samples used for testing comply with the documents.	Pass
26 DS 2017/005	Type tests		
26.1	General	Tests have been carried out, See Appendix B in report part IEC 60079-11 of this report and Appendix B of reports: NL/DEK/ExTR24.0019/00 and NL/DEK/ExTR17.0047/01.	Pass
26.2	Test configuration	Most unfavourable test configuration was tested, see all Appendix B reports.	Pass
26.3	Tests in explosive test mixtures	Tests in explosive mixtures have been carried out, See Appendix B of reports: NL/DEK/ExTR24.0019/00 and NL/DEK/ExTR17.0047/01.	Pass
26.4	Tests of enclosures		
26.4.1	Order of tests		
26.4.1.1	Metallic enclosures, metallic parts of enclosures and glass parts of enclosures	See 26.4.1.2.	N/A
26.4.1.2	Non-metallic enclosures or non-metallic parts of enclosures		
26.4.1.2.1	General	Excluded by Table 1 of IEC 60079-11: 2011 except for the drop test. IP20 required	N/A
26.4.1.2.2	Group I equipment	The equipment is not intended for group I.	N/A
26.4.1.2.3	Group II and Group III equipment	See cl. 26.4.1.2.1	Pass
26.4.2 DS 2020/001	Resistance to impact	Impact test is omitted for enclosure but is performed according to the testing of the built-in piezoelectric device, buzzer type BZ-9K. Refer to associated IEC 60079-11 test report.	Pass

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.4.3	Drop test	Equipment is handheld equipment. Two samples were tested. Each of them dropped four times from a height of 1 m to a concrete floor. Ambient temperature was -27 °C. EUT was kept in -27 °C for 24 hours prior to the test. Result: no visible damages to the enclosures. See Appendix B of part IEC 60079-11 and measurement section of this report.	Pass
26.4.4	Acceptance criteria	The equipment passed the tests. For details see Appendix B of part 60079-11.	Pass
26.4.5 See also DS 2012/003	Degree of protection (IP) by enclosures		
26.4.5.1	Test procedure	Requirements of IP20 is checked and recognized for compliance. Higher IP rating is not covered by this investigation.	Pass
26.4.5.2	Acceptance criteria	The equipment passed the tests. See Appendix B and measurement section of this report.	Pass

26.5	Thermal tests		
26.5.1	Temperature measurement		
26.5.1.1	General	Refer to associated IEC60079-11 test report.	Pass
26.5.1.2	Service temperature	For Gas Sensor, Type NCR-6309, $\Delta T = 8 \text{ K}$, see cl. B.3.1 from report part IEC 60079-11. The service temperature is considered to be 58 °C.	Pass
26.5.1.3	Maximum surface temperature	Modified requirements considered. See 5.3.1 and 5.3.3. For detector see Appendix A and B of the IEC 60079-11 report for details. Maximum surface temperature determined to +68.1 °C, for the gas sensor, Type NCR-6309, taking in to the consideration results of the thermal testing x 1.2 (acc. to 60079-1, cl. 15.4.3.2).	Pass
26.5.2	Thermal shock test	For “ia”: Excluded by table 1 of IEC 60079-11. Not applicable for gas sensor, Type NCR-6309.	N/A
26.5.3	Small component ignition test (Group I and Group II)		
26.5.3.1	General	This test was not done, see cl. 5.3.3.	N/A
26.5.3.2	Procedure	This test was not done, see cl. 5.3.3.	N/A
26.5.3.3	Acceptance criteria	This test was not done, see cl. 5.3.3.	N/A

26.6	Torque test for bushings		
26.6.1	Test procedure	This test was not required, see cl. 11.	N/A
26.6.2	Acceptance criteria	This test was not required, see cl. 11.	N/A

26.7	Non-metallic enclosures or non-metallic parts of enclosures		
------	-------------------------------------------------------------	--	--

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.7.1	General	Excluded by Table 1 of IEC 60079-11: 2011. For Gas Sensor, Type NCR-6309, "Ex da" see Appendix B of reports: NL/DEK/ExTR24.0019/00 and NL/DEK/ExTR17.0047/01.	Pass
26.7.2	Test temperatures	Excluded by Table 1 of IEC 60079-11: 2011. For Gas Sensor, Type NCR-6309, "Ex da" see Appendix B of reports: NL/DEK/ExTR24.0019/00 and NL/DEK/ExTR17.0047/01.	Pass
26.8 DS 2020/003	Thermal endurance to heat	Excluded by Table 1 of IEC 60079-11: 2011. For Gas Sensor, Type NCR-6309, "Ex da" see Appendix B of reports: NL/DEK/ExTR24.0019/00 cl. 2.4 and NL/DEK/ExTR17.0047/01 cl. 2.10.	Pass
26.9	Thermal endurance to cold	Excluded by Table 1 of IEC 60079-11: 2011. For Gas Sensor, Type NCR-6309, "Ex da" see Appendix B of reports: NL/DEK/ExTR24.0019/00 cl. 2.5 and NL/DEK/ExTR17.0047/01 cl. 2.11.	Pass
26.10	Resistance to UV light	This test was not required, see cl. 7.3.	N/A
26.11	Resistance to chemical agents for Group I equipment	This equipment is not intended for group I.	N/A
26.12	Earth continuity	This test was not required, see cl. 15.7.	N/A
26.13	Surface resistance test of parts of enclosures of non-metallic materials	See measurement section for more details and results. All material have surface resistance of less than 1 GΩ.	Pass
26.14	Measurement of capacitance	This test was not required, see cl. 7.5.	N/A
26.15	Verification of ratings of ventilating fans	The equipment does not contain ventilating fans.	N/A
26.16	Alternative qualification of elastomeric sealing O-rings	The alternative qualification was not used.	N/A
26.17	Transferred charge test	This test was not required, see cl. 7.4.2.	N/A
27	Routine tests	Routine tests are not required.	N/A
28 DS 2020/002 DS 2021/005	Manufacturer's responsibility	No part of the product evaluation.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
29 DS 2012/005A DS 2017/007 DS 2021/006	Marking		
DS 2021/005	Ex Equipment that includes Ex auxiliary equipment and Ex component	Equipment with Ex auxiliary equipment assessed and marked according to the decision sheet. General product information defines that sensor is designed in “Ex da” type of protection.	Pass
29.1	Applicability	Equipment is marked and complies with the applicable standards.	Pass
29.2	Location	Equipment is legibly marked on the main part.	Pass
29.3	General	The marking includes the following: a) Name of manufacturer b) Type identification c) Serial number d) The certificate number: IECEX: DEK 24.0014 and ATEX: DEKRA 24ATEX0016. e) an advisory marking f) The specific Ex marking per cl. 29.4 g) Additional marking required by other standards See drawings M4-4777-33-05K and M4-4777-33-07K.	Pass
29.4	Ex marking for explosive gas atmospheres	Ex da ia IIB T4...T3 Ga Ex ia IIB T4...T3 Ga See drawings M4-4777-33-05K, M4-4777-33-07K.	Pass
29.5	Ex marking for explosive dust atmospheres	The equipment is not intended for group III.	N/A
29.6	Combined types (or levels) of protection	The symbols of all types of marking are included.	Pass
29.7	Multiple types of protection	No Multiple types of protection applied.	N/A
29.8	Ga equipment using two independent Gb types (or levels) of protection	Equipment does not contain two independent Gb types of protection.	N/A
29.9	Boundary wall	No boundary wall applied.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
29.10 DS 2004/006A DS 2012/006A DS 2012/008	Ex Components	Not applicable for equipment.	N/A
29.11	Small Ex Equipment and small Ex Components	Equipment is not small.	N/A
29.12	Extremely small Ex Equipment and extremely small Ex Components	Equipment is not extremely small.	N/A
29.13	Warning markings	Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information in Cover report. Warning in user manual for Ex d: This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts.	Pass
29.14	Cells and batteries	Properly marked internally.	Pass
29.15	Electric machines operated with a converter	This equipment is not a converter-fed electrical machine.	N/A
29.16	Examples of marking	The examples of marking are informative.	N/A
30 DS 2021/006	Instructions		
30.1	General	The manual (document safety information) contains: - A recapitulation of marking, - Instructions for safety use, - Additional information for use, - A list of standards including the issue date.	Pass
30.2	Cells and batteries	Specific safety instructions are provided with regards to brand & type of battery.	Pass
30.3	Electrical machines	The equipment is no electrical machine.	N/A
30.4	Ventilating fans	Equipment does not contain ventilating fans.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
30.5	Cable glands	The equipment is no cable gland.	N/A

Annex A (Normative) See also DS 2017/001	Supplementary requirements for cable glands	Entry devices are not in the scope and to be selected by the end user.	N/A
-------------------------------------------------------------------	---------------------------------------------	------------------------------------------------------------------------	-----

Annex B (Normative)	Requirements for Ex Components		
Table B.1	Clauses with which Ex Components shall comply	Not applicable for Ex Equipment.	N/A

Annex C (Informative)	Example of rig for resistance to impact test		
--------------------------	----------------------------------------------	--	--

Annex D (Informative)	Electric machines connected to converters		
--------------------------	-------------------------------------------	--	--

Annex E (Informative)	Temperature evaluation of electric machines		
--------------------------	---------------------------------------------	--	--

Annex F (Informative)	Guideline flowchart for tests of non-metallic enclosures or non-metallic parts of enclosures (26.4)		
--------------------------	-----------------------------------------------------------------------------------------------------	--	--

Annex G (Informative)	Guidance flowchart for tests of cable glands		
--------------------------	----------------------------------------------	--	--

Annex H (Informative)	Shaft voltages resulting in motor bearing or shaft brush sparking Discharge energy calculation		
--------------------------	------------------------------------------------------------------------------------------------	--	--

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

Performed tests:

Equipment Tested:	GX-6000 w/ BUD-6000 (2 samples)
Date of Test (yyyy/mm/dd):	2015/01/12 to 2015/01/14
Clause and Standards:	26.4.3 of IEC 60079-0: 2017

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Samples were pre-conditioned in cold chamber with temperature of 30 °C. Conditioning time: from 2015-01-12 time 09.00 to 2015-01-14 time 08.00. The samples were dropped on horizontal concrete surface in the cold chamber. Drop performed four times for each sample in different positions. The samples were functioning normal after test.

Results

No visible damages or scratch

Equipment Tested:	ESC 9448N (black). Middle case and PET 300R. Panel sheet
Date of Test (yyyy/mm/dd):	2014/10/27 and 2015/02/05
Clause and Standards:	26.13 of IEC 60079-0: 2017

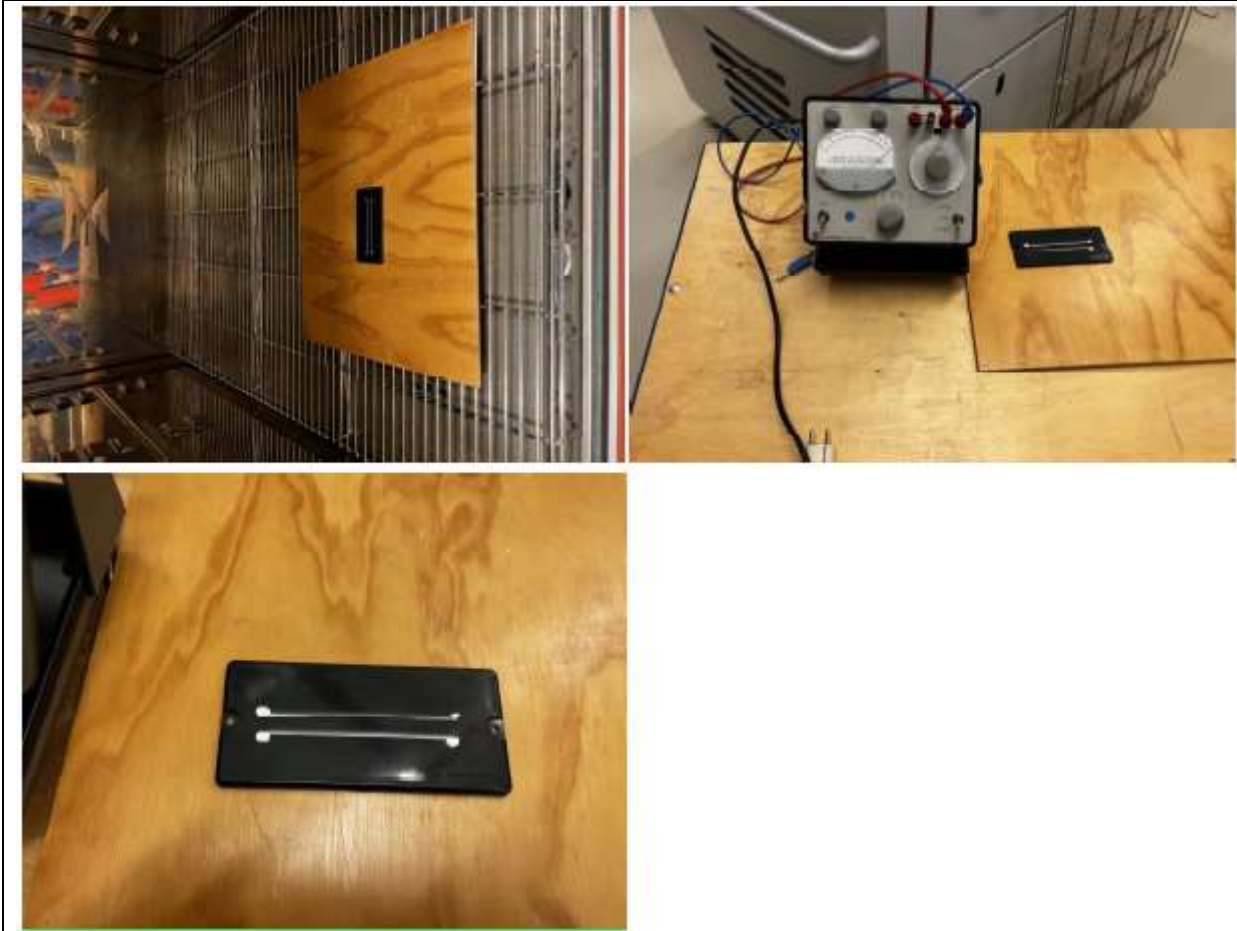
Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Part under test:	Test condition	Results: Pass
ESC 9448N (black). Middle case	24h pre-conditioning: 23.1 °C & 47.8 % RTH. 500 V insulation test in 60 s duration. 10 s rise/fall time. All other smaller parts of regular plastic material are checked for surface area less than 400 mm². Test performed on 2014-10-27	155 Ω (<1 GΩ)
PET 300R. Panel sheet	24h pre-conditioning: 22.4°C & 26.4% RTH. 500V insulation test in 60s duration. 10s rise/fall time. Test performed 2015-02-05	1.3 MΩ (<100 GΩ)

Equipment Tested:	PC LNP STAT-LOY D3000IEU6-4G7B1971 (sensor cover)
Date of Test (yyyy/mm/dd):	2023/10/31 to 2023/11/01
Clause and Standards:	26.13 of IEC 60079-0: 2017

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Part under test:	Test condition and procedure	Results: Pass
PC LNP STAT-LOY D3000IEU6- 4G7B1971	The material is cleaned with distilled water, then with isopropyl alcohol, and then once more with distilled water. Two parallel electrodes of conducting paint are painted on the surface. The EUT is conditioned for 24 hours in 23 °C and 50 % humidity. Testing is carried out under the same ambient conditions. 500 VDC is applied between the two electrodes for 60 seconds and the resistance between them are measured.	0.6 GΩ (<1 GΩ)





Report
IEC 60079-1
Explosive atmospheres – Part 1:
Equipment protection by flameproof enclosures "d"



Report Number..... :	See Report No. above.	
Free Reference Number..... :	See report cover.	
Compiled by + signature (ExTL)..... :	A. Hadak	<i>A. Hadak</i>
Reviewed by + signature (ExTL)..... :	H.J.G. de Wild	<i>H.J.G. de Wild</i>
Date of issue (yyyy-mm-dd)..... :	2024-06-19	

Ex Testing Laboratory (ExTL)..... :	DEKRA Certification B.V.
Address..... :	Meander 1051, 6825 MJ Arnhem, The Netherlands

Applicant's name..... :	See report cover.
Address..... :	See report cover.

Standard..... :	IEC 60079-1 : 2014, Edition 7.0 + C1 : 2018
Test procedure..... :	IECEx System
Test Report Form Number..... :	See footer, based on ExTR60079-1_7B_DS (released 2021-10)

Copyright © 2021 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item..... :	N/A
- test item does meet the requirement..... :	Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing Issuing Body and Ex Testing Laboratory.

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope		
2 DS2010/006A	Normative references		
3 DS 2015/015	Terms and definitions		
4	Level of protection (equipment protection level, EPL)		
4.1	General	The level of protection of this equipment is da. Applicable to catalytic sensor type NCR-6309 only.	Pass
4.2 DS2015/016A	Requirements for level of protection “da”	<p>The sensor assessed is a catalytic sensor to be used in a portable gas detector</p> <ul style="list-style-type: none"> - Internal volume < 1 cm³ - The electrical conductors are potted in the enclosure and assessed for clause 6, -The breather is assessed for clause 10 and casted in the sensor housing, leaving no gap. Both sensor's halves are secured with a metal clamp (caulking cap) around. See drawing M3-4463-10-02K -Supply is by an Ex ia circuit. Maximum dissipated power < 1.3 W (DC 1V, 100 mA) -The non-transmission tests were performed for group IIC with 50 ignitions for each test gas. 	Pass
4.3	Requirements for level of protection “db”	“db” not applied	N/A
4.4	Requirements for level of protection “dc”	“dc” not applied	N/A
5	Flameproof joints		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict

5.1	General requirements	<p>All joints comply with the requirements in Clause 5.</p> <p>An advisory mark is applied see drawing [40] M4-4777-33-07K: "WARNING Read manual for safety info".</p> <p>A limitation is applied in the manual: "This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts."</p> <p>Plastic enclosure, which does not require corrosion protection.</p> <p>For more details see drawing: M3-4463-10-02K.</p>	Pass
-----	----------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------

5.2 DS 2015/018	Non-threaded joints	The multi-step joint between enclosure halves. For details see Appendix A.	Pass
5.2.1	Width of joints (<i>L</i>)	The multi-step joint requirements applied, see cl. 5.2.9 below.	Pass
5.2.2	Gap (<i>i</i>)	The multi-step joint requirements applied, see cl. 5.2.9 below.	Pass
5.2.3 DS 2015/018	Spigot joints	No spigot joints.	N/A
5.2.4	Holes in joint surfaces	No holes in joint surfaces.	N/A
5.2.5	Conical joints	No conical joints.	N/A
5.2.6	Joints with partial cylindrical surfaces (not permitted for Group IIC)	No such joints.	N/A
5.2.7	Flanged joints for acetylene atmospheres	No flanged joint	N/A
5.2.8	Serrated joints	No serrated joints.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
5.2.9	Multi-step joints	<p>The joint 1 between enclosure halves assessed as multi-step joint consists of three adjacent segments where path changes direction two times by 90°.</p> <p>Length of the joint</p> $L_{\min} = 2.65 + 0.48 + 3.35 = 6.48 \text{ mm}$ <p>For details see Appendix A.</p> <p>Tested per clause 15.3 with the length of each segment reduced to not more than 75 %.</p> <p>An advisory mark is applied see drawing [40] M4-4777-33-07K – WARNING Read manual for safety info.</p> <p>A limitation is applied in the manual: "This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts."</p>	Pass
5.3	Threaded joints	No threaded joints	N/A
5.4	Gaskets (including O-rings)	The gasket is no part of the flameproof joint and does not interrupt it.	Pass
5.5	Equipment using capillaries	No capillaries applied.	N/A
6	Sealed joint		
6.1 DS 2015/015 DS 2020/005	Cemented joints		
6.1.1	General	<p>The joints between the in-casted breather and the Cap and between the electrical contacts and Base are cemented joints.</p> <p>Since the joint is formed by injection moulding, the molding parameters are defined on drawing M3-4463-10-02K.</p>	Pass
6.1.2	Mechanical strength	<p>The breather is fixed with a rim on top and under it. The contacts are fixed by their multiturn shape. These joints are not intended to be opened.</p> <p>Overpressure test of the enclosure with cemented joints is performed before and after the tests per IEC 60079-0 and the test result is judged satisfactory.</p> <p>For details see Appendix B of report NL/DEK/ExTR17.0047/01 cl. 3.1 and 3.2.</p>	Pass

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
6.1.3	Width of cemented joints	Internal volume is $\ll 10 \text{ cm}^3$. The width of the cemented joints: Joint 2. Contacts -specified: min. 3.9 mm $> 3 \text{ mm}$ Joint 3. Breather -specified: min. 3.66 mm $> 3 \text{ mm}$ For details see Appendix A.	Pass
6.2	Fused glass joints	No Fused glass joints	N/A
7	Operating rods	No operating rod applied.	N/A
8	Supplementary requirements for shafts and bearings	No shafts and bearings	N/A
9	Light-transmitting parts	No light transmitting part.	N/A
10	Breathing and draining devices which form part of a flameproof enclosure		
10.1	General	Breather device is part of enclosure used for exchange of hazardous atmosphere for gas sampling. Types of breather: pressed metal wire elements The breathing and draining devices withstand the dynamic effects and pressure from an internal explosions and prevent flame transmission as tested per cl. 15 and 16. For details see Appendix B of report NL/DEK/ExTR17.0047/01.	Pass
10.2	Openings for breathing or draining	No such openings.	N/A
10.3	Composition limits	The material is specified in drawing M3-4463-10-02K. The elements of breathing devices comprise of stainless steel only. (Cu content $< 0.1\%$)	Pass
10.4	Dimensions	The dimensions are specified in drawing M3-4463-10-02K. Press metal wire element -diameter: 10 ± 0.1 , thickness: $1.66 \pm 0.1 \text{ mm}$	Pass
10.5	Elements with measurable paths	The sintered metal element has no measurable paths.	N/A
10.6	Elements with non-measurable paths	The elements have a specified max. density and max. pore size and comply with the relevant requirements of Annex B. For details see Annex B.	Pass

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
10.7	Removable devices	The device cannot be dismantled.	N/A
10.8	Mechanical strength	Impact test was waived, see explanation in report IEC 60079-0 cl. 26.4.2. for the impact test.	Pass
10.9	Breathing devices and draining devices when used as Ex components	Breathing devices and draining devices are not used as Ex components.	N/A
11	Fasteners and openings	The Sensor does not have fasteners or openings, it is completely closed with an in-casted breather and cemented electrical contacts.	N/A
12 DS 2012/004	Materials		
12.1	Tests prescribed by Clauses 14 to 16	The equipment withstood the applicable tests in Clauses 14 through 16. For details see Appendix B of reports NL/DEK/ExTR17.0047/00 and NL/DEK/ExTR24.0019/00.	Pass
12.2	Assembly of multiple flameproof enclosures	One flameproof enclosure is used.	N/A
12.3	Intercommunicating enclosure compartments	No intercommunicating compartments.	N/A
12.4	Use of cast iron	No cast Iron used.	N/A
12.5	Use of liquids	No liquids used.	N/A
12.6	Insulating materials for Group I apparatus	The equipment is not intended for Group I.	N/A
12.7	Zinc content	This equipment is not made of zinc or zinc alloy with more than 80% zinc.	Pass
12.8	Copper or copper alloys in explosive gas atmospheres containing acetylene	No copper or copper alloys used.	Pass
13	Entries for flameproof enclosures	No entries into the enclosure	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
14	Verification and tests	This product complies with IEC 60079-0 and this standard. See IEC 60079-0 and Appendix B of report NL/DEK/ExTR17.0047/00 report cl. 3.5 for maximum surface temperature determination.	Pass
15	Type tests		
15.1	General	The required sequence is followed. Breather element and cemented joints were tested as part of previous project, for details about results see Appendix B of NL/DEK/ExTR17.0047/01. Subject of the additional testing was flameproof joint 1 (multi step joint). For details about results see Appendix B of report NL/DEK/ExTR24.0019/00.	Pass
15.2	Tests of ability of the enclosure to withstand pressure		
15.2.1 DS 2021/003	General	The equipment has been tested according to the requirements in clauses 15.2.3 and 15.3. No permanent deformation was observed. The units tested according to clause 15.2.3 was also subjected to the test for flame non-transmission with satisfactory result. For details see Appendix B of reports NL/DEK/ExTR17.0047/01 cl. 3.1, 3.2 and 3.3 and NL/DEK/ExTR24.0019/00 cl. 3.1 and 3.2.	Pass
15.2.2	Determination of explosion pressure (reference pressure)		
15.2.2.1	General	Determination of explosion pressure considered impracticable due to extremely small internal volume of the gas sensor.	N/A
15.2.2.2	Test procedure	See cl. 15.2.2.1 above.	N/A
15.2.2.3	Rotating electrical machines	The equipment is no rotating machine.	N/A
15.2.2.4	Pressure-piling	Clause not applied.	N/A
15.2.2.5	Apparatus intended for use in a single gas	This equipment is not intended to be used in a single specified gas.	N/A
15.2.3	Overpressure test		
15.2.3.1	General	First method (static) is used for the overpressure test.	Pass
15.2.3.2	Overpressure test - First method (static)	Tested acc. value from Table 8 (Relative pressures for small equipment) Volume < 10 cm ³ gas group IIC, for low ambient temperature: - 40 °C: value 1 MPa x 1.45 = 1.45 MPa applied. For details see Appendix B of report NL/DEK/ExTR24.0019/00 cl. 3.1.	Pass
15.2.3.3	Overpressure test - Second method (dynamic)	See clause 15.2.3.1.	N/A
15.3	Test for non-transmission of an internal ignition		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
15.3.1	General	For details see Appendix B of report NL/DEK/ExTR24.0019/00 cl. 3.2.	Pass
15.3.2	Electrical equipment of groups I, IIA and IIB	The equipment is for IIC.	N/A
15.3.3	Electrical apparatus of group IIC		
15.3.3.1	General	Tested by the second method.	Pass
15.3.3.2	First method – Testing by increased test gap	Second method applied.	N/A
15.3.3.3	Second method – Testing by increased pressure	Fifty ignitions (according to cl. 4.2) have been done with each test gas at pre-compression pressure (1.510-1.530 kPa) at normal ambient temperature. The test was satisfactory; the internal ignitions were not transmitted to the test chamber. For details see Appendix B of report NL/DEK/ExTR24.0019/00 cl. 3.2.	Pass
15.3.3.4	Third method – Testing by oxygen enrichment of test gases	Second method applied.	N/A
15.3.3.5	Number of tests for single piece production	The equipment is not a single piece production.	N/A
15.4	Tests of flameproof enclosures with breathing and draining devices		
15.4.1	General	The tests in accordance with 15.4.2 to 15.4.4 were conducted after the impact test. For details see Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.6. Determined maximum test pore size of the breather elements was min. 85 % of the specified maximum bubble test pore size.	Pass
15.4.2	Tests of ability of the enclosure to withstand pressure		
15.4.2.1	General	Additions and modifications made see below.	Pass
15.4.2.2	Replacement of breathing and draining devices	Because of the small size reference pressure measurement is waived.	N/A
15.4.2.3	Overpressure test	The breather is sealed for the overpressure test.	Pass
15.4.3	Thermal tests		
15.4.3.1	Test procedure	Tested per 15.4.4.2, 5 times with both gases, surface temperature measure. Because of the small size of the Sensor ignition on one location. No forced flow. No ventilating or sampling system. See also Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.5.	Pass
15.4.3.2	Acceptance criterion	No continuous burning observed. Temperature increase measured: 8.4 K (with C ₂ H ₂) T _{max surface} = 58 °C + 8.4 x 1.2 = 68.1 °C (<130 °C for T ₄) See also Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.5.	Pass
15.4.4	Tests for non-transmission of an internal ignition		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
15.4.4.1	General	The additions and modifications are made to 15.3	Pass
15.4.4.2	Test procedure	Tested. Because of the small size of the Sensor ignition on one location.	Pass
15.4.4.3	Non-transmission test for breathing and draining devices		
15.4.4.3.1	General	Tested for IIC, with non-measurable paths, tested per 15.4.4.3.3	Pass
15.4.4.3.2	Method A – Testing by increased pressure	See 15.4.4.3.1	N/A
15.4.4.3.3	Method B – Testing by oxygen enrichment of test gases	The non-transmission tests are performed with: 40% H ₂ , 20% O ₂ and N ₂ 10% C ₂ H ₂ , 24% O ₂ and N ₂ See Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.3.	Pass
15.4.4.4	Acceptance criterion	No flame transmission occurred.	Pass
15.5	Tests for “dc” devices	“dc” not applied.	N/A
16	Routine tests		
16.1	General	Routine tests are not required. See cl.16.2	N/A
16.2 DS 2015/015	Enclosures not incorporating a welded construction	The enclosure does not have a welded construction and has an internal volume < 10 cm ³ , so a routine test is not required.	Pass
16.3 DS 2015/015	Enclosures incorporating a welded construction	The enclosure is not a welded construction	N/A
16.4	Bushings not specific to one flameproof enclosure	No such bushing applied.	N/A
16.5 DS 2021/003	Acceptance criteria	See cl.16.2	N/A
16.6	Batch testing	No batch testing required	N/A
17	Switchgear for Group I	The equipment is not intended for Group I.	N/A
18	Lampholders and lamp caps	The product does not include lampholders and lamp caps.	N/A
19	Non-metallic enclosures and non-metallic parts of enclosures		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
19.1	General	The cemented joint complies with cl. 6 (since small leakage through cemented joint, non-transmission test was performed). Flameproof joint (multi step joint) includes two non-metallic faces of the joint.	Pass
19.2	Resistance to tracking and creepage distances on internal surfaces of the enclosure walls	Sensor is supplied by Ex i circuit, see also cl. 4.2.	N/A
19.3	Requirements for type tests	a) Due to small size ref. pressure determination is impracticable. b) Overpressure tests performed on samples after tests per 60079-0, see 15.2.3 c) Non-transmission tests performed on samples after tests per 60079-0, see 15.3.3.4 d) Erosion by flame not required, see 19.4 e) Not required, see above.	Pass
19.4	Test of erosion by flame	The internal volume < 50 cm ³ .	N/A
20	MARKING		
20.1	General	The marking includes 'da'	Pass
20.2	Caution and warning markings	No caution or warning markings required based on the clauses referenced in Table 14.	N/A
20.3	Informative markings	No informative markings applied.	N/A
21	Instructions	The instructions per IEC 60079-0 are assessed in that ExTR part. A limitation is added indicating that the flamepaths are not intended to be repaired.	Pass
Annex A (Normative)	Additional requirements for crimped ribbon elements and multiple screen elements of breathing and draining devices	This equipment has no crimped ribbon elements and multiple screen elements of breathing and draining devices.	N/A
Annex B (Normative)	Additional requirements for elements, with non-measurable paths, of breathing and draining devices		
B.1	Sintered metal elements	The breather is a pressed metal wire element.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
B.2	Pressed metal wire elements		
B.2.1	Construction	Matrix consists of five layers made from different combination of stainless steel wire braid mesh and diameter. (FP100 and FP75) FP100 is test sample, while FP75 is used in product. The pore size of FP100 is larger than FP75. Therefore the maximum pore size of pressed metal wire elements for products is always smaller than for test sample. FP100 and FP75 have same structure other than 2nd layer. Tests performed on FP100 can be used for acceptance of FP75.	Pass
B.2.2	Specifications	The wire diameter and mesh size of each gauze layer is specified. See drawing M3-4463-10-02K. Density of st.st. 316: 7.95 g/cm ³ . The specific density of the breather is 5.2 g/cm ³ . Resulting in a ratio of 0.65. This is accepted since the pressed wire element is also sintered which will give an increase of density.	Pass
B.2.3	Bubble test pore size	Performed on three samples. Design: 139.3 µm. All samples > 85% Test per 15.4.3 performed with 133 µm. See Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.6.	Pass
B.2.4	Density	Performed on 8 pieces being 5.041 g in total. Result: 5.139 g/cm ³ , this is regarded within the margin. See B.2.2 and Appendix B of NL/DEK/ExTR17.0047/01 cl. 3.7.	Pass
B.2.5	Open porosity and or fluid permeability	With the defined and checked pore size and density of the breather the functionality is sufficiently secured.	N/A
B.2.6	Identification	a. Stainless steel SUS316 b. Max. pore size: 139.3 µm c. Min. density: 5.2 g/cm ³ d. Thickness: 1.66 ± 0.1 mm Diameter: 10 mm e. Wire diameter, see B.2.2 f. N/A see B.2.5	Pass
B.3	Metal foam elements	The breather is a pressed metal wire element.	N/A
Annex C (Normative)	Additional requirements for flameproof entry devices	Flameproof entry devices are not in the scope of this assessment. Equipment has no openings.	N/A
Annex D (Normative)	Empty flameproof enclosures as ex components	The enclosure is part of Ex equipment.	N/A
Annex E (Normative)	Cells and batteries used in flameproof “d” enclosures	Battery is part of Ex i protection.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
Annex F (Informative)	Mechanical properties for screws and nuts		
Annex G (Normative) DS 2019/003	Additional requirements for flameproof enclosures with an internal source of release (containment system)	This equipment has no internal source of release (containment system).	N/A
Annex H (Normative)	Requirements for machines with flameproof “d” enclosures fed from converters	This equipment is no machines with flameproof “d” enclosures fed from converters.	N/A
Measurement Section, including Additional Narrative Remarks			N/A



Report
IEC 60079-11 Explosive atmospheres –
Part 11: Equipment protection by intrinsic safety "i"



Report Number..... : See Report No. above.

Free Reference Number : See report cover.

Compiled by + signature (ExTL).... : A. Hadak

Reviewed by + signature (ExTL) ... : B.P.O. Meijer

Date of issue (yyyy/mm/dd) : 2024-06-19

Ex Testing Laboratory (ExTL) : DEKRA Certification B.V.

Address..... : Meander 1051, 6825 MJ Arnhem, The Netherlands

Applicant's name : See report cover.

Address..... : See report cover.

Standard : IEC 60079-11:2011, Edition 6.0

Test procedure : IECEx System

Test Report Form Number..... : See footer, based on ExTR60079-11_6B_DS (released 2021-10)

Copyright © 2021 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : N/A

- test item does meet the requirement..... : Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing Body and Ex Testing Laboratory.

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope		
2 DS 010/006A	Normative references		
3	Terms and definitions		
4	Grouping and classification of intrinsically safe apparatus and associated apparatus	Ex ia IIB T4...T3 Ga	Pass
5	Levels of protection and ignition compliance requirements of electrical apparatus		
5.1	General	Equipment under test (EUT) is portable gas monitor GX-6000, GX-6100 and charger module BC-6000. See General product information. Ex ia Faults as described are applied Refer to Appendix A.1	Pass
5.2	Level of protection "ia"	Refer to Appendix A.1 for details.	Pass
5.3	Level of protection "ib"	Level of protection "ia".	N/A
5.4	Level of protection "ic"	Level of protection "ia".	N/A
5.5	Spark ignition compliance	Refer to Appendix A.2 for details.	Pass
5.6	Thermal ignition compliance		
5.6.1	General	Refer to Appendix A.3 for details.	Pass
5.6.2 DS 2015/016A DS 2015/009	Temperature for small components for Group I and Group II	Refer to Appendix A.3.1 for details.	Pass
5.6.3	Wiring within intrinsically safe apparatus for Group I and Group II	Refer to Appendix A.3.2 for details.	Pass
5.6.4	Tracks on printed circuit boards for Group I and Group II	Refer to Appendix A.3.3 for details.	Pass
5.6.5 DS 2020/006	Intrinsically safe apparatus and component temperature for Group III	Not for Group III.	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
5.7	Simple apparatus	Not simple apparatus	N/A
6	Apparatus construction		
6.1	Enclosures		
6.1.1	General	IP20 based on visual inspection	Pass
6.1.2	Enclosures for Group I or Group II apparatus		
6.1.2.1	General	Complies with table 5	Pass
6.1.2.2	Apparatus complying with Table 5	Refer to Appendix B.4.1 for details. > IP20, EUT is drop tested prior to IP test.	Pass
6.1.2.3 DS 2019/006	Apparatus complying with Annex F	Annex F not applied	N/A
6.1.3	Enclosures for Group III apparatus	Not group III	N/A
6.2	Facilities for connection of external circuits		
6.2.1	Terminals	No external connections other than charging facilities. Charging protection circuit and connection is provided and is evaluated in 7.4.	N/A
6.2.2	Plugs and sockets	No plugs and sockets	N/A
6.2.3	Determination of maximum external inductance to resistance ratio (L_o/R_o) for resistance limited power source	L_o/R_o is not applied	N/A
6.2.4	Permanently connected cable	No cable for external circuits	N/A
6.2.5	Requirements for connections and accessories for IS apparatus when located in the non-hazardous area	Charging is only allowed in non-hazardous area. Charging is evaluated and is documented throughout sub-clauses of 7.4 of this report. The U_m voltage will not take the safety components beyond 2/3 of their ratings.	Pass
6.3	Separation distances		
6.3.1	General	See 6.3.2 to 6.3.14	Pass
6.3.2	Separation of conductive parts	Refer to Appendix B.4.1 for details. Separation distances between different parts of the intrinsically safe circuit. The requirements of this clause are considered during the evaluation of the circuit and layout.	Pass
6.3.2.1	Distances according to Table 5	Refer to Appendix B.4.1 for details.	Pass
6.3.2.2	Distances according to Annex F	Annex F not applied	N/A
6.3.3	Voltage between conductive parts	Voltage of battery units considered. See Appendix A.1 to A.4 for details	Pass
6.3.4	Clearance	No partitions	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
6.3.5	Separation distances through casting compound	Considered for the moulded BUL-6000 (Li-ion battery pack). See also 7.3	Pass
6.3.6	Separation distances through solid insulation	Suitable internal wiring considered. See also above and 6.3.12	Pass
6.3.7	Composite separations	No composite separations considered	N/A
6.3.8	Creepage distance	Refer to Appendix B.4.1 for details.	Pass
6.3.9	Distance under coating	No conformal coating applied	N/A
6.3.10	Requirements for assembled printed circuit boards	a) and b) No conformal coating applied c) Considered in the evaluation of separation distances.	Pass
6.3.11	Separation by earthed screens	No earthed screen	N/A
6.3.12	Internal wiring	See Appendix A.3.2 & B.4 to B.5	Pass
6.3.13	Dielectric strength requirement	Battery powered equipment with non-metallic enclosure. Dielectric strength test is considered to be unnecessary.	N/A
6.3.14	Relays	No relays	N/A

6.4	Protection against polarity reversal	Provided for BUL-6000 & button cell Sony SR616. Appropriate internal markings provided for BUD-6000. See Appendix A.1 to A.4.	Pass
-----	--------------------------------------	-------------------------------------------------------------------------------------------------------------------------------	------

6.5	Earth conductors, connections and terminals	Battery powered equipment. No earthing required.	N/A
-----	---------------------------------------------	--------------------------------------------------	-----

6.6	Encapsulation		
6.6.1	General	See Appendix A.5	Pass
6.6.2	Encapsulation used for the exclusion of explosive atmospheres	BUL-6000 Li-ion battery pack is encapsulated and therefore is exempted from requirements of spark ignition assessment. See Appendix A to C	Pass

7	Components on which intrinsic safety depends		
---	----------------------------------------------	--	--

7.1 DS 2018/005A DS 2004/003	Rating of components	Refer to Appendix A.4 for details. Resistors and zener diodes are used as safety components. The safety factor of at least 1.5 is satisfied.	Pass
---------------------------------------	----------------------	-------------------------------------------------------------------------------------------------------------------------------------------------	------

7.2	Connectors for internal connections, plug-in cards and components	Incorrect connection of battery units is not possible due to the design. Removal or replacement of battery is not allowed in hazardous area. Warnings and adequate markings are provided.	Pass
-----	-------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
7.3	Fuses	A fuse is provided at the input of charger circuit. The charging is only allowed in safe area. This fuse is therefore not required to be encapsulated. See 7.5.2-7.5.3 & 10.6.2 & Appendix A.6	Pass

7.4	Primary and secondary cells and batteries		
7.4.1	General	EUT is powered by batteries. Batteries have therefore several aspects of safety concern. See Appendix B.6 & C.	Pass
7.4.2 DS 2010/003	Battery construction	Adequate protection concept investigated and recognized. See throughout Appendix A to C. Back-up secondary battery (Seiko SSI MS421R) is sealed battery (coin cell). BUL-6100 uses encapsulated 2 cells Panasonic NCR18650GA.	Pass
7.4.3	Electrolyte leakage and ventilation	See Appendix B.6 & C.	Pass
7.4.4	Cell voltages	See throughout Appendix A to C. Alkaline/BUD-6000 $V_{\text{peak open-circuit}}=1.65 \text{ V}$, $V_n=1.5 \text{ V}$ Li-ion/BUL-6000: $V_{\text{peak open-circuit}}=4.35 \text{ V}$, $V_n=3.7 \text{ V}$ Button cell (silver oxide) Sony SR616: $V_{\text{peak open-circuit}}=1.63 \text{ V}$, $V_n=1.55 \text{ V}$ Li-ion/BUL-6100: Positive electrode: (NCA) $\text{Li}(\text{NiCoAl})\text{O}_2$ Electrolyte: Liquid solution Negative electrode: Carbon Voltage: 3.6 V Maximum open circuit voltage: 4.2 V Seiko SSI MS421R: $V_{\text{peak open-circuit}}=3.3 \text{ V}$, $V_n=3 \text{ V}$	Pass
7.4.5	Internal resistance of cell or battery	Test according to cl. 10.5.3 is documented. See Appendix C. Internal resistance (NO/PRE/ExTR20.0043/00): $24 \text{ m}\Omega / 2 = 12 \text{ m}\Omega$ (not used in assessment).	Pass
7.4.6	Batteries in equipment protected by other types of protection	No other types of protection. Only intrinsic safety.	N/A
7.4.7	Batteries used and replaced in explosive atmospheres	The battery shall not be replaced	N/A
7.4.8	Batteries used but not replaced in explosive atmospheres	Proper protection concept provided for charging & discharging. Charger input is based on $U_m=250 \text{ V}$ and is evaluated accordingly. The battery BUL-6100 does not need current-limiting devices to ensure the safety of the battery itself.	Pass

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
7.4.9	External contacts for charging batteries	Complied with option a) of this requirement. Safe circuit using current limiting resistors and blocking diodes provided.	Pass

7.5 DS 2015/007	Semiconductors		
7.5.1	Transient effects	Adequate means of limiting transients provided. See below & Appendix A.6.	Pass
7.5.2	Shunt voltage limiters	By use of fuse F1 and triplicate controllable semiconductors (Field Effect Transistor), the shunt voltage limiters (Q1, Q2, Q3, ZD1, ZD2, ZD3, R1, R2, R3 in charger circuit) are composed and the voltage supplied to the charger circuit is limited. See Appendix A.6	Pass
7.5.3	Series current limiters	D1-D3 are used in line with the components which are described above. See Appendix A.1	Pass

7.6 DS 2016/002 DS 2012/009	Failure of components, connections and separations	Faults per this clause are considered	Pass
-----------------------------------------	----------------------------------------------------	---------------------------------------	------

7.7	Piezo-electric devices	The buzzer is considered. See Appendix A.2.6. Piezo element: Cre-sound FT-27T-3.2A1 Capacitance stated in documentation: $35 \text{ nF} \pm 30 \% = 45.5 \text{ nF}$. The piezo-electric device is infallible connected to 2 x 2 zener diodes (ZD49 to ZD52). Zener value is maximum 16.5 V. $V_F = 0.75 \text{ V}$. Total voltage = 17.25 V. $E = 0.5 \times C \times U^2 = 0.5 \times 45.5 \text{ nF} \times 17.25 \text{ V}^2 = 6.8 \text{ } \mu\text{J} < 50 \text{ } \mu\text{J}$ for IIC	Pass
-----	------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------

7.8	Electrochemical cells for the detection of gases	See Appendix B.6 and Appendix D to F for documented testing of different sensors	Pass
-----	--------------------------------------------------	----------------------------------------------------------------------------------	------

8	Infallible components, infallible assemblies of components and infallible connections on which intrinsic safety depends		
---	-------------------------------------------------------------------------------------------------------------------------	--	--

8.1	Level of Protection "ic"	Level of protection ia.	N/A
-----	--------------------------	-------------------------	-----

8.2	Mains transformers	No mains transformers. Battery powered equipment.	N/A
-----	--------------------	---------------------------------------------------	-----

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
8.3	Transformers other than mains transformers	No transformers in the equipment.	N/A
8.4	Infallible windings	No infallible windings in EUT.	N/A
8.5	Current-limiting resistors	All resistors on which intrinsic safety depends are metal film type. Refer to Appendix A.4 for ratings.	Pass
8.6 DS 2003/003	Capacitors		
8.6.1	Blocking capacitors	No blocking capacitors.	N/A
8.6.2	Filter capacitors	No filter capacitors.	N/A
8.7	Shunt safety assemblies		
8.7.1	General	Minimum two parallel paths of zener diodes used.	Pass
8.7.2	Safety shunts	See 7.5.2 and Appendix A.1 & A.4	Pass
8.7.3	Shunt voltage limiters	See 7.5.2 and Appendix A.1 & A.4	Pass
8.8	Wiring, printed circuit board tracks, and connections	See Appendix A.1 & A.3 & A.4 & B.4 with regards to wiring and PCB	Pass
8.9	Galvanically separating components	No galvanically separating components	N/A
9	Supplementary requirements for specific apparatus		
9.1	Diode safety barriers	Not such apparatus	N/A
9.2	FISCO apparatus	Not such apparatus	N/A
9.3	Handlights and caplights	Not such apparatus	N/A
10	Type verifications and type tests		
10.1 DS 2013/002	Spark ignition test		
10.1.1	General	Assessment using reference curves and tables Refer to Appendix A.2 for details.	Pass
10.1.2	Spark test apparatus	Assessment using reference curves and tables	N/A
10.1.4	Tests with the spark test apparatus	Assessment using reference curves and tables	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
10.1.5	Testing considerations		
10.1.5.1	General	Assessment using reference curves and tables	Pass
10.1.5.2	Circuits with both inductance and capacitance	Refer to Appendix A.2.4 for details.	Pass
10.1.5.3	Circuits using shunt short-circuit (crowbar) protection	No crowbar protection. However the charger circuit is functioned similarly.	N/A
10.2	Temperature tests	See Appendix A.3 & B.3 & B.6 & C to F for temperature tests and for temperature assessment of small components.	Pass
10.3	Dielectric strength tests	EUT is battery powered. No use of blocking capacitors, optocouplers or transformers.	N/A
10.4	Determination of parameters of loosely specified components	Max voltage of Li-ion batteries during charging has been determined by measuring the voltage of the batteries in BUL-6000 on 10 samples.	Pass
10.5	Tests for cells and batteries		
10.5.1	General	<p>Sony SR616: Appendix C.2, OK, NO/PRE/ExTR15.0012/00</p> <p>Seiko SSI MS421R: 1.5 mAh, $R_{int}=600\ \Omega$, with 3.3 V, max. 5.5 mA. The power is max 20 mW. ΔT is negligible and test is waived.</p> <p>Alkaline/BUD-6000: Appendix C.1, OK, NL/KEM/ExTR08.0019/00 for LR6T(JE), NL/DEK/ExTR13.0075/02 for MN1500</p> <p>Li-ion/BUL-6000: Appendix C.1, OK, NL/KEM/ExTR10.0035/03 for INR18650PB, NL/DEK/ExTR13.0075/00 for US18650VTC3 and INR18650-15M</p> <p>Li-ion/BUL-6100: Appendix C.3, OK, NO/PRE/ExTR20.0043/00 for NCR18650GA</p>	Pass
10.5.2	Electrolyte leakage test for cells and batteries	See Appendix B.6 & C.	Pass
10.5.3	Spark ignition and surface temperature of cells and batteries	See Appendix B.6 & C.	Pass
10.5.4	Battery container pressure tests	Not required, The battery cell is sealed.	N/A
10.6	Mechanical tests		
10.6.1	Casting compound	Casting compound is not used for external surface.	N/A
10.6.2	Determination of the acceptability of fuses requiring encapsulation	No encapsulated fuse	N/A
10.6.3	Partitions	No such partitions	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
10.7	Tests for intrinsically safe apparatus containing piezoelectric devices	Buzzer BZ-9K and Cre-sound FT-27T-3.2A1 are considered. See Appendix A.2.6.	Pass
10.8	Type tests for diode safety barriers and safety shunts	Adequate transient protection provided.	N/A
10.9	Cable pull test	See 6.2.4	N/A
10.10	Transformer tests	No transformers	N/A
10.11	Optical isolators tests	No optical isolator	N/A
10.12	Current carrying capacity of infallible printed circuit board connections	Clause not applied	N/A
11	Routine verifications and tests		
11.1	Routine tests for diode safety barriers		
11.1.1	Completed barriers	Not such apparatus	N/A
11.1.2	Diodes for 2-diode “ia” barriers	Not such apparatus	N/A
11.2	Routine tests for infallible transformers	Not such apparatus	N/A
12	Marking		
12.1	General	Marked according to IEC 60079-0. No intrinsically safe parameters to be marked.	Pass
12.2	Marking of connection facilities	Appropriate internal markings provided for BUD-6000. See Appendix A.1 to A.4.	Pass
12.3	Warning markings	Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information.	Pass
12.4	Examples of marking	The examples of marking are informative.	Pass

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
13	Documentation	According to IEC 60079-0. a) No parameters for entity concept. b) batteries are defined c) Um: 250 V for the battery charger. d) N/A, The battery should be charged with the dedicated defined charger. e) N/A (battery powered). f) N/A g) Ambient temperature is part of certification. h) Annex F is not used.	Pass

Annex A (Normative)	Assessment of intrinsically safe circuits		
A.1	Basic criteria	Applied	Pass
A.2	Assessment using reference curves and tables	Applied	Pass
A.3	Examples of simple circuits	Informative	Pass
A.4	Permitted reduction of effective capacitance when protected by a series resistance	Clause is not used	N/A

Annex B (Normative)	Spark test apparatus for intrinsically safe circuits	Assessment using curves and tables	N/A
------------------------	------------------------------------------------------	------------------------------------	-----

Annex C (Informative)	Measurement of creepage distances, clearances and separation distances through casting compound and through solid insulation		
--------------------------	------------------------------------------------------------------------------------------------------------------------------	--	--

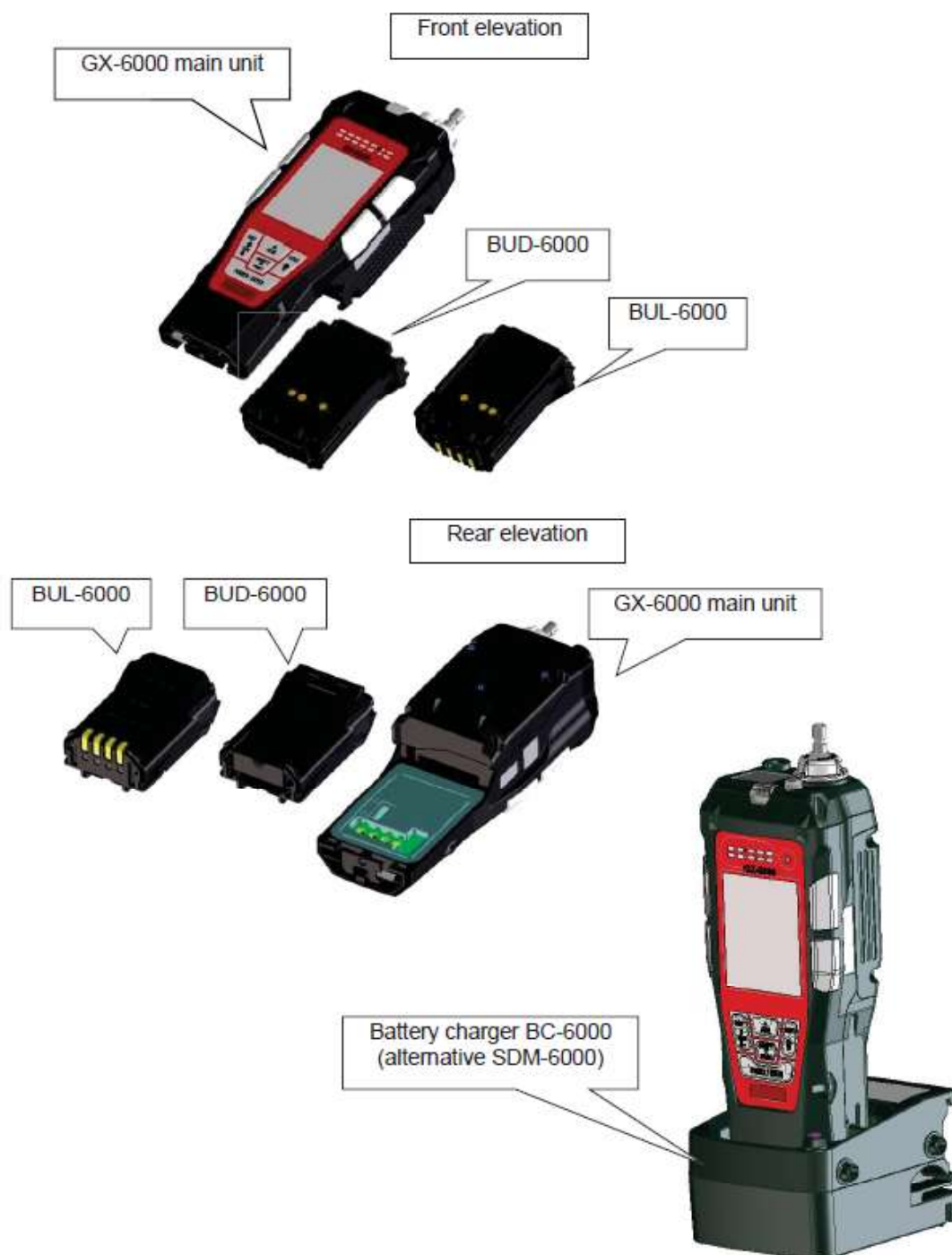
Annex D (Normative)	Encapsulation		
D.1	Adherence	See Appendix A.5	Pass
D.2	Temperature	See Appendix A.5	Pass

Annex E (Informative)	Transient energy test		
--------------------------	-----------------------	--	--

Annex F (Normative)	Alternative separation distances for assembled printed circuit boards and separation of components	Annex F is not used.	N/A
------------------------	----------------------------------------------------------------------------------------------------	----------------------	-----

Annex G (Normative)	Fieldbus intrinsically safe concept (FISCO) – Apparatus requirements	Not for FISCO certification	N/A
------------------------	----------------------------------------------------------------------	-----------------------------	-----

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
Annex H (Informative)	Ignition testing of semiconductor limiting power supply circuits		

Measurement Section, including Additional Narrative Remarks**APPENDIX A: Description of product****A.1 General overview****GX-6000 main unit & Battery unit**

EUT (equipment under test) is the portable gas monitor GX-6000, GX-6100 intended to measure maximum six gases with six sensors.

Standard unit GX-6000 measures four gases with four sensors for general combustible gases (LEL), Oxygen (O₂), Hydrogen Sulfide (H₂S) and Carbon Monoxide (CO).

Other remaining two slots are for Smart Sensors which consist of sensor part and circuit board and are connected with apparatus through digital signal output to various sensors. Four different types of detection principle are applied for Smart Sensors and up to two sensors can be mounted into the GX-6000.

Just like GX-6000, GX-6100 can measure up to six gases with six sensors.

The combustible gas sensor (LEL) for GX-6100 satisfies Ex da requirements. Moreover, Hotwire Semiconductor Sensor can be installed, making it possible to measure a range of combustible gas ppm. And with a Thermal Conductivity Sensor, %VOL of combustible gases can be measured. GX-6100 can measure a range of ppm, LEL, and %VOL of combustible gases with a use of these three sensors. Gas is sampled by a built-in micro pump.

Ambient temperature range for use: -20 °C to +50 °C

Ambient temperature range during charging: 0 °C to +40 °C (Non-hazardous area only)

The battery can be selected between either Li-ion battery or alkaline dry battery. Li-ion battery unit is called BUL-6000/BUL-6100 and alkaline dry battery unit is called BUD-6000/BUD-6100. BC-6000 is battery charger module for both GX-6000 and GX-6100.

Both battery units are designed so replacement can be performed by the end user with no use of tools. However replacement is only allowed in non-hazardous areas. Warnings and safety info are provided.

Electrical data

- Power supply of Li-ion battery unit : BUL-6000

Two parallel connected Li-ion cells used in battery pack BUL-6000 are from type Maxell INR18650PB1 or SDI INR18650-15M or SONY US18650VT3.

- Power supply of Li-ion battery unit : BUL-6100

Two parallel connected Li-ion cells used in battery pack BUL-6100 are from type PANASONIC NCR18650GA.

- $U_m = 250V$.

- Power supply of alkaline battery unit : BUD-6000 and BUD-6100

Powered by three series AA size alkaline batteries, model LR6T(JE) by TOSHIBA or model MN1500 by DURACELL

Description of protection:

BUL-6000 Li-ion battery unit

Two parallel connected Li-ion cells are placed in plastic (PC) case. The case is filled with epoxy resin, or silicon compound. Encapsulation prevent the battery to have any contact with external gases. Nominal battery voltage is 3.7 V and the peak open circuit voltage is 4.35 V according to table 14 of IEC 60079-0. Hence $U_{bat_therm} = 3.7 V$ (for thermal ignition assessment and rating of components),

$U_{bat_spark} = 4.35 V$ (for spark ignition assessment)

This battery unit is charged at less than 4.2 V (CCCV) by the exclusive battery charger BC-6000, alternative SDM-6000. Electronic design of both charger modules are identically. The difference is module's shape/form. Assessments performed for BC-6000 is representative for SDM-6000 module. SDM-6000 is a docking station for charging and calibration for both GX-6000 and GX-6100.

BUD-6000 alkaline battery unit

Three series connected alkaline manganese AA batteries, type LR6T(JE) manufactured by TOSHIBA or model MN1500 by DURACELL. Nominal battery voltage is 1.5 V and the peak open circuit voltage is 1.65 V according to table 13 of IEC 60079-0.

Eventual occurring of battery cell leakage cannot invalidate the creepage distances of the safety components, since no safety components are placed on the battery PCB.

Hence $U_{bat_therm} = 1.5 \times 3 = 4.5 V$, and $U_{bat_spark} = 1.65 \times 3 = 4.95 V$

Backup battery type SR616 manufactured by SONY for type GX-6000 (BAT MS421R for type GX-6100)

The apparatus is legibly marked (ref. drawing M4-4777-01-01K) with the following:

Ex ia IIB T4... T3 Ga

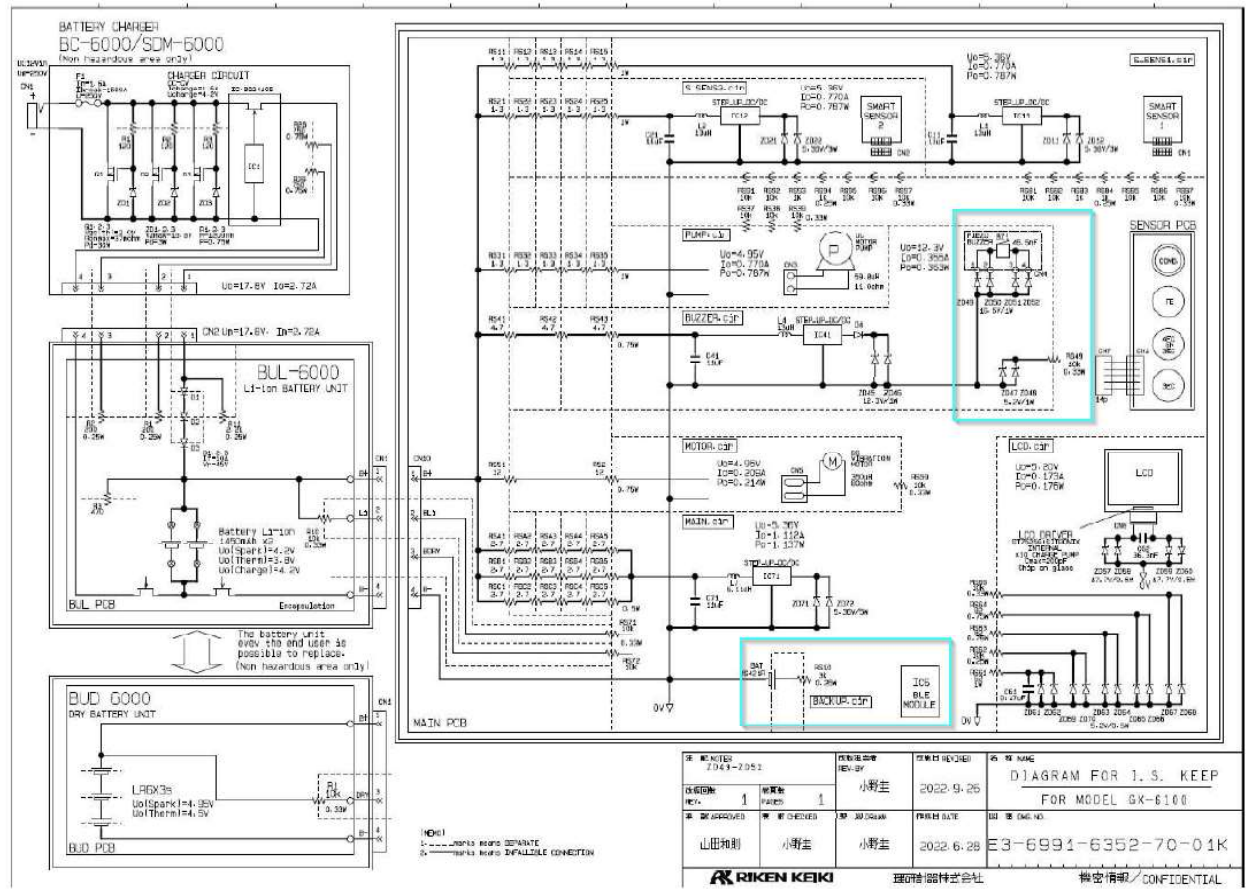
Ex da ia IIB T4... T3 Ga

- Ambient temperature range
- Manufacturers Model/Type designation
- Serial number (coded in INST. No. on the label and explained in the safety information)
- Name of the manufacturer
- IECEx Certificate number
- Read manual for safety info

The instruction manual contains the following warnings:

- Do not charge in hazardous location.
- Do not charge it except by genuine charger.
- Do not replace battery unit in hazardous location.
- Do not replace dry batteries in hazardous location.
- Do not attempt to disassemble or alter the instrument.
- Use only with connected alkaline aa battery, type LR6T(JE) manufactured by TOSHIBA, or type MN1500 manufactured by DURACELL
- The combustible gas sensor NCR-6309, to measure LEL, is the only part of this Gas
- Monitor system with flame - proof construction.
- This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts.
- NCR-6309 must not be exposed to ultraviolet light.
- This product integrates a sensor having flameproof construction.
- If assembly is not performed as specified, explosion protection performance will be compromised. When replacing the sensor and filter, properly install genuine parts and torque to specification.
- The re-adjustment and parts replacement etc including the gas calibration shall be contacted to our nearest agent or RIKEN KEIKI Co., Ltd.

The following block diagrams are demonstrating complete protection concept of EUT, E3-6991-5361-10-01K & E4-6991-5395-80-01K. Refer also to general block diagram document E3-6991-5393-30-01K. See below diagram for I.S. for type GX-6100 with marked in blue changes in reference to type GX-6000.



EUT are divided in following parts, BC-6000/SDM-6000 charger, BUL-6000 (Li-ion) & BUD-6000 (alkaline) battery units & main unit. Main unit consists of Main PCB, Sensor PCB and LCD. They are then divided into following blocks of circuits for assessments, Main circuit including backup-battery, Pump circuit (pump type RP-12), Buzzer circuit (piezoelectric device Buzzer type BZ-9K), Motor circuit (vibration motor type A3BE-MT4), LCD circuit (LCD module type BTD-128160B-FBWB) and Sensor-circuit (S_sen1 and Ssen2 circuits are identical).

Series resistors are used for current and power limitation of the battery and for segregation between the various voltage areas on the main PCB and battery PCB. Several double zener diode combinations are used for voltage limitation of the internal circuits.

By use of triplicate controllable semiconductors (Field Effect Transistor), the shunt voltage limiters (Q1, Q2, Q3, ZD1, ZD2, ZD3, R1, R2, R3 on the Li-ion battery PCB) are composed and the voltage supplied to the charger circuit is limited. This application is considered to be adequate protection in term of limiting transients. Refer to Appendix A.6 for assessments of the charger circuit by which reference voltage for assessments of internal circuits behind the charger circuits is determined to be 4.2 V. And also that fault conditions of charger circuit cause no risk which invalidates the type of protection.

S-SEN1 & S_SEN2 circuits are identical, therefore assessments for Sensor1 circuit are representative for both of S-SEN1 & S_SEN2.

The charger modules BC-6000 & SDM-6000 are included in this investigation and are assessed based on $U_m = 250$ V. The AC/DC power adapter is not part of this investigation.

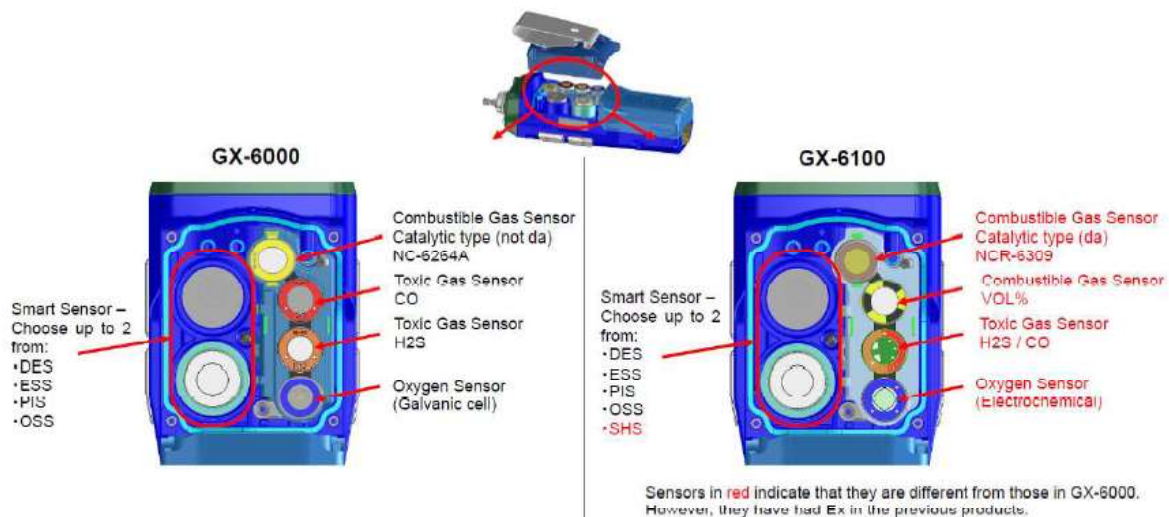
Difference between GX-6000 and GX-6100

Table list of sensors

		GX-6000				GX-6100				
		Measuring gas	Sensor type	Detection principle	Form	Measuring gas	Sensor type	Detection principle	Form	Ex. model Cert.No.
Standard four gas	1	Combustible gas (LEL)	NC-6264A	Catalytic Combustion		Combustible gas (LEL)	R sensor NCR-6309	Catalytic Combustion [da]		GX-Force IECEX DNV 22.0020X DNV 22 ATEX 05201X
	2	Oxygen (O ₂)	Oxygen Sensor	Galvanic cell		Oxygen (O ₂)	R-sensor 3EC	Electro Chemical		GX-Force IECEX DNV 22.0020X DNV 22 ATEX 05201X
	3	Hydrogen Sulfide (H ₂ S)	Toxic gas Sensor	Electro Chemical		Hydrogen Sulfide / Carbon Monoxide (H ₂ S / CO)	R-sensor 4EC	Electro Chemical		GX-Force IECEX DNV 22.0020X DNV 22 ATEX 05201X
	4	Carbon Monoxide (CO)	Toxic gas Sensor	Electro Chemical		Combustible gas (VOL%)	TE-7561	Thermal Conductivity		GX-2012 IECEX DEK 11.0045 DEKRA 11 ATEX 0123
Smart Sensor	5	VOC	Smart Sensor TYPE-PIS	PID		VOC	Smart Sensor TYPE-PIS	PID		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 0171X
	6	Toxic gases	Smart Sensor TYPE-ESS	Electro Chemical		Toxic gases	Smart Sensor TYPE-ESS	Electro Chemical		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 0171X
	7	Carbon Dioxide (CO ₂) or Combustible gas	Smart Sensor TYPE-DES	NDIR		Carbon Dioxide (CO ₂) or Combustible gas	Smart sensor TYPE-DES	NDIR		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 0171X
	8	Oxygen (O ₂)	Smart Sensor TYPE-OSS	Galvanic cell		Oxygen (O ₂)	Smart Sensor TYPE-OSS	Galvanic cell		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 0171X
	9	-	-	-	-	Combustible gas (ppm)	Smart Sensor TYPE-SHS*	Semi Conductor		SP-220 IECEX PRE 15.0060 Presafe 15 ATEX 7188X

* The SH-8861 sensor is installed inside the SHS sensor.

Comparison of sensors in GX-6000 and GX-6100:

- Both GX-6000 and GX-6100 can have a maximum of 6 sensors to be installed.
- Because the combustible sensor for GX-6000 is a catalytic sensor, only IIB is complied. A different sensor will be used in GX-6100 so as to comply IIC. It is used in GX-Force as "Ex da ia".
- Sensors for measurement of O₂ and toxic gases such as CO and H₂S is replaced by improved R sensors. The same sensor is used in GX-Force.
- A thermal conductivity sensor (non-catalytic) which can measure the VOL% range of combustible gas will be additionally installed in GX-6100. The same sensor is used in GX-2012 (IECEX DEK 11.0045).
- For GX-6000, it was possible to install a maximum of 2 Smart Sensors (DES, ESS, PIS, OSS). For GX-6100, in addition to these available sensors, a thermal conductivity sensor (non-catalytic) which measures the ppm range of combustible gas is added to make a choice of 5 sensors out of which up to 2 sensors can be installed. The same sensor used in SP-220 will be installed in SHS.

A.2 Spark ignition considerations

Assessment performed for BUD-6000 only and is representing the least favorable situation with highest U_{bat} . Assessment cover the use of BUL-6000 as well

A.2.1 Resistive spark ignition

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The maximum output voltage U_{o_sens11} available from the battery is 4.95 V.

The maximum voltage from the IC11 (TPS61020 Step-up DC/DC converter) is limited by ZD11, ZD12, to maximum voltage of $U_{o_sens12} = 5.36$ V, which should be taken into account for the spark ignition compliance.

The output current I_{o_sens1} is limited by R_{i_sens1}

$$R_{i_sens1} = (RS11 + RS12 + RS13 + RS14 + RS15) - 1\% = 6.435 \Omega.$$

$$I_{o_sens1} = U_{bat_spark} / (R_{i_sens1}) = 4.95 \text{ V} / 6.435 \Omega = 0.770 \text{ A}.$$

$$P_{o_sensor} = U_{bat_therm}^2 / (4 \times R_{i_sens1}) = 4.5 \text{ V}^2 / (4 \times 6.435 \Omega) = 787 \text{ mW}.$$

Pump circuit (Pump type RP-12)

The maximum output voltage U_{o_pump1} available from the battery is 4.95 V.

The maximum voltage of $U_{o_pump2} = U_{o_main2} = 5.36$ V, which should be taken into account for the spark ignition compliance.

$$R_{i_pump} = (RS31 + RS32 + RS33 + RS34 + RS35) - 1\% = 6.435 \Omega.$$

$$I_{o_pump} = U_{bat_spark} / (R_{i_pump}) = 4.95 \text{ V} / 6.435 \Omega = 0.770 \text{ A}.$$

$$P_{o_pump} = U_{bat_therm}^2 / (4 \times R_{i_pump}) = 4.5 \text{ V}^2 / (4 \times 6.435 \Omega) = 787 \text{ mW}.$$

Motor circuit (Vibration motor type A3BE-MT4)

The maximum output voltage U_{o_motor1} available from the battery is 4.95 V.

The maximum voltage of $U_{o_motor2} = U_{o_main2} = 5.36$ V

$$R_{i_motor} = (RS51 + RS52) - 1\% = 23.76 \Omega.$$

$$I_{o_motor} = U_{bat_spark} / R_{i_motor} = 4.95 \text{ V} / 23.76 \Omega = 0.209 \text{ A}.$$

$$P_{o_motor} = U_{bat_therm}^2 / (4 \times R_{i_motor}) = 4.5 \text{ V}^2 / (4 \times 23.76 \Omega) = 214 \text{ mW}.$$

Buzzer circuit (Buzzer type BZ-9K)

The maximum output voltage $U_{o_buzzer1}$ available from the battery is 4.95 V.

The maximum input voltage U_{i_buzzer} available from main circuit is 5.36 V. However the max voltage is clamped down to 5.2 V by ZD41 to ZD48. Hence, the maximum output voltage $U_{o_buzzer2} = 5.20$ V.

The maximum voltage from the IC41 (TPS61041 Step-up DC/DC converter) is limited by ZD45, ZD46 to maximum voltage of $U_{o_buzzer3} = 12.3$ V

$$R_{i_buzzer} = (RS41 + RS42 + RS43) - 1\% = 13.95 \Omega.$$

$$I_{o_buzzer} = U_{bat_spark} / R_{i_buzzer} = 4.95 \text{ V} / 13.95 \Omega = 0.355 \text{ A}.$$

$$P_{o_buzzer} = U_{bat_therm}^2 / (4 \times R_{i_buzzer}) = 4.5 \text{ V}^2 / (4 \times 13.96 \Omega) = 363 \text{ mW}.$$

Main circuit

The maximum output voltage U_{o_main1} available from the battery is 4.95 V.

The maximum voltage from the IC71 (TPS61020 Step-up DC/DC converter) is limited by ZD71, ZD72.

Hence maximum voltage of $U_{o_main2} = 5.36$ V, which should be taken into account for the spark ignition compliance.

$$R_{i_main} = (RSA1 - RSA5 // RSB1 - RSB5 // RSC1 - RSC5) - 1\% = 4.455 \Omega.$$

$$I_{o_main} = U_{bat_spark} / R_{i_main} = 4.95 \text{ V} / 4.455 \Omega = 1.112 \text{ A}.$$

$$P_{o_main} = U_{bat_therm}^2 / (4 \times R_{i_main}) = 4.5 \text{ V}^2 / (4 \times 4.455 \Omega) = 1137 \text{ mW}.$$

LCD circuit

The maximum input voltage U_{i_lcd1} available from main.cir 5.36 V.

Input 5.36 V from MAIN.circuit to LCD.circuit is clamped down to 5.20 V by ZD61 to ZD68.

Hence, the maximum output voltage $U_{o_lcd1} = 5.20$ V.

The charge pump circuit is built in the LCD driver (ST75256), and the voltage is boosted to a maximum of ± 10 times. The maximum output voltage $U_{o_lcd2} = 5.20 \text{ V} \times 10 = 52.0 \text{ V}$ and -52.0 V .

In order to reduce the voltage of the capacitor C62 in the LCD driver, zeners ZD57 to ZD60 is used.

The maximum output voltage (for C62) $U_{o_lcd3} = 17.7 \text{ V}$ and -17.7 V .

$$R_{i_lcd} = (RS61 // RS62 // RS63 // RS64 // RS65) - 1\% = 24.31 \Omega.$$

$$I_{o_lcd} = U_{bat_spark} / (R_{i_main} + R_{i_lcd}) = 4.95 \text{ V} / (4.455 \Omega + 24.31 \Omega) = 0.173 \text{ A}.$$

$$P_{o_lcd} = U_{bat_therm}^2 / (4 \times (R_{i_main} + R_{i_lcd})) = 4.5 \text{ V}^2 / (4 \times (4.455 \Omega + 24.31 \Omega)) = 176 \text{ mW}.$$

Backup battery (placed on Main PCB)

The maximum open circuit voltage for Silver oxide battery, type SONY SR616, according to table 14 of IEC60079-0 is $U_{backup_spark} = 1.63 \text{ V}$.

Normal voltage according to table 11 of IEC60079-0 is $U_{backup_therm} = 1.55 \text{ V}$ which should be used for thermal analysis and rating of components.

The output current I_{o_backup} is limited by RS10.

The backup battery is protected from charging by diode D7

$$R_{i_backup} = R_{10} - 1\% = 990 \Omega.$$

$$I_{o_backup} = U_{o_backup_spark} / R_{i_backup} = 1.63 \text{ V} / 990 \Omega = 1.7 \text{ mA}.$$

$$P_{o_backup} = U_{backup_therm}^2 / (4 \times R_{i_backup}) = 1.55 \text{ V}^2 / (4 \times 990 \Omega) = 0.7 \text{ mW}.$$

Battery charger circuit (For BUL-6000 only in safe area)

The exclusive chargers of GX-6000 are BC-6000 and SDM-6000.

For power input of battery charger, AC adaptor with 12 Vdc output shall be used. The input of AC adaptor is specified to max 220 Vac but has $U_m = 250 \text{ V}$. A shunt voltage limiting circuit together with a fuse is used as protection from U_m . Fuse $I_n = 1.6 \text{ A}$ is used. The maximum current of charging circuit is limited to $I_{o_charge} = 1.6 \text{ A} \times 1.7 = 2.72 \text{ A}$.

The charge current of the battery is functional limited to 1.5 A by charging control IC during recharge. The battery voltage is limited to 4.2 V by function of charging control IC at recharging. $U_{bat_charge} = 4.2 \text{ V}$.

Ref. drawing no. E3-6991-5361-10-01K

Based on the highest assessed current 1.112 A which max source voltage higher than 5 V is allowed (ref figure A.1 of IEC 60079-11), the result is therefore within the acceptable level.

A.2.2 Inductive spark ignition

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The effective internal inductance is $L_{sens1} = 13 \mu\text{H}$

Based on $I_{o_sens1} = 0.770 \text{ A}$, the maximum allowed inductance is $L = 59.9 \mu\text{H}$ ($L = 2E / I^2 = 2 \times 40 \mu\text{J} / (1.5 \times 0.770 \text{ A})^2$) according to figure A.6 of IEC60079-11.

Pump circuit (Pump type RP-12)

The effective internal inductance of the pump motor is 59.8 μH maximum.

Taken into account the minimum resistance of the motor, the current through the windings is $I_{o_pump} = 4.95 \text{ V} / (6.435 \Omega + 11.0 \Omega) = 0.284 \text{ A}$. The maximum allowed inductance is $L = 440 \mu\text{H}$ ($L = 2E / I^2 = 2 \times 40 \mu\text{J} / (1.5 \times 0.284 \text{ A})^2$).

Motor circuit (Vibration motor type A3BE-MT4)

The effective internal inductance of the vibration motor is 350 μH maximum.

Taken into account the minimum resistance of the motor, through a windings is $I_{o_motor} = 4.95 \text{ V} / (23.76 \Omega + 80 \Omega) = 0.048 \text{ A}$. The maximum allowed inductance is $L = 15622 \mu\text{H}$ ($L = 2E / I^2 = 2 \times 40 \mu\text{J} / (1.5 \times 0.048 \text{ A})^2$).

Buzzer circuit (Buzzer type BZ-9K)

The effective internal inductance is $L_{buzzer} = 13 \mu\text{H}$

Based on $I_{o_buzzer} = 0.355 \text{ A}$, the maximum allowed inductance is $L = 282 \mu\text{H}$ ($L = 2E / I^2 = 2 \times 40 \mu\text{J} / (1.5 \times 0.355 \text{ A})^2$).

Main circuit

The effective internal inductance is $L_{mainr} = 6.11 \mu\text{H}$

Based on $I_{o_main} = 1.112 \text{ A}$, the maximum allowed inductance is $L = 28.7 \mu\text{H}$ ($L = 2E / I^2 = 2 \times 40 \mu\text{J} / (1.5 \times 1.112 \text{ A})^2$).

A.2.3 Capacitive spark ignition

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The effective internal capacitance is $C_{sens1} = 41.2 \mu\text{F}$ (Type-ESS)

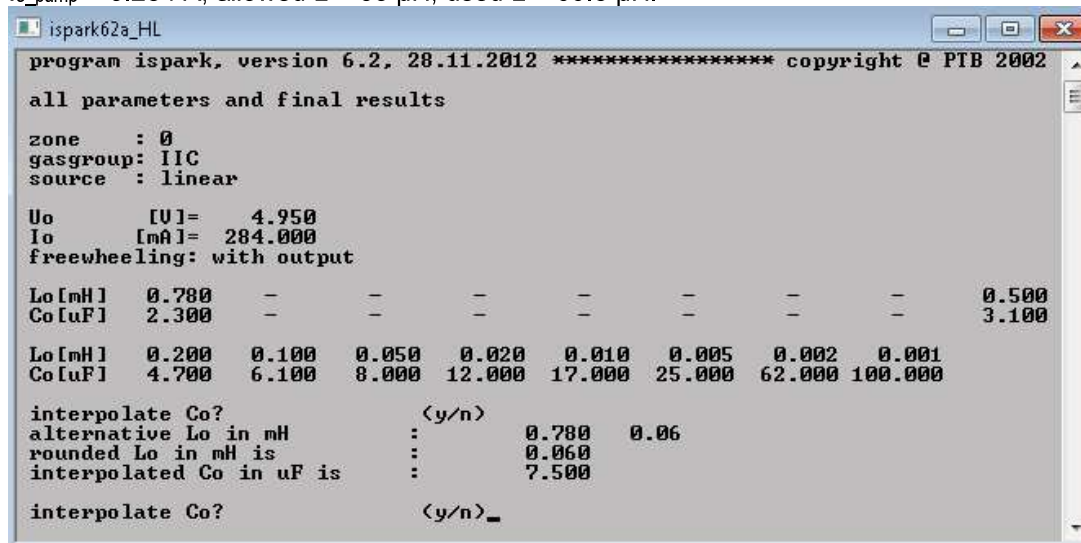
Based on $U_{o_sens12} = 5.36 \text{ V}$, the maximum allowed external capacitance is $C = 65 \mu\text{F}$ (ref. Table A.2 of IEC60079-11. This capacitance in smart sensor1 circuit is effectively separated from the main circuit by RS81 – RS87 (of min 1 k Ω each)

The same values are for Sensor 2 circuit, see schematic [05].

Pump circuit

$U_{o_pump1} = 4.95 \text{ V}$, allowed $C = 7.5 \text{ }\mu\text{F}$, used $C = 5.0 \text{ }\mu\text{F}$.

$I_{o_pump} = 0.284 \text{ A}$, allowed $L = 60 \text{ }\mu\text{H}$, used $L = 59.8 \text{ }\mu\text{H}$.



```

program ispark, version 6.2, 28.11.2012 ***** copyright © PTB 2002

all parameters and final results

zone      : 0
gasgroup: IIC
source    : linear

Uo        [U]=    4.950
Io         [mA]=  284.000
freewheeling: with output

Lo [mH]    0.780  -    -    -    -    -    -    -    0.500
Co [uF]    2.300  -    -    -    -    -    -    -    3.100

Lo [mH]    0.200  0.100  0.050  0.020  0.010  0.005  0.002  0.001
Co [uF]    4.700  6.100  8.000 12.000 17.000 25.000 62.000 100.000

interpolate Co?          <y/n>
alternative Lo in mH      :      0.780  0.06
rounded Lo in mH is      :      0.060
interpolated Co in uF is  :      7.500

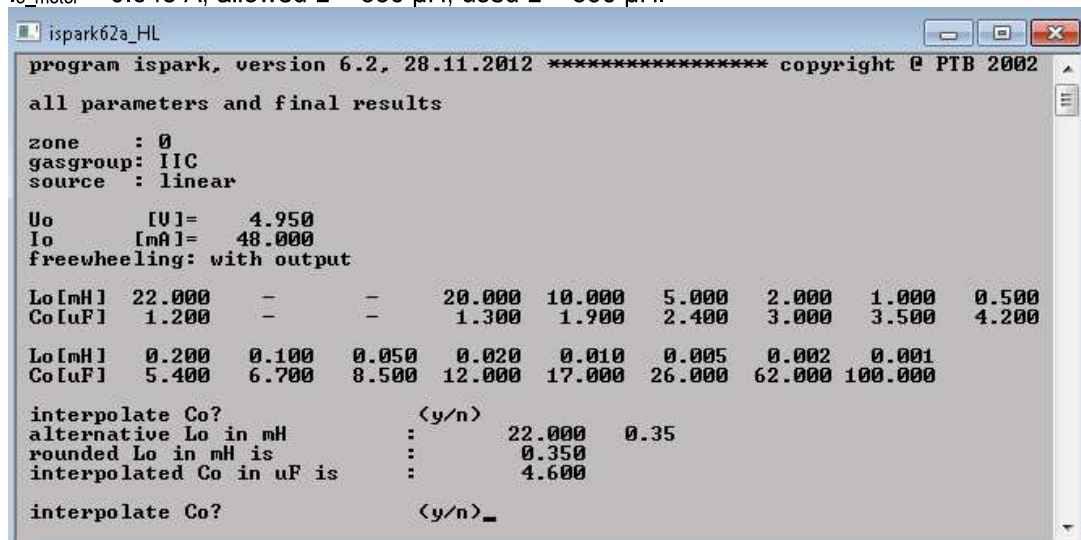
interpolate Co?          <y/n>_
  
```

Isark shows that combination is allowed.

Motor circuit

$U_{o_motor1} = 4.95 \text{ V}$, allowed $C = 4.6 \text{ }\mu\text{F}$, used $C = 2.2 \text{ }\mu\text{F}$

$I_{o_motor} = 0.048 \text{ A}$, allowed $L = 350 \text{ }\mu\text{H}$, used $L = 350 \text{ }\mu\text{H}$.



```

program ispark, version 6.2, 28.11.2012 ***** copyright © PTB 2002

all parameters and final results

zone      : 0
gasgroup: IIC
source    : linear

Uo        [U]=    4.950
Io         [mA]=   48.000
freewheeling: with output

Lo [mH]    22.000  -    -    20.000 10.000  5.000  2.000  1.000  0.500
Co [uF]    1.200  -    -    1.300  1.900  2.400  3.000  3.500  4.200

Lo [mH]    0.200  0.100  0.050  0.020  0.010  0.005  0.002  0.001
Co [uF]    5.400  6.700  8.500 12.000 17.000 26.000 62.000 100.000

interpolate Co?          <y/n>
alternative Lo in mH      :      22.000  0.35
rounded Lo in mH is      :      0.350
interpolated Co in uF is  :      4.600

interpolate Co?          <y/n>_
  
```

Isark shows that combination is allowed.

A.2.6 Other spark ignition considerations

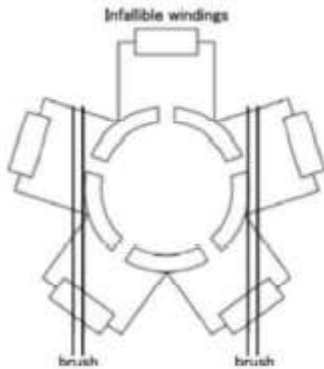
Pump RP-12: (Internal motor of pump type A12B-09-SS)

Pumps are not assessed as infallible windings. However max and min of inductance & resistance is taken into account in assessments of the most severe ignition condition (situation where the winding is disconnected or short-circuited).

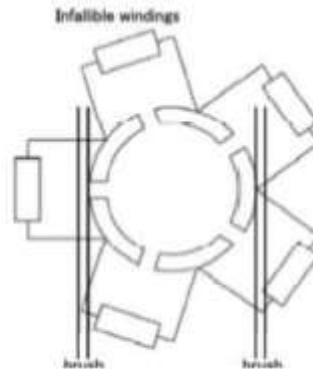
The motor coil resistance is taken as an infallible resistance to protect its inductance. The minimum motor coil resistance and maximum motor coil inductance of A12B-09-SS are as follows:.

case1: one commutator segment active.

case2: two commutator segments active.



Rmin 13.1 Ω / Lmax 59.8 μH



Rmin 11.0 Ω / Lmax 49.8 μH

The range of the motor coil resistance and the motor coil inductance are as follows.

Rmin = 11.0 Ω - 13.1 Ω , Lmax = 49.8 μH - 59.8 μH

The worst value is Rmin = 11.0 Ω and Lmax = 59.8 μH respectively

Vibration motor is assessed as for pump motor by which worst combination of internal inductance and resistance have been considered. See Appendix A.2.1 to A.2.4.

Piezoelectric device:

1) For GX-6000, Buzzer type BZ-9K. Ci = 22 nF @ 30% \rightarrow 28.6 nF

The buzzer is infallible connected to protective zener diodes ZD49, 50, 51 and 52. This is assessed against open circuit failure by the following:

- The infallible connection consists of two wires in parallel. These wires are soldered to a 2 mm track, which is infallible connected to zener diodes ZD49, 50, 51 and 52.
- The buzzer has been verified to comply with IEC 60079-11 clause 10.7 by applying an impact of 1 kg weight dropped from a height of 0.7 m on the outside of the enclosure twice. Test of piezo-electric device type BZ-9K was performed as part of NO/PRE/ExTR15.0012/00. Buzzer wires did not break and the protective components were not affected.
- Spark energy assessment.
 - Voltage across buzzer is clamped by ZD40 to ZD52, $V = 17.5 \text{ V}$ ($V_z + V_f$)
 - $E = \frac{1}{2} \times C \times V^2 = \frac{1}{2} \times 28.6 \text{ nF} \times 17.5 \text{ V}^2 = 4.38 \text{ } \mu\text{J} < 50 \text{ } \mu\text{J}$ (limit for IIC. Ref clause 10.7 of IEC 60079-11: 2011). Buzzer wiring is documented in Appendix A.3.2

2) For GX-6100, Piezo element: Cre-sound FT-27T-3.2A1

Capacitance stated in documentation: 35 nF \pm 30 % = 45.5 nF.

The buzzer has been verified to comply with IEC 60079-11 clause 10.7 by applying an impact of 1 kg weight dropped from a height of 0.7 m on the outside of the enclosure twice. Test of piezo-electric device type Cre-sound FT-27T-3.2A1 was performed 2022.09.16 (not used in evaluation) as part of NO/PRE/ExTR15.0012/05.

The piezo-electric device is infallible connected to 2 x 2 zener diodes (ZD49 to ZD52). Zener value is maximum 16.5 V. $V_F = 0.75 \text{ V}$. Total voltage = 17.25 V.

$$E = 0.5 \times C \times U^2 = 0.5 \times 45.5 \text{ nF} \times 17.25 \text{ V}^2 = 6.8 \text{ } \mu\text{J} < 50 \text{ } \mu\text{J} \text{ (limit for IIC. Ref clause 10.7 of$$

IEC 60079-11: 2011). Buzzer wiring is documented in Appendix A.3.2

A.3 Thermal ignition consideration

A.3.1 Temperature for small components for Group I and Group II

Refer to temperature measurements which are performed and are documented in Appendix B.3.
Only least favorable cases are considered.

A.3.2 Wiring within intrinsically safe apparatus for Group I and Group II

Battery (BUD-6000)

Connection to alkaline batteries by means of a number of spring which have a diameter of 0.6 mm. The maximum permissible current according to table 3 of IEC 60079-11 for temperature class T4 at an ambient of 40 °C for a wire with a diameter of 0.5 mm is 7.7 A and therefore is acceptable for temperature class T4.

Battery (BUL-6000)

Connection to battery units by means of a number of internal spring which have a diameter of 2.5 mm. The maximum permissible current according to table 3 of IEC 60079-11 for temperature class T4 at an ambient of 40 °C for a wire with a diameter of 0.5 mm is 7.7 A and therefore is acceptable for temperature class T4. BUL-6000 is totally encapsulated.

Pump wire

Ref. M4-4181-61-01K Pump RP-12. Information reviewed and recognized. Wire type is UL style 1571 AWG28, max length 48 mm.

Buzzer wire

Ref. E4-6991-5008-70-01K. Information reviewed and recognized. Wire type is UL1571 AWG32, max length 45 mm, two wires in parallel for the connection of the buzzer.

EUT uses in general suitable wiring and connectors.

A.3.3 Tracks on printed circuit boards for Group I and Group II

Suitable PCB used. PCB info are documented in different PCB drawings, e.g. E3-6991-5372-80-01A (Main PCB). Thickness: 1.6 mm. Two layers and multi layers PCB used. CTI : 100 above. Thickness copper film & VIA's : 35 µm. Minimum conductor width : 0.2 mm. Information reviewed and recognized.

A.3.4 Intrinsically safe apparatus and component temperature for Group III

Not group III equipment.

A.4 Rating of components

Series resistors are used for current and power limitation of the battery and for segregation between the various voltage areas on the main PCB and battery PCB. Several double zener diode combinations are used for voltage limitation of the internal circuits. Safety factor ($W1 / W2$) ≥ 1.5 is documented in the tables below.

Component designation	Value	Rating used (W2)	Maximum rating (W1) @ 60 °C	W1 / W2	Calculation
Sensor1_circuit (Same as S_SENS2)					
RS11...RS15	1.3Ω / 1% 1W	0.630 W	1 W	1.58	$P_d = U_{bat_therm}^2 / (RS11...RS15)$ $= 4.5^2 / (1.3 \times 5) - 1\% / 5$
RS81,82,85 RS86,87	10k Ω / 0.5%, 0.33W	2.1 mW	0.33 W	>100	$P_d = U_{bat_therm}^2 / RS81 = 4.5^2 / 10k - 0.5\%$
RS83,84	1k Ω / 1% 0.25 W	21 mW	0.25 W	11	$P_d = U_{bat_therm}^2 / RS83 = 4.5^2 / 1 k - 1\%$
ZD11,12	1SMB5918 Uzmax = 5.36V / 3W Tjmax = 150 °C	0.787 W	1.538 W	1.9	$P_d = P_{o_sens1}$ $R_{th(j-a)} = 33.5 \text{ °C/W}$, $R_{th(j-c)} = 25.0 \text{ °C/W}$, $R_{th(j-a)} = 58.5 \text{ °C/W}$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (150 - 60) / 58.5 = 1.538$
Pump circuit					
RS31...RS35	1.3Ω / 1% 1W	0.630 W	1 W	1.58	$P_d = U_{bat_therm}^2 / (RS31...RS35)$ $= 4.5^2 / (1.3 \times 5) - 1\% / 5$
RS37,38,39	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$P_d = U_{bat_therm}^2 / RS37$ $= 4.5^2 / 10 k - 0.5\%$
Buzzer circuit					
RS41...RS43	4.7Ω / 1% 0.75W	0.484 W	0.75 W	1.54	$P_d = U_{bat_therm}^2 / (RS41...RS43)$ $= 4.5^2 / (4.7 \times 3) - 1\% / 3$
RS47,48,49	10k Ω / 0.5% 0.33W	2.1 mW	0.33 W	>100	$P_d = U_{bat_therm}^2 / RS47$ $= 4.5^2 / 10k - 0.5\%$
ZD41,42,43, ZD44,47,48	KDZ4.7B Uzmax = 5.2V / 1W	0.363 W	0.72 W	1.9	$P_d = P_{o_buzzer}$ $W1 = 0.72W @ 60^\circ C$ (see datasheet Pd-Ta)
ZD45,46	KDZ11B Uzmax = 12.3V / 1W	0.363 W	0.72 W	1.9	$P_d = P_{o_buzzer}$
ZD49,50 ZD51,52	KDZ15B Uzmax = 16.5V / 1W	0.363 W	0.72 W	1.9	$P_d = P_{o_buzzer}$
Motor circuit					
RS51,52	12Ω / 1% 0.75W	0.427 W	0.75 W	1.7	$P_d = U_{bat_therm}^2 / (RS51...RS52)$ $= 4.5^2 / (12 \times 2) - 1\% / 2$
RS59	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$P_d = U_{bat_therm}^2 / RS59$ $= 4.5^2 / 10 k - 0.5\%$
Main circuit					
RSA1...RSA5 RSB1...RSB5 RSC1...RSC5	2.7Ω / 1% 0.5W	0.304 W	0.5 W	1.6	$P_d = U_{bat_therm}^2 / (RSA1...RSA5)$ $= 4.5^2 / (2.7 \times 5) - 1\% / 5$
RS78,79	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$P_d = U_{bat_therm}^2 / R61$ $= 4.5^2 / 10 k - 0.5\%$
ZD71,72	1N5338B Uzmax = 5.36V / 5W Tjmax = 200°C	1.137 W	3.733 W	3.2	$P_d = P_{o_main}$ $R_{th(j-a)} = 27.5 \text{ °C/W}$ (measured) and $R_{th(j-c)} = 10 \text{ °C/W}$ (manufacturers datasheet and wires of 0.1 inch) $R_{th(j-a)} + R_{th(j-c)} = R_{th(j-a)} = 37.5 \text{ °C/W}$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (200 - 60) / 37.5 = 3.733$
LCD circuit					

Note: Typo mistake in main circuit, RS78, 79, correct is RS71, 72.

RS61	62Ω / 1% 1W	0.351 W	1 W	2.8	$P_d = (U_{\text{bat_therm}} / (R_{\text{L_main}} + RS61))^2 \times RS61$ $= 4.5 / (4.455 + 62)^2 \times 62$
RS62,65	10k Ω / 0.5% 0.33W	2.1 mW	0.33 W	>100	$P_d = U_{\text{a_therm}}^2 / RS62$ $= 4.5^2 / 10 \text{ k} - 0.5\%$
RS63,64	82Ω / 1% 0.75W	0.275 W	0.75 W	2.7	$P_d = (U_{\text{bat_therm}} / (R_{\text{L_main}} + RS63))^2 \times RS63$ $= 4.5 / (4.455 + 82)^2 \times 82$
ZD61...70	TFZ5.1B Uzmax = 5.2V / 0.5W	0.176 W	0.36 W	2.0	$P_d = P_{\text{a_buzzw}}$ W1 = 0.36W @60°C (see datasheet Pd-Ta)
ZD57...60	TFZ18B Uzmax = 17.7V / 0.5W	0.176 W	0.36 W	2.0	$P_d = P_{\text{a_buzzw}}$
Backup battery circuit					
RS10	1k Ω / 1% 0.25W	2.5 mW	0.25 W	100	$P_d = U_{\text{backup_therm}}^2 / RS10$ $= 1.55^2 / 1 \text{ k} - 1\%$
D7	MMSD301 Vr = 30V, If = 200mA	5.36 V 1.7 mA	30 V 200 mA	5.5 >100	$U = U_{\text{a_main2}}$ $I = I_{\text{a_backup}}$
BUD-6000					
R1	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$P_d = U_{\text{bat_therm}}^2 / R1$ $= 4.5^2 / 10 \text{ k} - 0.5\%$
BUL-6000					
R1,2	200Ω / 1% 0.25W	0.073 W	0.25 W	3.4	$P_d = U_{\text{bat_therm}}^2 / R1$ $= 3.8^2 / 200 - 1\%$
R3	470Ω / 1% 0.25W	0.032 W	0.25 W	7.8	$P_d = U_{\text{bat_therm}}^2 / R3$ $= 3.8^2 / 470 - 1\%$
R10	10k Ω / 0.5% 0.33 W	1.5 mW	0.25 W	>100	$P_d = U_{\text{bat_therm}}^2 / R10$ $= 3.8^2 / 10 \text{ k} - 1\%$
R11	2.2k Ω / 1% 0.25 W	0.007 W	0.25 W	35	$P_d = U_{\text{bat_therm}}^2 / R11$ $= 3.8^2 / 2.2 \text{ k} - 1\%$
D1,2,3	MBRD1045 Vr = 45V, If = 10A	3.8 V	30 V	7.8	$U = U_{\text{bat_therm}}$

During battery charging or use with charging. (non-hazardous area only)

Component designation	Value	Rating used (W2)	Maximum rating (W1) @ 60 °C	W1 W2	Calculation
BUL-6000					
R1,2	200Ω / 1% 0.25W	0.071 W	0.25 W	3.5	$P_d = (U_{\text{charge}} / (R1 + R28_{\text{BC-6000}}))^2 \times R1$ $= (17.8 / (200 + 750))^2 \times 200$
R3	470Ω / 1% 0.25W	0.074W	0.25 W	3.3	$P_d = (U_{\text{charge}} / (R3 + R1 + R28_{\text{BC-6000}}))^2 \times R3$ $= (17.8 / (470 + 200 + 750))^2 \times 470$
R10	10k Ω / 1% 0.25 W	1.8 mW	0.25 W	>100	$P_d = U_{\text{bat_charge}}^2 / R10$ $= 4.2^2 / 10 \text{ k} - 1\%$
R11	2.2k Ω / 1% 0.25 W	0.146 W	0.25 W	1.7	$P_d = U_{\text{charge}}^2 / R11$ $= 17.8^2 / 2.2 \text{ k} - 1\%$
D1,2,3	MBRD1045 Vr = 45V, If = 10A R _{THJC} = 2.43 °C/W T _{rise} = 24.6 °C VF@10A = 0.57 V, Tjmax = 175 °C.	17.8 V 2.72 A 1.56 W	30 V 10 A 45 W	1.7 3.6 28	$U = U_m$ $I = I_m$ $P_d = V_f \times I_m = 0.57 \text{ V} \times 2.72 \text{ A} = 1.56 \text{ W}$ $P_{\text{max-diode@65°C}} = (T_{j\text{max}} - T_a - T_{\text{diode-rise}}) / R_{\text{THJC}}$ $= (175 - 40 - 24.6) / 2.43 = 45 \text{ W}$
BC-6000					
R1...3	120 Ω / 1%	0.034W	0.75 W	22	$P_d = V_{\text{gs_threshold}}^2 / R1 = 2.0^2 / 120 - 1\%$

	0.75 W				
ZD1...3	1SMB5918 U _{zmax} = 15.8V / 3W	0.266 W	1.538 W	5.7	$P_d = I_{zst} \times U_{zmax}$, $I_{zst} = V_{gs_threshold} / R1$ $P_d = 2.0 / 120-1\% \times 15.8$
Q1...3*	TPCA8107-H V _{gs(th)} = 2.0V R _{onmax} = 37mΩ P _d = 30W T _{jmax} = 150°C	2.74 W 97A ² S	1.152 W 1.005A ² S	22 96	$P_d = (I_n \times 1.7)^2 \times R_{onmax} = (1.6 \times 1.7)^2 \times 37m$ $R_{th(j-a)} = 78.1 K/W$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (150-80) / 78.1 = 1.152W$ $P_t = ((T_{jmax} - T_a) / R_{th(j-a)}) / R_{onmax} \times t$ $= ((150-80) / 25) / 37m \times 1$ (see datasheet , fig R _{th(j-a)})
R28,29	750 Ω / 1% 0.75 W	0.427W	0.75 W	1.7	$P_d = U_{charge}^2 / R28$ $= 17.8^2 / 750 -1\%$

Note: For Q1...3, 2.74 W is typo mistake, correct is 0.273 W. SF is 4.2 not 22.

A.5 Encapsulation

A.5.1 The BUL-6000 contains two parallel battery cells, Maxell model INR18650PB (Lithium-ion battery), size : Φ18*65 mm (cylindrical shape), rating 3.7 V & 1450 mAh, max OCV = 4.35 V.

This lithium-ion battery has manganese acid on positive electrode side, which prevent the battery from generating heat.

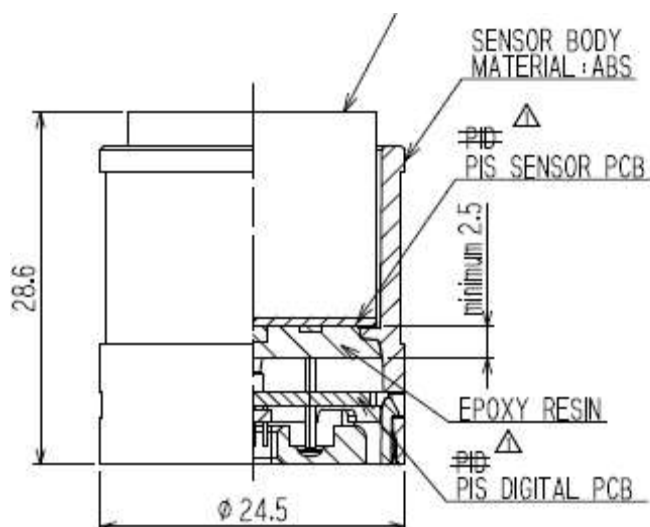
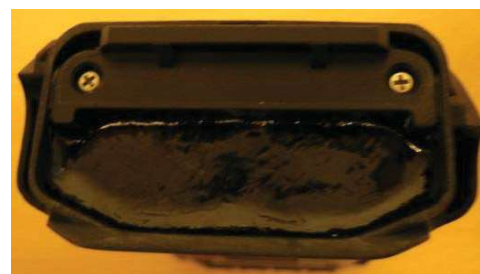
This lithium-ion battery does not have a built in "Protection Component (PTC)". The maximum open-circuit voltage for the Li-ion battery is determined according to IEC 60079-11, clause 10.4: Determination of parameters of loosely specified components. Testing 10 samples of batteries resulted in value of 4.2 V which then be used for spark energy analysis. The nominal battery voltage is used for thermal analysis and rating of components.

Hence U_{BATTherm} = 3.7 V and U_{BATTspark energy} = 4.35 V.

However assessments of EUT used with BUD-6000 (max 4.95 V) are covering assessments of EUT used with BUL-6000.



The two batteries are placed in a plastic (PC) case. The case is filled with epoxy resin, or silicon-compound, Epoxy resin DP-270 black, COT = -55 °C to 121.1 °C confirmed by manufacturer 3M. Encapsulation prevent ingress of external gases. The compound thickness is significant greater than the required 0.5 mm solid insulation.



A.5.2 The smart sensor type PIS has also partly encapsulation in term of requirements for safety distances. Epoxy resin is used as shown in the dedicated drawing. The encapsulation is checked for compliance with applicable requirements e.g. minimum thickness of 1 mm.

A.6 Fuses and charging mode

Charging of the batteries is only permitted outside the hazardous area.

Recognized fuse used. Littelfuse 216 series (5 x 20 mm) Axial lead, fast acting. UL recognized E10480. In accordance to IEC 60127-2, VDE approval 4001383.

The fuse used in battery charger circuit has a rating of $I_N = 1.6 \text{ A}$; $I_{Break} = 1500 \text{ A}$; $U_m = 250 \text{ V}$. The charge input is protected against U_m by the fuse and a shunt voltage limiting circuit with safety components R1, R2, R3, FETs Q1, Q2, Q3 and zener diodes ZD1, ZD2, ZD3. This circuit is designed to have similar function as a crowbar circuit which handles overvoltage fault condition.

The maximum gate threshold voltage of the FET is -2.0 V which means that at this voltage the gate will be triggered and the FET will be switched on. In overvoltage fault condition the $1.7 \times 1.6 \text{ A}$ will be dissipated for a short period to earth reference (BAT – pol). The fuse will break fault current in short time. Any failure will shut down the charging mode and thereof the charging voltage.

By the shunt voltage limiting circuit, the maximum voltage is limited to be $V_{zd} + V_{gs(th)} = 15.8 \text{ V} + 2.0 \text{ V} = 17.8 \text{ V}$ but under charging mode the Lithium-ion battery pack will pull down the charger voltage to 4.2 V . Refer to Appendix C for charging test of batteries. Infallible connections to batteries are provided.

The lithium-ion cells are parallel connected by which one single cell at a time is considered for failure. Total collapse of the charger circuit and failure of both cells at the same time are considered to be unlikely.

Failure of short-circuited R1 $\rightarrow V_{gs(th)} < 2.0 \text{ V} \rightarrow$ this leads to normal charging.

Failure of short-circuited ZD1 $\rightarrow V_{gs(th)} > 2.0 \text{ V} \rightarrow$ Q1 is triggered leading high current for a short time by which the fuse will break the fault current. Fuse breaks the fault current also when Q1 is short-circuited.

Diodes D1-D3 and safety resistors in line are preventing discharging back to charger circuit or other circuits as well.

Since fault conditions of charging circuit cause shutdown of charger voltage and current break or is leading fault current to earth reference. Internal circuits beyond the charger circuit (ref. Diagram For I. S. Keep For GX-6000 E3-6991-5361-10-01K) will not be impacted.

BUL-6000 battery pack is encapsulated and therefore is exempted for spark ignition requirements. Thermal aspects have been documented by assessments of short-circuited cell.

Due to the assessed situations as mentioned above no safety distances are found necessary for safety components of the charger circuit. Positive terminal of DC input to other circuits is across the recognized fuse which is an appropriate certified device. Wiring is documented in Appendix A.3.2. Internal circuits beyond this charging level (ref. Diagram For I. S. Keep For FI-8000 E3-6991-5361-10-01K) will have 4.2 V as reference voltage for assessments.

APPENDIX B:**B.1 Tests of applicable standards**

Refer to associated IEC 60079-0 test report for documented drop test & surface resistance test in measurement section.

The design uses components from similar models which are separately tested and approved. Reference to associated ExTR test reports is indicated in the documented testing. The testing of these specific components is reviewed and recognized. See throughout Appendix B to F of this report.

Tests of Piezoelectric devices:

Test is performed for GX-6000, Buzzer type BZ-9K ($C_i = 22 \text{ nF} @ 30\% \rightarrow 28.6 \text{ nF}$) as part of NO/PRE/ExTR15.0012/00.

The buzzer has been verified to comply with IEC 60079-11 clause 10.7 by applying an impact of 1 kg weight dropped from a height of 0.7 m on the outside of the enclosure twice. Buzzer wires did not break and the protective components were not affected. For evaluation see Appendix A.2.6.

Test is performed for GX-6100, Piezo element: Cre-sound FT-27T-3.2A1

Capacitance stated in documentation: $35 \text{ nF} \pm 30 \% = 45.5 \text{ nF}$.

The buzzer has been verified to comply with IEC 60079-11 clause 10.7 by applying an impact of 1 kg weight dropped from a height of 0.7 m on the outside of the enclosure twice. Test of piezo-electric device type Cre-sound FT-27T-3.2A1 was performed 2022.09.16 (not used in evaluation) as part of NO/PRE/ExTR15.0012/05.

B.2 Spark ignition test

Higher safety factors achieved and are documented. No spark ignition test is necessary. However see throughout Appendix A to F for evaluation of internal electronics and testing of specific components e.g. batteries and piezoelectric device.

See Appendix A.2.4 to A.2.6. For internal circuits the assessed values of combination of capacitance & inductance are below 50% of the max allowed values. Ref IEC 60079-11 cl. 10.1.5.2 b) 2).

See Appendix A.2.6. Internal pump is not assessed as infallible windings. However max inductance and minimum resistance is taken into account in assessments of the most severe ignition condition (situation where the winding is disconnected or short-circuited).

See Appendix A.2.6. Assessments of ignition energy were performed for buzzer (piezoelectric device).

B.3 Temperature measurements

Only least favorable cases are tested taken into account max ambient and other conditions as well. The following listed temperature measurements below are considered as worst situations where highest temperatures of components were achieved. Some specific components are in addition tested for thermal ignition capabilities. Other components should have lower temperatures in fault conditions. See also Appendix A.3

B.3.1 Measured internal temperatures of EUT

(For information only. No service temperature is required. See 5.2 of associated IEC 60079-0 test report).

Measured Location	ΔT °C	T_{corr} °C ¹⁾	Remark
GX-6000. Main unit. Normal use	8	58	$T_{a\ max} = 50^{\circ}\text{C}$
GX-6000. Main unit. Charging	10	50	$T_{a\ max} = 40^{\circ}\text{C}$
GX-6000. Main unit. Charging & use	14	54	$T_{a\ max} = 40^{\circ}\text{C}$
BUL-6000. Charging	18	58	$T_{a\ max} = 40^{\circ}\text{C}$
BUL-6000. Charging & use	18	58	$T_{a\ max} = 40^{\circ}\text{C}$
Supplementary information: ¹⁾ Max temperature is corrected for $T_{a\ max}$			

B.3.2 Temperature for small components for Group I and Group II

Only highest achieved temperature for small components is listed.

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Maximum power in this circuit is $P_{o_main} = 1.137\text{W}$. According to Table 3 and 4 of IEC 60079-0 a maximum of 1.2 W is allowed at an ambient of 60 °C for small components ($\geq 20\text{mm}^2$), wiring and PCB tracks (including the FPC between main PCB to LCD).

The temperature test result of the small components of each circuit is as follows.

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The surface temperature of the small components $< 20\text{mm}^2$ measured while dissipating 0.787 W.

This resulted in a maximum temperature rise is 185 °C (on ESS SENSOR PCB – D1).

At ambient temperature of 60 °C the maximum surface temperature would hence be 245 °C which is below the 275 °C limit.

1. D1 on ESS SENSOR PCB : Trise = 185 °C
2. L1 on ESS SENSOR PCB : Trise = 147 °C
3. ZD13 on MAIN PCB : Trise = 122 °C

Pump circuit

The surface temperature of the small components $< 20\text{mm}^2$ measured while dissipating 0.787 W.

This resulted in a maximum temperature rise is 88 °C (MAIN_PCB – Q3). At ambient temperature of 60 °C the maximum surface temperature would hence be 148 °C which is below the 275 °C limit.

Motor circuit

The surface temperature of the small components $< 20\text{mm}^2$ measured while dissipating 0.214 W.

This resulted in a maximum temperature rise is 17°C (MAIN_PCB – ZD5). At ambient temperature of 60°C the maximum surface temperature would hence be 77°C which is below the 275°C limit.

Buzzer circuit

The surface temperature of the small components $< 20\text{mm}^2$ measured while dissipating 0.363 W.

This resulted in a maximum temperature rise is 49 °C (MAIN_PCB – D4).

At ambient temperature of 60 °C the maximum surface temperature would hence be 110 °C which is below the 275 °C limit.

1. D4 on MAIN PCB : Trise = 49 °C
2. IC41 on MAIN PCB : Trise = 48 °C

Main circuit

The surface temperature of the small components $< 20\text{mm}^2$ measured while dissipating 1.137 W.

This resulted in a maximum temperature rise of 204 °C (SENSOR_PCB – NF3). At ambient temperature of 60 °C the maximum surface temperature would hence be 264 °C which is below the 275 °C limit.

1. NF1 on MAIN PCB : Trise = 204 °C
2. PT1 on MAIN PCB : Trise = 178 °C
3. D9 on MAIN PCB : Trise = 156 °C
4. Q16 on MAIN PCB : Trise = 127 °C
5. Q3 on SENSOR PCB : Trise = 127 °C

LCD circuit

The surface temperature of the small components < 20mm² measured while dissipating 0.176 W. This resulted in a maximum temperature rise is 33 °C (MAIN_PCB – NF4). At ambient temperature of 60 °C the maximum surface temperature would hence be 93 °C which is below the 275 °C limit.

B.3.3 Temperature measurement of shunt zeners

Worst case of shunt zeners for EUT is ZD71 type 1N5338B which is used in Main circuit with max dissipated power 1138 mW (from BUD-6000).

The same zener type 1N5338B was used in another model GX-8000. This testing was recognized as representative for the worst case of shunt zeners of this investigation.

Equipment Tested:	Zener diode ZD1, type 1N5338B, $U_{zmax} = 5.36V / 5W$, manufacturer ON specification: $R_{th(j-l)} = 16 K/W$ with 0.3 inch lead length. $T_{jmax} = 200^{\circ}C$
Date of Test (yyyy/mm/dd):	2009/09/25
Clause and Standards:	10.2 of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/KEM/ExTR10.0035/03.

$U_{zmax} = 5.36V / 5W$, manufacturer ON specification:
 $R_{th(j-l)} = 16 K/W$ with 0,3 inch lead length.
 $T_{jmax} = 200^{\circ}C$

$T_a = 50^{\circ}C$
 $dT = 10K$
 $T_{amax} = 60^{\circ}C$
 $T_{jmax} = 200^{\circ}C$
 $P_d = 5W$

$P_{o_max} = 1.14W$
 $R_{th(j-l)} = 16.0K/W$. See Fig. 1
 $R_{th(j-l)} = 34.6K/W$. See result sheet
 $R_{th(j-a)} = 50.6K/W$
Max rating 2.767W
2/3 rating 1.84W

$$T_j = 40.8 + 50 + 1.2 * 16 = 110^{\circ}C$$

Measuring point 0.3 in from cathode terminal.

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Max. Steady State Power Dissipation (@ $T_L = 75^{\circ}C$; Lead Length = 3/8 in Derate above $75^{\circ}C$)	P_D	5 40	W mW/°C
Operating and Storage Temperature Range	T_A, T_{stg}	-65 to +200	°C

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

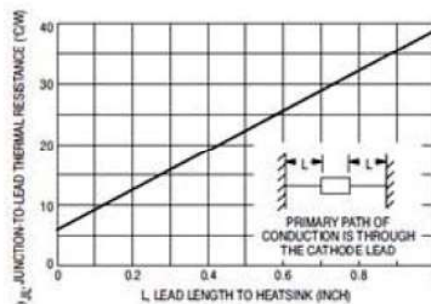


Figure 1. Typical Thermal Resistance

Results

$\Delta T = 39.4 K$ with $P = 1.14 W \Rightarrow R_{th(l-a)} = 34.6 K/W$
Measuring point is 0.3 inch from cathode terminal.

B.3.4 Temperature test of L4 (part of IC16 / BLE module)

Equipment Tested:	L4 (inductor) as a part of the hybrid component IC16 (BLE module EYSHJN)
Date of Test (yyyy/mm/dd):	2022/05/19
Clause and Standards:	10.2 of IEC 60079-11: 2011

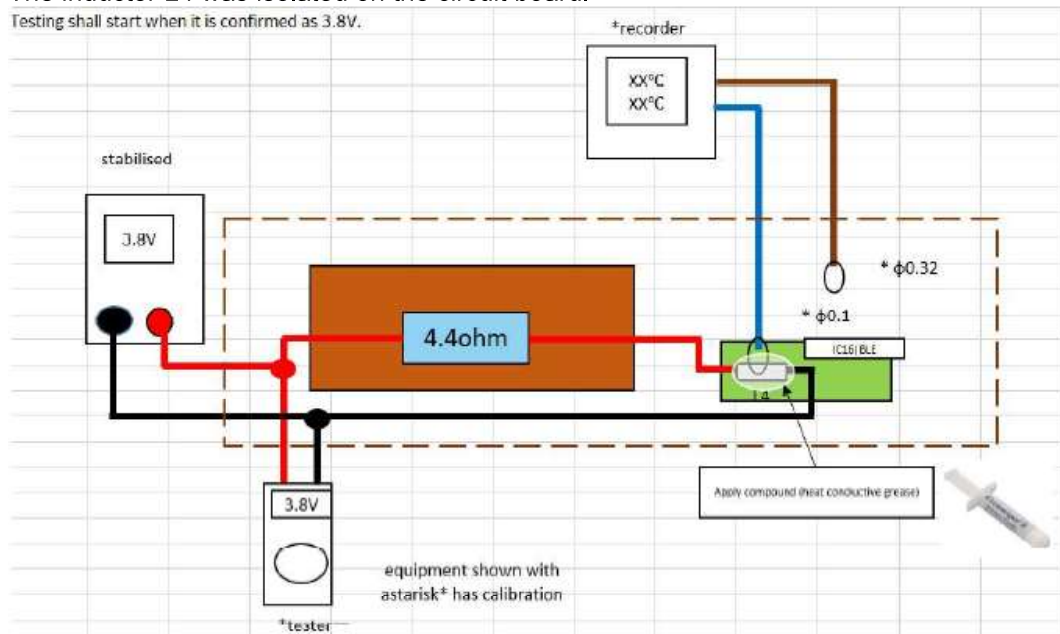
Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00. (For GX-Force, Dekra report no. NL/DEK/ExTR24.0019/00).

Test procedures

According to clause 7.6.h of IEC 60079-11: 2011 the resistance of an inductor at failure shall be between nominal value (0.34 Ω) and 0.

The inductor L4 was isolated on the circuit board.

Testing shall start when it is confirmed as 3.8V.



$$R = 4.37 \, \Omega \quad U = 3.8 \, V$$

Results

$$T_{\text{measured}} = 171 \, ^\circ\text{C} \quad T_{\text{a-max}} = 60 \, ^\circ\text{C} \quad T_{\text{a}} = 26 \, ^\circ\text{C} \quad \Delta T = 145 \, \text{K}$$

1) Evaluated at maximum power

The maximum power of the GX-Force is 0.7513 W and the test result is a temperature rise of 145 $^\circ\text{C}$.

As the maximum power of the GX-6100 is 1.137 W, the temperature rise is $1.137 \, \text{W} / 0.7513 \, \text{W} \times 145 \, ^\circ\text{C} = 219.5 \, ^\circ\text{C}$.

Ambient temperature 50 $^\circ\text{C}$

Result: $219.5 \, ^\circ\text{C} + 50 \, ^\circ\text{C} = 269.5 \, ^\circ\text{C} < 275 \, ^\circ\text{C}$

2) Since the power is constant even after boosting the voltage, it is considered before boosting.

The maximum power of the BLE module section is

From $U_0 = 4.5 \, \text{V}$ of the dry cell battery and the composite resistance of 4.455 Ω from current limiting resistors RSA1 to RSC5

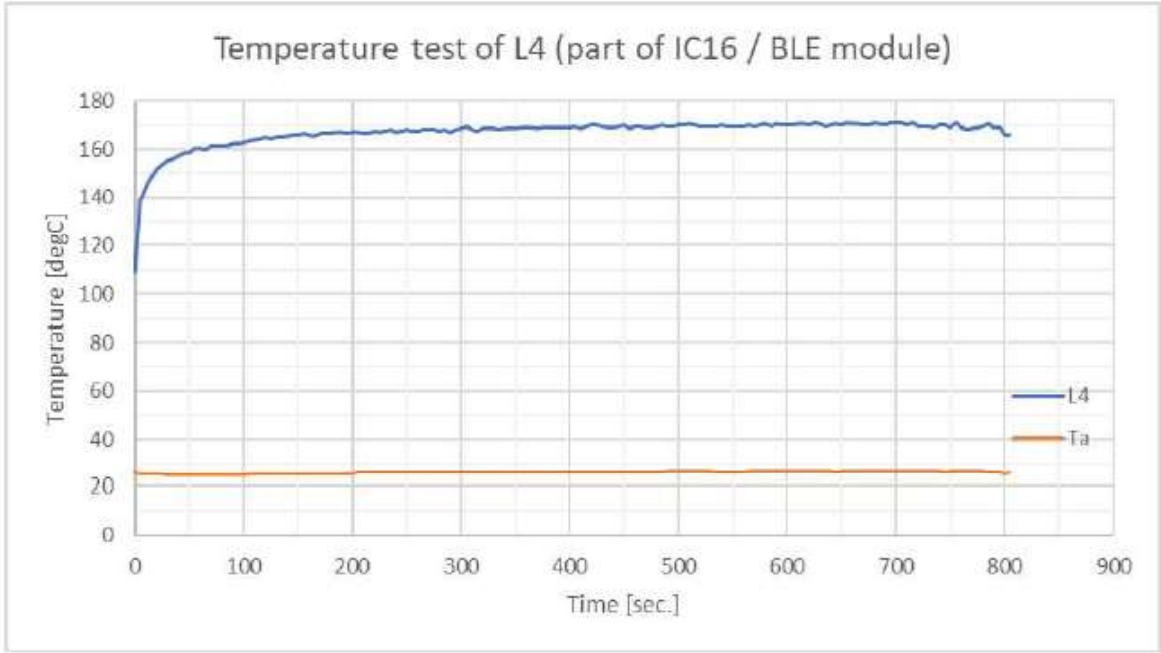
$$P_{0_th} = (4.5 \, \text{V} / 4.455 \, \Omega) \times 4.5 \, \text{V} / 4 = 1.137 \, \text{W}$$

GX-6100 connected to BLE module through limiting resistors 4.455 Ω at 4.5 V power supply

GX-Force is connected to the BLE module with a power supply of 3.8 V through a limiting resistors 4.4 Ω → temperature rise 145 $^\circ\text{C}$ at this time.

Therefore, the temperature rise of the BLE module of the GX-6100 is $(4.5 \, \text{V} / 3.8 \, \text{V})^2 \times 145 \, ^\circ\text{C} = 203.4 \, ^\circ\text{C}$

Result: $203.4 \, ^\circ\text{C} + 50 \, ^\circ\text{C} = 254.4 \, ^\circ\text{C} < 275 \, ^\circ\text{C}$



B.4 Infallible distance & connection measurements

B.4.1 Infallible distances: CR & CL → creepage & clearance. All values are in mm.

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Maximum voltage of circuit on the following is below 10 V and therefore the following segregation distances shall be applied according to table 5 of IEC 60079-11:

Location ^{a)}	CL	CR	Min. ^{Ⓜ)}	CTI
Sensor circuits. Voltage area < 10V.				
RS11...RS15 Sens1 circuit to battery	3.2	3.2	1.5	>100
RS21...RS25 Sens2 circuit to battery	3.2	3.2	1.5	>100
RS81...RS87 Sens1 to other circuits	1.6	1.6	1.5	>100
RS91...RS97 Sens2 to other circuits	1.6	1.6	1.5	>100
Pump circuit. Voltage area < 10V.				
RS31...RS35 (to battery)	3.2	3.2	1.5	>100
RS37...RS39 (to other circuits)	1.6	1.6	1.5	>100
Solid insulation (pump body and wiring) >0.5 ¹⁾	—	—	0.5	>100
Motor circuit. Voltage area < 10V.				
RS51, RS52 (to battery)	3.2	3.2	1.5	>100
RS59 (to other circuits)	1.6	1.6	1.5	>100
Buzzer circuit. Voltage area < 10V.				
R41...R43 (to battery)	3.2	3.2	1.5	>100
RS47...RS49 (to other circuits)	1.6	1.6	1.5	>100
Solid insulation (buzzer body and wiring) >0.5 ¹⁾	—	—	0.5	>100
Buzzer. ²⁾	—	—	—	—
Main circuit. Voltage area < 10V.				
RSA1...RSA5	1.6	1.6	1.5	>100
RSB1...RSB5	1.6	1.6	1.5	>100
RSC1...RSC5	1.6	1.6	1.5	>100
RS61...RS65	1.6	1.6	1.5	>100
Backup circuit. Voltage area < 10V.				
D7	2.4	2.4	1.5	>100
RS10	1.6	1.6	1.5	>100
BUD-6000. Voltage area < 10V.				
R1	1.6	1.6	1.5	>100
Encapsulated BUL-6000. $V_{bat}=4.2V$ considered.				
D1-D3 measured across components	1.0	1.0	0.5	>100
R1 to adjacent tracks	1.3	1.3	0.5	>100
R2 to adjacent tracks	1.3	1.3	0.5	>100
R3 measured across components	2.3	2.3	0.5	>100
R10 measured across components	2.3	2.3	0.5	>100
R11 to adjacent tracks	0.5	0.5	0.5	>100
Voltage areas of U_m				
Charger circuit	³⁾	³⁾	³⁾	>175

Supplementary information:

^{a)} Distances across component and to adjacent tracks are checked.

^{Ⓜ)} Wiring & body material insulation.

¹⁾ All internal wiring aspects such as arrangement or solid insulation are checked and recognized. See also Appendix A.3.2.

²⁾ The buzzer and its wiring is assessed and is documented in Appendix A.3.2 and A.2.6.

³⁾ Assessment of charger circuit is documented in Appendix A.6. No safety distances are required for R1 to R3. Positive terminal of DC input to other circuits is across the recognized fuse which is an appropriate certified device. Wiring is documented in Appendix A.3.2.

B.4.2 Infallible connections

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Connection	Method *)	Comment
Sensor circuits		
ZD11, ZD12 to IC11	2 mm track	35 µm
ZD21, ZD22 to IC12	2 mm track	35 µm
ZD11, ZD12, ZD21, ZD22 to 0V	2 mm track	35 µm
Buzzer circuit		
ZD45 – ZD46 to safety resistors in line	2 mm track	35 µm
ZD45 – ZD46 to 0V	2 mm track	35 µm
ZD41 – ZD44 & ZD47 – ZD48 to safety resistors in line	2 mm track	35 µm
ZD41 – ZD44 & ZD47 – ZD48 to 0V	2 mm track	35 µm
ZD49 – ZD52 to CN4 (Main PCB)	2 mm track	35 µm
ZD49 – ZD52 to 0V (Main PCB)	2 mm track.	35 µm
Main circuit		
ZD71 – ZD72 to IC71	2 mm track & single 2 mm circumference via	35 µm
ZD71 – ZD72 to 0V	2 mm track & single 2 mm circumference via	35 µm
LCD circuit		
ZD57 – ZD60 to CN6 (LCD) & 0V	2 mm track.	35 µm
ZD61 – ZD70 to safety resistors in line	2 mm track.	35 µm
ZD61 – ZD70 to 0V	2 mm track.	35 µm
BC-6000		
R1, R2, R3 to F1 and source terminal of Q1, Q2, Q3	2 mm track	35 µm
R1, R2, R3 to ZD1, ZD2, ZD3	2 mm track	35 µm
R1, R2, R3 to gate terminal of Q1, Q2, Q3	1mm track ¹⁾	35 µm
ZD1,ZD2,ZD3 and Q1,Q2,Q3 to 0V	2 mm track	35 µm
BUL-6000		
D1-D3 & R1, R2, R11 to B+	2 mm track ²⁾	35 µm
R10 & CN1-1 to B+	2 mm track	35 µm
B- to 0V	2 mm track	35 µm
Wiring to buzzer & pump	³⁾	-
Supplementary information: *) Required minimum width of track/connection is checked. Larger track width is documented in Layout-documents. Refer to List of Descriptive documents 1) Use of triplicate controllable semiconductors. Open-circuiting is considered as one countable fault. Situations of two countable faults at a time is assessed. 2) Min 2mm track/connections between those components are not required but are used. The connections help to reduce temperature on components. 3) Wiring is documented in Appendix A.3.2		

B.5 Dielectric strength test

Suitable (UL approved) insulated wiring used. No dielectric strength test is found necessary.

B.6 Test of specific components.

- Appendix C: Testing of batteries
- Appendix D: Testing of lamp part (T- 3/4 BPA in DES sensor)
- Appendix E: Testing of combustible sensor NC6264A
- Appendix F: Assessment of the smart sensor type PIS

B.6.1 Test of batteries

Battery testing is documented by Test reports NL/KEM/ExTR08.0019/00, NL/KEM/ExTR10.0035/00, NL/DEK/ExTR13.0075/00 and NL/DEK/ExTR13.0075/02. See Appendix C.

B.6.2 Test of Lamp part type OL-82708PA

Testing of Lamp part type OL-82708PA which is used in DES sensor, is documented by Test report NL/DEK/ExTR12.0033/00. See Appendix D.

B.6.3 Test of sensors

Listed below are different types/models of sensors which are included in this investigation. They are sorted into following detection principles (See Appendix A.1 for details). Electrochemical, Galvanic cell, Catalytic combustion, PID, Infrared ray (IR). The sensor types in a) and b) below are standard gas sensors (See Appendix A.1 for details).

a) The Oxygen sensor used "Galvanic cell" detection principle, ref. M4-4080-82-07K. The toxic gas sensors used "Electrochemical" detection principle, ref. M4-4084-92-03K & M4-4084-30-08K. These type of sensors consist of no energy storing/generating components/parts in the sensors. Only internal wiring has been considered and is included in temperature assessment/test in Appendix A.3 & B.3. Based on the design and dedicated application these types of sensor need no further assessment.

b) The combustible gas sensor NC6264A used "Catalytic combustion" detection principle. This sensor type consists only internal coil but no other components. The NC6264A sensor is a separately Ex certified device and the testing is documented in NL/KEM//ExTR07.0057. Applicable requirements are considered for this sensor. Results of testing are listed in Appendix E.

c) The smart sensor type ESS consists of a small electronic PCB and a toxic gas sensor. The toxic gas sensor is considered in a), "Electrochemical" detection principle is used. The ESS sensor circuit/electronics consists no safety components and therefore is treated as part of the Sensor circuit. This circuit is included in temperature assessment/test in Appendix A.3 & B.3. Refer to dedicated files in List of descriptive documents.

d) The smart sensor type DES consist of small DES digital PCB & DES sensor PCB including the T-3/4 BPA Lamp, "Infrared ray (IR)" detection principle is used. Refer to files numbered 28 to 31 in List of descriptive documents. Both circuits of DES digital PCB & DES sensor PCB used no safety components and therefore are treated as part of the main circuit. These circuits are included in temperature assessment/test in Appendix A.3 & B.3. The T- 3/4 BPA Lamp is a separately Ex certified device which testing is documented in ExTR12.0033. Associated test reports were reviewed and recognized for compliance of this investigation. Results of testing are listed in Appendix D of this report.

e) The smart sensor type OSS consists of a small electronic PCB and Oxygen sensor. The Oxygen sensor is considered in a), "Electrochemical" detection principle is used. The OSS sensor circuit/electronics consists no safety components and therefore is treated as part of the Sensor circuit. This circuit is included in temperature assessment/test in Appendix A.3 & B.3. Refer to dedicated files in List of descriptive documents.

f) The smart sensor type PIS consist of two small PCB, PIS digital PCB and PIS sensor PCB, and the separately certified Mini PID sensor. The Mini PID sensor is covered by certificate Baseefa 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00. Additional assessment for intrinsic safe connection is documented in Appendix F.

Appendix C

Appendix C.1 Separately tested batteries by Dekra

Equipment Tested:	Rechargeable battery unit type BUL-8000 of the detector GX-8000 (uses the same batteries as BUL-6000)
Date of Test (yyyy/mm/dd):	2009/11/02, 2009/06/03 to 2009/06/05
Clause and Standards:	10.4 of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/KEM/ExTR10.0035/03.

Results

A voltage measurement has been done over the two batteries inside of the GX-8000 on 10 different cells and combination while charging the batteries. The maximum voltage defined by manufacturer was 4.25 V (4.198 V result from test).

Equipment Tested:	Primary battery Alkaline LR6T(JE) manufactured by Toshiba and secondary Lithium-ion battery type INR18650PB manufactured by Maxell
Date of Test (yyyy/mm/dd):	2008/04/22, 2009/06/03 to 2009/06/05
Clause and Standards:	10.5 of IEC 60079-11: 2011

Note: Test for LR6T(JE) was performed and documented as part of NL/KEM/ExTR08.0019/00, for others types NL/KEM/ExTR10.0035/03.

Results for LR6T(JE):

T_a = 55 °C (considered) ΔT = 65.8 K T_{measured} = 120 °C

Maximum short circuit current: 9 A

Note: 2 samples had leakage, for more details see original report listed above.

Results for INR18650PB:

Manufacturing battery cell type with negative electrode material is Lithium, nominal voltage is 3.7 V, maximum open-circuit voltage is 4.17 V (measured), by manufacturer 4.25 V.

Capacitance: 1450 mAh

Charge Current = 0.870 mA

Discharge Current = 1450 mA

T_a = 55 °C (considered) ΔT = 74.8 K T_{measured} = 128.7 °C

Maximum short circuit current: not measured

Note: 2 samples had leakage, for more details see original report listed above.

This battery is not listed in Table 14, because of that testing according to cl. 10.4 was performed to define the voltages.

Equipment Tested:	Battery pack BP-8000, BUL-8000
Date of Test (yyyy/mm/dd):	Not specified in NL/KEM/ExTR10.0035/00
Clause and Standards:	10.2 of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/KEM/ExTR10.0035/00).

Results:

Maximum temperature rise of the cell under encapsulation: ΔT = 40.2 K

Maximum temperature rise for the safety diode components inside the encapsulation: ΔT = 24.6 K

Maximum temperature rise for the safety R5A to R5F components inside the encapsulation: ΔT = 21.5 K

Maximum temperature rise of the battery pack on the surface of the encapsulation: ΔT = 30.1 K.

Note: One cell has failed during the test (probably due to a short prior to the short circuit of the test) but the result of the other three cells is satisfactory.

Equipment Tested:	Secondary Lithium-ion battery - type US18650VTC3 manufactured by Sony and - type INR18650-15M manufactured by Samsung - SDI.
Date of Test (yyyy/mm/dd):	2013/08 to 2013/09
Clause and Standards:	10.5 of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/DEK/ExTR13.0075/00.

Rechargeable cells or batteries are fully charged with a current of 750 m A (0.5 C), discharged at least twice with a current of 300 mA (0.2 C).

Results

For both types: No leakage after testing. The short circuit current measurement is not determined.

The maximum temperature rise of Sony battery during short circuit at 60 °C is 17.7 K.

The maximum temperature rise of Samsung - SDI battery during short circuit at 60 °C ambient temperature is 24.6 K.

Equipment Tested:	10 cells of each type MN1500 by Duracell (primary cells)
Date of Test (yyyy/mm/dd):	2018/06/04 to 2018/06/06
Clause and Standards:	10.5 of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/DEK/ExTR13.0075/02.

Results

The maximum temperature rise of battery during short circuit at 60 °C ambient temperature is 86 K. (resulting in maximum surface temperature of 146 °C), which confirms with temperature class T3 requirements. For this application, the maximum ambient temperature is 50 °C.

There was no leakage of electrolyte from any sample.

The maximum peak current measured during short circuit was 19.9 A.

Appendix C.2 Testing of batteries type Sony SR616 performed by Presafe AS

Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/00.

Equipment Tested:	Batteries type Sony SR616 (Silver oxide)
Date of Test:	All tests performed in period 2015-03-10 to 2015-03-13
Clause and Standards:	Clause 10.5 of IEC60079-11: 2011 (EN60079-11: 2012)

Cl. 10.5.3. a) Spark ignition of cells.

All cells are measured to 1.597V open-circuit. No spark ignition assessment is required since peak open-circuit voltage is less than 4.5V

Cl. 10.5.3 Two test case were considered. Ten new samples are used for each test case (total 20 samples used). The linear correction for max rated ambient is considered to give worst results than if test was performed at max rated ambient.

Case 1: Surface temperature of cells during short-circuiting. Ambient = 23.6°C.										
Case 1. Sample no.	1	2	3	4	5	6	7	8	9	10
Measured T (°C) 1)	29.2	28.8	28.6	28.2	27.7	27.4	29.9	30.3	27.2	31.2
ΔT	5.6	5.2	5.0	4.6	4.1	3.8	6.3	6.7	3.6	7.6
Corrected T (°C) 2)	55.6	55.2	55	54.6	54.1	53.8	56.3	56.7	53.6	57.6
Leakage 3)	No	No	No	No	No	No	No	No	No	No
Case 2: Surface temperature of cells during abnormal charging. Ambient = 22.6°C										
Case 2. Sample no.	1	2	3	4	5	6	7	8	9	10
Current (mA) 4)	3.50	3.54	3.51	3.52	3.54	3.51	3.51	3.50	3.52	3.52
Measured T (°C) 5)	23.8	23.9	23.8	23.9	23.9	23.8	23.8	23.8	23.8	23.9
ΔT	1.2	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.2	1.3
Corrected T (°C) 2)	51.2	51.3	51.2	51.3	51.3	51.2	51.2	51.2	51.2	51.3
Leakage 3)	No	No	No	No	No	No	No	No	No	No
Supplementary information: 1) The measured maximum temperature is achieved at the start of test due to the peak short-circuited current, then it is falling during the discharging. The measured peak current were in the range of 55-65mA but is falling very fast to about 3mA (after approximately 30s) 2) T is corrected for max rated ambient 3) Refer to Cl. 10.5.2 of IEC60079-11: 201. All samples were placed in 50°C heat chamber in 12h after the short-circuiting test. 4) Abnormal charging current at input of 5.37V. Diode D7 at backup battery Sony SR616 was short-circuited. Abnormal charging current is slowly falling during test. 5) Test performed until achieved thermal equilibrium										

Cl. 10.5.4 Battery container pressure test. No external container other than the cell itself. No test is found necessary based on review of design.

Appendix C.3 Testing of batteries type Panasonic NCR18650GA (single cell) performed by DNV

Equipment Tested:	Panasonic NCR18650GA (single cell)
Date of Test (yyyy/mm/dd):	Date of issue for ExTR: 2020/03/30
Clause and Standards:	10.5 of IEC 60079-11: 2011

Note: This test was performed as partial testing and it is documented in NO/PRE/ExTR20.0043/00.

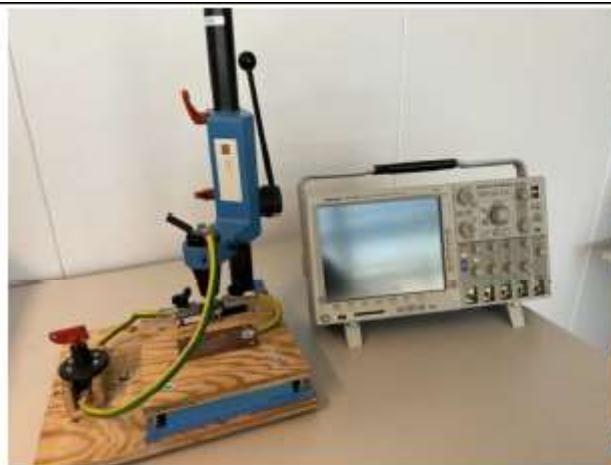
Test procedures

Tested according to 10.5.3.a and 10.5.3.b and 10.5.2. Test results are copied from IECEx TR NO/PRE/ExTR20.0043/00.

Results

Panasonic NCR18650GA:
Spark ignition testing, clause 10.5.3. a:

No.	Open circuit voltage [V]	Resistance of short circuit link [mΩ]	Measured voltage over short circuit link [mV]	Short circuit current ($I = U / R$) [A]	Internal resistance ($R = U / I$) [mΩ]
1	4,139	2	300	150	28
2	4,127	2	324	162	25
3	4,127	2	320	160	26
4	4,128	2	334	167	25
5	4,139	2	328	164	25
6	4,137	2	340	170	24
7	4,138	2	320	160	26
8	4,126	2	324	162	25
9	4,143	2	322	161	26
10	4,132	2	324	162	25



Overview.



The cell is placed between the contact points.



Probe for oscilloscope measures voltage drop over shunt resistor. Short circuit current is then calculated ($I = U / R$).



Calibrated shunt resistor of 2mΩ.

Surface temperature testing, clause 10.5.3.b (single cell):

No.	Ambient temperature [°C]	Measured temperature [°C]	Delta temperature [K]	Max. ambient temperature [°C]	Temperature class
1	60	89	29	60	T5
2	60	103	43	60	T4
3	60	96	36	60	T5
4	60	89	29	60	T5
5	60	87	27	60	T5
6	60	91	31	60	T5
7	60	93	33	60	T5
8	60	90	30	60	T5
9	60	85	25	60	T5
10	60	89	29	60	T5

NOTE: the temperature tests are done without an enclosure upon customer request. Due to the large safety margin (32 K) T4 is accepted.

A thermal camera is used to find the hottest point on the cell, so the thermal couple can be placed at the correct area. The thermal couple is fixed to the cell and temperature rise is measured by temperature meter.



Note: the temperature rise is measured by thermal couple and not the thermal camera.
Electrolyte leakage testing, clause 10.5.2:
The ten test cells are placed over a piece of blotting paper.
Test duration ≥ 12 h.



Results:
Maximum short circuit current (if required): 170 A
Minimum internal resistance: 24 m Ω
Maximum temperature rise: 43 K
Visible sign of electrolyte on the blotting paper or on the external surfaces of the test samples: No
Comments:
Discharged with 2.5 A, and a cut off voltage of 2.5 V.
Rated capacity: 3300 mAh

Appendix C.4 Testing of battery pack BUL-6100 with cells type Panasonic NCR18650GA by DNV

Equipment Tested:	battery pack BUL-6100 with parallel and encapsulated cells type Panasonic NCR18650GA, samples 11, 12, 13, 14, 16
Date of Test (yyyy/mm/dd):	2023/09/18 and 2023/09/19 (Measured surface temperature) 2023/09/19 and 2023/09/20 (Electrolyte leakage testing)
Clause and Standards:	10.5 of IEC 60079-11: 2011

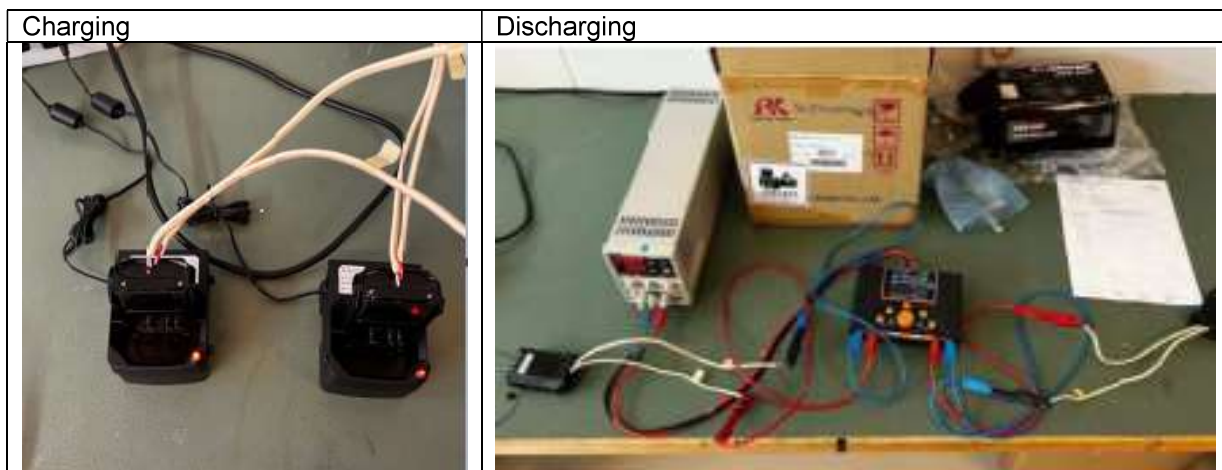
Note: This test was performed and documented as part of NO/PRE/ExTR15.0012/06.

Test procedures

Surface temperature measurement tests and electrolyte tests are performed, due to parallel coupling and that the cells are encapsulated

Battery conditioning:

Test Sample #	11	12	13	14	16
Battery S. No.:	230404-003	230404-004	230404-005	230606-001	230303-003
1st Charge:	2023-06-14	2023-06-14	2023-06-15	2023-06-27	2023-09-05
1st Discharge:	2023-06-15	2023-06-15	2023-06-16	2023-06-28	2023-09-06
2nd Charge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-06
2nd Discharge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-07
3rd Charge:	2023-06-19 Re-charged 2023-09-18	2023-06-19 Re-charged 2023-09-18	2023-06-20 Re-charged 2023-09-18	2023-06-30 Re-charged 2023-09-18	2023-09-07



Surface temperature testing (surface of the battery pack).

Measured Temperatures when batteries are short circuited (2 cells in each battery pack):

Test Sample #	11	12	13	14	16
Battery S. No.:	230404-003	230404-004	230404-005	230606-001	230303-003
Ambient Temperature [°C]:	19,2	19,2	19,2	50,0	50
Measured Surface Temperature [°C]:	72,6	70,8	69,1	78,7	76,2
Temperature Difference [K]:	53,4	51,6	49,9	28,7	26,2
Max Ambient Temperature [°C]	50	50	50	50	50

$$T = \Delta T + T_a$$

$$T = 28.7 \text{ K} + 50 \text{ °C} = 78.7 \text{ °C} \rightarrow T_6$$

$$T = 53.4 \text{ K} + 19.2 \text{ °C} = 72.6 \text{ °C} \rightarrow T_6$$

Results: The surface temperature of the battery pack does not affect the temperature classification of the EUT (T4 and T3).



Electrolyte leakage testing:

The ten test cells are placed over a piece of blotting paper (5 battery packs).

Test duration ≥ 12 h. Number of hours: 19.5 h

No visible sign of electrolyte on the blotting paper or on the external surfaces of the test.



Appendix D

Equipment Tested:	Lamp part type OL-82708PA, "lamp with bulb" and "lamp without bulb", for IR DETECTOR type DE-3123.
Date of Test (yyyy/mm/dd):	2012/04/13
Clause and Standards:	26.5.3 of IEC 60079-0: 2017 and 5.3.3. a) of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/DEK/ExTR12.0033/02.

Results

Lamp-type OL-8270BPA cannot become an ignition source because the lamp wire will break without ignition for temperature class T4 at $T_{amb} = 60\text{ }^{\circ}\text{C}$.

Appendix E

Equipment Tested:	Sensor type NC-6264A
Date of Test (yyyy/mm/dd):	2007/06/07 and 2007/06/28
Clause and Standards:	26.5.3 of IEC 60079-0: 2017 and 5.3.3. a) of IEC 60079-11: 2011

Note: This test was performed and documented as part of NL/KEM/ExTR07.0057/00.

Results

At the pre-tests the following typical values were noted

Voltage across the sensor wire [V]	1	2	3	3.3	> 3...4
Current [mA]	85	125	145	135	Open-circuited

The voltage is raised gradually within a few seconds and is measured across the sensor wire.

Sample No.	1	2	3	4	5
Voltage [V]	3.0	3.0	3.0	3.1	3.0
Current [mA]	130	130	130	145	145

None of the five samples caused ignition during this process.

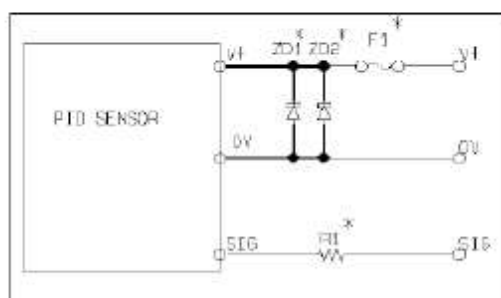
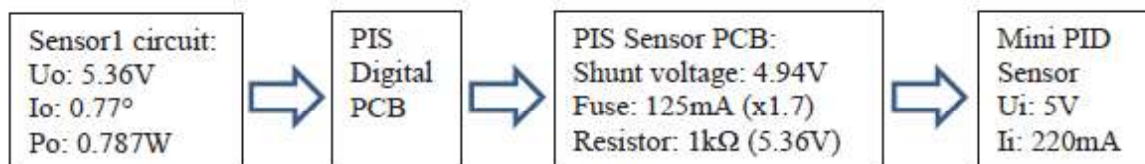
The mixture of each test were verified for ignition after the open-circuiting of coil.

Sensor type NC-6264A cannot become an ignition source for temperature class T4 at $T_{amb} = 50\text{ }^{\circ}\text{C}$.

Appendix F: Smart sensor type PIS Assessment

Note: This assessment was performed and documented as part of NO/PRE/ExTR15.0012/06.

The Mini PID sensor used inside smart sensor type PIS, is separately Ex certified device which is covered by certificate 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00. Marking code of Mini PID sensor is Ex ia IIC T4 for ambient range up to 60°C. The device is investigated for intrinsic safe connection to EUT.



The PIS sensor is provided with two PCB as shown above whereof protection is located in PIS sensor PCB. Zeners, fuse and safety resistor is provided as power limiting devices.

Input line:

$$I_{\max} = 125\text{mA} \times 1.7 = 213\text{mA}$$

$$P_{\max} = 4.94\text{V} \times 213\text{mA} = 1.05\text{W}$$

Signal line:

$$I = 5.36\text{V} / 1\text{k}\Omega @ 1\% = 5.42\text{mA} \rightarrow P_{R1} = 30\text{mW}$$

$U_o < U_i$	$I_o < I_i$	$P_o < P_i$	Remark
$4.94\text{V} < 5\text{V}$	$213\text{mA} < 220\text{mA}$	$0.787\text{W} < 1.1\text{W}$	Safe connection
I_{R1}	P_{R1}	P (rating of R1)	Safety factor
5.42mA	30mW	250mW	8.7x
Supplementary information:			

Safety distances of R1 is documented. Voltage area 5.36V:

Location	Measured CR	Measured CL	Required	Remark
R1 (measured to adjacent tracks)	0.85	0.85	> 0.5 *)	Pass. CTI ≥ 100
Supplementary information:				
*) Encapsulated part. See Appendix A.5.2				

Another shunt device (double zeners) is also provided internal in Mini PID sensor so in fact this connection has two times of double zeners (total four zeners used at input lines).

The PIS digital PCB used no safety components and therefore are treated as part of the Sensor circuit which is covered by the temperature assessment/test in Appendix B.3.

Intrinsic safe connection to Mini PID sensor is hereby documented. Refer also to certificate 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00.



ATEX ASSESSMENT REPORT IECEx TEST REPORT of NATIONAL DIFFERENCES



ExTR Reference Number	See Report No. above.	
ATEX Assessment Report Number:	See Report No. above.	<i>Aya Hadak</i>
ExTR Free Reference Number	See report cover.	
Compiled by + signature (ExTL)	A. Hadak	<i>[Signature]</i>
Reviewed by + signature (ExTL).....	B.P.O. Meijer (Ex i part) H.J.G. de Wild (Ex d part)	<i>[Signature]</i> <i>[Signature]</i>
Date of issue (yyyy-mm-dd).....	2024-06-19	
Ex Testing Laboratory (ExTL).....	DEKRA Certification B.V.	
Address	Meander 1051, 6825 MJ Arnhem, the Netherlands	
Applicant's name.....	See report cover.	
Address	See report cover.	
Country/Region	The European Union	
Directive.....	ATEX directive 2014/34/EU	
Standards	EN IEC 60079-0 : 2018 EN 60079-1 : 2014 EN 60079-11 : 2012	
Related reports	NL/DEK/ExTR17.0047/01 and NL/DEK/ExTR24.0019/00 for combustible "Ex da" gas sensor NCR-6309	
Test procedure.....	IECEx System	
Test Report Form Number.....	Form 255, based on IECEx form released 2018-03.	

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item..... : N/A
- test item does meet the requirement : Pass


General remarks:

The test results presented in this ExTR of National Differences relate only to the item or product tested. Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point is used as the decimal separator.

The technical content of this ExTR of National Differences shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Clause	Requirement – Test	Result – Remark	Verdict
--------	--------------------	-----------------	---------

ATEX directive 2014/34/EU			
1.0.5	Marking		
	Name, registered trade name, or registered trade mark and address of the manufacturer	Name and address of the manufacturer are on the marking.	Pass
	CE marking	CE mark applied.	Pass
	Identification number of the Notified body monitoring the production	Marked: XXXX. This is a placeholder for the identification number of the Notified Body. Marking of the applicable number is a manufacturers responsibility. Verification is not required at the product assessment.	Pass
	the year of construction	Year of construction is marked and explained in safety instructions.	Pass
	The ATEX certificate number	DEKRA 24ATEX0016 is marked	Pass
	 marking, followed by equipment group I or II and category M 1, M 2, 1, 2, or 3.	Ex marked, followed by: II 1.	Pass
	the letter "G" and/or "D"	Marked: G	Pass
1.0.6	Instructions		
	Instructions are written in one of the community languages	Instructions are in English.	Pass

EN IEC 60079-0 : 2018 based on IEC 60079-0 : 2017 (Ed. 7.0) + C1 : 2020 + IS1 : 2019			
ZY.2 30.1	Instructions	Requirements on the language are covered per ATEX directive 2014/34/EU as detailed above.	
		The instructions include information for safety at installation and erection, other than the general requirements given in EN 60079-14 and EN 50628 (mines).	Pass
ZY.3	Marking	Requirements are covered per ATEX directive 2014/34/EU as detailed above.	
ZY.4 17.2.5	Fans	The product is no room ventilating fan.	N/A

EN 60079-1 : 2014 based on IEC 60079-1 : 2014 (Ed. 7.0) + C1 : 2018			
All		No National Differences.	

EN 60079-11 : 2012 + IS01 : 2014 based on IEC 60079-11 : 2011 (Ed. 6.0) + ISH1 : 2014 + ISH2 : 2016 + ISH3 : 2016 + ISH4 : 2019 + ISH5 : 2019 + ISH6 : 2019			
All		No National Differences.	

Measurement Section, including Additional Narrative Remarks (as deemed applicable) N/A			
----------------------------------------------------------------------------------------	--	--	--





 <div style="text-align: center;"> Report Appendix A Description of the test item </div> 	
Report Number.....:	See Report No. above.
Free Reference Number	See report cover.
Compiled by + signature (ExTL):	A. Hadak 
Reviewed by + signature (ExTL) ...:	H.J.G. de Wild 
Date of issue (yyyy-mm-dd)	2024-06-19
Ex Testing Laboratory (ExTL)	DEKRA Certification B.V.
Address	Meander 1051, 6825 MJ Arnhem, The Netherlands
Applicant's name	See report cover.
Address	See report cover.
Test item description	See report cover.
Model/type reference	See report cover.
Standards	See report cover.
Test procedure	IECEX System
Instructions for Intended Use of Report Appendix A: Appendix A describes (the assessment of) the test item.	
General remarks: The test results presented in this report Appendix A relate only to the item or product tested. - Throughout this document, a point is used as the decimal separator. The technical content of this report Appendix shall not be reproduced except in full without the written approval of the Issuing Body and Ex Testing Laboratory .	

TABLE OF CONTENTS

1 General product information:..... 3

2 General requirements..... 3

3 Type of protection flameproof: 6

 3.1 General overview 6

 3.2 Multi-step joints 7

 3.3 Cemented joints 7

1 General product information:

The portable battery-operated handheld gas monitors GX-6000 and GX-6100 are used for measuring flammable gas concentration in hazardous location.

Different battery units may be used, BUL-6000/6100 (rechargeable Li-ion battery) and BUD-6000/6100 (alkaline dry battery). Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas.

Following parts are also included in the investigation, charger module BC-6000 or SDM-6000, Combustible gas sensor, Toxic gas sensor and Oxygen sensor, Smart sensor type DES, ESS, PIS, SHS & OSS.

Ambient temperature range for use: -20 °C to +50 °C

Ambient temperature range during charging: 0 °C to +40 °C (Non-hazardous area only)

For more information about Type designation and Ex code see Annex 1 to this report.

The examination of the portable gas monitor does not include a judgment of the functional performance of the equipment.

This Appendix A defines gas sensor NCR-6309, combustible gas sensor designed in "Ex da" type of protection that is used in gas monitors GX-6100. For other parts of detector, designed in "Ex i" type of protection, see Appendix A of report part IEC 60079-11.

Gas sensor NCR-6309 was tested and results are reported in Appendix B of NL/DEK/ExTR17.0047/01 and NL/DEK/ExTR24.0019/00.

Breather element (cl. 3.4, 3.5, 3.6 and 3.7) and cemented joints (cl. 2.10, 2.11, 3.1 and 3.2) were tested as part of NL/DEK/ExTR17.0047/01, while additional testing of flameproof joint 1 (multi step joint, cl. 2.4, 2.5, 3.1 and 3.2) was documented in NL/DEK/ExTR24.0019/00.

Results are used for this project and all Appendix B reports are listed in Cover ExTR Package Contents.

2 General requirements

Marking and rating:

For Model GX-6100:

Ex da ia IIC T4... T3 Ga, Tamb = -20°C to +50°C (Including flammable gas sensor.)

Note: Sensor is for gas group IIC, but the complete equipment is certified for IIB.

Ratings of the sensor: DC 1 V, 100 mA

Battery operated:

- Power supply of Li-ion battery unit : BUL-6000 and BUL-6100
- Um=250V.
- Power supply of alkaline battery unit : BUD-6000 and BUD-6100

Temperatures:

For Model GX-6100: Stand by 150 mA / 4.5 V / 675 mW

When gas is detected 170 mA / 4.5 V / 810 mW (maximum power)

T_{service sensor} = 58 °C

Schedule of Limitations from Report No. [NL/DEK/ExTR17.0047/02](#) for Gas Sensor type NCR-6309 with conclusions of assessment:

- 1) The Sensor is tested with low risk of mechanical danger for use in a Group I environment.
- 2) The Sensor is assessed for use in a monitor unit with a max. temperature increase of 5 K.
- 3) The Sensor shall not be exposed to ultraviolet light or used in equipment in which it is not fully enclosed.
- 4) This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts.
- 5) The equipment shall not be exposed to oil or hydraulic fluid.

Conclusions:

- 1) Group I not applied
- 2) In NL/DEK/Ex17.0047/02: $T_{\text{service sensor}} = 82.6 \text{ }^{\circ}\text{C}$ (tested for $110 \text{ }^{\circ}\text{C}$), in this application: $T_{\text{service sensor}} = 58 \text{ }^{\circ}\text{C}$, so results are acceptable
- 3) Sensor is covered with enclosure of the detector
- 4) Stated in safety instructions for the detector
- 5) Group I not applied

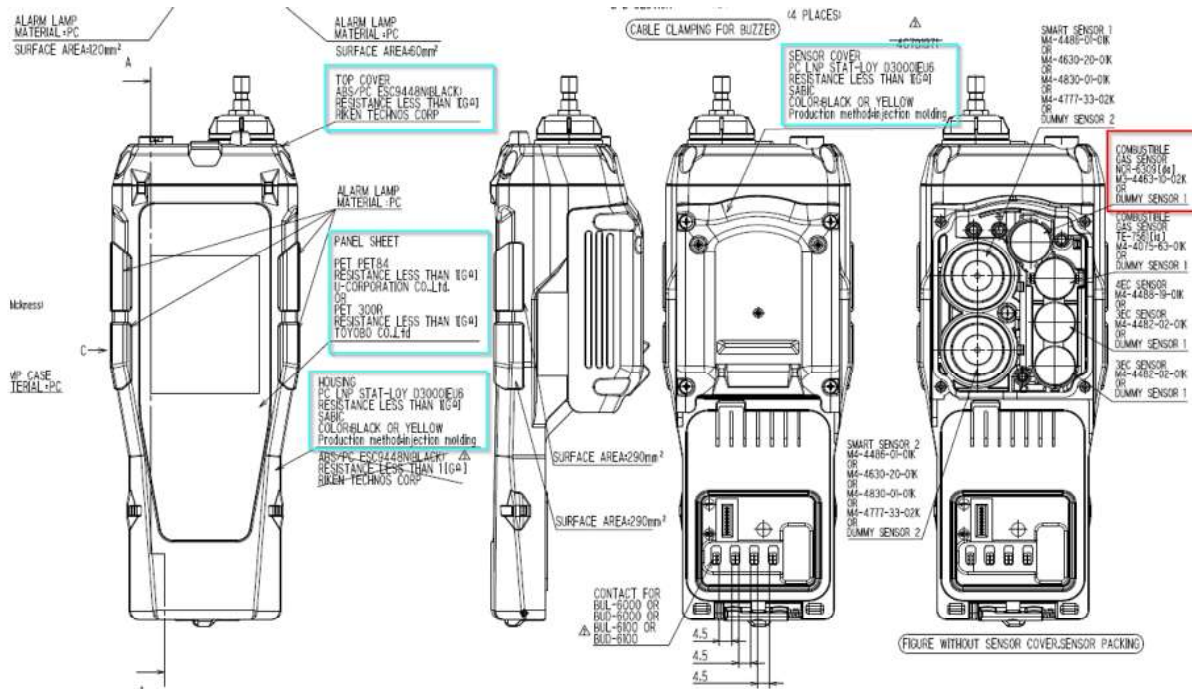
Data for used plastic:

For sensor, see drawing: M3-4463-10-02K. RTI required $> 75 \text{ }^{\circ}\text{C}$

For detector, see drawing M2-4777-33-01K.

All plastic materials part of detector enclosure surface have resistance of $< 1 \text{ G}\Omega$.

Used at:	Sensor NCR-6309 enclosure, see Picture 1, red rectangular	Detector enclosure, see Picture 1, blue rectangular: a) Top cover (black) b) Panel sheet c) Sensor cover and housing (black or yellow)
Manufacturer name	DIC Corporation	a) Riken TECHNOS CORP b) Toyobo Co.Ltd. c) Sabic
Material identification	PPS FZ-1130-D5 Colour: natural, Glass fillers: 30%	a) ESC 9448N b) PET 300R c) PC LNP STAT-LOY D3000IEU6-4G7B1971
Surface treatment	None	None
RTI	+130 $^{\circ}\text{C}$, graphics show no loss of strength at -40 $^{\circ}\text{C}$	N/A
Resistance to UV	Protected against UV by enclosure of the detector	N/A
Relevant for:	Ex d protection	Enclosure is not relevant for Ex i protection, but only as UV protection for sensor and for electrostatic requirements.



Picture 1: Overview of plastic materials used for gas monitors type GX-6100 with sensor Ex da

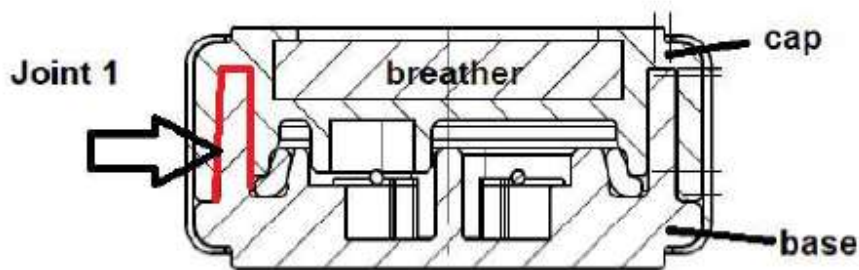
3 Type of protection flameproof:

3.1 General overview

The gas sensor, type NCR-6309, consists of two catalytic elements in a flameproof enclosure. It is used in the portable gas detectors GX force which are no part of this assessment (gas detectors are designed in Ex i protection). The gas sensor is fed by an Ex i signal from the gas detector.

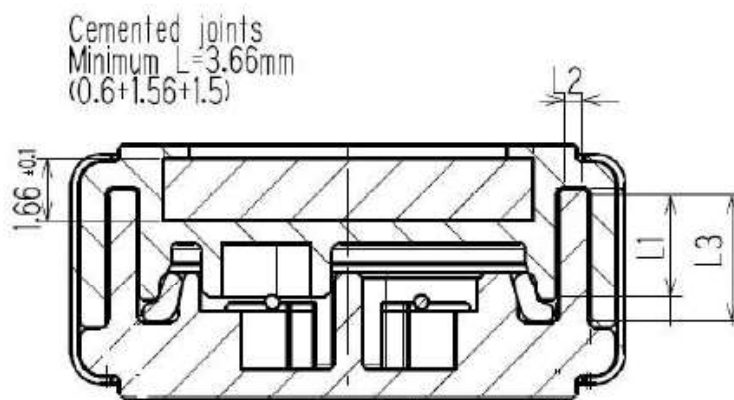
- Internal volume < 1 cm³

The gas sensor consists of two plastic enclosure halves (the Cap and the Base) permanently fixed together with metallic rim. A stainless steel breather element is enclosed in the cap by injection moulding.



Picture 2. Flameproof enclosure of the gas sensor NCR-6309

The enclosure consists of one multi-step joint and two cemented joints. As shown on picture 3 below



Picture 3. Flameproof enclosure of the gas sensor NCR-6309

3.2 Multi-step joints

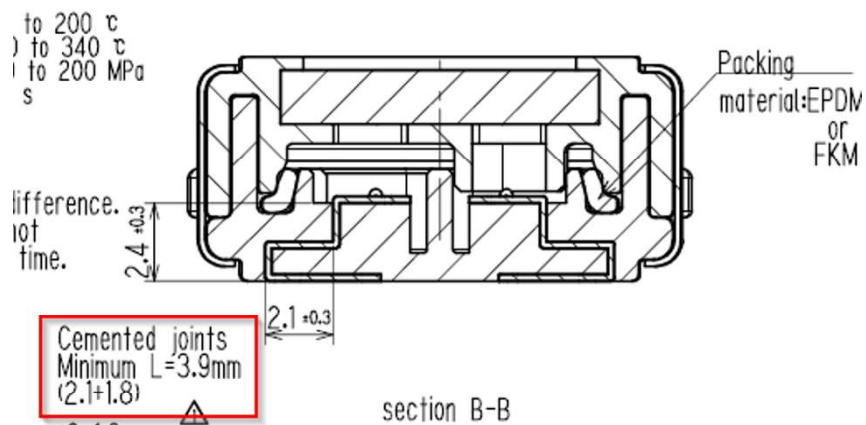
Table 1. Multi-step joint 1

Segment x	Lx min [mm] (specified drawing M3-4463-10-02K)	Gap max (ic) [mm] (specified drawing M3-4463-10-02K)
1	2.65	0.10
2	0.48	0.15
3	3.35	0.10
Total length:	6.48	-

3.3 Cemented joints

Table 2. Cemented joints 2 and 3

Cemented joints according to Clause 6.1.3	Requirement [mm]	Specification [mm]
Cemented joints 2 of electrical contacts	≥ 3	$3.9 = 2.1 + 1.8$
Cemented joints 3 of breather element	≥ 3	$3.66 = 0.6 + 1.56 + 1.5$



Picture 4. Flameproof enclosure of the gas sensor NCR-6309

Electrical data

Battery operated:

- Power supply of Li-ion battery unit : BUL-6000 and BUL-6100
- $U_m=250V$.
- Power supply of alkaline battery unit : BUD-6000 and BUD-6100

Type designation and Ex code

Tables below give relation between Ex code and used battery for both types of the equipment.

GX-6000:

Ex code	Ambient temperature	Battery
Ex ia IIB T4 Ga	-20 °C to +50 °C	BUL-6000 / BUL-6100
Ex ia IIB T4 Ga	-20 °C to +50 °C	BUD-6000 / BUD-6100 LR6T(JE) (Toshiba)
Ex ia IIB T3 Ga	-20 °C to +50 °C	BUD-6000 / BUD-6100 MN1500 (Duracell)

GX-6100:

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex da ia IIB T4 Ga	-20 °C to +50 °C	Mounted	BUL-6000 / BUL-6100
Ex ia IIB T4 Ga	-20 °C to +50 °C	Not mounted	BUL-6000 / BUL-6100
Ex da ia IIB T4 Ga	-20 °C to +50 °C	Mounted	BUD-6000 / BUD-6100 LR6T(JE) (Toshiba)
Ex ia IIB T4 Ga	-20 °C to +50 °C	Not mounted	BUD-6000 / BUD-6100 LR6T(JE) (Toshiba)
Ex da ia IIB T3 Ga	-20 °C to +50 °C	Mounted	BUD-6000 / BUD-6100 MN1500 (Duracell)
Ex ia IIB T3 Ga	-20 °C to +50 °C	Not mounted	BUD-6000 / BUD-6100 MN1500 (Duracell)

Ambient temperature range during battery charging for both types: 0 °C to +40 °C



IECEx TEST REPORT
Appendix B
Description of the tests



ExTR Reference Number.....:	See Report No. above	<i>A. Hadak</i>
ExTR Free Reference Number.....:	See report cover.	
Compiled by + signature (ExTL).....:	A. Hadak	
Reviewed by + signature (ExTL)	H.J.G. de Wild (Ex d part) B.P.O. Meijer (Ex i part)	<i>H.J.G. de Wild</i> <i>B.P.O. Meijer</i>
Date of issue (yyyy-mm-dd).....:	2024-04-15	
Ex Testing Laboratory (ExTL).....:	DEKRA Certification B.V.	
Address :	Meander 1051, 6825 MJ Arnhem, The Netherlands	
Applicant's name	See report cover.	
Address	See report cover.	
Test item description.....:	See report cover.	
Model/type reference.....:	See report cover.	
Standards.....:	See report cover.	
Test procedure.....:	IECEx System	
Instructions for Intended Use of ExTR Appendix B: Appendix B describes the tests performed.		
General remarks: The test results presented in this ExTR Appendix B relate only to the item or product tested. - Throughout this document, a point is used as the decimal separator. The technical content of this ExTR Appendix shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.		

TABLE OF CONTENTS

1	Test Samples and test sequence	3
1.1	Overview of samples	3
1.2	Test sequence	3
2	Tests of IEC 60079-0	4
2.1	Drop test	4
2.2	IP-tests	5
2.3	Temperature measurement	6
2.4	Thermal endurance to heat	6
2.5	Thermal endurance to cold	6
2.6	Measurement of capacitance	7
3	Tests of IEC 60079-1	8
3.1	Overpressure test (static)	8
3.2	Test for non-transmission of an internal ignition	8

1 Test Samples and test sequence

1.1 Overview of samples

no	Description
1	GX-Force (test sample 7)
2	GX-Force (test sample 8)
3	Gas Sensor NCR-6309, sample no. 3-1 (Sensors especially prepared for FNT)
4	Gas Sensor NCR-6309, sample no. 3-2 (Sensors especially prepared for FNT)
5	Gas Sensor NCR-6309, sample no. 3-3 (Sensors especially prepared for FNT)
6	Gas Sensor NCR-6309, sample no. 3-4 (Sensors especially prepared for FNT)
7	Gas Sensor NCR-6309, sample no. 3-5 (Sensors especially prepared for FNT)
8	Complete test sample / nipple

1.2 Test sequence

The test sequence is different for different set of samples and can be determined with dates of testing. The listed tests are performed and documented as part of IECEx report no. NO/DNV/ExTR21.0088/00.

Note: Temperature test performed and documented in NL/DEK/ExTR17.0047/01 is not listed below.

sample no			1	2	3	4	5	6	7	8
Standard	Test	Date								
IEC 60079-0	Thermal endurance to heat	2022-01-07 to 2022-02-04			X	X	X	X	X	
IEC 60079-0	Thermal endurance to cold	2022-02-07 to 2022-02-08			X	X	X	X	X	
IEC 60079-0	Drop test	2022-01-26	X	X						
IEC 60079-0	IP-test	2022-01-26	X							
IEC 60079-0	Measurement of capacitance	2022-01-25								X
IEC 60079-1	Overpressure test (static)	2022-03-16			X	X				
IEC 60079-1	Test for non-transmission of an internal ignition	2022-04-29 to 2022-05-17					X			

2 Tests of IEC 60079-0

2.1 Drop test

Equipment Tested:	GX-Force (test sample 7 and 8)
Date of Test (yyyy-mm-dd):	2022-01-26
Standard and Clause:	IEC 60079-0 : 2017 (Ed. 7), clause 26.4.3

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/Procedure:

4 drop tests on two different test samples are performed from a height of 1m onto a concrete surface. Ambient temperature: -45 °C for 24 hours prior to the tests. The actual tests were also performed in this temperature (inside freezer).



Picture: Temperature measured on channel A4

Results:
Only superficial scratches to the enclosure after drop tests. No damages to invalidate the protection, see photos below.



Conclusion

Pass, no damage affecting the type of protection.

2.2 IP-tests

Equipment Tested:	GX-Force (test sample 7)
Date of Test (yyyy-mm-dd):	2022-01-26
Standard and Clause:	IEC 60079-0 : 2017 (Ed.7), clause 26.4.5

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/Procedure:

Test probe for IP20 was used to determine the ingress protection, after the test sample was drop tested.

Result/conclusion :

The test probe could not enter the enclosure in any place. Ingress protection is IP20 or better.

2.3 Temperature measurement

Equipment Tested:	Sample Gas Sensor NCR-6309 in detector GX-3R and GX-3R Pro
Date of Test (yyyy-mm-dd):	2018-02-19 to 2018-02-21
Standard and Clause:	IEC 60079-0 : 2017 (Ed. 7), clause 26.5.1

Note: This test was performed and documented as part of NL/DEK/ExTR17.0047/01.

The service temperature has been measured and then calculated to +69.3 °C ($\Delta T=9.3$ K) on the external (plastic) surface of the gas sensor at the highest ambient temperature of +60 °C.

The highest surface temperature has been measured and then calculated to +79.4 °C ($\Delta T=19.4$ K) on the pressed metal wire of the (breather element) of the gas sensor at the highest ambient temperature of +60 °C.

2.4 Thermal endurance to heat

Equipment Tested:	Sample no. Gas Sensor NCR-6309 3-1, 3-2, 3-3, 3-4 and 3-5 (Sensors especially prepared for FNT)
Date of Test (yyyy-mm-dd):	2022-01-07 to 2022-02-04
Standard and Clause:	IEC 60079-0 : 2017 (Ed. 7), clause 26.8

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/Procedure:

The samples were submitted to continuous storage for:
4 weeks in an ambience of 90 % relative humidity and at a temperature of 90 °C

Result

No any visible damage or changes on samples was observed.

Conclusion

After the following tests

2.5 Thermal endurance to cold

Equipment Tested:	Sample no. Gas Sensor NCR-6309 3-1, 3-2, 3-3, 3-4 and 3-5 (Sensors especially prepared for FNT)
Date of Test (yyyy-mm-dd):	2022-02-07 to 2022-02-08
Standard and Clause:	IEC 60079-0 : 2017 (Ed. 7), clause 26.9

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/Procedure:

Samples were submitted to continuous storage for 24 hours in an ambience of a temperature of -46 °C

Result

No any visible damage or changes on samples was observed.

Conclusion

After the overpressure tests.

2.6 Measurement of capacitance

Equipment Tested:	Complete test sample / nipple
Date of Test (yyyy-mm-dd):	2022-01-25
Standard and Clause:	IEC 60079-0 : 2017 (Ed. 7), clause 26.14

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/procedure:

The test sample was conditioned for 1.5 hours in 25 °C and 50 % RH.

Results:

Test 1:

Stray capacitance 3-5 mm above nipple and unearthed metal plate: 6.8 pF

Measured capacitance between nipple and un-earthed metal plate: 7.8 pF
capacitance: 1 pF

Test 2:

Stray capacitance 3-5 mm above nipple and unearthed metal plate: 6.7 pF

Measured capacitance between nipple and un-earthed metal plate: 8.3 pF
capacitance: 1.6 pF

Test 3:

Stray capacitance 3-5 mm above nipple and unearthed metal plate: 6.5 pF

Measured capacitance between nipple and un-earthed metal plate: 8.0 pF
capacitance: 1.5 pF

Average capacitance = $(1 \text{ pF} + 1.6 \text{ pF} + 1.5 \text{ pF}) / 3 = 1.4 \text{ pF}$, $1.4 \text{ pF} < 3 \text{ pF}$

Conclusion

Pass, the measured capacitance is below the maximum allowed capacitance

3 Tests of IEC 60079-1

3.1 Overpressure test (static)

Equipment Tested:	Sample no. 3-1, 3-2 (Sensors especially prepared for FNT, flame non-transmission).
Date of Test (yyyy-mm-dd):	2022-03-16
Standard and Clause:	IEC 60079-1 : 2014 (Ed. 7), clause 15.2.3

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description/procedure

Test performed on normal ambient temperature. Sensor head tested empty, the wire mesh was covered with thin membrane from the inner side. Test performed in four test rounds.

The overpressure test was made at 14.5 bar. This pressure was held for 60 s. The ambient temperature during test was +20 °C.

Conclusion:

Pass, no leakage through the cemented joints, deformation or damage affecting the type of protection.

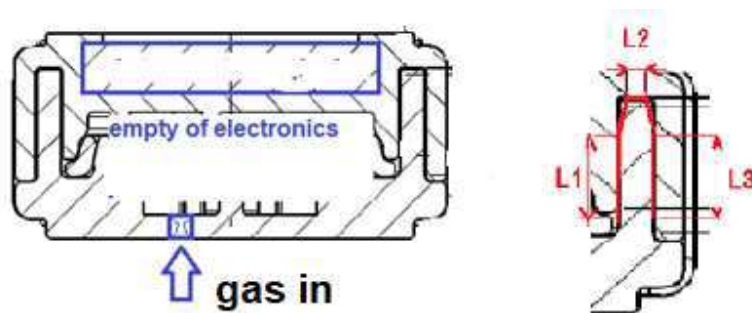
3.2 Test for non-transmission of an internal ignition

Equipment Tested:	Sample no. 3-3 (Sensors especially prepared for FNT)
Date of Test (yyyy-mm-dd):	2022-04-29 to 2022-05-17
Standard and Clause:	IEC 60079-1 : 2014 (Ed. 7), clause 15.3

Note: This test was performed and documented as part of NO/DNV/ExTR21.0088/00.

Description

Subject of this test was Joint 1 (multi-step joint) as shown on picture below. Test gap provided a follows.



Picture 3. Especially prepared sample of the gas sensor NCR-6309 enclosure for flame non-transmission test

Verification of the specially prepared sample for Flame Non-transmission test.

Multistep joint (declared and verified measures)

Segment	Lc max	Le (reduced)	Gap (ie)	Comment
1	1.95	74%	0.10	100%
2	0.35	73%	0.15	100%
3	2.5	75%	0.10	100%

For test arrangement see picture above. Ignition point was located on gas inlet.

The gas mixture was measured at the gas outlet from the both sample and external chamber prior to each internal ignition. The internal mixture was ignited by spark plug. The test was made at pre-compression pressure (1500-1530 mbar) and normal ambient temperature of 20 °C, 50 times with each gas mixture, for Acetylene within the range by (7.4 to 7.9)% volumetric ratio to air and with Hydrogen by (27.0 to 27.5)% volumetric ratio to air.

Mixture in external enclosure verified the same as in the test sample before each ignition.

Gas A: acetylene

Lab temp and pressure: +21°C, 1012-1015 mbar.

Gas B: hydrogen

Lab temp and pressure: +21°C, 1004-1007 mbar.

Ignition no	O ₂ %	Pressure	Result	Ignition no	O ₂ %	Pressure	Result
1	19.40	1520	Pass	1	15.29	1500	Pass
2	19.38	1520	Pass	2	15.28	1500	Pass
3	19.37	1520	Pass	3	15.27	1500	Pass
4	19.37	1530	Pass	4	15.25	1500	Pass
5	19.37	1530	Pass	5	15.25	1500	Pass
6	19.37	1520	Pass	6	15.24	1500	Pass
7	19.36	1530	Pass	7	15.24	1500	Pass
8	19.36	1520	Pass	8	15.24	1500	Pass
9	19.36	1520	Pass	9	15.24	1500	Pass
10	19.36	1520	Pass	10	15.24	1510	Pass
11	19.36	1520	Pass	11	15.24	1510	Pass
12	19.35	1520	Pass	12	15.24	1510	Pass
13	19.35	1530	Pass	13	15.23	1510	Pass
14	19.35	1530	Pass	14	15.23	1500	Pass
15	19.35	1520	Pass	15	15.23	1500	Pass
16	19.35	1520	Pass	16	15.23	1500	Pass
17	19.34	1530	Pass	17	15.23	1510	Pass
18	19.34	1520	Pass	18	15.23	1510	Pass
19	19.34	1530	Pass	19	15.23	1510	Pass
20	19.34	1530	Pass	20	15.23	1510	Pass
21	19.34	1530	Pass	21	15.22	1500	Pass
22	19.34	1530	Pass	22	15.22	1500	Pass
23	19.34	1530	Pass	23	15.22	1510	Pass
24	19.33	1520	Pass	24	15.22	1500	Pass
25	19.33	1530	Pass	25	15.22	1500	Pass
26	19.33	1520	Pass	26	15.22	1500	Pass
27	19.33	1520	Pass	27	15.22	1510	Pass
28	19.33	1520	Pass	28	15.22	1510	Pass
29	19.33	1520	Pass	29	15.22	1510	Pass



30	19.33	1520	Pass	30	15.21	1510	Pass
31	19.33	1520	Pass	31	15.21	1510	Pass
32	19.32	1520	Pass	32	15.21	1510	Pass
33	19.32	1520	Pass	33	15.21	1510	Pass
34	19.32	1530	Pass	34	15.21	1510	Pass
35	19.32	1520	Pass	35	15.21	1510	Pass
36	19.32	1520	Pass	36	15.21	1510	Pass
37	19.32	1520	Pass	37	15.21	1510	Pass
38	19.32	1520	Pass	38	15.21	1510	Pass
39	19.32	1520	Pass	39	15.20	1510	Pass
40	19.31	1530	Pass	40	15.20	1510	Pass
41	19.31	1520	Pass	41	15.20	1510	Pass
42	19.31	1520	Pass	42	15.20	1510	Pass
43	19.31	1520	Pass	43	15.20	1510	Pass
44	19.31	1530	Pass	44	15.20	1510	Pass
45	19.31	1520	Pass	45	15.20	1510	Pass
46	19.31	1520	Pass	46	15.20	1510	Pass
47	19.31	1520	Pass	47	15.20	1510	Pass
48	19.30	1520	Pass	48	15.20	1510	Pass
49	19.30	1520	Pass	49	15.19	1510	Pass
50	19.30	1520	Pass	50	15.19	1510	Pass

Conclusion:

Pass, no transmission to the surrounding atmosphere



IECEX TEST REPORT APPENDIX B DESCRIPTION OF THE TESTS

ExTR Reference Number	NL/DEK/ExTR17.0047/01	
ExTR Free Reference Number	222988000	
Compiled by + signature (ExTL)	A. Hamaker	
Reviewed by + signature (ExCB)...	K.R. Sekhri	
Date of issue.....	2018-11-16	
Ex Testing Laboratory (ExTL)	DEKRA Certification B.V.	
Address :	Meander 1051, 6825 MJ Arnhem, The Netherlands	
Applicant's name.....	Riken Keiki Co.,Ltd	
Address.....	2-7-6, Azusawa, Itabashi-ku, Tokyo 174-8744, Japan	
Test item description.....	Gas Sensor	
Model/type reference.....	NCR-6309	
Standards	See cover sheet	
Test procedure	IECEX System	
Test Report Form Number	N/A	
Instructions for Intended Use of ExTR Appendix B: Appendix B describes the tests performed.		
General remarks: The test results presented in this ExTR Appendix B relate only to the item or product tested. <ul style="list-style-type: none">- Throughout this document, a point is used as the decimal separator.- When a series of sample is intended this is noted with an '-' e.g. no.'s 34 up to and including 41 is noted as: 34-41 or 34 – 41. The technical content of this ExTR Appendix shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.		

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

TABLE OF CONTENTS

1	Test Samples and test sequence	3
1.1	Overview of samples	3
1.2	Test sequence	5
2	Tests of IEC 60079-0	7
2.1	Resistance to impact before thermal test	7
2.2	Resistance to impact general	8
2.3	Resistance to impact for max. ambient temperature: +60 °C	10
2.4	Temperature measurement GX-3R	12
2.5	Temperature measurement GX-3R Pro	14
2.6	Thermal endurance to heat of sensors	16
2.7	Thermal endurance to cold of sensors	16
2.8	Thermal endurance to heat of enclosures	16
2.9	Thermal endurance to cold of enclosures	17
2.10	Thermal endurance to heat of sensors seq. 4	17
2.11	Thermal endurance to cold of sensors seq. 4	17
2.12	Thermal endurance to heat for seq. 5	18
2.13	Thermal endurance to cold for seq. 5	18
3	Tests of IEC 60079-1	19
3.1	Overpressure test (static) before aging	19
3.2	Overpressure test (static) after aging	20
3.3	Test for non-transmission of an internal ignition	21
3.4	Tests of flameproof enclosures with breathing and draining devices	23
3.5	Thermal tests	23
3.6	Bubble test pore size	25
3.7	Density determination	27

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

1 Test Samples and test sequence

1.1 Overview of samples

Sample No	Description	Quantity,
1	Part: Sensor <ul style="list-style-type: none"> Without caulking cap Internal rims removed Holes: suitable for support jig T1 	1 for thermal test breather
2, 3, 4, 5, 6, 7, 8 and 9	Part: Sensor <ul style="list-style-type: none"> Caulking Cap, not caulked Breather blocked from the inside E.g. with silicon kit Internal rims removed With M3 (female) hole in Base Suitable for flame-propagation test 	4 for aging + overpressure Rest: spare.
10 and 11	Part: Sensor <ul style="list-style-type: none"> Breather blocked from the inside E.g. with silicon kit With M3 (female) hole in Base 	2 for overpressure test before aging.
Worst of: 2, 3, 4, 5, 6, 7, 8 or 9 after testing	Part: Sensor housing with breather <ul style="list-style-type: none"> Without Caulking Cap Gap between 90 and 100% of max. design. Joint width < 115% of min. of 6 mm Flat parts gap: > 1 mm Pore size > 85% of 139.3 µm 	1 for flame propagation
12, 13 and 14	Part: Breather <ul style="list-style-type: none"> Breather complete with Cap. 	3 for bubble test.
15 m (multiple)	Part: Breather <ul style="list-style-type: none"> Bare breather without any other material than the pressed metal wire. Breather composition as designed. 	≥ 3, at least > 5 gram in total For density measurement
18, 19, 20, 21, 22, 23, 24 and 25	Part: Sensor <ul style="list-style-type: none"> Caulking Cap (Caulked) Breather blocked from the inside E.g. with silicon kit Internal rims removed With M3 (female) hole in Base 	4 for aging + overpressure 4 spare
26, 27, 28, 29, 30, 31, 32 and 33	Part: Equipment enclosure <ul style="list-style-type: none"> Empty GX-3R enclosure Empty GX-3R Pro enclosure 	4 Samples GX-3R 4 Samples GX-3R Pro To be aged and used for impact testing.

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

Sample No	Description	Quantity,
34, 35, 36, 37, 38, 39, 40 and 41	Part: Equipment enclosure <ul style="list-style-type: none"> • Empty GX-3R enclosure • Empty GX-3R Pro enclosure 	4 Samples GX-3R 4 Samples GX-3R Pro To be aged and used for impact testing.
48 thru 52	Part: Sensor <ul style="list-style-type: none"> • With caulking cap • With blind plate instead of breather • Hole in blind plate: M3 	4 in total for overpressure tests before and after aging to test changed electrical contact preparation. 1 for spare.
1 T 72347-1	Part: <ul style="list-style-type: none"> • Complete gas monitor GX-3R • Including sensors 	1 for service temperature measurement
2 T 72347-2	Part: <ul style="list-style-type: none"> • Complete gas monitor GX-3R Pro • Including sensors 	1 for service temperature measurement
Support parts	Part: <ul style="list-style-type: none"> • Charger • Dry cell batteries 	2 for overpressure before aging
Additional samples for NL/DEK/ExTR17.0047/01		
no	Description	
1 - 4 73804 1-4	Part: Equipment enclosure <ul style="list-style-type: none"> • Empty GX-3R enclosure 4 off: • Sensor cap: PC B-4110R • Sensor cover: PC B-4110R 	
5 - 8. 73804 5-8	Part: Equipment enclosure <ul style="list-style-type: none"> • Empty GX-3R Pro enclosure 4 off: • Sensor cap: PC B-4110R • Sensor cover: PC B-4110R 	
9 - 16 73804	Part: <ul style="list-style-type: none"> • NCR 6309 sensor 	
17 - 20 73804 9-12	Part: Equipment enclosure <ul style="list-style-type: none"> • Empty GX-3R enclosure 4 off: • Sensor cap: PC B-4110R • Sensor cover: Teijin Panlite L-1225Z100M 	
21 - 24. 73804 13-16	Part: Equipment enclosure <ul style="list-style-type: none"> • Empty GX-3R Pro enclosure 4 off: • Sensor cap: PC B-4110R • Sensor cover: Teijin Panlite L-1225Z100 	
25 - 32 73804	Part: <ul style="list-style-type: none"> • NCR 6309 sensor 	

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

1.2 Test sequence

The test sequence is top down according the table below.

Test	sample no	1	2-5	10, 11	12-14	15 m	18-21	22-25	34-41	1T	2T	18, 49	50, 51
Sequence 1													
60079-1													
B.2.3 pore size					X								
10.8 impact test	X				X 13								
15.4.3.1 thermal test breather	X				X 13								
15.2.3.2 Overpressure test before aging			X										
B.2.4 Density determination						X							
60079-0													
26.8 Endurance to heat		X					X						
26.9 Endurance to cold		X					X						
60079-1													
15.2.3.2 Overpressure test		X					X	X					
15.3.3.4 Dimension check		X											
15.3.3.4 Non-transmission		X 5											
60079-0													
26.8 Endurance to heat									X				
26.9 Endurance to cold									X				
26.4.2 Impact test		X							X				
Sequence 2													
60079-0													
26.5.1.2 Temperature measurement										X	X		
Sequence 4													
60079-1													
15.2.3.2 Overpressure test												X	
60079-0													
26.8 Endurance to heat													X
26.9 Endurance to cold													X
60079-1													
15.2.3.2 Overpressure test													X

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

Sequence 5 for NL/DEK/ExTR17.0047/01

sample no	1-4	5-8	9-16	17-20	21-24	25-32
Test						
60079-0						
Thermal endurance to heat	X	X	X	X	X	X
Thermal endurance to cold	X	X	X	X	X	X
Resistance to impact	X	X	X			

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2 Tests of IEC 60079-0

2.1 Resistance to impact before thermal test

Sample(s) Tested:	Sample no. 1, 13
Date of Test (dd/mm/yyyy):	04/12/2017
Standard and Clause:	IEC 60079-0:2011, clause 26.4.2

Description:

The samples were submitted to the effect of a test mass of 1 kg falling vertically from a height (h).

Procedure:

The mass is fitted with an impact head in hardened steel in the form of a hemisphere of 25 mm diameter.

Before each test, the surface of the impact head is checked for good condition.

The points of impact are the places considered to be the weakest.

The samples were placed on a steel base, having a mass of at least 20 kg, so that the direction of the impact was normal to the surface being tested at the point of impact.

Result:

Sample no.	Height h [m]	Temperature of the sample [°C]	Location of impact	Result
1	0.7	20	On breather cell	Slight flattening of breather
1	0.7	20	On breather cell	Slight flattening of breather

Remarks:

The sensor was hit directly on the breather, no protection or guards mounted.

For support the sensor was placed in an empty enclosure.

Result; no damage affecting the type of protection.

Picture:



Sensor after impact.

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

2.2 Resistance to impact general

Sample(s) Tested:	Sample no. 34 – 41 using 18 – 21
Date of Test (dd/mm/yyyy):	28/02/2018 and 09/03/2018
Standard and Clause:	IEC 60079-0:2011, clause 26.4.2

Description:

The samples were submitted to the effect of a test mass of 1 kg falling vertically from a height (*h*).

Procedure:

The mass is fitted with an impact head in hardened steel in the form of a hemisphere of 25 mm diameter.

Before each test, the surface of the impact head is checked for good condition.

The points of impact are the places considered to be the weakest.

The samples were placed on a steel base, having a mass of at least 20 kg, so that the direction of the impact was normal to the surface being tested at the point of impact.

The sensors 18 – 21 were placed in the enclosures before testing and inspected afterward for damage

Result:

Sample no.	Height <i>h</i> [m]	Temperature of the sample [°C]	Location of impact	Result
36, 18	0.7	+73	Top of sensor cap	Dent and cracks in enclosure Sensor not affected
36, 18	0.7	+73	Side of sensor cap	Dent in enclosure Sensor not affected
37, 19	0.7	+73	Top of sensor cap	Dent and cracks in enclosure Sensor not affected
37, 19	0.7	+73	Side of sensor cap	Dent and cracks in enclosure Sensor not affected
40, 20	0.7	+73	Top of sensor cap	Dent and small crack in enclosure Sensor not affected
40, 20	0.7	+73	Side of sensor cap	Dent in enclosure Sensor not affected
41, 21	0.7	+73	Top of sensor cap	Dent and cracks in enclosure Sensor not affected
41, 21	0.7	+73	Side of sensor cap	Dent and cracks in enclosure Sensor not affected
34, 18	0.7	-47	Top of sensor cap	Cracks in enclosure Sensor not affected
34, 18	0.7	-47	Side of sensor cap	Cracks in enclosure, cap broke Sensor not affected
35, 19	0.7	-47	Top of sensor cap	Cracks in enclosure Sensor not affected
35, 19	0.7	-47	Side of sensor cap	Dent in enclosure Sensor not affected
38, 20	0.7	-47	Top of sensor cap	Dent and cracks in enclosure Sensor not affected

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

38, 20	0.7	-47	Side of sensor cap	Dent and cracks in enclosure Sensor not affected
39, 21	0.7	-47	Top of sensor cap	Small cracks in enclosure Sensor not affected
39, 21	0.7	-47	Side of sensor cap	Dent in enclosure Sensor not affected

Result: the protective enclosure is damaged, but the sensor did not suffer damage affecting the type of protection.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2.3 Resistance to impact for max. ambient temperature: +60 °C

Sample(s) Tested:	Sample no.'s: 1 up and till 16
Date of Test (dd/mm/yyyy):	09/10/2018 and 11/10/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.4.2 and 26.4.4

Description:

The samples were submitted to the effect of a test mass of 1 kg falling vertically from a height (*h*).

Procedure:

The mass is fitted with an impact head in hardened steel in the form of a hemisphere of 25 mm diameter.

Before each test, the surface of the impact head is checked for good condition.

The points of impact are the places considered to be the weakest.

The samples were placed on a steel base, having a mass of at least 20 kg, so that the direction of the impact was normal to the surface being tested at the point of impact.

See overview on the next page.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

Results:

Sample no.	Height h [m]	Temperature of the sample [°C]	Location of impact	Result
1	0.7	+82	On top of sensor cover	Guard broke / cracked, Sensor not affected.
1	0.7	+82	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
2	0.7	+82	On top of sensor cover	Guard broke / cracked, Sensor not affected.
2	0.7	+82	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
3	0.7	-47	On top of sensor cover	Guard broke / cracked, Sensor: superficial damage.
3	0.7	-47	At side of sensor cover near joint	Guard broke / cracked, Sensor: superficial damage.
4	0.7	-47	On top of sensor cover	Guard broke / cracked, Sensor not affected.
4	0.7	-47	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
5	0.7	+82	On top of sensor cover	Guard broke / cracked, Sensor not affected.
5	0.7	+82	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
6	0.7	+82	On top of sensor cover	Guard broke / cracked, Sensor not affected.
6	0.7	+82	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
7	0.7	-47	On top of sensor cover	Guard broke / cracked, Sensor not affected.
7	0.7	-47	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.
8	0.7	-47	On top of sensor cover	Guard broke / cracked, Sensor not affected.
8	0.7	-47	At side of sensor cover near joint	Guard broke / cracked, Sensor not affected.

Conclusion:

Pass, no damage affecting the type of protection.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2.4 Temperature measurement GX-3R

Equipment Tested:	Sample no. 1 T
Date of Test (dd/mm/yyyy):	19/02/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.5.1

This test is performed to determine the service temperature of the Gas Monitor when operating, since it is used as protection of the Sensor.

Description

- Sample mounted in different normally used positions, in drought free room ambient.
- The final temperature is considered to be reached when the rate of rise of temperature does not exceed 1 K/h.
- The measuring devices (thermocouples, thermometers, etc.) and the connecting cables are selected and arranged so that they do not significantly affect the thermal behavior of the sample.

Conditions of loading/output/operation:

Where the sample rating is a range, test is performed at the highest or lowest rating value in the range, whichever gave the highest temperature rise.

Test condition and result sample 1 T (GX-3R):

Sample number:	U _{rated} [Vdc]	I _{rated} [mA]	Power [mW]	U _{test} : [Vdc]	I _{test} : [mA]	Power [mW]	ambient: [°C]	Test position:
1 T	3.7	64.1	237	4.2	57.3	241	21.5	Vertical position (sensors upward)
Dekra reporter ID: 42381								
Report annex: 1								
Method of measurement was performed with: *) TC(J) = Thermocouple J-type, TC(K) = Thermocouple K-type, RR = Rise-of-Resistance method, TM = Thermometer								
*) used method is applicable for all channels								
Channel number	Location of measurement (component / surface / part)		Maximum absolute [°C]		Maximum DeltaT [K]			
1	Housing, inside center		24.7		3.2			
2	Housing, inside near sensors		24.7		3.2			
3	Housing, inside opposite sensors		24.3		2.8			
4	Housing, inside close to center sensor		23.1		1.6			
5	Housing, inside close to outer sensor		23.5		2.0			
6	Inside outer cap		23.3		1.8			
7	Lab ambient (inside cabinet)		21.5		0.0			

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

Sample number:	U _{rated} [Vdc]	I _{rated} [mA]	Power [mW]	U _{test} : [Vdc]	I _{test} : [mA]	Power [mW]	ambient: [°C]	Test position:
1	3.7	64.1	237	4.2	57.3	241	20.5	horizontal position (batteries downward)
Dekra reporter ID: 42390 Report annex: 2								
Method of measurement was performed with: *) TC(J) = Thermocouple J-type, TC(K) = Thermocouple K-type, RR = Rise-of-Resistance method, TM = Thermometer *) used method is applicable for all channels								
Channel number	Location of measurement (component / surface / part)					Maximum absolute [°C]	Maximum DeltaT [K]	
1	Housing, inside center					23.7	3.4	
2	Housing, inside near sensors					23.6	3.3	
3	Housing, inside opposite sensors					23.4	3.1	
4	Housing, inside close to center sensor					22.0	1.7	
5	Housing, inside close to outer sensor					22.4	2.1	
6	Inside outer cap					22.0	2.2	
7	Lab ambient (inside cabinet)					20.5	0.0	

Remarks:

Maximum power dissipation according to customer at 114% of rated voltage, with fully charged batteries.
Prior to the test, batteries were fully loaded with customer's charger.
Alarm mode was activated as per customer's instructions.
Test was performed in a sound proof cabinet.

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

2.5 Temperature measurement GX-3R Pro

Equipment Tested:	Sample no. 2 T
Date of Test (dd/mm/yyyy):	20-21/02/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.5.1

This test is performed to determine the service temperature of the Gas Monitor when operating, since it is used as protection of the Sensor.

Description

- Sample mounted in different normally used positions, in drought free room ambient.
- The final temperature is considered to be reached when the rate of rise of temperature does not exceed 1 K/h.
- The measuring devices (thermocouples, thermometers, etc.) and the connecting cables are selected and arranged so that they do not significantly affect the thermal behavior of the sample.

Conditions of loading/output/operation:

Where the sample rating is a range, test is performed at the highest or lowest rating value in the range, whichever gave the highest temperature rise.

Test condition and result sample 1 T (GX-3R Pro):

Sample number:	U _{rated} [Vdc]	I _{rated} [mA]	Power [mW]	U _{test} : [Vdc]	I _{test} : [mA]	Power [mW]	ambient: [°C]	Test position:
2	3.0	100.0	300	2.7	119.2	322	21.1	Vertical position (sensors upward)
Dekra reporter ID: 42397								
Report annex: 1								
Method of measurement was performed with: *) TC(J) = Thermocouple J-type, TC(K) = Thermocouple K-type, RR = Rise-of-Resistance method, TM = Thermometer								
*) used method is applicable for all channels								
Channel number	Location of measurement (component / surface / part)		Maximum absolute [°C]		Maximum DeltaT [K]			
1	Housing, inside center		24.3		3.3			
2	Housing, inside near sensors		25.1		4.0			
3	Housing, inside opposite sensors		25.4		4.3			
4	Housing, inside close to center sensor		24.2		3.1			
5	Housing, inside close to outer sensor		23.8		2.7			
6	Inside outer cap		23.5		2.5			
7	Lab ambient (inside cabinet)		21.1		0.0			

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

Sample number:	U _{rated} [Vdc]	I _{rated} [mA]	Power [mW]	U _{test} : [Vdc]	I _{test} : [mA]	Power [mW]	ambient: [°C]	Test position:
2	3.0	100.0	300	2.7	119.2	322	21.3	Horizontal position (batteries downward)
Dekra reporter ID: 42402 Report annex: 1								
Method of measurement was performed with: *) TC(J) = Thermocouple J-type, TC(K) = Thermocouple K-type, RR = Rise-of-Resistance method, TM = Thermometer *) used method is applicable for all channels								
Channel number	Location of measurement (component / surface / part)		Maximum absolute [°C]		Maximum DeltaT [K]			
1	Housing, inside center		24.2		3.0			
2	Housing, inside near sensors		25.1		3.9			
3	Housing, inside opposite sensors		25.5		4.2			
4	Housing, inside close to center sensor		24.0		2.8			
5	Housing, inside close to outer sensor		23.5		2.3			
6	Inside outer cap		23.3		2.1			
7	Lab ambient (inside cabinet)		21.3		0.0			

Remarks:

Maximum power dissipation according to customer at 90% of rated voltage, with battery charge of 1/3.
Alarm mode was activated as per customer's instructions.
Test was performed in a sound proof cabinet.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2.6 Thermal endurance to heat of sensors

Equipment Tested:	Sample no. 2 – 5, 18 – 21
Date of Test (dd/mm/yyyy):	20/12/2018 – 17/01/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.8

Description:

The samples were submitted to continuous storage for:
336 h in an ambience of 90 % relative humidity and at a temperature of +95 °C,
followed by a period of 336 h at a temperature of +103 °C.

Result:

The samples showed discolouration of the material.

Conclusion:

Depending on other tests.

2.7 Thermal endurance to cold of sensors

Equipment Tested:	Sample no. 2 – 5, 18 – 21
Date of Test (dd/mm/yyyy):	18-19/01/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.9

Description:

Samples were submitted to continuous storage for 24 hours in an ambience of a temperature of -47 °C

Result:

The samples showed no visual effect at all.

Conclusion:

Depending on other tests.

2.8 Thermal endurance to heat of enclosures

Equipment Tested:	Sample no. 34 – 41
Date of Test (dd/mm/yyyy):	26/01-23/02/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.8

Description:

The samples were submitted to continuous storage for:
672 h in an ambience of 90 % relative humidity and at a temperature of +80 °C

Result:

The samples showed no visual effect at all.

Conclusion:

Depending on other tests.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2.9 Thermal endurance to cold of enclosures

Equipment Tested:	Sample no. 34 – 41
Date of Test (dd/mm/yyyy):	26-27/02/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.9

Description:

Samples were submitted to continuous storage for 24 hours in an ambience of a temperature of -47 °C

Result:

The samples showed no visual effect at all.

Conclusion:

Depending on other tests.

2.10 Thermal endurance to heat of sensors seq. 4

Equipment Tested:	Sample no. 50, 51
Date of Test (dd/mm/yyyy):	16/04/2018 – 15/05/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.8

Description/Procedure:

The samples were submitted to continuous storage for:

336 h in an ambience of 90 % relative humidity and at a temperature of 95 °C, followed by a period of 336 h at a temperature of 103 °C.

Result:

The samples showed discolouration of the material.

Conclusion:

After the following tests

2.11 Thermal endurance to cold of sensors seq. 4

Equipment Tested:	Sample no. 50, 51
Date of Test (dd/mm/yyyy):	15-16/05/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.9

Description/Procedure:

Samples were submitted to continuous storage for 24 hours in an ambience of a temperature of -47 °C

Result:

The samples showed no visual effect at all.

Conclusion:

After the following tests

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

2.12 Thermal endurance to heat for seq. 5

Equipment Tested:	Sample no.'s: 1 up and till 32
Date of Test (dd/mm/yyyy):	07/09/2018 – 05/10/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.8

Description/Procedure:

The samples were submitted to continuous storage for:
672 hours in an ambience of 90 % relative humidity and at a temperature of +90 °C.

Result:

The samples showed no visual effect at all.

Remark:

Covers are not opened and re-closed, since there are no covers that can be opened at the Sensor.

Conclusion: After the following tests.

2.13 Thermal endurance to cold for seq. 5

Equipment Tested:	Sample no.'s: 1 up and till 32
Date of Test (dd/mm/yyyy):	08/10/2018 to 09/10/2018
Standard and Clause:	IEC 60079-0:2011 clause 26.9

Description/Procedure:

Samples were submitted to continuous storage for 24 hours in an ambience of a temperature of -47 °C

Result

The samples showed no visual effect at all.

Remark:

Covers are not opened and re-closed, since there are no covers that can be opened at the Sensor.

Conclusion: After the following tests.

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

3 Tests of IEC 60079-1

3.1 Overpressure test (static) before aging

Equipment Tested:	Sample no. 48, 49
Date of Test (dd/mm/yyyy):	28/03/2018
Standard and Clause:	IEC 60079-1:2014 clause 15.2.3

Description.

The overpressure test was carried out at room temperature.

First method (static).

At the following pressures, since reference pressure determination has been impracticable:

Test applied	Volume (cm ³)	Group	Pressure [kPa] ^a
YES	≤ 10	I, IIA, IIB, IIC	1000
NO	> 10	I	1000
NO	> 10	IIA, IIB	1500
NO	> 10	IIC	2000

a) For equipment intended for use at an ambient temperature below –20 °C, the above pressures shall be increased by the appropriate test factors noted in Table 7.

Increased to 1450 kPa for –40 °C ambient low.

The period of application of the pressure was at least 10 s but shall exceed 60 s.

The test is made once on each sample.

Result: no leakage, deformation or damage affecting the type of protection

Pictures:



No leakage at contacts of sample 48



No leakage at contacts of sample 49

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

3.2 Overpressure test (static) after aging

Equipment Tested:	Sample no. 50 – 51
Date of Test (dd/mm/yyyy):	18/05/2018
Standard and Clause:	IEC 60079-1:2014 clause 15.2.3

Description.

The overpressure test was carried out at room temperature.

First method (static).

At the following pressures, since reference pressure determination has been impracticable:

Test applied	Volume (cm ³)	Group	Pressure [kPa] ^a
YES	≤ 10	I, IIA, IIB, IIC	1000
NO	> 10	I	1000
NO	> 10	IIA, IIB	1500
NO	> 10	IIC	2000

a) For equipment intended for use at an ambient temperature below –20 °C, the above pressures shall be increased by the appropriate test factors noted in Table 7.

Increased to 1450 kPa for –40 °C ambient low.

The period of application of the pressure was at least 10 s but shall exceed 60 s.

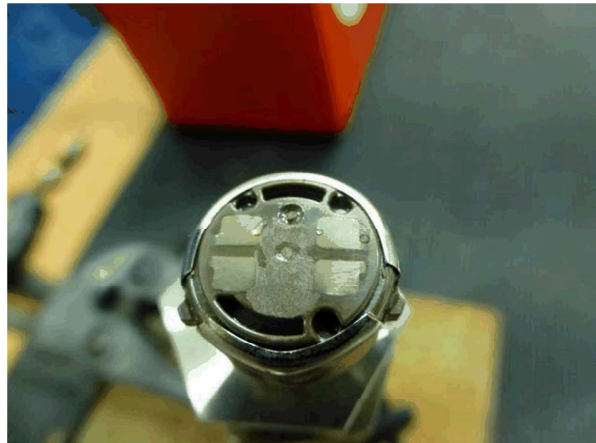
The test is made once on each sample.

Result: no leakage up to 1200 kPa. Above 1200 kPa droplet leakage.

Pictures:



Leakage at contacts of sample 50 > 1200 kPa



Leakage at contacts of sample 51 > 1200 kPa

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

3.3 Test for non-transmission of an internal ignition

Equipment Tested:	Sample no. 5 using tool 1
Date of Test (dd/mm/yyyy):	12-15/03/2018
Standard and Clause:	IEC 60079-1:2014 clause 15.3.3.4 / 15.4.4.3.3

Description

The non-transmission tests were carried out on a sample of the enclosure under the following conditions:

- Enclosure tested empty, because of the small size of the equipment a tool is used to hold the equipment. The tool, with an internal volume as small as possible, is to make the required connections possible.
- Ambient/sample temperature: room temperature.
- No overpressure applied.
- Tested with oxygen enrichment.

The sample was prepared as follows:

- All o-rings removed.
- So called 'caulking cap' removed.
- The cylindrical joint checked to be $\geq 90\%$ of constructional gap.
- Gap length checked to be $\leq 115\%$ of min. length.
- The flat part of the flamepath is enlarged to 0.3 mm

Location of gas connections, pressure transducers and ignition source:

Spark plug 1: At side wall of test enclosure (Tool T1)
P.T. (1): At side wall of test enclosure (Tool T1)
P.T. (2): At manifold of test vessel
Gas in: At side wall of test enclosure (Tool T1)
Gas out: At side wall of test enclosure (Tool T1)

Tests performed:


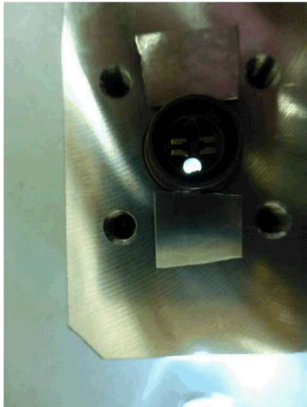
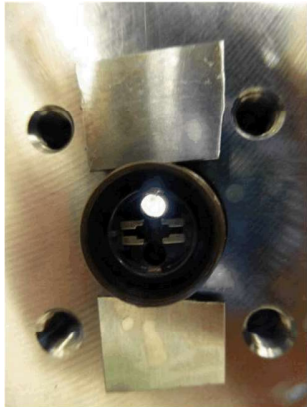
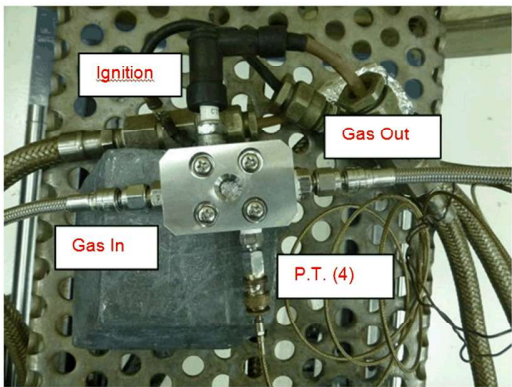


Fifty (50) tests with $(40 \pm 1) \%$ hydrogen, $(20 \pm 1) \%$ oxygen and the rest nitrogen and
Fifty (50) tests with $(10 \pm 1) \%$ acetylene, $(24 \pm 1) \%$ oxygen and the rest nitrogen.

At all tests the internal volume ignited without propagation to the surrounding atmosphere.

Result: no transmission to the surrounding atmosphere.

Pictures of set-up on next page:

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

 <p>Flat part of joint enlarged with 0.3 mm shim</p>	 <p>gas inlet open (checked with a light source)</p>	 <p>gas outlet open (checked with a light source)</p>
 <p>Test enclosure in test vessel with connections</p>	 <p>Bottom part after 100 ignitions</p>	 <p>Top part after 100 ignitions</p>

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

3.4 Tests of flameproof enclosures with breathing and draining devices

General.

Tests of ability of the enclosure to withstand pressure.

The tests are in accordance with 15.1 with the following additions and modifications:

Determination of the explosion pressure not performed because of the very small internal volume.

For the overpressure test in accordance with 15.2.3 a thin flexible membrane (silicon kit) was laid over the inner surfaces of the breathing device.

Result:

After the overpressure test, the device did not show permanent deformation or damage, affecting the type of protection.

3.5 Thermal tests

Equipment Tested:	Sample no. 5 and breather 13
Date of Test (dd/mm/yyyy):	08/12/2017
Standard and Clause:	IEC 60079-1:2014 clause 15.4.3.1

Description.

The enclosure with the device(s) fitted was tested in accordance with the method 15.4.3.1 but with the ignition source only in one position as provided by tool 1.

The temperature of the external surface of the device(s) was monitored during the test.

The test was made five times with (4.2 ± 0.1) % propane in volumetric ratio with air and at atmospheric pressure and five times with (7.5 ± 1) % acetylene in volumetric ratio with air and at atmospheric pressure.

In an enclosure where there is the possibility of a forced or induced flow of a potentially dangerous gas, the enclosure is arranged during the tests so that the gas can flow through the device(s) and the enclosure. After each of the tests the external explosive mixture was maintained for a sufficient time to allow any continuous burning of the face of the device to become evident (e.g. for at least 10 min so as to increase the temperature of the external surface of the device or to make heat transfer to the outer face possible).

Ign	Gas mixture 4.2 ± 0.1 % propane (C ₃ H ₈)				
	Measured Temperature [°C]	Ambient [°C]	ΔT [K]	Safety factor 1,2	Max. external Surface [°C] <i>calculated</i>
1	22.0	20.7	1.3	-	26.4
2	21.8	20.5	1.3	-	26.2
3	22.0	20.5	1.5	-	26.4
4	22.1	20.4	1.7	-	26.5
5	21.8	20.6	1.2	-	26.7
Ign	Gas mixture 7.5 ± 1.0 % acetylene (C ₂ H ₂)				
	Measured Temperature [°C]	Ambient [°C]	ΔT [K]	Safety factor 1,2	Max. external Surface [°C] <i>calculated</i>
1	26.5	20.1	6.4	-	31.8
2	26.8	20.3	6.5	-	32.1

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

3	26.9	20.4	6.5	-	32.3
4	28.8	20.4	8.4	-	34.6
5	24.3	20.4	3.9	-	29.2

Results

No continuous burning was observed. No flame transmission did occur. The measured external surface temperature rise of the device being 8.4 K was multiplied by a safety factor of 1.2 for the determination of the temperature class of the electrical apparatus, resulting in a maximum external surface temperature increase of 10.0 K.

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

3.6 Bubble test pore size

Equipment Tested:	Sample no. 12 – 14
Date of Test (dd/mm/yyyy):	06/12/2018
Standard and Clause:	IEC 60079-1:2014 clause B.2.3

Procedure:

The test piece was clean, dry and free from extraneous material and any trace of grease or similar substances likely to hinder the perfect and uniform wetting action of the test liquid.

The used liquid is reported and the density and surface tension of the liquid obtained from the table under clause 5.6 in the standard.

The test piece is completely impregnated with the test liquid, inserted in the bubble test apparatus and maintained fixed, immersed consistent under the smallest depth of test liquid with the convenient observation of the appearance of the bubbles.

This depth h (see the figure in the standard) and the temperature of the liquid are measured and registered.

From an effective gas pressure of zero, the pressure is increased regularly at a rate of between 20 and 100 Pa/s (according to the estimated pore size), while the surface of the test piece was under constant observation.

Test conditions:

Used test liquid: Methanol

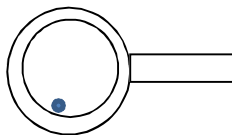
Density of test liquid (ρ_l): 790 kg/m³

Surface tension of test liquid (γ): 0.0225 N/m

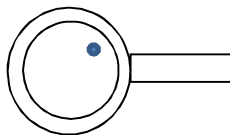
Temperature of test liquid: 18.8 °C

Test results:

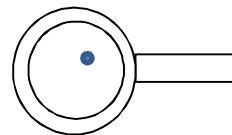
Position of the first bubble:



Sample 1



Sample 2



Sample 3

h sample 1: 0.03 m

h sample 2: 0.03 m

h sample 3: 0.03 m

First bubble pressure P_{g1} : 980 Pa

First bubble pressure P_{g2} : 910 Pa

First bubble pressure P_{g3} : 860 Pa

$$P_l = 9,81 \times \rho_l \times h$$

$$P_l = 9,81 \times \rho_l \times h$$

$$P_l = 9,81 \times \rho_l \times h$$

$$P_{l1} = 9,81 \times 790 \times 0.03 = 232.497 \text{ Pa}$$

$$P_{l2} = 9,81 \times 790 \times 0.03 = 232.497 \text{ Pa}$$

$$P_{l3} = 9,81 \times 790 \times 0.03 = 232.497 \text{ Pa}$$

$$\Delta p = p_g - p_l$$

$$\Delta p = p_g - p_l$$

$$\Delta p = p_g - p_l$$

$$\Delta p_1 = p_{g1} - p_{l1} = 980 - 232.497 = 747.50 \text{ Pa}$$

$$\Delta p_2 = p_{g2} - p_{l2} = 910 - 232.497 = 677.50 \text{ Pa}$$

$$\Delta p_3 = p_{g3} - p_{l3} = 860 - 232.497 = 627.50 \text{ Pa}$$

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

Capillary diameter corresponding to the bubble pore size test, in meters:

$$d = \frac{4 \gamma}{\Delta p} \quad d_1 = \frac{4 \gamma}{\Delta p_1} = \frac{4 \times 0.0225}{747.50} = 120 \mu\text{m}$$

$$d = \frac{4 \gamma}{\Delta p} \quad d_2 = \frac{4 \gamma}{\Delta p_1} = \frac{4 \times 0.0225}{677.50} = 133 \mu\text{m}$$

$$d = \frac{4 \gamma}{\Delta p} \quad d_3 = \frac{4 \gamma}{\Delta p_1} = \frac{4 \times 0.0225}{627.50} = 143 \mu\text{m}$$

Arithmetical mean of the three determinations (in 2 decimals): 132 μm

Result:

Required: $\geq 118.4 \mu\text{m}$ (= 85% of 139.3 μm) okay.

Appendix B to: NL/DEK/ExTR17.0047/00
 Applicant's name: Riken Keiki
 Test item: Gas Sensor

3.7 Density determination

Equipment Tested:	Sample no. 15 m (8 pieces used being > 5 g in weight)
Date of Test (dd/mm/yyyy):	06/12/2018
Standard and Clause:	IEC 60079-1:2014 clause B.2.4

Procedure:

Determination of the initial mass of the test piece

Weigh the test piece in the condition in which it was received, to obtain m_1 .

Removal of oil from the test piece by solvent extraction

Approximately 3 h of soaking and about ten solvent changes are required to remove the oil from test pieces of average density and small wall thickness. For thick walls and high density, up to 24 h are sometimes required. Weigh the test piece after solvent extraction and drying to obtain m_2 .

m_1 .

Sample 1: 0.627 g
 Sample 2: 0.630 g
 Sample 3: 0.631 g
 Sample 4: 0.628 g
 Sample 5: 0.629 g
 Sample 6: 0.633 g
 Sample 7: 0.628 g
 Sample 8: 0.635 g

m_2 .

Sample 1: 0.628
 Sample 2: 0.631
 Sample 3: 0.631
 Sample 4: 0.627
 Sample 5: 0.628
 Sample 6: 0.633
 Sample 7: 0.628
 Sample 8: 0.634

total mass: 5.041 g

Partial impregnation (suitable for determination of the volume)

The requirements of the oil are the same as stated in 8.4.1. Submerge the test piece in hot oil (70 °C ±10 °C) until no further air bubbles appear. Cool the test piece to room temperature whilst still submerged in oil by removing it from the hot oil and quickly transferring it to cold oil. Remove the cooled test piece from the cold oil, allow to drain, and remove the surplus surface oil as described in 7.4. (oil Referenz fluessigket IRM 902)

Determination of the volume of the test piece

Determine the volume V of the test piece by weighing in air to obtain m_a , and then submerge in water or other liquid of known density ρ_w (see table 4) to obtain m_w . The volume V in cm³ is given by the equation:

Temperature water: 21.9 °C

ρ_w : 0.9978 g/cm³

$$V = \frac{m_a - m_w}{\rho_w}$$

m_a .

Sample 1: 0.663 g
 Sample 2: 0.666 g
 Sample 3: 0.678 g
 Sample 4: 0.677 g
 Sample 5: 0.668 g
 Sample 6: 0.675 g
 Sample 7: 0.674 g
 Sample 8: 0.673 g

m_w .

Sample 1: 0.541 g → V: 0.1222
 Sample 2: 0.521 g → V: 0.1453
 Sample 3: 0.581 g → V: 0.1062
 Sample 4: 0.557 g → V: 0.1202
 Sample 5: 0.549 g → V: 0.1192
 Sample 6: 0.550 g → V: 0.1252
 Sample 7: 0.552 g → V: 0.1222
 Sample 8: 0.523 g → V: 0.1503

Appendix B to: NL/DEK/ExTR17.0047/00
Applicant's name: Riken Keiki
Test item: Gas Sensor

Density







$$\text{Density} = \frac{m_2}{V}$$

Sample 1: 5.139 g/cm³
Sample 2: 4.342 g/cm³
Sample 3: 5.941 g/cm³
Sample 4: 5.216 g/cm³
Sample 5: 5.268 g/cm³
Sample 6: 5.055 g/cm³
Sample 7: 5.139 g/cm³
Sample 8: 4.218 g/cm³

Result: density between 4.218 – 5.941 g/cm³
median: 5.139 g/cm³




IECEx TEST REPORT COVER

ExTR Reference Number.....:	NO/PRE/ExTR15.0012/06	
ExTR Free Reference Number	SC277576_2	
Compiled by + signature (ExTL)	Gunnar Nielsen	
Reviewed by + signature (ExTL).....	Stig André Norheim	
Endorsed by + signature (ExCB)	Asle Kaastad	
Date of issue	2023-11-27	
Ex Testing Laboratory (ExTL)		
Address	DNV Product Assurance AS Veritasveien 1 1363 Høvik Norway	
Ex Certification Body (ExCB)		
Address	DNV Product Assurance AS Veritasveien 1 1363 Høvik Norway	
Applicant's name.....:		
Address	RIKEN KEIKI Co., Ltd. 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan	
Standards associated with this ExTR package	IEC 60079-0: 2017 edition 7 IEC 60079-1: 2014 edition 7 IEC 60079-11: 2011 edition 6	
Clauses considered	All clauses considered	
Test Report Form Number	ExTR Cover_10 (released 2022-10)	
Related Amendments, Corrigenda or ISHs	N / A	
Test item description	Portable Gas Monitor	
Model/type reference	GX-6000 and GX-6100	
Code (e.g. Ex __ II__ T__).....:	Ex ia IIB T4/T3 Ga Ex ia IIC T4/T3 Ga Ex da ia IIC T4/T3 Ga See General Product Information for details.	
Rating	Battery operated. BUL-6000/6100 (rechargeable Li-ion battery unit) or BUD-6000/6100 (Alkaline battery unit). For BUD-6000/6100: use only Toshiba LR6 or Duracell MN1500 AA-batteries. Both battery units can be installed into GX-6000 and GX-6100.	

ExTR Package Contents

Assembled ExTR documents and Additional reference material:
IECEX Test Report Cover
IECEX Test Report Addendum: IEC 60079-0, Edition 7
IECEX Test Report Addendum: IEC 60079-11, Edition 6

Manufacturer's name	RIKEN KEIKI Co., Ltd.
Address	2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan
	Additional locations: RIKEN KEIKI Co., Ltd. 2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan RIKEN KEIKI NARA MFG. Co., Ltd. 49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan TOKYO MICRO SEIKI Co., Ltd. 1-15-24, Shingashi, Itabashi-ku, Tokyo, 175-0081, Japan EBINA DENKI Manufacturing Co., LTD. 23-10, Yananecho, Kawaguchi-shi, Saitama, 333-0864, Japan
Trademark	
Certificate No. (optional)	IECEX PRE 15.0011/07
QAR Reference No. (optional)	NO/PRE/QAR19.0018/06
Particulars: Test item vs. Test requirements	
Classification of installation and use	Portable (hand-held)
Ingress protection	Min. IP20
Rated ambient temperature range (°C).....	-20°C ≤ Ta ≤ +50°C
General remarks:	
<p>The test results presented in this ExTR package relate only to the item or product tested.</p> <ul style="list-style-type: none"> ▪ "(See Attachment #)" refers to additional information appended to the ExTR package. ▪ "(See appended table)" refers to a table appended to the ExTR package. ▪ Throughout this ExTR package, a point is used as the decimal separator. ▪ <i>Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.</i> ▪ <i>In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.</i> <p>The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.</p> <p>Use of uncertainty of measurement for decisions on conformity (Decision rule):</p> <p>No decision rule is specified by the standards associated with this ExTR package, when comparing the measurement result with the applicable limit according to the specification in these standards. The decisions on conformity are made without applying the measurement uncertainty as described in IECEx OD 012 (i.e. "simple acceptance" decision rule, previously known as "accuracy method").</p>	
General product information:	
Details of change (applicable only when revising an existing ExTR package):	
New additional secondary cells for use in BUL-6100.	

Copy of Marking Plate:

GX-6000(LABEL A)

MODEL GX-6000

INST.No.

RIKEN KEIKI Co., Ltd.

2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

GX-6000, BUL-, BUD- (LABEL D)

GX-6100(LABEL A)

MODEL GX-6100

INST.No.

RIKEN KEIKI Co., Ltd.

2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

BUL- (LABEL B) : 6000 OR 6100MODEL BUL-

INST.No.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan

WARNING

Do not charge battery in haz.loc.

GX-6100, BUL-, BUD- (LABEL D)BUD- (LABEL C) : 6000 OR 6100MODEL BUD-

INST.No.

RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan

WARNING Use only battery types

LR6 TOSHIBA or MN1500 DURACELL

Details regarding ‘trade agent’ / ‘local assembler’ application in accordance with OD 203:[N / A](#)**Testing not fully performed by ExTL staff at the above ExTL address:**[N / A](#)**National differences considered as part of this evaluation:**[N / A](#)**“Specific Conditions of Use” / “Schedule of Limitations”:**[N / A](#)**Routine tests:**[N / A](#)**Date(s) of performance for all testing:**

EUT preparation (Charge / Discharge):					
Test Sample #	11	12	13	14	16
Battery S. No.:	230404-003	230404-004	230404-005	230606-001	230303-003
1st Charge:	2023-06-14	2023-06-14	2023-06-15	2023-06-27	2023-09-05
1st Discharge:	2023-06-15	2023-06-15	2023-06-16	2023-06-28	2023-09-06
2nd Charge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-06
2nd Discharge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-07
3rd Charge:	2023-06-19 Re-charged 2023-09-18	2023-06-19 Re-charged 2023-09-18	2023-06-20 Re-charged 2023-09-18	2023-06-30 Re-charged 2023-09-18	2023-09-07
<p>Measured surface temperature of battery pack: 2023-09-18: test samples 11, 12 and 13. 2023-09-19: test samples 14 and 16.</p> <p>Electrolyte leakage testing: 2023-09-19 to 2023-09-20</p> <p>Surface resistance testing: 2023-10-31 to 2023-11-01</p>					
<p>Copyright © 2022 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.</p> <p>This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.</p>					

Technical Documents			
Title:	Drawing No.:	Rev. Level:	Date:
*INDEX GX-6000	E3-6991-5470-70-01K	9	2023.03.08
*INDEX GX-6100	E3-6991-5470-70-02K	5	2023.11.22
*Safety Information	-	9	2023.10.18

Note: An * is included before the title of documents that are new or revised.



IECEx TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/06

ExTR Free Reference Number : SC277576_2

Compiled by + signature (ExTL) : Gunnar Nielsen

Reviewed by + signature (ExTL) ... : Stig André Norheim

Date of issue : 2023-11-13

Gunnar Nielsen
Stig André Norheim

Ex Testing Laboratory (ExTL) :



Address : DNV Product Assurance AS
Veritasveien 1
1363 Høvik
Norway

Applicant's name :



Address : RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standards : IEC 60079-0: 2017 edition 7
IEC 60079-11: 2011 edition 6

Test Report Form Number : ExTR Addendum_3 (released 2018-02)

Related Amendments, Corrigenda
or ISHS : N / A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : N / A

- test item does meet the requirement : Pass

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a **comma** is used as the decimal separator.

The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Clause	Requirement – Test	Result – Remark	Verdict
IEC 60079-0:			
5.3.1	Determination of maximum surface temperature	Maximum surface temperature for the battery pack is measured to be: $T = \Delta T + T_a$ $T = 28,7K + 50^{\circ}C = 78,7^{\circ}C \rightarrow T_6$ $T = 53,4K + 19,2^{\circ}C = 72,6^{\circ}C \rightarrow T_6$ The surface temperature of the battery pack does not affect the temperature classification of the EUT (T4/T3).	Pass
7.4.2	Avoidance of a build-up of electrostatic charge for Group I and Group II	a) Sensor cover made of PC LNP STAT-LOY D3000IEU6-4G7B1971 is tested according to clause 26.13.	Pass
23.1	General	EUT is powered by two secondary parallel coupled cells. The cell is tested in NO/PRE/ExTR20.0043/00, but new surface temperature measurement tests and electrolyte tests are performed, due to parallel coupling and that the cells are encapsulated.	Pass
23.2	Interconnection of cells to form batteries	Parallel coupled according to IEC 60079-11.	Pass
23.3	Cell types	Panasonic NCR18650GA According to table 14: Type system: Lithium ion Positive electrode: (NCA) Li(NiCoAl)O ₂ Electrolyte: Liquid solution Negative electrode: Carbon Voltage: 3,6V Maximum open circuit voltage: 4,2V Rated capacity: 2 x3300mA = 6,6Ah.	Pass
23.4	Cells in a battery	Two identical cells.	Pass
23.5	Ratings of batteries	Ambient temperature discharge: -20°C to + 60°C Ambient temperature charge: +10°C to + 45°C Ambient temperature for EUT: -20°C to + 50°C Max discharge current for the battery is 8A. Nominal discharge for EUT is: 150mA Discharge when alarm is activated: 170mA	Pass
23.6	Interchangeability	The cells are encapsulated. Interchangeability is not possible.	Pass
23.8	Leakage	Tested according to clause 10.5.2 of IEC 60079-11. No leakage occurred.	Pass
23.9	Connections	Connections according to manufacturer's recommendations.	Pass
23.10	Orientation	Battery orientation is not important for safe operation.	Pass
23.11	Replacement of cells or batteries	The cells are encapsulated.	Pass
23.12	Replaceable battery pack	BUL- battery pack.	Pass

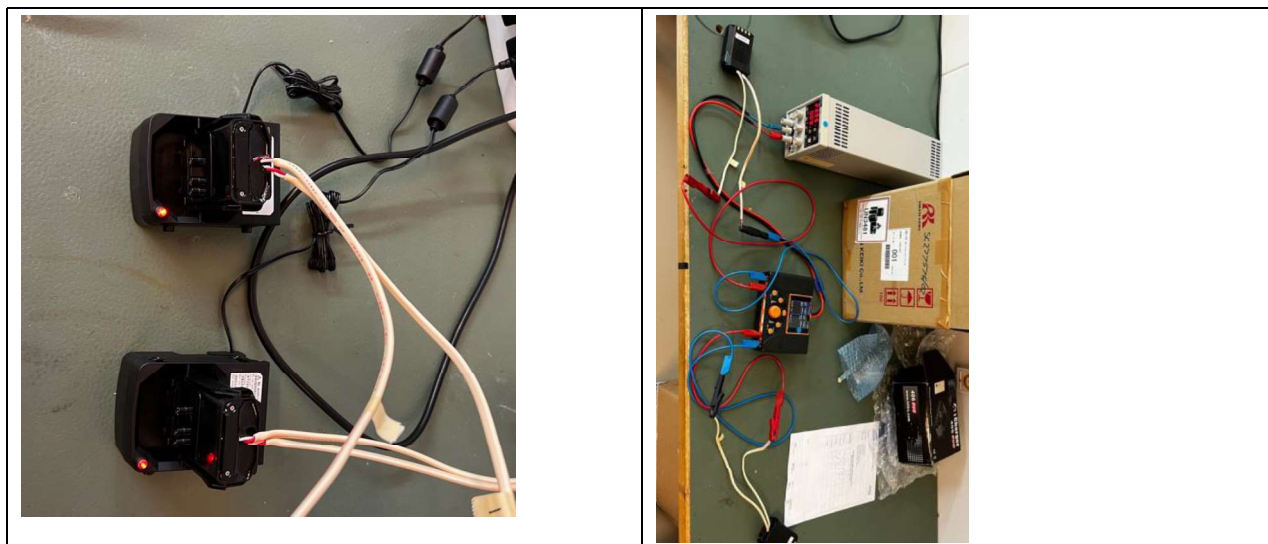
Clause	Requirement – Test	Result – Remark	Verdict
24	Documentation	Manufacturer has prepared documentation that details the Ex safety of the equipment according to IEC 60079-0, IEC 60079-1 and IEC 60079-11. Cells Panasonic NCR18650GA is included in the documentation for BUL-6100.	Pass
26.13	Surface resistance test of parts of enclosures of non-metallic materials	Sensor cover made of PC LNP STAT-LOY D3000IEU6-4G7B1971 is conditioned in 50% humidity and 23°C for 24 hours, before tested in equal surroundings. Resistance: <0,6GΩ See <i>Measurement Section</i> below for details.	Pass
IEC 60079-11:			
7.4.1	Primary and secondary cells and batteries - General	Two parallel coupled cells of Panasonic NCR18650GA. The battery shall not be replaced by the user or be charged in hazardous area.	Pass
7.4.2	Battery construction	The battery is sealed.	Pass
7.4.3	Electrolyte leakage and ventilation	No electrolyte spillage. The battery has been tested according to clause 10.5.2. Both without encapsulation (NO/PRE/ExTR20.0043/00) and with encapsulation (this report). No visible signs of electrolyte leakage.	Pass
7.4.4	Cell voltages	According to table 14 of IEC 60079-0: Type system: Lithium ion Positive electrode: (NCA) Li(NiCoAl)O ₂ Electrolyte: Liquid solution Negative electrode: Carbon Voltage: 3,6V Maximum open circuit voltage: 4,2V	Pass
7.4.5	Internal resistance of cell or battery	Internal resistance (NO/PRE/ExTR20.0043/00): 24mΩ / 2 = 12mΩ (not used in assessment).	Pass
7.4.8	Batteries used but not replaced in explosive atmospheres	The battery doesn't need current-limiting devices to ensure the safety of the battery itself.	Pass
7.4.9	External contacts for charging batteries	The current from the battery to the external charging contact is limited by the safety resistors R1, R2 and R11. These resistors are mounted in parallel. In addition one parallel track has three serial connected blocking diodes (D1, D2 and D3). The protection is equal as in original report and maximum voltage is not changed. N / A EUT satisfies sub-clause "a".	Pass

Clause	Requirement – Test	Result – Remark	Verdict
10.5.1	Tests for cells and batteries - General	The battery cells are tested in IECEx test report NO/PRE/ExTR20.0043 . Test results for electrolyte leakage test are copied from that report. Surface temperature and electrolyte leakage tests performed during this project, as the cells are encapsulated.	Pass
10.5.2	Electrolyte leakage test for cells and batteries	See measurement section below for details.	Pass
10.5.3	Spark ignition and surface temperature of cells and batteries	See measurement section below for details.	Pass
10.5.4	Battery container pressure tests	The battery cell is sealed.	N / A

Measurement Section, including Additional Narrative Remarks (as deemed applicable)**Battery conditioning**

Test Sample #	11	12	13	14	16
Battery S. No.:	230404-003	230404-004	230404-005	230606-001	230303-003
1st Charge:	2023-06-14	2023-06-14	2023-06-15	2023-06-27	2023-09-05
1st Discharge:	2023-06-15	2023-06-15	2023-06-16	2023-06-28	2023-09-06
2nd Charge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-06
2nd Discharge:	2023-06-16	2023-06-16	2023-06-19	2023-06-29	2023-09-07
3rd Charge:	2023-06-19 Re-charged 2023-09-18	2023-06-19 Re-charged 2023-09-18	2023-06-20 Re-charged 2023-09-18	2023-06-30 Re-charged 2023-09-18	2023-09-07

Charging:	Discharging:
-----------	--------------



Surface temperature testing (surface of the battery pack)

Measured Temperatures when batteries are short circuited (2 cells in each battery pack):

Test Sample #	11	12	13	14	16
Battery S. No.:	230404-003	230404-004	230404-005	230606-001	230303-003
Ambient Temperature [°C]:	19,2	19,2	19,2	50,0	50
Measured Surface Temperature [°C]:	72,6	70,8	69,1	78,7	76,2
Temperature Difference [K]:	53,4	51,6	49,9	28,7	26,2
Max Ambient Temperature [°C]	50	50	50	50	50

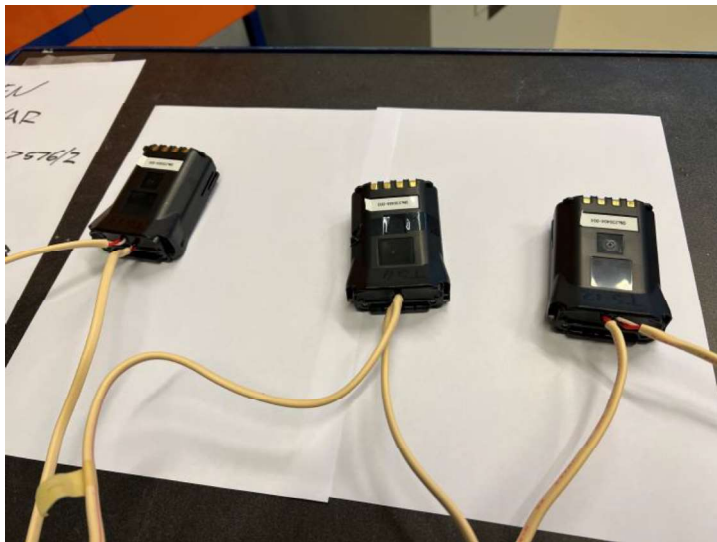


Electrolyte leakage testing

☒ The ten test cells are placed over a piece of blotting paper (5 battery packs).

☒ Test duration ≥ 12 hours. Number of hours: 19,5

No visible sign of electrolyte on the blotting paper or on the external surfaces of the test.



IEC 60079-0, clause 26.13 - Surface resistance test of parts of enclosures of non-metallic materials

The material that the sensor cover is made of (PC LNP STAT-LOY D3000IEU6-4G7B1971) is cleaned with distilled water, then with isopropyl alcohol, and then once more with distilled water.

Two parallel electrodes of conducting paint are painted on the surface.

The EUT is conditioned for 24 hours in 23°C and 50% humidity. Testing is carried out under the same ambient conditions.

500VDC is applied between the two electrodes for 60 seconds and the resistance between them are measured.

Test result: <0,6GΩ.

Requirement: <1GΩ

The material passes the requirement.





IECEx TEST REPORT COVER

ExTR Reference Number.....: NO/PRE/ExTR15.0012/05

ExTR Free Reference Number: SC277576_1

Compiled by + signature (ExTL): Gunnar Nielsen

Reviewed by + signature (ExTL).....: Stig André Norheim

Endorsed by + signature (ExCB) ...: Asle Kaastad

Date of issue: 2022-11-02

Gunnar Nielsen
Stig André Norheim
Asle Kaastad

Ex Testing Laboratory (ExTL).....:



Address.....: DNV Product Assurance AS
Veritasveien 1
1363 Høvik
Norway

Ex Certification Body (ExCB).....:



Address.....: DNV Product Assurance AS
Veritasveien 1
1363 Høvik
Norway

Applicant's name.....:



Address.....: RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standards associated with this
ExTR package: IEC 60079-0: 2017 edition 7
IEC 60079-1: 2014 edition 7
IEC 60079-11: 2011 edition 6

Clauses considered: All clauses considered

Test Report Form Number: ExTR Cover_9 (released 2021-09)

Related Amendments, Corrigenda
or ISHs: N / A

Test item description: Portable Gas Monitor

Model/type reference: GX-6000 and GX-6100

Code (e.g. Ex __ II__ T__):
Ex ia IIB T4/T3 Ga
Ex ia IIC T4/T3 Ga
Ex da ia IIC T4/T3 Ga
See General Product Information for details.

Rating.....: Battery operated. BUL-6000 (rechargeable Li-ion battery unit) or
BUD-6000 (Alkaline battery unit). For BUD-6000: use only Toshiba
LR6 or Duracell MN1500 AA-batteries.

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

IECEX Test Report Cover

IECEX Test Report: IEC 60079-1, Edition 7

IECEX Test Report Addendum: IEC 60079-0, Edition 7

IECEX Test Report Addendum: IEC 60079-11, Edition 6

Manufacturer's name: RIKEN KEIKI Co., Ltd.

Address: 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

Additional location.....: RIKEN KEIKI Co., Ltd.
2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan

RIKEN KEIKI NARA MFG. Co., Ltd.
49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan

TOKYO MICRO SEIKI Co., Ltd.
1-15-24, Shingashi, Itabashi-ku, Tokyo, 175-0081, Japan

EBINA DENKI Manufacturing Co., LTD.
23-10, Yananecho, Kawaguchi-shi, Saitama, 333-0864, Japan

Trademark: 

Certificate No. (optional): IECEX PRE 15.0011/06

QAR Reference No. (optional): NO/PRE/QAR19.0018/05

Particulars: Test item vs. Test requirements

Classification of installation and use: Hand-held

Ingress protection: Min. IP20

Rated ambient temperature range (°C).....: $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$ **General remarks:**

The test results presented in this ExTR package relate only to the item or product tested.

- "(See Attachment #)" refers to additional information appended to the ExTR package.
- "(See appended table)" refers to a table appended to the ExTR package.
- Throughout this ExTR package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEX 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.*

The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Use of uncertainty of measurement for decisions on conformity (Decision rule):

No decision rule is specified by the standards associated with this ExTR package, when comparing the measurement result with the applicable limit according to the specification in these standards. The decisions on conformity are made without applying the measurement uncertainty as described in IECEX OD 012 (i.e. "simple acceptance" decision rule, previously known as "accuracy method").

General product information:

This report covers the portable gas monitors GX-6000 and GX-6100, which is used for measuring flammable gas concentration in hazardous location. GX-6000 and GX-6100 are battery-operated handheld portable devices and are built up by anti-electrostatic plastic enclosure with minor metal parts

such as assembly screws. Two alternative battery units may be used, BUL-6000 (rechargeable Li-ion battery) and BUD-6000 (alkaline dry battery). Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. Safety instructions and warnings must be followed. Following parts are also included in the investigation, charger module BC-6000 or SDM-6000, Combustible gas sensor, Toxic gas sensor and Oxygen sensor, Smart sensor type DES, ESS, PIS & OSS.

GX-6000: When the combustible gas sensor is used the gas group is limited to IIB.

GX-6100: Combustible gas sensor, NCR-6309, is used and the gas group is IIC, as sensor is certified as "da".

Ambient temperature range during battery charging: $-0^{\circ}\text{C} \leq T_a \leq +40^{\circ}\text{C}$

GX-6000:

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex ia IIB T4 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUL-6000
Ex ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUL-6000
Ex ia IIB T4 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIB T3 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUD-6000 MN1500 (Duracell)
Ex ia IIC T3 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUD-6000 MN1500 (Duracell)

GX-6100:

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex da ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUL-6000
Ex ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUL-6000
Ex da ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIC T4 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUD-6000 LR6 (Toshiba)
Ex da ia IIC T3 Ga	-20°C to $+50^{\circ}\text{C}$	Mounted	BUD-6000 MN1500 (Duracell)
Ex ia IIC T3 Ga	-20°C to $+50^{\circ}\text{C}$	Not mounted	BUD-6000 MN1500 (Duracell)

Details of change (applicable only when revising an existing ExTR package):

Added the model GX-6100, new piezo-electric buzzer, backup battery changed and new BLE module.

Copy of Marking Plate:

GX-6100(LABEL A)

MODEL GX-6100
 INST.No.
 RIKEN KEIKI Co., Ltd.
 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

BUL-6000(LABEL B)

MODEL BUL-6000
 INST.No.
 RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
 Itabashi-ku, Tokyo, 174-8744, Japan
 WARNING
 Do not charge battery in haz.loc.

BUD-6000(LABEL C)

MODEL BUD-6000
 INST.No.
 RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
 Itabashi-ku, Tokyo, 174-8744, Japan
 WARNING Use only battery types
 LR6 TOSHIBA or MN1500 DURACELL

GX-6100, BUL-6000, BUD-6000(LABEL D)



GX-6000(LABEL A)

MODEL GX-6000
 INST.No.
 RIKEN KEIKI Co., Ltd.
 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

△	Correction
△	記 号

GX-6000, BUL-6000, BUD-6000(LABEL D)

**Details regarding 'trade agent' / 'local assembler' application in accordance with OD 203:**

N / A

Testing not fully performed by ExTL staff at the above ExTL address:

N / A

National differences considered as part of this evaluation:

N / A

"Specific Conditions of Use" / "Schedule of Limitations":

N / A

Routine tests:

N / A

Date(s) of performance for all testing:

Drop test: 2022.10.05

Test of piezo-electric device: 2022.09.16 (not used in evaluation)

Copyright © 2021 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Technical Documents			
Title:	Drawing No.:	Rev. Level:	Date:
INDEX GX-6000	E3-6991-5470-70-01K	7	2021.07.26
*INDEX GX-6100	E3-6991-5470-70-02K	2	2022.10.11

Note: An * is included before the title of documents that are new or revised.



IECEx TEST REPORT
IEC 60079-1

Explosive atmospheres – Part 1: Equipment protection by flameproof enclosures "d"

ExTR Reference Number : NO/DNV/ExTR21.0088/00
ExTR Free Reference Number..... : PRJN-313142-2021-PA-NOR
Compiled by + signature (ExTL).... : Nenad Stanivukovic
Reviewed by + signature (ExTL) ... : Bjørn Spongsveen
Date of issue..... : 2022-07-04

Ex Testing Laboratory (ExTL) :



DNV DNV Product Assurance AS

Address : Veritasveien 1, 1363 Høvik, Norway

Applicant's name : RIKEN KEIKI Co., Ltd.

Address : 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

Standard : IEC 60079-1:2014, 7th Edition

Test procedure : IECEx System

Test Report Form Number : ExTR60079-1_7A_DS (released 2019-12)

Instructions for Intended Use of Ex Test Report:

An Ex Test Report provides a clause-by-clause documentation of the initial evaluation and testing that verified compliance of an item or product with an IEC, ISO, ISO/IEC or IEC/IEEE Ex standard or technical specification. This Ex Test Report is part of an ExTR package that may include other Ex Test Report, Addendum, National Differences and Partial Testing documents, along with a single ExTR Cover. An Ex Test Report is to be compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the Ex Test Report as part of the overall ExTR package on the associated ExTR Cover.

Copyright © 2017 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item..... : N / A
- test item does meet the requirement..... : Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope This ExTR considers gas sensors type NCR-6309 for use in “GX-Force” gas detectors.		
2 See also DS2010/006A	Normative references		
3 See also DS 2015/015	Terms and definitions		
4	Level of protection (equipment protection level, EPL)		
4.1	General	Level of protection “db” (EPL Ga)	Pass
4.2 See also DS2015/016A	Requirements for level of protection “da”	<p>The sensor assessed is a catalytic sensor to be used in a portable gas detector</p> <ul style="list-style-type: none"> - Internal volume < 1 cm³ - The electrical conductors are potted in the enclosure and assessed for clause 6, -The breather is assessed for clause 10 and casted in the enclosure wall, leaving no gap and secured with a rim on both sides. -Supply is by an Ex ia circuit. Maximum dissipated power < 3.3 W -The flame non-transmission test was performed with 50 ignitions for each test gas. 	Pass
4.3	Requirements for level of protection “db”	Not evaluated.	N/A
4.4	Requirements for level of protection “dc”	Not evaluated.	N/A
5	Flameproof joints		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
5.1	General requirements	<p>The flameproof joints comply with the requirements of clause 5.</p> <p>Specific condition of use in the certificate will apply:</p> <p>“X” - The flameproof joints are not intended to be repaired.</p> <p>A limitation and advisory marking are applied:</p> <p>"This product is an explosion-proof product and is not to be disassembled or modified with the exception of specified parts."</p> <p>Plastic enclosure, which does not require corrosion protection.</p> <p>For design details see drawing: M3-4463-10-02K</p>	Pass
5.2 See also DS 2015/018	<p>Non-threaded joints</p> <p>Relevant for:</p> <ol style="list-style-type: none"> 1. The multi-step joint between enclosure halves. 2. Cemented joints of electrical contacts. 3. Cemented joint of breather element. 		
5.2.1	Width of joints (<i>L</i>)	The multi-step joint requirements applied see 5.9 below.	Pass
5.2.2	Gap (<i>i</i>)	The multi-step joint requirements applied see 5.9 below.	Pass
5.2.3 See also DS 2015/018	Spigot joints	No spigot joints.	N/A
5.2.4	Holes in joint surfaces		
5.2.4.1	General	See 5.2.3 above.	N/A
5.2.4.2	Flanged joints with holes outside the enclosure (see Figures 3 and 5)	See 5.2.3 above.	N/A
5.2.4.3	Flanged joints with holes inside the enclosure (see Figure 4)	See 5.2.3 above.	N/A
5.2.4.4	Spigot joints where, to the edges of the holes, the joint consists of a cylindrical part and a plane part (see Figure 6)	See 5.2.3 above.	N/A
5.2.4.5	Spigot joints where, to the edges of the holes, the joint consists only of the plane part (see Figures 7 and 8), in so far as plane joints are permitted (see 5.2.7)	See 5.2.3 above.	N/A
5.2.5	Conical joints	No conical joints.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
5.2.6	Joints with partial cylindrical surfaces (not permitted for Group IIC)	No partial cylindrical surfaces as per fig. 9a.	N/A
5.2.7	Flanged joints for acetylene atmospheres	No flanged joints.	N/A
5.2.8	Serrated joints	No serrated joints.	N/A
5.2.9	Multi-step joints	<p>The joint 1 between enclosure halves assessed as multi-step joint consists of three adjacent segments where path changes direction two times by 90°.</p> <p>Length of the joints L</p> <p>Segment 1 (L1) -specified: min 2.65 mm -measured: 2.75 mm</p> <p>Segment 2 (L2) -specified: 0.48 mm -measured: 0.50 mm</p> <p>Segment 3 (L3) -specified: min 3.35 mm -measured: 3.5 mm</p> <p>Construction gaps ic</p> <p>Segment 1 (ic1) and 3 (ic3) -specified: max. 0.10 mm -measured: 0.10 mm</p> <p>Segment 2 (ic2) -specified: 0.05 mm -measured: 0.05 mm</p> <p>“X” - The flameproof joints are not intended to be repaired.</p> <p>See Comment 2 at the end of this report.</p>	Pass
5.3	Threaded joints	No threaded joints.	N/A
5.4	Gaskets (including O-rings)	O-rings doesn't have influence to flameproof joints dimensions.	Pass
5.5	Equipment using capillaries	No capillaries used.	N/A
6	Sealed joint		
6.1 See Also DS 2015/015	Cemented joints		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
6.1.1	General	The joints between the in-casted breather and the Cap and between the electrical contacts and Base are cemented joints. Since the joint is formed by injection molding, the molding parameters are relevant here, these are found on drawing M3-4463-10-02K.	Pass
6.1.2	Mechanical strength	The breather is fixed with a rim on top and under it. The contacts are fixed by their multi-turn shape. These joints are not intended to be opened. Tests done on the breather: An overpressure test on two samples with the breather blocked before ageing. An overpressure test on two samples with the breather blocked after ageing. Tests on the in-casted contacts: An overpressure test on two samples, before ageing, with the breather replaced by plate. An overpressure test on two samples with the breather replaced by plate after ageing. The mechanical strength is provided by enclosure. It isn't dependent upon the cement. The cement is blocked and secured and it is not part of the external wall of the enclosure. See 15.2.3.2 below and report 60079-0.	Pass
6.1.3	Width of cemented joints	Internal volume is $\ll 10 \text{ cm}^3$. The width of the cemented joints: Joint 2. Contacts -required: 3 mm -specified: min. 3.9 mm -verified: min. 3.9 mm Joint 3. Breather -required: 3 mm -specified: min. 3.66 mm -verified: min. 3.66 mm See Comment 2.2 at the end of this report.	Pass
6.2	Fused glass joints		
6.2.1	General	Not fused glass joints.	N/A
6.2.2	Width of fused glass joints	Not applicable.	N/A
7	Operating rods	No operating rods.	N/A
8	Supplementary requirements for shafts and bearings	No shafts and bearings.	N/A
9	Light-transmitting parts	No light-transmitting parts.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
10	Breathing and draining devices which form part of a flameproof enclosure		
10.1	General	Breather device is part of enclosure used for exchange of hazardous atmosphere for gas sampling. Types of breather with pressed metal wire element used. The breathers are tested to withstand overpressure and flame propagation without deformation.	Pass
10.2	Openings for breathing or draining	Not a such construction.	Pass
10.3	Composition limits	Stainless steel only.(Cu content < 0.1%)	Pass
10.4	Dimensions	Breathing devices and their parts are fully specified in the descriptive drawings with appropriate tolerances. Press metal wire element -diameter: 10 ± 0.1 , thickness: 1.66 ± 0.1 mm	Pass
10.5	Elements with measurable paths	No such elements.	N/A
10.6	Elements with non-measurable paths	See Annex B (below).	Pass
10.7	Removable devices		
10.7.1	General	The breather can't be removed.	N/A
10.7.2	Mounting arrangements of the elements	See above.	N/A
10.8	Mechanical strength	Constructed such a way that prevents any risk of the mechanical damage. The position of breather element is fully protected by "detector enclosure" which considered as "guard". See report 60079-0 for the Impact test.	Pass
10.9	Breathing devices and draining devices when used as Ex components	Breathing devices aren't going to be used as Ex components.	N/A
11	Fasteners and openings	The Sensor does not have fasteners or openings, it is completely closed with an incasted breather and cemented electrodes.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
12 See also DS 2012/004	Materials		
12.1	Tests prescribed by Clauses 14 to 16	Equipment tested according to clause 14 to 16	Pass
12.2	Assembly of multiple flameproof enclosures	No multiple flameproof enclosures.	N/A
12.3	Intercommunicating enclosure compartments	No intercommunicating compartments.	N/A
12.4	Use of cast iron	Cast iron not used.	N/A
12.5	Use of liquids	Liquids not used.	N/A
12.6	Insulating materials for Group I apparatus	Group I not evaluated.	N/A
12.7	Zinc content	No Zn content.	Pass
12.8	Copper or copper alloys in explosive gas atmospheres containing acetylene	No copper or copper alloys used.	Pass
13	Entries for flameproof enclosures	No entries.	N/A
14	Verification and tests	See 60079-0 report for maximum surface temperature determination.	Pass
15	Type tests		

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
15.1	General	<p>Breather element and cemented joints were excluded from testing because they were tested before. (refer to reports NL/DEK/ExTR17.0047/00-02).</p> <p>Subject of the additional testing (performed in this report) was flameproof joint 1 in test sequence as follows:</p> <ol style="list-style-type: none"> 1. Overpressure test 2. Test for non-transmission performed on samples which have been used for previous test sequence. <p>See comment 1, 3 and 4 at the end of this report.</p>	Pass

15.2	Tests of ability of the enclosure to withstand pressure		
15.2.1	General	The equipment has been tested according to the requirements in clauses 15.2.3 and 15.3 No permanent deformation was observed. The units tested according to clause 15.2.3 was also subjected to the test for flame non-transmission with satisfactory result.	Pass
15.2.2	Determination of explosion pressure (reference pressure)		
15.2.2.1	General	Determination of explosion pressure considered impracticable due to extremely small internal volume of the gas sensor.	N/A
15.2.2.2	Test procedure	See 15.2.2.1 above.	N/A
15.2.2.3	Rotating electrical machines	Not a rotating electrical machine.	N/A
15.2.2.4	Pressure-piling	Group IIC tested.	N/A
15.2.2.5	Apparatus intended for use in a single gas	Not evaluated.	N/A
15.2.3	Overpressure test		
15.2.3.1	General	Performed by first method.	Pass
15.2.3.2	Overpressure test - First method (static)	<p>Tested acc. value from Table 8 (Relative pressures for small equipment) Volume << 10 cm³ gas group IIC, for low ambient temperature: -40 °C: (value 10 bar x 1.45 = 14.5 bar applied.</p> <p>See Comment 3 at the end of this report.</p>	Pass
15.2.3.3	Overpressure test - Second method (dynamic)	First method used.	N/A

15.3	Test for non-transmission of an internal ignition		
15.3.1	General	Flame transmission didn't occur. See Comment 4 at the end of this report.	Pass
15.3.2	Electrical equipment of groups I, IIA and IIB		
15.3.2.1	Test gap and test gas	Not evaluated.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
15.3.2.2	Increasing of gaps for test	Not evaluated.	N/A
15.3.2.3	Number of tests and acceptance criterion	Not evaluated.	N/A
15.3.3	Electrical apparatus of group IIC		
15.3.3.1	General	All the test performed according to the second method. See 15.3.3 below and Comment 4 at the end of this report.	Pass
15.3.3.2	First method – Testing by increased test gap	Not used.	N/A
15.3.3.3	Second method – Testing by increased pressure	The test gaps provided were 90% -100% of construction gaps. Test gas mixture acetylene (7.5 ± 1)% and H ₂ -hydrogen (27.5 ± 1.5)% volume in air used. Fifty ignition have been done with each test gas at pre-compression pressure (1510-1530 mbar) and normal ambient temperature See Comment 4 at the end of this report.	Pass
15.3.3.4	Third method – Testing by oxygen enrichment of test gases	Not used.	N/A
15.3.3.5	Number of tests for single piece production	Not a single piece production.	N/A
15.4	Tests of flameproof enclosures with breathing and draining devices		
15.4.1	General	Tests carried out acc. the test sequence described in 15.1 above: Determined maximum test pore size of the breather elements was min. 85% of the specified maximum bubble test pore size.	Pass
15.4.2	Tests of ability of the enclosure to withstand pressure		
15.4.2.1	General	Tests have been made in accordance with 15.2 with following additions and modifications.	Pass
15.4.2.2	Replacement of breathing and draining devices	See 15.2.2.1	N/A
15.4.2.3	Overpressure test	Thin flexible membrane has been fitted in each of the tested breather elements. No permanent deformation or damage observed after the test.	Pass
15.4.3	Thermal tests		
15.4.3.1	Test procedure	Tested per 15.4.4.2 5 times with both gases, surface temperature measure. Because of the small size of the Sensor ignition on one location. No forced flow. No ventilating or sampling system. See 14 (above) and Comment 1 at the end of this report.	Pass

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
15.4.3.2	Acceptance criterion	No continuous burning observed. Temperature increase measured: 8.4 K (with C ₂ H ₂)	Pass
15.4.4	Tests for non-transmission of an internal ignition		
15.4.4.1	General	The test made according to 15.3 including the following additions and modifications	Pass
15.4.4.2	Test procedure	Breather elements are tested as part of the gas sensor enclosure with ignition on one location due to small size of the gas sensor.	Pass
15.4.4.3	Non-transmission test for breathing and draining devices		
15.4.4.3.1	General	Tests performed according to (Group IIC with non-measurable paths) the “Method B”.	Pass
15.4.4.3.2	Method A – Testing by increased pressure	Not applied.	N/A
15.4.4.3.3	Method B – Testing by oxygen enrichment of test gases	The non-transmission tests are performed with: 40% H ₂ , 20% O ₂ and N ₂ 10% C ₂ H ₂ , 24% O ₂ and N ₂ See 15.3.3.4	Pass
15.4.4.4	Acceptance criterion	No flame transmission occurred.	Pass
15.5	Tests for “dc” devices	Not applicable.	N/A
16	Routine tests		
16.1	General		
16.1.1	Overview	Routine tests not required.	N/A
16.1.2	Routine overpressure test – first method	Not applicable.	N/A
16.1.3	Routine test – second method	Not applicable.	N/A
16.1.4	Routine test – empty enclosure & parts of enclosure	Not applicable.	N/A
16.2 See also DS 2015/015	Enclosures not incorporating a welded construction	The enclosure does not have a welded construction and has an internal volume << 10 cm ³ , a routine test isn't required.	Pass
16.3 See also DS 2015/015	Enclosures incorporating a welded construction	Not applicable.	N/A
16.4	Bushings not specific to one flameproof enclosure	Not applicable.	N/A

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
16.5	Acceptance criteria	Not applicable.	N/A
16.6	Batch testing	Not applicable.	N/A
17	Switchgear for Group I	Not a switchgear.	N/A
18	Lampholders and lamp caps	Not a lamp holder or lamp cap.	N/A
19	Non-metallic enclosures and non-metallic parts of enclosures		
19.1	General	Flameproof joint 1 includes two non-metallic faces of the joint.	Pass
19.2	Resistance to tracking and creepage distances on internal surfaces of the enclosure walls	The electrodes are molded directly in the plastic of the base part. Between 2 elements: CTI: 175 V, voltage: 3.7 V, distance 3.6 mm. Because in normal operation there is no potential difference between the electrodes of one element; creepage will not occur.	Pass
19.3	Requirements for type tests	a) Due to small size ref. pressure determination is impracticable. b) Overpressure tests performed on samples after tests per 60079-0, see 15.2.3 c) Non-transmission tests performed on samples after tests per 60079-0, see 15.3.3.4 d) Erosion by flame not required, see 19.4 e) Not required, see above.	Pass
19.4	Test of erosion by flame	The internal volume is $\ll 50 \text{ cm}^3$.	Pass
20	MARKING		
20.1	General	“da”	Pass
20.2	Caution and warning markings	No caution or warning marking required.	Pass
20.3	Informative markings	No informative markings required.	Pass

IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
21	Instructions	See 60079-0 report.	Pass
Annex A (Normative)	Additional requirements for crimped ribbon elements and multiple screen elements of breathing and draining devices	No crimped ribbon and multiple screen elements	N/A
Annex B (Normative)	Additional requirements for elements, with non-measurable paths, of breathing and draining devices		
B.1	Sintered metal elements	No sintered elements.	N/A
B.2	Pressed metal wire elements		
B.2.1	Construction	Matrix consists of five layers made from different combination of stainless steel wire braid mesh and diameter. (FP100 and FP75)	Pass
B.2.2	Specifications	The wire diameters and mesh size are specified for each layer in the matrix. (ref dwg M3-4463-10-02K) Density of st.st. 316: 7.95 g/cm ³ . The specific density of the breather is 5.2 g/cm ³ . Resulting in a ratio of 0.65 This is accepted since the pressed wire element is also sintered which will give an increase of density.	Pass
B.2.3	Bubble test pore size	Performed on three samples. Design: 139.3 µm. All samples > 85% Test per 15.4.3 performed with 133 µm.	Pass
B.2.4	Density	Performed on 8 pieces being 5.041 g in total. Result: 5.139 g/cm ³ this is regarded within the margin. See B.2.2 and Appendix B.	Pass
B.2.5	Open porosity and or fluid permeability	With the defined and checked pore size and density of the breather the functionality is sufficiently secured.	Pass
B.2.6	Identification	a) Stainless steel SUS316 b) Max. pore size: 139.3 µm c) Min. density: 5.2 g/cm ³ d) Thickness: 1.66 ± 0.1 mm, Diameter: 10 mm e) Wire diameter, see B.2.2 f) N/A see B.2.5	Pass
B.3	Metal foam elements	No metal foam elements.	N/A
Annex C (Normative)	Additional requirements for flameproof entry devices	Not applicable.	N/A
Annex D (Normative)	Empty flameproof enclosures as Ex components	Not applicable.	N/A

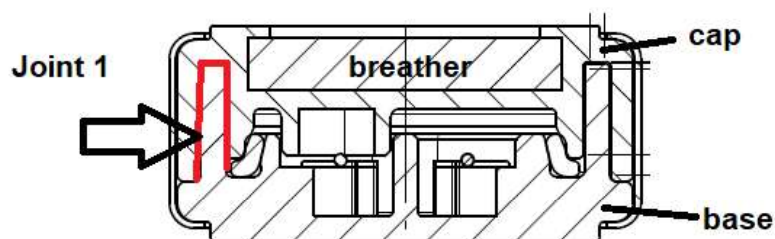
IEC 60079-1			
Clause	Requirement – Test	Result – Remark	Verdict
Annex E (Normative)	Cells and batteries used in flameproof “d” enclosures	Not applicable.	N/A
Annex F (Informative)	Mechanical properties for screws and nuts		
Annex G (Normative) See also DS 2019/003	Additional requirements for flameproof enclosures with an internal source of release (containment system)	Not applicable.	N/A
Annex H (Normative)	Requirements for machines with flameproof “d” enclosures fed from converters	Not applicable.	N/A

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

1. General description

The subject of the testing is gas sensor, type NCR-6309, consists of two catalytic elements in a flameproof enclosure. The gas sensor is to be used in the portable gas detectors GX force which are no part of this assessment. The gas sensor is fed by an Ex i signal from the gas detector.

The gas sensor consists of two plastic enclosure halves (the Cap and the Base) permanently fixed together metallic rim. A stainless steel breather element is enclosed in the cap by injection moulding.



Picture 1. Flameproof enclosure of the gas sensor NCR-6309

This report is based on NL/DEK/ExTR17.0047/00-02 test reports. Subject of additional testing (in this report) was flameproof joint 1 (multi-step joint).

2. Flameproof joints

The enclosure consists of one multi-step joint and two cemented joints. As shown on picture 2 below. The requirements for group IIC have been considered.

Date	2022-03-20
------	------------

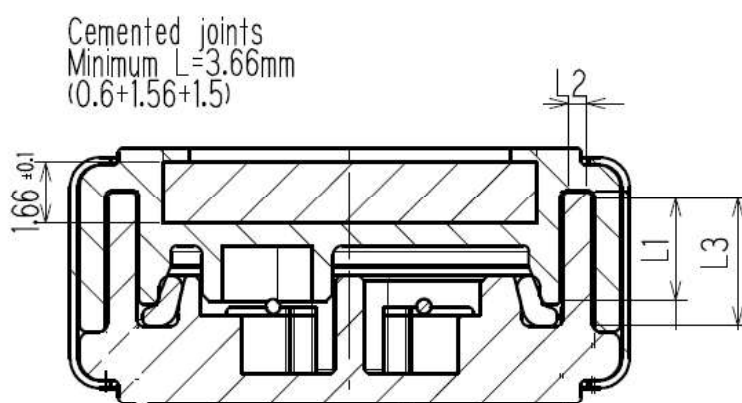
Samples	Breather - type pressed metal wire element D23 (PPS) no. 39, (2-1)
Equipment	No
Digital calliper	P0021
Micrometer 0-25mm (self cal.) standard reference 25 mm	P0284

2.1 Multi-step joint

Joint 1. Cap – Base

Table 1. Multi-step joint (declared and verified measures)

Segment	Lx min (specified)	Lx (measured)	Gap (ic) (specified)	Gap (ic) (measured)
1	2,65	2.75	0,10	0,10
2	0,48	0.50	0,05	0,05
3	3,35	3.5	0,10	0,10



Picture 2. Flameproof enclosure of the gas sensor NCR-6309

2.2 Cemented Joints

Cemented Joint 2 - "Cemented joints of electrical contacts.

Cemented joints Clause 6.1.3 Table 2	Requirement [mm]	Specification [mm]	Verification [mm]
Width	≥ 3 mm	3.9	3.9

Cemented Joint 3 - "Cemented joint of breather element.

Cemented joints Clause 6.1.3 Table 3	Requirement [mm]	Specification [mm]	Verification [mm]
Width	≥ 3 mm	3.6	3.6

3. Overpressure Test

Date	2020-03-16
Sample	3-1, 3-2 (Sensors especially prepared for FNT).
Equipment	No
Pressure gauge	P0223

There was no any damage observed or leakage through the cemented joints.

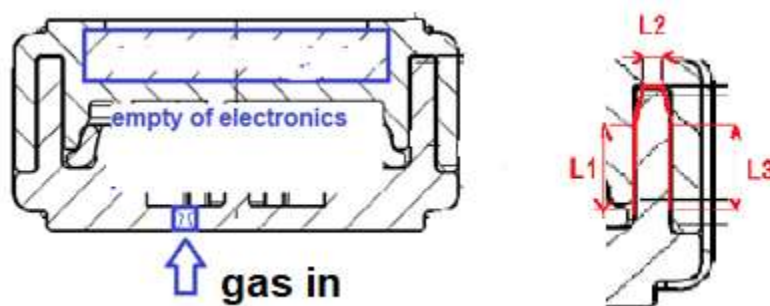
Test performed on normal ambient temperature. Sensor head tested empty, the wire mesh was covered with thin membrane from the inner side. Test performed in four test rounds.

The overpressure test was made at 14.5 bar. This pressure was held for 60 s The ambient temperature during test was +20°C.

4. Non-transmission of an Internal Ignition Test

Date	2022-04-29 to 2022-05-17
Sample	3-3 (Sensor especially prepared for FNT)
Equipment	No
Oxygen analyzer	P0114
Oxygen Transmitter	P0115
Pressure meter	P0027
Barrometer&thermometer	P0083

Subject of the test was Joint 1 (multi-step joint) as shown on picture 3 below. Test gap provided a follows:



Picture 3. Especially prepared sample of the gas sensor NCR-6309 enclosure for flame non-transmission test

Verification of the specially prepared sample for Flame Non-transmission test.

Multistep joint (declared and verified measures)

Segment	Lc max	Le (reduced)	Gap (ie)	Comment
1	1,95	74%	0,10	100%
2	0,35	73%	0,05	100%
3	2,5	75%	0,10	100%

No flame transmission out of enclosure occurred during the non-transmission tests.

The test arrangement used e (see picture 3 above) ignition point was located on gas inlet.

The gas mixture was measured at the gas outlet from the both sample and external chamber prior to each internal ignition. The internal mixture was ignited by spark plug.

The test was made at pre-compression pressure (1500-1530 mbar) and normal ambient temperature of 20°C, 5 times with each gas mixture, for Acetylene within the range by (7.4 to 7.9)% volumetric ratio to air and with Hydrogen by (27.0 to 27.5)% volumetric ratio to air.

Mixture in external enclosure verified the same as in the test sample before each ignition..

Gas A: acetylene

Gas B: hydrogen

Lab temp and pressure: +21C, 1012-1015 mbar.

Lab temp and pressure: +21C, 1004-1007 mbar.

Ignition no	O ₂ %	Pressure	Result	Ignition no	O ₂ %	Pressure	Result
1	19.40	1520	Pass	1	15.29	1500	Pass
2	19.38	1520	Pass	2	15.28	1500	Pass
3	19.37	1520	Pass	3	15.27	1500	Pass
4	19.37	1530	Pass	4	15.25	1500	Pass
5	19.37	1530	Pass	5	15.25	1500	Pass
6	19.37	1520	Pass	6	15.24	1500	Pass
7	19.36	1530	Pass	7	15.24	1500	Pass
8	19.36	1520	Pass	8	15.24	1500	Pass
9	19.36	1520	Pass	9	15.24	1500	Pass
10	19.36	1520	Pass	10	15.24	1510	Pass
11	19.36	1520	Pass	11	15.24	1510	Pass
12	19.35	1520	Pass	12	15.24	1510	Pass
13	19.35	1530	Pass	13	15.23	1510	Pass
14	19.35	1530	Pass	14	15.23	1500	Pass
15	19.35	1520	Pass	15	15.23	1500	Pass
16	19.35	1520	Pass	16	15.23	1500	Pass
17	19.34	1530	Pass	17	15.23	1510	Pass
18	19.34	1520	Pass	18	15.23	1510	Pass
19	19.34	1530	Pass	19	15.23	1510	Pass
20	19.34	1530	Pass	20	15.23	1510	Pass
21	19.34	1530	Pass	21	15.22	1500	Pass
22	19.34	1530	Pass	22	15.22	1500	Pass
23	19.34	1530	Pass	23	15.22	1510	Pass
24	19.33	1520	Pass	24	15.22	1500	Pass
25	19.33	1530	Pass	25	15.22	1500	Pass
26	19.33	1520	Pass	26	15.22	1500	Pass
27	19.33	1520	Pass	27	15.22	1510	Pass
28	19.33	1520	Pass	28	15.22	1510	Pass
29	19.33	1520	Pass	29	15.22	1510	Pass

30	19.33	1520	Pass	30	15.21	1510	Pass
31	19.33	1520	Pass	31	15.21	1510	Pass
32	19.32	1520	Pass	32	15.21	1510	Pass
33	19.32	1520	Pass	33	15.21	1510	Pass
34	19.32	1530	Pass	34	15.21	1510	Pass
35	19.32	1520	Pass	35	15.21	1510	Pass
36	19.32	1520	Pass	36	15.21	1510	Pass
37	19.32	1520	Pass	37	15.21	1510	Pass
38	19.32	1520	Pass	38	15.21	1510	Pass
39	19.32	1520	Pass	39	15.20	1510	Pass
40	19.31	1530	Pass	40	15.20	1510	Pass
41	19.31	1520	Pass	41	15.20	1510	Pass
42	19.31	1520	Pass	42	15.20	1510	Pass
43	19.31	1520	Pass	43	15.20	1510	Pass
44	19.31	1530	Pass	44	15.20	1510	Pass
45	19.31	1520	Pass	45	15.20	1510	Pass
46	19.31	1520	Pass	46	15.20	1510	Pass
47	19.31	1520	Pass	47	15.20	1510	Pass
48	19.30	1520	Pass	48	15.20	1510	Pass
49	19.30	1520	Pass	49	15.19	1510	Pass
50	19.30	1520	Pass	50	15.19	1510	Pass



IECEx TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/05

ExTR Free Reference Number : SC277576_1

Compiled by + signature (ExTL) : Gunnar Nielsen

Reviewed by + signature (ExTL) ... : Stig André Norheim

Date of issue : 2022-11-02

Ex Testing Laboratory (ExTL) :



Address : DNV Product Assurance AS
Veritasveien 1
1363 Høvik
Norway

Applicant's name..... :



Address : RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standards..... : IEC 60079-0: 2017 edition 7
IEC 60079-1: 2014 edition 7
IEC 60079-11: 2011 edition 6

Test Report Form Number..... : ExTR Addendum_3 (released 2018-02)

Related Amendments, Corrigenda
or ISHs : N / A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item :N / A

- test item does meet the requirement :Pass

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a [comma](#) is used as the decimal separator.

The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Clause	Requirement – Test	Result – Remark	Verdict
IEC 60079-0:			
4.3	Group II	Model GX-6100 is grouped as IIC.	Pass
5.1.1	Ambient temperature	Model GX-6100: $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$	Pass
5.2	Service temperature	Model GX-6100: Stand by : 150mA/4.5V/675mW When gas is detected : 170mA/4.5V/810mW (maximum power) Due to the low power consumption the service temperature is considered to be \approx ambient temperature.	Pass
5.3.1	Determination of maximum surface temperature	Model GX-6100: Maximum surface temperature is considered taken into account requirements of thermal ignition compliance of cl.5.6 of IEC 60079-11. Evaluation documented in Appendix B.1 in measurement section below.	Pass
5.3.2.2	Group II electrical equipment	See 5.3.1. T4 and T3 temperature class assigned and recognized. See Copy of marking plate.	Pass
5.3.3	Small component temperature for Group I or Group II electrical equipment	Model GX-6100: Maximum surface temperature is considered taken into account requirements of thermal ignition compliance of cl.5.6 of IEC 60079-11. Evaluation documented in Appendix B.1 in measurement section below.	Pass
7.4.2	Avoidance of a build-up of electrostatic charge on Group I or Group II electrical equipment	Material ESC9448N & LCD panel sheet PET 300R or PET84. All material have surface resistance of less than $1\text{G}\Omega$. See appended table 26.13. All smaller parts of regular plastic material have surface area less than 400mm^2 . Refer to drawing M2-4777-01-01K. Same material as previous tested for model GX-6000.	Pass
7.5	Accessible metal parts	Small accessible metal parts exist but enclosure's conductive plastic materials are used so the mentioned parts are not isolated. However small metallic parts are considered to represent not more than 3pF . Refer to Note 1 of cl. 7.5 of this standard. See appended Table 26.13 Clip: To attach the EUT to person's clothes. The clip itself is mounted to conductive plastic material. Discharges to approaching earthed objects are not expected as it is attached to a person.	Pass
23	Apparatus incorporating cells and batteries	Evaluation for new back-up battery (Seiko SSI MS421R): the battery itself has a very small capacity, 1,5mAh, and is considered as a capacitor in this evaluation. The physical dimensions is 4,8mm (diameter), 2,1mm (height) and 0,11g (standard mass). Main battery package, BUD-6000 and BUL-6000: no changes.	Pass

Clause	Requirement – Test	Result – Remark	Verdict
23.3	Cell types	Secondary battery, MS421R:SII considered as a capacitor.	N / A
23.5	Ratings of batteries	Charging voltage of the secondary battery is 3.1V. 3.3V-D3, Vf (0.2V). It charges through 3.1V and the internal switch of IC5. The battery is protected by the serial resistor, RS10 (3kΩ). Maximum discharge, $I = 3,3V / 3k\Omega = 1,1mA$ Charging voltage according to datasheet: 2.9V to 3,3V. Maximum discharge current according to datasheet: 10mA Range of temperature: -20°C to +50°C.	Pass
24	Documentation	Documentation concerning explosion safety aspects of EUT is prepared by the manufacturer and is reviewed as part of this investigation. Documentation is kept in file at DNV Product Assurance AS.	Pass
25	Compliance of prototype or sample with documents	EUT is checked for compliance with documentation required by clause 24.	Pass
26.4.2	Resistance to impact	Impact test is exempted for enclosure but is performed according to the testing of the built-in buzzer, piezoelectric device type FT-27T-3.2A1. Refer to IEC60079-11 part of test report.	Pass
26.4.3	Drop test	Two samples were tested. Each of them dropped four times from a height of 1m to a concrete floor. Ambient temperature was -27°C. EUT was kept in -27°C for ≈24 hours prior to the test. Result: no visible damages to the enclosures.	Pass
26.4.5.1	Test procedure	Requirements of IP20 is checked and recognized for compliance. Higher IP rating is not covered by this investigation.	
26.5.1	Temperature measurement	Refer to IEC60079-11 part of test report.	Pass
28.1	Conformity with the documentation	The manufacturer is held responsible to carry out necessary tests and verifications to ensure that each produced items is in compliance with the documentation which is provided for this investigation. Such verifications should be part of the procedures incorporated in the QA system of manufacturer.	Pass
28.2	Certificate	Certificate is issued in due course of this investigation.	Pass

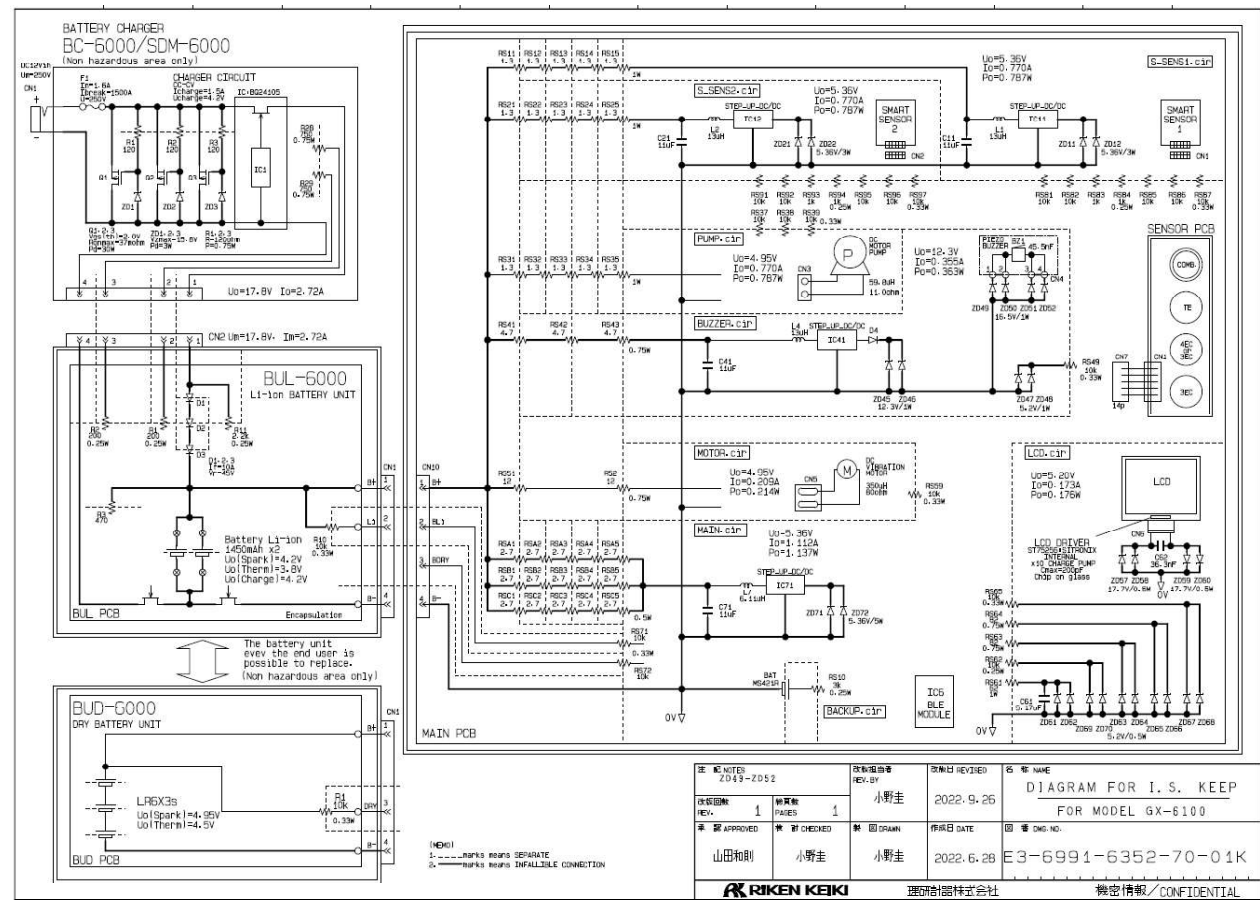
Clause	Requirement – Test	Result – Remark	Verdict
29.3	Marking, general	a) RIKEN KEIKI Co., Ltd b) Model GX-6100 c) Serial number is INST No. on the label, and its explanation is described in the last part of the safety information. d) IECEx DNV 15.0011, Presafe 15ATEX6171X and DNV 22UKEX25912X. e) No “X marking” in IECEx certificate. (ATEX and UKEX include “X”.) f) See below g) N / A	Pass
29.4	Ex marking for explosive gas atmospheres	Ex ia IIB T4/T3 Ga -20°C ≤ Ta ≤ +50°C Ex ia IIC T4/T3 Ga -20°C ≤ Ta ≤ +50°C Ex da ia IIC T4/T3 Ga -20°C ≤ Ta ≤ +50°C	Pass
29.14	Cells and batteries	Properly marked internally.	Pass
30.1	General	Documentation required by clause 24 of IEC60079-0 & clause 13 of IEC60079-11 is reviewed and recognized for compliance.	Pass
30.2	Cells and batteries	Specific safety instructions are provided with regards to brand & type of battery.	Pass
IEC 60079-1:			
The catalytic combustion sensor is already tested and certified in NO/DNV/ExTR21.0088. DNV free reference number is PRJN-313142-2021-PA-NOR/00.			
IEC 60079-11:			
5.6.2	Temperature for small components for Group I and Group II	New BLE module, : ref. DNV project PRJN-3131-42-2021-PA-NOR. Refer to appendix A.1 and B.1 for details.	Pass
7.4.1	Primary and secondary cells and batteries - general	See clause 23 of the IEC 60079-0 part of the report.	N / A
7.4.2	Battery construction	a) Sealed battery (coin cell).	Pass
7.4.3	Electrolyte leakage and ventilation	The enclosure is not sealed. The standard mass is only 0,11g for the back-up battery.	Pass
7.4.4	Cell voltages	See clause 23 of the IEC 60079-0 part of the report.	N / A

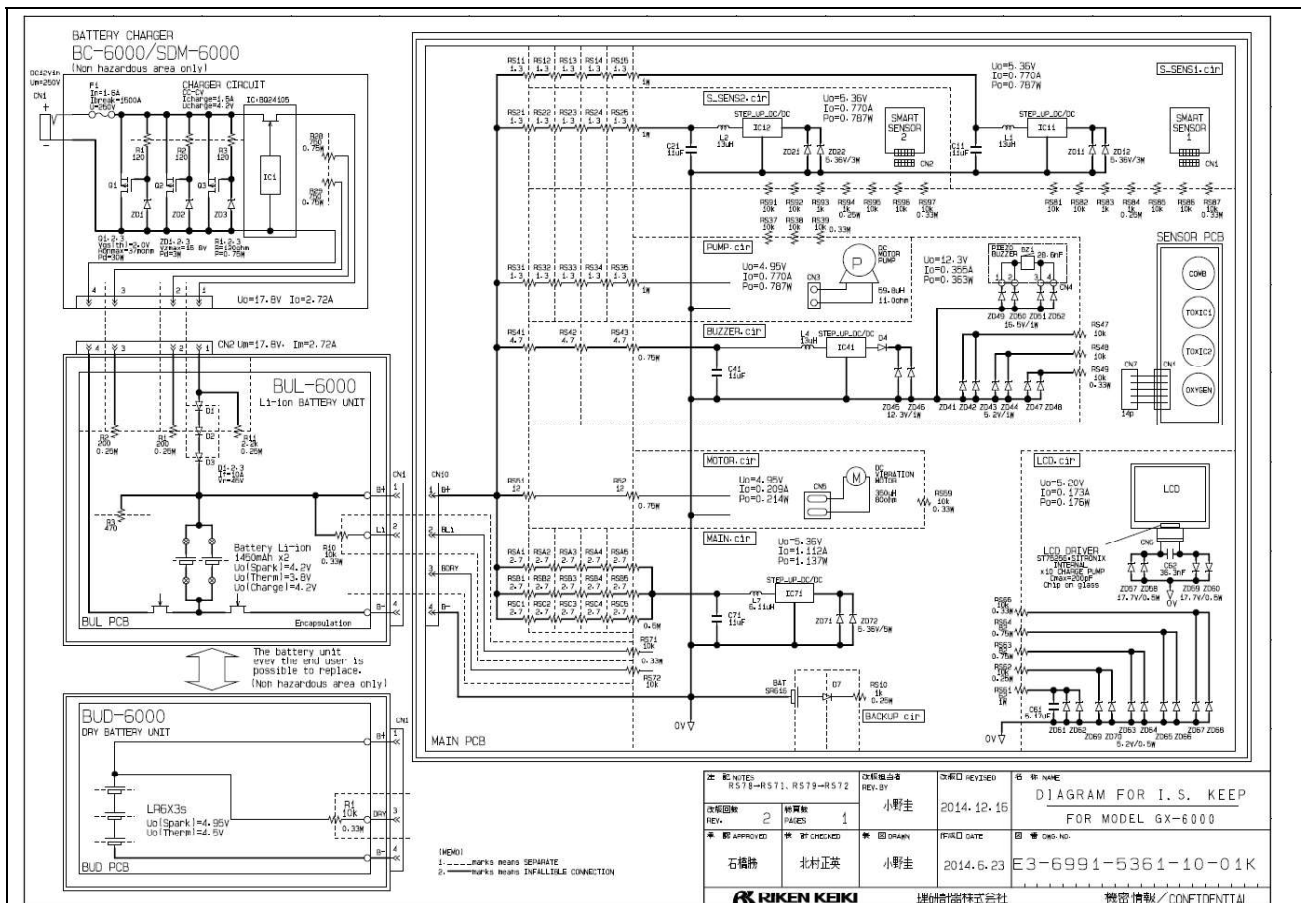
Clause	Requirement – Test	Result – Remark	Verdict
7.7	Piezo-electric devices	<p>Piezo element: Cre-sound FT-27T-3.2A1 Capacitance stated in documentation: 35nF ± 30% = 45,5nF.</p> <p>The piezo-electric device is unfailable connected to 2 x 2 zener diodes (ZD49 to ZD52). Zener value is maximum 16,5V. $V_f = 0,75V$. Total voltage = 17,25V.</p> $E = 0,5 \times C \times U^2 = 0,5 \times 45,5nF \times 17,25V^2 = 6,8\mu J$ $6,8\mu J < 50\mu J \rightarrow IC$	Pass
10.5	Tests for cells and batteries	See clause 23 of the IEC 60079-0 part of the report.	N / A

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

The differences between the GX-6000 and GX-6100 in terms of intrinsically safe explosion protection are shown in red in the diagram below. The other parts are the same in terms of configuration and constants.

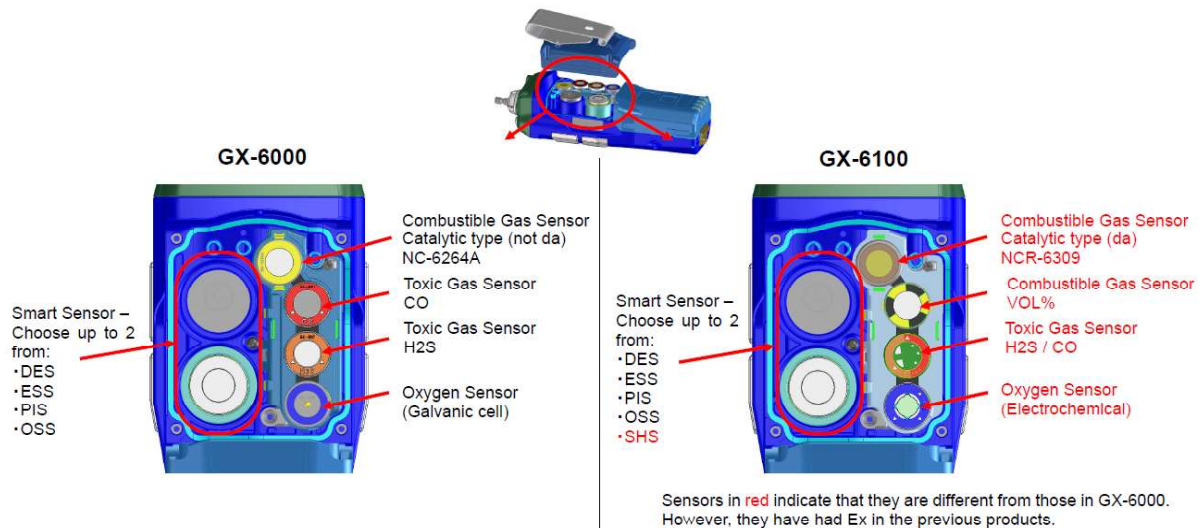
- (1) For sensors, please refer "Comparison of sensors in GX-6000 and GX-6100" below.
- (2) The piezoelectric buzzer has been discontinued, therefore the parts have been changed.
- (3) The backup battery was changed from a primary battery to a secondary battery (MS421R:SII).
- (4) The same BLE module as in the GX-Force is installed (IECEX DNV 22.0029X).







Comparison of sensors in GX-6000 and GX-6100:

- Both GX-6000 and GX-6100 can have a maximum of 6 sensors to be installed.
- Because the combustible sensor for GX-6000 is a catalytic sensor, only IIB is complied. A different sensor will be used in GX-6100 so as to comply IIC. The same sensor used in GX-Force will be installed in GX-6100.
ialIIB → daialIIC = Main purpose of the development of GX-6100
- Sensors for measurement of O₂ and toxic gases such as CO and H₂S will be replaced by our improved R sensors. The same sensor used in GX-Force will be installed in GX-6100.
- A thermal conductivity sensor (non-catalytic) which can measure the VOL% range of combustible gas will be additionally installed in GX-6100. The same sensor used in GX-2012 (IECEX DEK 11.0045) will be installed in GX-6100.
- For GX-6000, it was possible to install a maximum of 2 Smart Sensors (DES, ESS, PIS, OSS). For GX-6100, in addition to these available sensors, a thermal conductivity sensor (non-catalytic) which measures the ppm range of combustible gas will be added to make a choice of 5 sensors out of which up to 2 sensors can be installed. The same sensor used in SP-220 will be installed in SHS.



		GX-6000				GX-6100				
		Measuring gas	Sensor type	Detection principle	Form	Measuring gas	Sensor type	Detection principle	Form	Ex. model Cert.No.
Standard four gas	1	Combustible gas (LEL)	NC-6264A	Catalytic Combustion		Combustible gas (LEL)	R-sensor NCR-6309	Catalytic Combustion [da]		GX-Force IECEX DNV 22.0029X DNV 22 ATEX 05201X
	2	Oxygen (O2)	Oxygen Sensor	Galvanic cell		Oxygen (O2)	R-sensor 3EC	Electro Chemical		GX-Force IECEX DNV 22.0029X DNV 22 ATEX 05201X
	3	Hydrogen Sulfide (H2S)	Toxic gas Sensor	Electro Chemical		Hydrogen Sulfide / Carbon Monoxide (H2S / CO)	R-sensor 4EC	Electro Chemical		GX-Force IECEX DNV 22.0029X DNV 22 ATEX 05201X
	4	Carbon Monoxide (CO)	Toxic gas Sensor	Electro Chemical		Combustible gas (VOL%)	TE-7561	Thermal Conductivity		GX-2012 IECEX DEK 11.0045 DEKRA 11 ATEX 0123
Smart Sensor	5	VOC	Smart Sensor TYPE-PIS	PID		VOC	Smart Sensor TYPE-PIS	PID		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 6171X
	6	Toxic gases	Smart Sensor TYPE-ESS	Electro Chemical		Toxic gases	Smart Sensor TYPE-ESS	Electro Chemical		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 6171X
	7	Carbon Dioxide (CO2) or Combustible gas	Smart Sensor TYPE-DES	NDIR		Carbon Dioxide (CO2) or Combustible gas	Smart sensor TYPE-DES	NDIR		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 6171X
	8	Oxygen (O2)	Smart Sensor TYPE-OSS	Galvanic cell		Oxygen (O2)	Smart Sensor TYPE-OSS	Galvanic cell		GX-6000 IECEX PRE 15.0011 Presafe 15 ATEX 6171X
	9	-	-	-	-	Combustible gas (ppm)	Smart Sensor TYPE-SHS*	Semi Conductor		SP-220 IECEX PRE 15.0060 Presafe 15 ATEX 7188X

* The SH-8661 sensor is installed inside the SHS sensor.

A.1 Temperature assessment for L4 (part of IC6 / BLE module – EYSHJN) (Test performed in DNV project number PRJN-313142-2021-PA-NOR, for GX-Force)

1) Evaluated at maximum power.

The maximum power of the GX-Force is 0.7513W and the test result is a temperature rise of 145°C.

As the maximum power of the GX-6100 is 1.137W, the temperature rise is $1.137W / 0.7513W \times 145^\circ C = 219.5^\circ C$.

Ambient temperature 50°C

Result: $219.5^\circ C + 50^\circ C = 269.5^\circ C < 275^\circ C$

(2) Since the power is constant even after boosting the voltage, it is considered before boosting.

The maximum power of the BLE module section is

From $U_0 = 4.5 \text{ V}$ of the dry cell battery and the composite resistance of 4.455Ω from current limiting resistors RSA1 to RSC5

$$P_{o_th} = (4.5 \text{ V} / 4.455 \Omega) \times 4.5 \text{ V} / 4 = 1.137 \text{ W.}$$

GX-6100 connected to BLE module through limiting resistor 4.455Ω at 4.5 V power supply

GX-Force is connected to the BLE module with a power supply of 3.8 V through a limiting resistor 4.4Ω ($\approx 4.455 \Omega$) \Rightarrow temperature rise 145°C at this time.

Therefore, the temperature rise of the BLE module of the GX-6100 is $(4.5\text{V}/3.8\text{V})^2 \times 145^\circ\text{C} = 203.4^\circ\text{C}$

Result: $203.4^\circ\text{C} + 50^\circ\text{C} = 254.4^\circ\text{C} < 275^\circ\text{C}$

See test in B.1 below.

B.1 Test conducted Temperature test of L4 (part of IC6 / BLE module – EYSHJN) (Test performed in DNV project number PRJN-313142-2021-PA-NOR, for GX-Force)

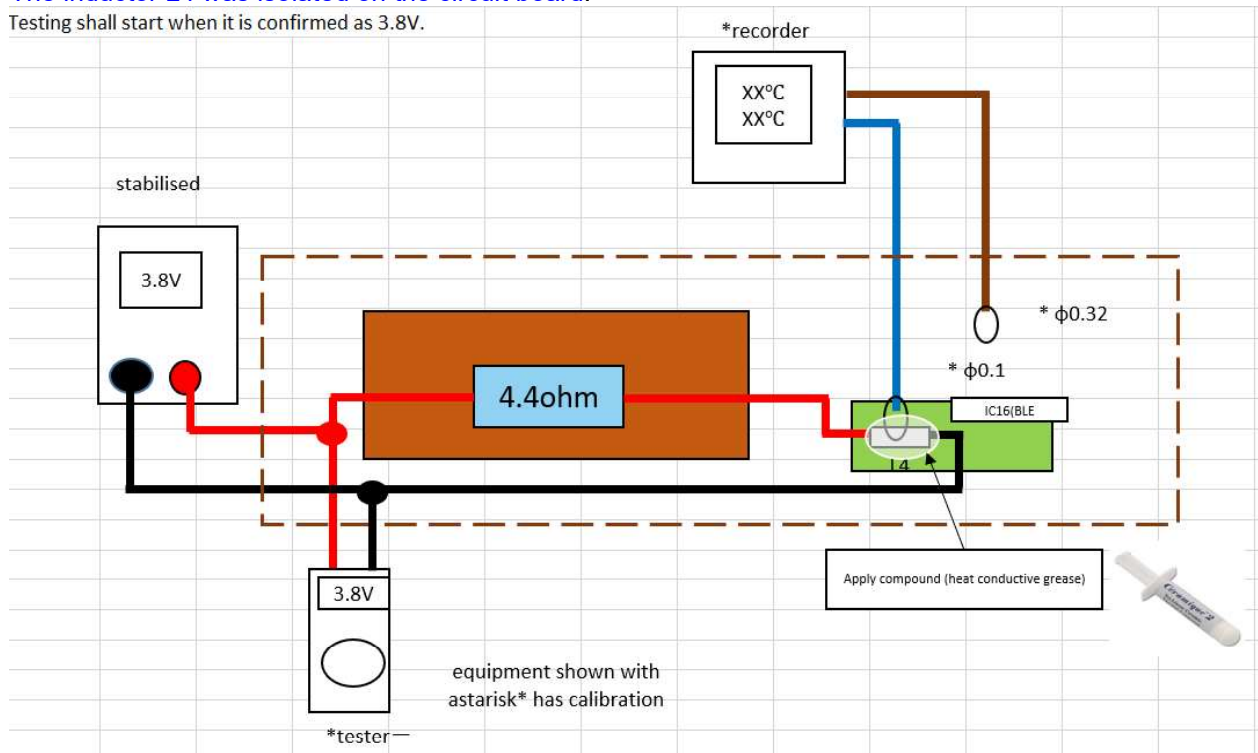
Equipment Tested:	L4 (inductor) as a part of the hybrid component IC6
Date of Test (yyyy/mm/dd):	2022/05/19
Clause and Standards:	10.2 of IEC 60079-11: 2011

B.1.1 Test procedures

According to clause 7.6.h of IEC 60079-11: 2011 the resistance of an inductor at failure shall be between nominal value (0.34Ω) and 0 .

The inductor L4 was isolated on the circuit board.

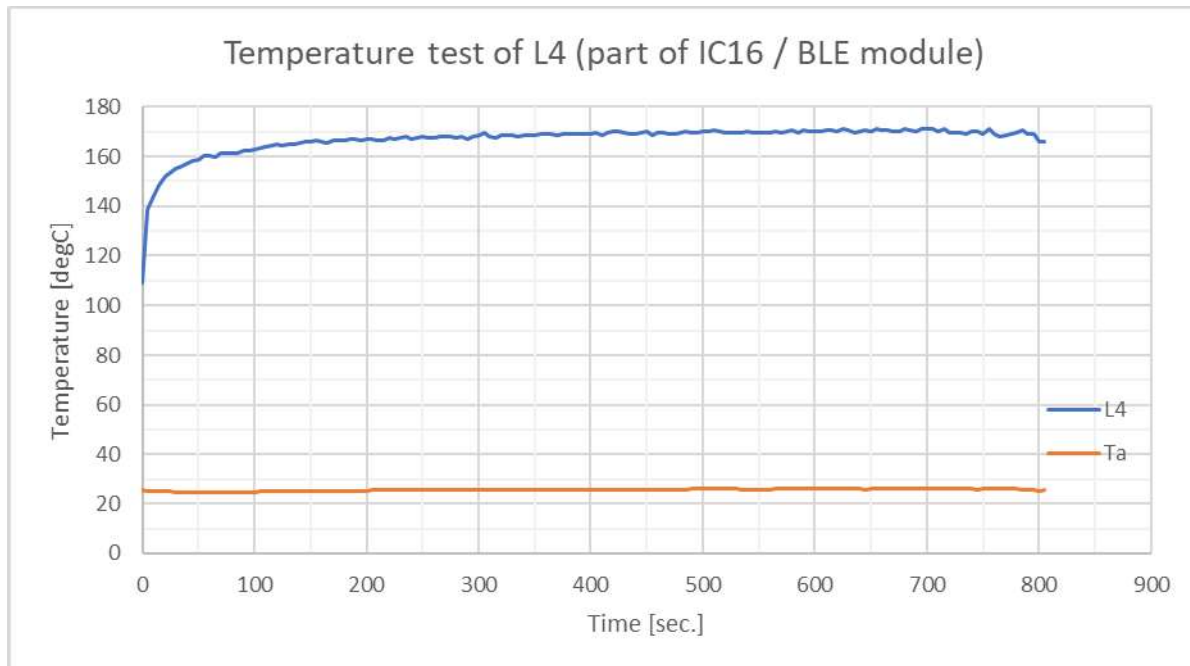
Testing shall start when it is confirmed as 3.8 V .



$$R = 4.37 \Omega \quad U = 3.8 \text{ V}$$




B.7.2 Results

$T_{\text{measured}} = 171^{\circ}\text{C}$ $T_{\text{a-max}} = 60^{\circ}\text{C}$ $T_{\text{a}} = 26^{\circ}\text{C}$ $\Delta T = 145\text{K}$
 $T_{\text{max}} = 145\text{K} + 60^{\circ}\text{C} = 205^{\circ}\text{C}$
 $205^{\circ}\text{C} < 275^{\circ}\text{C} \rightarrow T_4$





IECEx TEST REPORT COVER


ExTR Reference Number.....:	NO/PRE/ExTR15.0012/04	
ExTR Free Reference Number	PRJN-277576-2021-PA-NOR	<i>leshan it83</i>
Compiled by + signature (ExTL)	Ke Shen	
Reviewed by + signature (ExTL).....:	Gunnar Nielsen	<i>Gunnar Nielsen</i>
Approved by + signature (ExCB):	Asle Kaastad	<i>Asle Kaastad</i>
Date of issue	2021-08-05	
Ex Testing Laboratory (ExTL).....:	 DNV	
Address	DNV Product Assurance AS Veritasveien 3 1363 Høvik Norway	
Ex Certification Body (ExCB).....:	 DNV	
Address	DNV Product Assurance AS Veritasveien 3 1363 Høvik Norway	
Applicant's name.....:	 RIKEN KEIKI	
Address	RIKEN KEIKI Co., Ltd. 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan	
Standards associated with this ExTR package	IEC 60079-0: 2017 edition 7 IEC 60079-11: 2011 edition 6	
Clauses considered	All clauses considered	
Test Report Form Number	ExTR Cover_8 (released 2020-05)	
Related Amendments, Corrigenda or ISHs	N / A	
Test item description	Portable Gas Monitor	
Model/type reference	GX-6000	
Code (e.g. Ex _ II_ T_).....:	Ex ia IIB T4/T3 Ga Ex ia IIC T4/T3 Ga See General Product Information for details.	
Rating	Battery operated. BUL-6000 (rechargeable Li-ion battery unit) or BUD-6000 (Alkaline battery unit). For BUD-6000: use only Toshiba LR6 or Duracell MN1500 AA-batteries.	

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

IECEx Test Report Cover

ExTR Package Contents	
Assembled ExTR documents and Additional reference material:	
IECEx Test Report Addendum: IEC 60079-0, Edition 7	

Manufacturer's name	RIKEN KEIKI Co., Ltd.
Address	2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan RIKEN KEIKI Co., Ltd. 2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan RIKEN KEIKI NARA MFG. Co., Ltd. 49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan
Trademark	
Certificate No. (optional)	IECEx PRE 15.0011/05
QAR Reference No. (optional)	NO/PRE/QAR19.0018/01
Particulars: Test item vs. Test requirements	
Classification of installation and use	portable / hand-held
Ingress protection	Min. IP 20
Rated ambient temperature range (°C)	-20°C ≤ Ta ≤ +50°C
Rated service temperature range (°C) for Ex Components	portable / hand-held
General remarks:	
<p>The test results presented in this ExTR package relate only to the item or product tested.</p> <ul style="list-style-type: none"> ▪ "(See Attachment #)" refers to additional information appended to the ExTR package. ▪ "(See appended table)" refers to a table appended to the ExTR package. ▪ Throughout this ExTR package, a point is used as the decimal separator. ▪ <i>Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.</i> ▪ <i>In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.</i> <p>The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.</p>	
General product information:	
<p>Equipment under test hereby referred to as EUT is a portable gas monitor model GX-6000 manufactured by Riken Keiki Co., Ltd. EUT is used for measuring flammable gas concentration in hazardous location. EUT is build up in major by approximately same parts of similar models (e.g. models GX-2012GT, GX-2009 or GX-8000 which all are manufactured by Riken Keiki) and has same Ex protection concept (intrinsic safe). These similar models are separately Ex certified devices. This investigation is therefore based on former evaluation of the used parts. Test results and safety info are extracted from respective test reports of similar models and are documented in this report package. Additional evaluation are performed for relevant requirements which may not be covered by these certifications.</p> <p>EUT is an battery-operated handheld portable device and is built up by plastic enclosure with minor metal parts such as assembly screws. The display is located in front/top of EUT. At the bottom/rear side is the battery unit. Two alternative battery units may be used with EUT. BUD-6000 is the alkaline dry battery unit and BUL-6000 is the Li-ion battery unit. Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. More technical details of design is explained in Appendix A.1 of the associated IEC60079-11 test report.</p> <p>Several safety instructions are found in attached manual. Specific safe instructions are also marked on</p>	

labels. See Copy of marking plate in addition.

- Warning: "Do not charge in hazardous location"
- Warning: "Do not charge it except by genuine charger"
- Warning: "Do not replace battery unit in hazardous location"
- Warning: "Do not replace dry batteries in hazardous location"
- Warning: "Do Not attempt to disassemble or alter the instrument"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba or MN1500 by Duracell, or use chargeable battery unit type BUL-6000.

EUT is consisting of a main part and a battery unit (BUL-6000 or BUD-6000). No tools is needed to remove battery units from the main part. The BUL-6000 battery unit is an encapsulated device. The enclosure used anti-electrostatic material with minor smaller parts of other regular plastic material. Small accessible metal parts are built-in to the anti-electrostatic material and therefore are not considered to be isolated. Inside the main part is electronics including small internal pump RP-12, DC vibration motor and piezoelectric device BZ-9K. These devices are used in similar models which have been separately certified with regards to Ex requirements. The majority of this investigation is based on test reports and associated appendix with inter alia Test report no. NL/KEM/ExTR11.0038 & NL/DEK/ExTR13.0075/00. However report reference to extracted test results will be detailed in associated test reports of this certification.

The charger modules BC-6000 & SDM-6000 are assessed and included in this investigation but not the AC/DC power adapter. Electronic design concept of charger modules are identically. The difference between the two charger modules made no impact to the type of protection. Assessment of module BC-6000 is representative for module SDM-6000 as well.

Included in this certification are following parts which comprise EUT:

- GX-6000: Portable Gas Monitor
- BUL-6000: Rechargeable Li-ion battery unit
- BUD-6000: Alkaline battery unit. Use only Toshiba LR6 or DURACELL MN1500 AA-batteries.
- BC-6000: Charge module
- SDM-6000: Charge module
- NC-6264A: Combustible gas sensor
- Toxic gas sensor
- Oxygen sensor
- Smart sensor type DES
- Smart sensor type ESS
- Smart sensor type PIS
- Smart sensor type OSS

When the combustible gas sensor is used the gas group is limited to IIB.

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUL-6000
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUL-6000
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIB T3 Ga	-20°C to +50°C	Mounted	BUD-6000 MN1500 (Duracell)
Ex ia IIC T3 Ga	-20°C to +50°C	Not mounted	BUD-6000 MN1500 (Duracell)

List of descriptive documents:

	DRAWING NAME	DRAWING No.	REV	DATE
01	BLOCK DIAGRAM FOR MODEL GX-6000	E3-6991-5393-30-01K	0	2014.7.28
02	DIAGRAM FOR I.S. KEEP FOR MODEL GX-6000	E3-6991-5361-10-01K	2	2014.12.16
03	OUTER STRUCTURE GX-6000	M3-4777-01-01K	0	2014.7.18
04	MAIN UNIT GX-6000	M2-4777-01-01K	1	2014.9.30
05	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-01K	0	2014.7.14
06	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-02K	0	2014.7.14
07	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-03K	0	2014.7.14
08	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-04K	0	2014.7.14
09	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-05K	0	2014.7.14
10	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (1/4)	0	2014.7.14
11	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (2/4)	3	2014.12.16
12	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (3/4)	1	2014.11.5
13	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (4/4)	0	2014.7.14
14	MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-01A	0	2014.7.14
15	MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-02A	0	2014.7.14
16	SCHEMATIC SENSOR PCB FOR MODEL GX-6000	E3-6991-5373-50-01K	1	2014.11.5
17	PARTS LIST OF SENSOR PCB	PLT-6991-5373-50 (1/1)	2	2014.12.16
18	SENSOR PCB FOR MODEL GX-6000	E4-6991-5373-50-01A	1	2014.11.5
19	SENSOR to MAIN WIRE FOR MODEL GX-6000	E4-6991-5382-70-01K	0	2014.7.14
20	PUMP RP-12	M4-4181-61-01K	3	2013.1.29
21	Buzzer BZ-9K	E4-6991-5008-70-01K	0	2011.2.28
22	COMBUSTIBLE GAS SENSOR NC SENSOR	M3-4462-64-05K	3	2012.4.17
23	TOXIC GAS SENSOR	M4-4084-92-03K	0	2014.7.30
24	OXYGEN SENSOR	M4-4080-82-07K	0	2014.7.30
25	SMART SENSOR Type-ESS	M4-4486-01-01K	0	2014.7.30
26	TOXIC GAS SENSOR	M4-4084-30-08K	0	2014.7.30
27	ESS SENSOR PCB	E3-6991-5384-10-01K	0	2014.7.14
28	SMART SENSOR Type-UE-S	M4-4630-20-01K	0	2014.7.24
29	DES SENSOR PCB	E3-6991-5385-90-01K	1	2015.5.25
30	DES DIGITAL PCB	E3-6991-5386-60-01K	1	2015.2.24

	DRAWING NAME	DRAWING No.	REV	DATE
31	T-3/4 BPA LAMP OL-02700PA	E4-6991-5129-60-01K	0	2012.2.24
32	SMART SENSOR Type-PIS	M4-4830-01-01K	1	2015.3.25
33	PIS SENSOR PCB	F4-6991-5387-30-01K	2	2015.3.25
34	PIS DIGITAL PCB	E3-6991-5388-10-01K	1	2015.3.25
35	BUL-6000	M3-4777-03-01K	0	2014.7.28
36	BUL PCB	E3-6991-5389-80-01K	1	2014.9.5
37	BUD-6000	M3-4777-04-01K	1	2015.3.6
38	BUD PCB	E4-6991-5390-50-01K	1	2014.9.5
39	DIAGRAM FOR I.S. KFFP FOR MODEL BC-6000 / SDM-6000	E4-6991-5395-80-01K	1	2014.9.5
40	LABEL	M4-4777-01-01K	7	2021.7.26
41	LABEL BC-6000 / SDM-6000	M4-4777-01-02K	0	2014.7.28
42	SCHEMATIC CHARGER PCB FOR MODEL BC-6000	E3-6991-5255-80-01K	0	2014.12.16
43	CHARGER PCB FOR MODEL BC-6000	E3-6991-5255-80-01A	0	2014.12.16
44	SCHEMATIC CHARGER PCB FOR MODEL SDM-6000	E3-6991-5445-60-01K	1	2015.3.5
45	CHARGER PCB FOR MODEL SDM-6000	E3-6991-5445-60-01A	2	2015.6.12
46	SMART SENSOR Type-OSS	M4-4080-01-01K	0	2015.2.24
47	OSS SENSOR PCB	E4-6991-5457-00-01K	0	2015.2.24
48	OSS DIGITAL PCB	E3-6991-5458-70-01K	0	2015.2.24
49	OXYGEN SENSOR	M4-4080-01-02K	0	2015.2.24
50	BC-6000	M3-4777-02-01K	1	2015.3.23
51	SDM-6000	M3-4395-23-01K	1	2015.3.23

注 記 NOTES	No.40	改訂担当者 REV BY	改訂日 REVISU	名称 NAME
改訂回数 REV	7	総頁数 PAGES	1	INDEX
承認 APPROVED	検討 CHECKED	製図 DRAWN	作成日 DATE	図番 DWG NO.
石橋勝	北村正英	小野圭	2015.3.6	E3-6991-5470-70-01K
RIKEN KEIKI 理研計器株式会社 機密情報/CONFIDENTIAL				



IECEx TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/04
ExTR Free Reference Number : PRJN-277576-2021-PA-NOR
Compiled by + signature (ExTL) : Ke Shen
Reviewed by + signature (ExTL) ... : Gunnar Nielsen
Date of issue : 2021-08-05

Ke Shen

Gunnar Nielsen

Ex Testing Laboratory (ExTL) :



Address : DNV Product Assurance AS
Veritasveien 3
1363 Høvik
Norway

Applicant's name :



Address : RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standards : IEC 60079-0: 2017 edition 7
IEC 60079-11: 2011 edition 6

Test Report Form Number : ExTR Addendum_3 (released 2018-02)

Related Amendments, Corrigenda
or ISHs : N/A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : N / A
- test item does meet the requirement : Pass

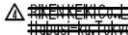

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point is used as the decimal separator.

The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Clause	Requirement – Test	Result – Remark	Verdict
23.11	Replacement of cells or batteries	<p>Warnings provided. See 29.13 and Copy of marking plates and associated IEC60079-11 test report.</p> <p>The warning marking is updated with two option battery cell type.</p> <p>BUD-6000(LABEL C) </p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>MODEL BUD-6000 INST.NO. RIKEN KEIKI Co., Ltd./2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan WARNING Use only battery types LR6 TOSHIBA or MN1500 DURACELL</p> </div>	Pass
29.13	Warning markings	<p>Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information.</p> <p>The warning marking is updated with two option battery cell type.</p> <p>BUD-6000(LABEL C) </p> <div style="border: 1px solid black; padding: 5px; width: fit-content;"> <p>MODEL BUD-6000 INST.NO. RIKEN KEIKI Co., Ltd./2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan WARNING Use only battery types LR6 TOSHIBA or MN1500 DURACELL</p> </div>	Pass

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

Warning marking:

GX-6000(LABEL A)

MODEL GX-6000
INST.No.
RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

BUL-6000(LABEL B) 

MODEL BUL-6000
INST.No.
RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan
WARNING
Do not charge battery in haz.loc.

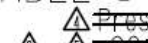
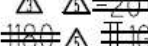







BUD-6000(LABEL C) 

MODEL BUD-6000
INST.No.
RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan
WARNING Use only battery types
LR6 TOSHIBA or MN1500 DURACELL

GX-6000, BUL-6000, BUD-6000(LABEL D)



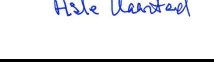



CE 2460 **Ex**

II 1GEEx IIC / II BT4 / T3 Gd
Presafe15 ATEX 617 IX
IECEx PRE 15.0011
-20°C ≤ Ta ≤ +50°C
WARNING
Read manual for safety info.
Do not open in haz.loc.

CE 	
	REVISION
	REVISION
	REVISION
	REVISION
	REVISION
	REVISION
	記 事 4



IECEx TEST REPORT COVER

ExTR Reference Number.....:	NO/PRE/ExTR15.0012/03	
ExTR Free Reference Number	PRJN-238467-2021-PA-NOR	
Compiled by + signature (ExTL)	Gunnar Nielsen	
Reviewed by + signature (ExTL).....	Stig André Norheim	
Approved by + signature (ExCB)	Asle Kaastad	
Date of issue	2021-04-28	
Ex Testing Laboratory (ExTL).....:	 DNV	
Address	DNV Product Assurance AS Veritasveien 3 1363 Høvik Norway	
Ex Certification Body (ExCB).....:	 DNV	
Address	DNV Product Assurance AS Veritasveien 3 1363 Høvik Norway	
Applicant's name.....:	 RIKEN KEIKI	
Address	RIKEN KEIKI Co., Ltd. 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan	
Standards associated with this ExTR package	IEC 60079-0: 2017 edition 7 IEC 60079-11: 2011 edition 6	
Clauses considered	All clauses considered	
Test Report Form Number	ExTR Cover_8 (released 2020-05)	
Related Amendments, Corrigenda or ISHs	N / A	
Test item description	Portable Gas Monitor	
Model/type reference	GX-6000	
Code (e.g. Ex __ II__ T__).....:	Ex ia IIB T4/T3 Ga Ex ia IIC T4/T3 Ga See General Product Information for details.	
Rating	Battery operated. BUL-6000 (rechargeable Li-ion battery unit) or BUD-6000 (Alkaline battery unit). For BUD-6000: use only Toshiba LR6 or Duracell MN1500 AA-batteries.	

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

IECEx Test Report Cover

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

IECEX Test Report: IEC 60079-0, Edition 7

IECEX Test Report Addendum: IEC 60079-0, edition 7 and IEC 60079-11, Edition 6

Manufacturer's name: RIKEN KEIKI Co., Ltd.
 Address: 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan
 Additional locations: RIKEN KEIKI Co., Ltd.
 2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan
 RIKEN KEIKI NARA MFG. Co., Ltd.
 49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan

Trademark: 

Certificate No. (optional): IECEX PRE 15.0011/04

QAR Reference No. (optional): NO/PRE/QAR19.0018/01

Particulars: Test item vs. Test requirements

Classification of installation and use: portable / hand-held

Ingress protection: Min. IP 20

Rated ambient temperature range (°C).....: -20°C ≤ Ta ≤ +50°C

General remarks:

The test results presented in this ExTR package relate only to the item or product tested.

- "(See Attachment #)" refers to additional information appended to the ExTR package.
- "(See appended table)" refers to a table appended to the ExTR package.
- Throughout this ExTR package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEX 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.*

The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

General product information:

Equipment under test hereby referred to as EUT is a portable gas monitor model GX-6000 manufactured by Riken Keiki Co., Ltd. EUT is used for measuring flammable gas concentration in hazardous location. EUT is build up in major by approximately same parts of similar models (e.g. models GX-2012GT, GX-2009 or GX-8000 which all are manufactured by Riken Keiki) and has same Ex protection concept (intrinsic safe). These similar models are separately Ex certified devices. This investigation is therefore based on former evaluation of the used parts. Test results and safety info are extracted from respective test reports of similar models and are documented in this report package. Additional evaluation are performed for relevant requirements which may not be covered by these certifications.

EUT is an battery-operated handheld portable device and is built up by plastic enclosure with minor metal parts such as assembly screws. The display is located in front/top of EUT. At the bottom/rear side is the battery unit. Two alternative battery units may be used with EUT. BUD-6000 is the alkaline dry battery unit and BUL-6000 is the Li-ion battery unit. Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. More technical details of design is explained in Appendix A.1 of the associated IEC60079-11 test report.

Several safety instructions are found in attached manual. Specific safe instructions are also marked on labels. See Copy of marking plate in addition.

- Warning: "Do not charge in hazardous location"
- Warning: "Do not charge it except by genuine charger"
- Warning: "Do not replace battery unit in hazardous location"
- Warning: "Do not replace dry batteries in hazardous location"
- Warning: "Do Not attempt to disassemble or alter the instrument"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba or MN1500 by Duracell, or use chargeable battery unit type BUL-6000.

EUT is consisting of a main part and a battery unit (BUL-6000 or BUD-6000). No tools is needed to remove battery units from the main part. The BUL-6000 battery unit is an encapsulated device. The enclosure used anti-electrostatic material with minor smaller parts of other regular plastic material. Small accessible metal parts are built-in to the anti-electrostatic material and therefore are not considered to be isolated. Inside the main part is electronics including small internal pump RP-12, DC vibration motor and piezoelectric device BZ-9K. These devices are used in similar models which have been separately certified with regards to Ex requirements. The majority of this investigation is based on test reports and associated appendix with inter alia Test report no. NL/KEM/ExTR11.0038 & NL/DEK/ExTR13.0075/00. However report reference to extracted test results will be detailed in associated test reports of this certification.

The charger modules BC-6000 & SDM-6000 are assessed and included in this investigation but not the AC/DC power adapter. Electronic design concept of charger modules are identically. The difference between the two charger modules made no impact to the type of protection. Assessment of module BC-6000 is representative for module SDM-6000 as well.

Included in this certification are following parts which comprise EUT:

- GX-6000: Portable Gas Monitor
- BUL-6000: Rechargeable Li-ion battery unit
- BUD-6000: Alkaline battery unit. Only type Toshiba LR6 AA size is allowed.
- BC-6000: Charge module
- SDM-6000: Charge module
- NC-6264A: Combustible gas sensor
- Toxic gas sensor
- Oxygen sensor
- Smart sensor type DES
- Smart sensor type ESS
- Smart sensor type PIS
- Smart sensor type OSS

When the combustible gas sensor is used the gas group is limited to IIB.

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUL-6000
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUL-6000
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIB T3 Ga	-20°C to +50°C	Mounted	BUD-6000 MN1500 (Duracell)
Ex ia IIC T3 Ga	-20°C to +50°C	Not mounted	BUD-6000 MN1500 (Duracell)

Details of change (applicable only when revising an existing ExTR package):

Updated to the latest edition of IEC 60079-0, include an additional battery cell for use with BUD-6000 and update gas group to IIB when the combustible gas sensor (NC-6264A) is used.

Copy of Marking Plate:

MODEL GX-6000
INST.No.
RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

MODEL BUL-6000
INST.No.
RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan
WARNING
Do not charge battery in haz.loc.

MODEL BUD-6000
INST.No.
RIKEN KEIKI Co., Ltd./2-7-6, Azusawa,
Itabashi-ku, Tokyo, 174-8744, Japan
WARNING
Use only battery types: LR6 TOSHIBA

 2460 
II 1GEExia IIC/II B T4/T3 Gd
Presafe15ATEX6171X
IECEX PRE 15.0011
-20°C ≤ Ta ≤ +50°C
WARNING
Read manual for safety info.
Do not open in haz.loc.

Details regarding 'trade agent' / 'local assembler' application in accordance with OD 203:[N / A](#)**Testing not fully performed by ExTL staff at the above ExTL address:****National differences considered as part of this evaluation:**[N / A](#)**"Specific Conditions of Use" / "Schedule of Limitations":**[No 'Specific condition of use' are claimed.](#)**Routine tests:**[N / A](#)**Date(s) of performance for all testing:**[N / A – No extra testing for this update.](#)

Copyright © 2020 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEX System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEX System is acknowledged as copyright owner and source of the material. The IECEX system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Technical Documents

Title:	Drawing No.:	Rev. Level:	Date:
*INDEX GX-6000	E3-6991-5470-70-01K	6	2021.04.23

Note: An * is included before the title of documents that are new or revised.

List of descriptive documents:

	DRAWING NAME	DRAWING No.	REV	DATE		DRAWING NAME	DRAWING No.	REV	DATE	
01	BLOCK DIAGRAM FOR MODEL GX-6000	E3-6991-5393-30-01K	0	2014.7.28		31	T- 3/4 BPA LAMP OL-5270BPA	E4-6991-5129-60-01K	0	2012.2.24
02	DIAGRAM FOR I.S. KEEP FOR MODEL GX-6000	E3-6991-5361-10-01K	2	2014.12.16		32	SMART SENSOR Type-PIS	M4-4830-01-01K	1	2015.3.25
03	OUTER STRUCTURE GX-6000	M3-4777-01-01K	0	2014.7.18		33	PIS SENSOR PCB	E4-6991-5387-30-01K	2	2015.3.25
04	MAIN UNIT GX-6000	M2-4777-01-01K	1	2014.9.30		34	PIS DIGITAL PCB	E3-6991-5388-10-01K	1	2015.3.25
05	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-01K	0	2014.7.14		35	BUL-6000	M3-4777-03-01K	0	2014.7.28
06	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-02K	0	2014.7.14		36	BUL PCB	E3-6991-5389-80-01K	1	2014.9.5
07	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-03K	0	2014.7.14		37	BUD-6000	M3-4777-04-01K	1	2015.3.6
08	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-04K	0	2014.7.14		38	BUD PCB	E4-6991-5390-50-01K	1	2014.9.5
09	SCHEMATIC MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-05K	0	2014.7.14		39	DIAGRAM FOR I.S. KEEP FOR MODEL DC-6000 / SDM-6000	E4-6991-5395-80-01K	1	2014.9.5
10	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (1/4)	0	2014.7.14	*	40	LABEL	M4-4777-01-01K	6	2021.4.23
11	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (2/4)	3	2014.12.16		41	LABEL BC-6000 / SDM-6000	M4-4777-01-02K	0	2014.7.28
12	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (3/4)	1	2014.11.5		42	SCHEMATIC CHARGER PCB FOR MODEL BC-6000	E3-6991-5255-80-01K	0	2014.12.16
13	PARTS LIST OF MAIN PCB	PLT-6991-5372-80 (4/4)	0	2014.7.14		43	CHARGER PCB FOR MODEL BC-6000	E3-6991-5255-80-01A	0	2014.12.16
14	MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-01A	0	2014.7.14		44	SCHEMATIC CHARGER PCB FOR MODEL SDM-6000	E3-6991-5445-60-01K	1	2015.3.5
15	MAIN PCB FOR MODEL GX-6000	E3-6991-5372-80-02A	0	2014.7.14		45	CHARGER PCB FOR MODEL SDM-6000	E3-6991-5445-60-01A	2	2015.6.12
16	SCHEMATIC SENSOR PCB FOR MODEL GX-6000	E3-6991-5373-50-01K	1	2014.11.5		46	SMART SENSOR Type-OSS	M4-4080-01-01K	0	2015.2.24
17	PARTS LIST OF SENSOR PCB	PLT-6991-5373-50 (1/1)	2	2014.12.16		47	OSS SENSOR PCB	E4-6991-5457-00-01K	0	2015.2.24
18	SENSOR PCB FOR MODEL GX-6000	E4-6991-5373-50-01A	1	2014.11.5		48	OSS DIGITAL PCB	E3-6991-5458-70-01K	0	2015.2.24
19	SENSOR to MAIN WIRE FOR MODEL GX-6000	E4-6991-5382-70-01K	0	2014.7.14		49	OXYGEN SENSOR	M4-4080-01-02K	0	2015.2.24
20	PUMP RP-12	M4-4181-61-01K	3	2013.1.29		50	BC-6000	M3-4777-02-01K	1	2015.3.23
21	Buzzer BZ-9K	E4-6991-5008-70-01K	0	2011.2.28		51	SDM-6000	M3-4395-23-01K	1	2015.3.23
22	COMBUSTIBLE GAS SENSOR NC SENSOR	M3-4462-64-05K	3	2012.4.17						
23	TOXIC GAS SENSOR	M4-4084-92-03K	0	2014.7.30						
24	OXYGEN SENSOR	M4-4080-82-07K	0	2014.7.30						
25	SMART SENSOR Type-ESS	M4-4486-01-01K	0	2014.7.30						
26	TOXIC GAS SENSOR	M4-4004-30-00K	0	2014.7.30						
27	ESS SENSOR PCB	E3-6991-5384-10-01K	0	2014.7.14						
28	SMART SENSOR Type-DES	M4-4630-20-01K	0	2014.7.24						
29	DES SENSOR PCB	E3-6991-5385-90-01K	1	2015.5.25						
30	DES DIGITAL PCB	E3-6991-5386-60-01K	1	2015.2.24						

注 記 NOTES	No.40	改修担当者 REV BY	改修日 REVISED	名称 NAME
改修回数 REV	6	小野圭	2021.4.23	INDEX
原頁数 PAGES	1			GX-6000
承認 APPROVED	検討 CHECKED	製図 DRAWN	作成日 DATE	図番 DWG. NO.
石橋勝	北村正英	小野圭	2015.3.6	E3-6991-5470-70-01K
 理研計器株式会社				
機密情報 / CONFIDENTIAL				



IECEx TEST REPORT
IEC 60079-0
Explosive atmospheres – Part 0: Equipment – General requirements

ExTR Reference Number.....: NO/PRE/ExTR15.0012/03
ExTR Free Reference Number: PRJN-238467-2021-PA-NOR
Compiled by + signature (ExTL): Gunnar Nielsen
Reviewed by + signature (ExTL).....: Stig André Norheim
Date of issue: 2021-04-28

Gunnar Nielsen
Stig André Norheim

Ex Testing Laboratory (ExTL).....:



Address: DNV Product Assurance AS
Veritasveien 3
1363 Høvik
Norway

Applicant's name.....:



Address: RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standard.....: IEC 60079-0:2017, Edition 7.0
Test procedure: IECEx System
Test Report Form Number: ExTR60079-0_7B_DS (released 2018-01)
Related Amendments, Corrigenda or
ISHs: N/A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item:N / A
- test item does meet the requirement:Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a comma "," is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope		
2	Normative references		
3	Terms and definitions		
4	Equipment grouping		
4.1	General	According to clause 4.3.	Pass
4.2	Group I	Group II.	N / A
4.3	Group II	Equipment under test hereby referred to as EUT is portable gas monitor GX-6000 including charger modules BC-6000/SDM-6000. See General product information. Ex ia IIB/IIC T4/T3 Ga $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$ See <i>Measurement Section, including Additional Narrative Remarks</i> at the end of the report for details.	Pass
4.4	Group III	Group II.	N / A
4.5	Equipment for a particular explosive gas atmosphere	No particular explosive atmosphere specified.	N / A
5 See also DS 2015/011A	Temperatures		
5.1	Environmental influences		
5.1.1	Ambient temperature	Ex ia IIC T4/T3 Ga $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$ See <i>Measurement Section, including Additional Narrative Remarks</i> at the end of the report for details.	Pass
5.1.2	External source of heating or cooling	No external sources of heating or cooling.	N / A
5.2	Service temperature	Not required due to exclusion of cl. 7.2 by Table 1 of IEC60079-11: 2011.	N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
5.3	Maximum surface temperature		
5.3.1	Determination of maximum surface temperature	Maximum surface temperature is considered taken into account requirements of thermal ignition compliance of cl.5.6 of IEC 60079-11. Evaluation documented in Appendix A.3 & B.3 of associated IEC60079-11 and addendum test reports.	Pass
5.3.2	Limitation of maximum surface temperature		
5.3.2.1	Group I electrical equipment	Not Group I electrical equipment.	N / A
5.3.2.2	Group II electrical equipment	See 5.3.1. T4/T3 temperature class assigned and recognized. See Copy of marking plate.	Pass
5.3.2.3	Group III electrical equipment	Not Group III electrical equipment.	N / A
5.3.2.3.1	Maximum surface temperature for EPL Da		N / A
5.3.2.3.2	Maximum surface temperature for EPL Db		N / A
5.3.2.3.3	Maximum surface temperature determined without a layer of dust for EPL Dc		N / A
5.3.3	Small component temperature for Group I or Group II electrical equipment	Considered taken into account requirements of thermal ignition compliance cl. 5.6 of IEC 60079-11. Evaluation documented in Appendix A.3 & B.3 of associated IEC60079-11 and addendum test reports.	Pass
5.3.4	Component temperature of smooth surfaces for Group I or Group II electrical equipment	No such components.	N / A

6	Requirements for all electrical equipment		
---	-------------------------------------------	--	--

6.1	General	Requirements of IEC60079-11: 2011 considered. Code Ex ia IIB/IIC T4/T3 Ga.	Pass
-----	---------	----------------------------------------------------------------------------	------

6.2	Mechanical strength of equipment	Excluded by Table 1 of IEC60079-11: 2011 except for the drop test which is documented in appended Table 26.4.3. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N / A
-----	----------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------

6.3	Opening times	Excluded by Table 1 of IEC60079-11: 2011	N / A
-----	---------------	------------------------------------------	-------

6.4	Circulating currents in enclosures (e.g. of large electric machines)	Excluded by Table 1 of IEC60079-11: 2011	N / A
-----	----------------------------------------------------------------------	------------------------------------------	-------

6.5	Gasket retention	Excluded by Table 1 of IEC60079-11: 2011	N / A
-----	------------------	------------------------------------------	-------

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
6.6	Electromagnetic and ultrasonic energy radiating equipment	EUT is not electromagnetic or ultrasonic energy radiating equipment	Pass
6.6.1	General		N / A
6.6.2	Radio frequency sources		N / A
6.6.3	Ultrasonic sources		N / A
6.6.4	Lasers, luminaires, and other non-divergent continuous wave optical sources	The lamp OL-8270BPA is separately Ex certified, test report TxTR12.0033 is documented. See Appendix D in associated IEC60079-11 test report.	Pass

7	Non-metallic enclosures and non-metallic parts of enclosures		
---	--------------------------------------------------------------	--	--

7.1	General		
7.1.1	Applicability	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N / A
7.1.2	Specification of materials		
7.1.2.1	General	See above and clauses 7.4 & 24.	Pass
7.1.2.2	Plastic materials	See above.	Pass
7.1.2.3	Elastomers	O-ring used but not for Ex safety purpose.	N / A
7.1.2.4	Materials used for cementing	No such parts.	N / A

7.2	Thermal endurance	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N / A
7.2.1	Tests for thermal endurance		N / A
7.2.2	Material selection		N / A
7.2.3	Alternative qualification of elastomeric sealing O-rings		N / A

7.3	Resistance to ultraviolet light	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N / A
-----	---------------------------------	----------------------------------------------------------------------------------------------------------------	-------

7.4	Electrostatic charges on external non-metallic materials		
7.4.1	Applicability	Applied.	Pass
7.4.2	Avoidance of a build-up of electrostatic charge for Group I or Group II	Material ESC9448N & LCD panel sheet PET 300R. All material have surface resistance of less than 1GΩ. See appended table 26.13. All smaller parts of regular plastic material have surface area less than 400mm². Refer to drawing M2-4777-01-01K.	Pass
7.4.3	Avoidance of a build-up of electrostatic charge for Group III	Not Group III equipment.	N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
7.5	Attached external conductive parts	Small accessible metal parts exist but enclosure's conductive plastic materials are used so the mentioned parts are not isolated. However small metallic parts are considered to represent not more than 3pF. Refer to Note 1 of cl. 7.5 of this standard. See appended Table 26.13.	Pass
8	Metallic enclosures and metallic parts of enclosures		
8.1	Material composition	See 8.3 & 24.	Pass
8.2	Group I	Not Group I equipment.	N / A
8.3	Group II	Small parts of stainless steel material used such as air inlets. Less than 10 % in total of Al, Mg, Ti & Zr and less than 7.5% in total of Mg, Ti & Zr. See also 7.5	Pass
8.4	Group III	Not Group III equipment.	N / A
8.5	Copper Alloys	No copper alloys.	N / A
9	Fasteners	Excluded by Table 1 of IEC60079-11: 2011.	N / A
9.1	General		N / A
9.2	Special fasteners		N / A
9.3	Holes for special fasteners		
9.3.1	Thread engagement		N / A
9.3.2	Tolerance and clearance		N / A
9.4	Hexagon socket set screws		N / A
10	Interlocking devices	No such parts.	N / A
11	Bushings	No such parts.	N / A
12	(Reserved for future use)		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
13 See also DS 2014/001	Ex Components	EUT is not investigated as Ex component.	N / A
13.1	General		N / A
13.2	Mounting		N / A
13.3	Internal mounting		N / A
13.4	External mounting		N / A
13.5	Ex Component certificate		N / A
14	Connection facilities	Requirements of this clause is excluded by Table 1 of IEC60079-11. Gas monitor GX-6000 and charger module BC-6000 are treated as the entire EUT. Connection between them is intrinsic safe and is assessed according to requirements of IEC60079-11. Charging in safe area only. Refer to associated IEC60079-11 test report.	N / A
14.1	General		N / A
14.2	Type of protection		N / A
14.3	Creepage and clearance		N / A
15	Connection facilities for earthing or bonding conductors	Requirements of this clause is excluded by Table 1 of IEC60079-11.	N / A
15.1	Equipment requiring earthing or bonding		
15.1.1	Internal earthing		N / A
15.1.2	External bonding		N / A
15.2	Equipment not requiring earthing		N / A
15.3	Size of protective earthing conductor connection		N / A
15.4	Size of equipotential bonding conductor connection		N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
15.5	Protection against corrosion		N / A
15.6	Secureness of electrical connections		N / A
15.7	Internal earth continuity plate		N / A
16	Entries into enclosures	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N / A
16.1	General		N / A
16.2	Identification of entries		N / A
16.3	Cable glands		N / A
16.4	Blanking elements		N / A
16.5	Thread adapters		N / A
16.6	Temperature at branching point and entry point		N / A
16.7	Electrostatic charges of cable sheaths		N / A
17	Supplementary requirements for electric machines	Excluded by Table 1 of IEC60079-11: 2011. However EUT's built-in micro pump type RP-12 is assessed for intrinsic safe requirements. Refer to associated IEC60079-11 test report.	N / A
17.1	General		N / A
17.2	Ventilation		
17.2.1	Ventilation openings		N / A
17.2.2	Materials for external fans		N / A
17.2.3	Cooling fans of rotating electric machines		N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
17.2.3.1	Fans and fan hoods		N / A
17.2.3.2	Construction and mounting of the ventilating systems		N / A
17.2.3.3	Clearances for the ventilating system		N / A
17.2.4	Auxiliary motor cooling fans		N / A
17.2.5	Room ventilating fans		
17.2.5.1	Applicability		N / A
17.2.5.2	General		N / A
17.2.5.3	Fan and fan hoods		N / A
17.2.5.4	Construction and mounting		N / A
17.2.5.5	Clearances for rotating parts		N / A
17.3	Bearings		N / A
18	Supplementary requirements for switchgear	Excluded by Table 1 of IEC60079-11: 2011.	N / A
18.1	Flammable dielectric		N / A
18.2	Disconnectors		N / A
18.3	Group I – Provisions for locking		N / A
18.4	Doors and covers		N / A
19	Reserved for future use		
20	Supplementary requirements for external plugs, socket outlets and connectors for field wiring connection	Excluded by Table 1 of IEC60079-11: 2011.	N / A
20.1	General		N / A
20.2	Explosive gas atmospheres		N / A
20.3	Explosive dust atmospheres		N / A
20.4	Energized plugs		N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
21	Supplementary requirements for luminaires	Excluded by Table 1 of IEC60079-11: 2011.	N / A
21.1	General		N / A
21.2	Covers for luminaires of EPL Mb, EPL Gb, or EPL Db		N / A
21.3	Covers for luminaires of EPL Gc or EPL Dc		N / A
21.4	Sodium lamps		N / A
22	Supplementary requirements for caplights and handlights	No such parts.	N / A
22.1	Group I caplights		N / A
22.2	Group II and Group III caplights and handlights		N / A
23	Equipment incorporating cells and batteries		
23.1	General	Refer to associated IEC60079-11 test report for detailed assessments and testing of battery units.	Pass
23.2	Interconnection of cells to form batteries	BUD-6000 & BUL-6000 units & SR616 button cell assessed. See 23.1	Pass
23.3	Cell types	Refer to associated IEC60079-11 test report	Pass
23.4	Cells in a battery	Refer to associated IEC60079-11 test report	Pass
23.5	Ratings of batteries	Refer to associated IEC60079-11 test report	Pass
23.6	Interchangeability	Warnings provided. See General product information and Copy of marking plates. For alkaline batteries only Toshiba LR6 or MN1500 by Duracell (AA size) are allowed to be used. See also 29.13. No other batteries are interchangeable.	Pass

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
23.7	Charging of primary batteries	No charging circuits for dry battery unit BUD-6000.	Pass
23.8	Leakage	Refer to associated IEC60079-11 test report.	Pass
23.9	Connections	Refer to associated IEC60079-11 test report.	Pass
23.10	Orientation	Refer to associated IEC60079-11 test report.	Pass
23.11	Replacement of cells or batteries	Warnings provided. See 29.13 and Copy of marking plates and associated IEC60079-11 test report.	Pass
23.12	Replaceable battery pack	See 23.11.	Pass
24	Documentation	Documentation concerning explosion safety aspects of EUT is prepared by the manufacturer and is reviewed as part of this investigation. Documentation is kept in file at DNV Product Assurance AS.	Pass
25	Compliance of prototype or sample with documents	EUT is checked for compliance with documentation required by clause 24.	Pass
26	Type tests		
26.1	General	Type tests performed accordingly. Refer to Measurement section of this report and Appendix section of the associated IEC 60079-11: 2011 test report.	Pass
26.2	Test configuration	Least favorable test condition considered for each test.	Pass
26.3	Tests in explosive test mixtures	Refer to associated IEC60079-11 test report.	Pass
26.4	Tests of enclosures		
26.4.1	Order of tests		
26.4.1.1	Metallic enclosures, metallic parts of enclosures and glass parts of enclosures	Excluded by Table 1 of IEC60079-11: 2011 except for the drop test which is documented in appended Table 26.4.3. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.4.1.2	Non-metallic enclosures or non-metallic parts of enclosures		
26.4.1.2.1	General		N / A
26.4.1.2.2	Group I equipment		N / A
26.4.1.2.3	Group II and Group III equipment		N / A
26.4.2	Resistance to impact	Impact test is exempted for enclosure but is performed according to the testing of the built-in piezoelectric device, buzzer type BZ-9K. Refer to associated IEC60079-11 test report.	Pass
26.4.3	Drop test	See appended table 26.4.3.	Pass
26.4.4	Acceptance criteria	Considered.	Pass
26.4.5 See also DS 2012/003	Degree of protection (IP) by enclosures		
26.4.5.1	Test procedure	Requirements of IP20 is checked and recognized for compliance. Higher IP rating is not covered by this investigation.	Pass
26.4.5.2	Acceptance criteria	See above.	Pass

26.5	Thermal tests		
26.5.1	Temperature measurement		
26.5.1.1	General	Refer to associated IEC60079-11 test report.	Pass
26.5.1.2	Service temperature	See 5.2.	Pass
26.5.1.3	Maximum surface temperature	Modified requirements considered. See 5.3.1 to 5.3.3.	Pass
26.5.2	Thermal shock test	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N / A
26.5.3	Small component ignition test (Group I and Group II)		
26.5.3.1	General	See 5.3.1 to 5.3.3 and associated IEC60079-11 test report	Pass
26.5.3.2	Procedure		Pass
26.5.3.3	Acceptance criteria		Pass

26.6	Torque test for bushings	Excluded by Table 1 of IEC60079-11: 2011.	N / A
26.6.1	Test procedure		N / A
26.6.2	Acceptance criteria		N / A

26.7	Non-metallic enclosures or non-metallic parts of enclosures	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable. See General product information.	N / A
26.7.1	General		N / A
26.7.2	Test temperatures		N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.8	Thermal endurance to heat	See 26.7.	N / A
26.9	Thermal endurance to cold	See 26.7.	N / A
26.10	Resistance to UV light	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N / A
26.10.1	General		
26.10.2	Light exposure		
26.10.3	Acceptance criteria		N / A
26.11	Resistance to chemical agents for Group I equipment	Not Group I equipment. Also excluded by Table 1 of IEC60079-11: 2011.	N / A
26.12	Earth continuity	Handheld portable equipment.	N / A
26.13	Surface resistance test of parts of enclosures of non-metallic materials	See appended table 26.13.	N / A
26.14	Measurement of capacitance		
26.14.1	General	See 7.5.	N / A
26.14.2	Test procedure		N / A
26.15	Verification of ratings of ventilating fans	Excluded by Table 1 of IEC60079-11: 2011.	N / A
26.16	Alternative qualification of elastomeric sealing O-rings	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N / A
26.17	Transferred charge test	Tested according to clause 26.13.	N / A
26.17.1	Test equipment		N / A
26.17.2	Test sample		N / A
26.17.3	Test procedure		N / A
27	Routine tests	No routine verification and tests are required for any used components by clause 11 of IEC60079-11: 2011	N / A
28	Manufacturer's responsibility		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
28.1	Conformity with the documentation	The manufacturer is held responsible to carry out necessary tests and verifications to ensure that each produced items is in compliance with the documentation which is provided for this investigation. Such verifications should be part of the procedures incorporated in the QA system of manufacturer.	Pass
28.2	Certificate	Certificate is issued in due course of this investigation.	Pass
28.3	Responsibility for marking	Compliance with applicable requirements of relevant standards is documented.	Pass
29	Marking		
29.1	Applicability	Marking applied.	Pass
29.2	Location	Marking labels are visible on external enclosure.	Pass
29.3	General	See below.	Pass
29.4	Ex marking for explosive gas atmospheres	Ex ia IIB/IIC T4/T3 Ga -20°C ≤ Ta ≤ +50°C See Copy of marking plate and Measurement Section, including Additional Narrative Remarks below.	Pass
29.5	Ex marking for explosive dust atmospheres		N / A
29.6	Combined types (or levels) of protection	See 29.4. One type/level of protection employed.	N / A
29.7	Multiple types of protection		N / A
29.8	Ga equipment using two independent Gb types (or levels) of protection	No such application.	N / A
29.9	Boundary wall	EUT not intended for installation in a boundary wall. EUT is hand held.	N / A
29.10	Ex Components	Ex equipment considered.	N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
29.11	Small Ex Equipment and small Ex Components		N / A
29.12	Extremely small Ex Equipment and extremely small Ex Components		N / A
29.13	Warning markings	Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information.	Pass
29.14	Cells and batteries	Properly marked internally.	Pass
29.15	Electric machines operated with a converter	No such parts.	N / A
29.16	Examples of marking	See Copy of marking plate.	Pass
30	Instructions		
30.1	General	Documentation required by clause 24 of IEC60079-0 & clause 13 of IEC60079-11 is reviewed and recognized for compliance.	Pass
30.2	Cells and batteries	Specific safety instructions are provided with regards to brand & type of battery.	Pass
30.3	Electrical machines	No such parts.	N / A
30.4	Ventilating fans	No such parts.	N / A
30.5	Cable glands	No such parts.	N / A
Annex A (Normative)	Supplementary requirements for cable glands	No cable glands.	N / A
A.1	General		N / A
A.2	Constructional requirements		
A.2.1	Cable sealing		N / A
A.2.2	Filling compounds		N / A
A.2.3	Clamping		
A.2.3.1	General		N / A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
A.2.3.2	Group II or III cable glands		N / A
A.2.4	Lead-in of cable		
A.2.4.1	Sharp edges		N / A
A.2.4.2	Point of entry		N / A
A.2.5	Released by a tool		N / A
A.2.6	Fixing		N / A
A.2.7	Degree of protection		N / A
A.3	Type tests		
A.3.1	Tests of clamping of non-armoured and braided cables		
A.3.1.1	Cable glands with clamping by the sealing ring		N / A
A.3.1.2	Cable glands with clamping by filling compound		N / A
A.3.1.3	Cable glands with clamping by means of a clamping device		N / A
A.3.1.4	Clamping test		N / A
A.3.1.5	Mechanical strength		N / A
A.3.2	Tests of clamping of armoured cables		
A.3.2.1	Tests of clamping where the armourings are clamped by a device integral to the gland		
A.3.2.1.1	General		N / A
A.3.2.1.2	Clamping test		N / A
A.3.2.1.3	Mechanical strength		N / A
A.3.2.2	Tests of clamping where the armourings are not clamped by a device integral to the gland		N / A
A.3.3	Type test for resistance to impact		N / A
A.3.4	Test for degree of protection (IP) of cable glands		N / A
A.4	Marking		
A.4.1	Marking of cable glands		N / A
A.4.2	Identification of cable-sealing rings		N / A
A.5	Instructions		N / A

Annex B (Normative)	Requirements for Ex Components		
Table B.1	Applicability of clauses to Ex Components	Ex equipment considered.	N / A

Annex C (Informative)	Example of rig for resistance to impact test		
--------------------------	----------------------------------------------	--	--

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
Annex D (Informative)	Electric machines connected to converters		
Annex E (Informative)	Temperature evaluation of electric machines		
Annex F (Informative)	Guideline flowchart for tests of non-metallic enclosures or non-metallic parts of enclosures (26.4)		
Annex G (Informative)	Guidance flowchart for tests of cable glands		
Annex H (Informative)	Shaft voltages resulting in motor bearing or shaft brush sparking Discharge energy calculation		

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

When the combustible gas sensor is used the gas group is limited to IIB.

Ex code	Ambient temperature	Combustible gas sensor	Battery
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUL-6000
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUL-6000
Ex ia IIB T4 Ga	-20°C to +50°C	Mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIC T4 Ga	-20°C to +50°C	Not mounted	BUD-6000 LR6 (Toshiba)
Ex ia IIB T3 Ga	-20°C to +50°C	Mounted	BUD-6000 MN1500 (Duracell)
Ex ia IIC T3 Ga	-20°C to +50°C	Not mounted	BUD-6000 MN1500 (Duracell)

Clause 26.4.2 Impact test is exempted for enclosure but is performed according to the testing of the built-in piezoelectric device, buzzer type BZ-9K. Refer to associated IEC60079-11 test report.

§ 26.4.3	Drop test		P *)
Part under test	Test condition	Remarks	
GX-6000 w/ BUD-6000	*)	No visible damages or scratch	
GX-6000 w/ BUL-6000	*)	No visible damages or scratch	

Supplementary information.

*) Samples were pre-conditioned in cold chamber with temperature of 30°C. Conditioning time: from 2015-01-12 time 09.00 to 2015-01-14 time 08.00. The samples were dropped on horizontal concrete surface in the cold chamber. Drop performed four times for each sample in different positions. The samples were functioning normal after test.

§ 26.13	Surface resistance test		P
Part under test	Test condition *)	Remarks	
ESC 9448N (black). Middle case	*)	155Ω (<1GΩ)	
PET 300R. Panel sheet	*)	1.3MΩ (<1GΩ)	

Supplementary information.

*) 24h pre-conditioning: 23.1°C & 47.8% rth. 500V insulation test in 60s duration. 10s rise/fall time. All other smaller parts of regular plastic material are checked for surface area less than 400mm². Test performed on 2014-10-27

α) 24h pre-conditioning: 22.4°C & 26.4% rth. 500V insulation test in 60s duration. 10s rise/fall time. Test performed 2015-02-05



IECEx TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/03
ExTR Free Reference Number : PRJN-238467-2021-PA-NOR
Compiled by + signature (ExTL) : Gunnar Nielsen
Reviewed by + signature (ExTL) ... : Stig André Norheim
Date of issue : 2021-04-28

Gunnar Nielsen
Stig André Norheim

Ex Testing Laboratory (ExTL) :



Address : DNV Product Assurance AS
Veritasveien 3
1363 Høvik
Norway

Applicant's name :



Address : RIKEN KEIKI Co., Ltd.
2-7-6, Azusawa, Itabashi-ku,
Tokyo, 174-8744, Japan

Standards : IEC 60070-0 edition 7 and IEC 60079-11 edition 6

Test Report Form Number : ExTR Addendum_3 (released 2018-02)

Related Amendments, Corrigenda
or ISHs : N / A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : N / A
- test item does meet the requirement : Pass

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a **comma** is used as the decimal separator.




The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

Clause	Requirement – Test	Result – Remark	Verdict
--------	--------------------	-----------------	---------

IEC 60079-0:			
23	<p>Equipment incorporating cells and batteries</p> <p>The new, additional primary batteries that can be used (MN1500 by Duracell) is tested by DEKRA. Test report NL/DEK/ExTR13.0075/02 is used for inclusion of the battery to be used in this certification.</p> <p>The primary cell is a manganese dioxide, alkali with IEC 60086-1 letter code L (nominal voltage 1,5V and maximum open-circuit voltage 1,65V).</p> <p>Due to the large safety margin of, 200°C – 86K - 50°C = 64K, T3 is accepted based directly on the test results from the DEKRA report, even if the temperature measurements of the Duracell batteries are performed without the equipment's battery enclosure used in this certification.</p> <p><i>See Measurement Section, including Additional Narrative Remarks below for details referring to the DEKRA report.</i></p>		Pass
IEC 60079-11:			
4	Grouping and classification of intrinsically safe apparatus and associated apparatus	When the combustible gas sensor (NC-6264A) is used the gas group will be IIB (previous IIC). This is according to IECEx DS 2015/016A.	Pass
7.4	Primary and secondary cells and batteries	<i>See Measurement Section, including Additional Narrative Remarks below for details referring to the DEKRA report.</i>	Pass

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

[Appendix D of NL/DEK/ExTR13.0075/02:](#)

 IECEx TEST REPORT of PARTIAL TESTING APPENDIX D DESCRIPTION OF THE TESTS	
ExTR Reference Number	NL/DEK/ExTR13.0075/02
ExTR Free Reference Number	222765200
Compiled by + signature (ExTL)....	E. Bornhof 
Reviewed by + signature (ExTL)...	R. Schuller 
Date of issue	2018-06-22
Ex Testing Laboratory (ExTL)	DEKRA Certification B.V.
Address :	Meander 1051, 6825 MJ Arnhem, The Netherlands
Applicant's name	Riken Keiki Co. Ltd.
Address	2-7-8, Azusawa, Itabashi-ku, Tokyo 174-8744, Japan
Test item	Alkaline cell size AA type MN1500 by Duracell
Standards	See cover sheet
Test procedure	IECEx System
Test Report Form Number	
Instructions for Intended Use of ExTR Appendix: The Appendix describes the tests performed, For each applicable test the description, procedure, results and conclusion are reported,	
General remarks: The test results presented in this ExTR Appendix relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product. <ul style="list-style-type: none"> Throughout this document, a point is used as the decimal separator. The technical content of this ExTR Appendix shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.	

Appendix D to: NL/DEK/ExTR13.0075/02
 Applicant's name: Riken Keiki Co, Ltd.
 Test item: Alkaline cell size AA type MN1500 by Duracell

1 Tests of IEC 60079-11

1.1 Tests for cells and batteries

Equipment Tested:	10 cells of each type MN1500 by Duracell
Date of Test (dd/mm/yyyy):	2018-06-04 to 2018-06-06
Standard and Clause:	IEC 60079-11:2011, clause 10.5

Description

Test procedure:

10.5.1 General:

- [X] Non rechargeable cells shall be checked if they are newly supplied cells from the cell manufacturer and fully charged (e.g. with a voltage test for a short period with a certain load)
 NOTE: Cells can be regarded new when supplied in original packaging

10.5.2 Electrolyte leakage test for cells and batteries:

Ten test samples are subjected to the most onerous of the following:

- [X] short circuit until discharged;
 [] application of input or charging currents within the manufacturer's recommendations;
 [] charging a battery within the manufacturer's recommendations with one cell fully discharged or suffering from polarity reversal.

The test samples are placed with any case discontinuities, for example seals, (the + pole in most cases) facing downward or in the orientation specified by the manufacturer of the device, over a piece of blotting paper for a period of **at least 12 h** after the application of the above tests.

10.5.3 Spark ignition and surface temperature test of cells and batteries:

- [] Spark ignition assessment or testing shall be carried out at the cell or battery external terminals using a gas mixture for Gas group IIA/IIB/IIC including/excluding safety factor,
 [X] The short circuit current is determined taking the most onerous value of short-circuit current from a test of 10 samples of the cell/battery
 [X] The maximum surface temperature is determined as follows. All current-limiting devices external to the cell or battery shall be short-circuited for the test. Any external sheath (of paper or metal, etc.) not forming part of the actual cell enclosure is removed for the test. The temperature is determined on the outer enclosure of each cell or battery and the maximum figure taken.

10.5.4 Battery container pressure test:

- [] Five samples of the battery container shall be subjected to a pressure test to determine the venting pressure. Pressure shall be applied to the inside of the container. The pressure is to be gradually increased until venting occurs. The maximum venting pressure shall be recorded and shall not exceed 30 kPa. The maximum recorded venting pressure shall be applied to a sample of the battery container for a period of at least 60 s,

Appendix D to: NL/DEK/ExTR13.0075/02
 Applicant's name: Riken Keiki Co. Ltd.
 Test item: Alkaline cell size AA type MN1500 by Duracell

Test conditions:

10.5.1 General:

When a short-circuit is required for test purposes the resistance of the short-circuit link, excluding connections to it, either shall not exceed 3 mΩ or have a voltage drop across it not exceeding 200 mV or 15 % of the cell e.m.f. The short-circuit shall be applied as close to the cell or battery terminals as practicable.

The 3 mΩ is achieved by connecting/soldering short wires directly to the poles.

10.5.2 Electrolyte leakage test for cells and batteries:

The electrolyte leakage test shall be conducted at the most onerous temperature for this type of cell which might require a number of additional test (and hence additional samples) before the real test can be started.

For this apparatus the maximum ambient temperature is 60 °C.

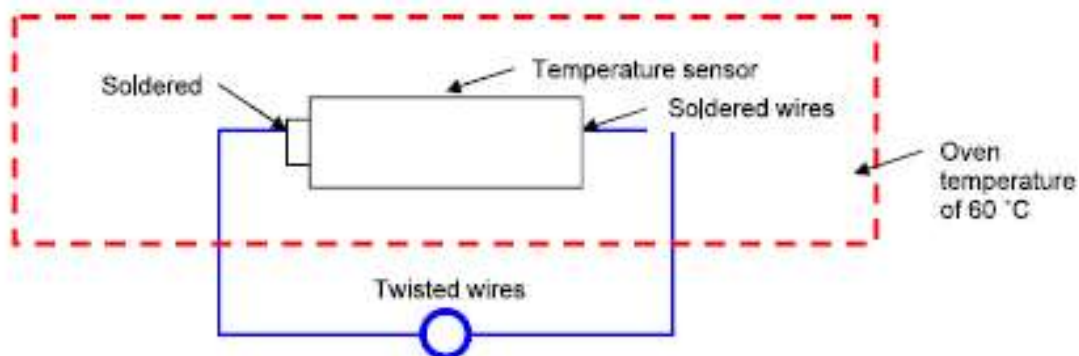
10.5.3 Spark ignition and surface temperature test of cells and batteries:

The short circuit current measurement is determined by measuring the peak voltage over a resistor of 5 mΩ.

Since the temperature behavior of batteries is considered to be non linear the temperature test is conducted at the highest ambient temperature (see IEC 60079-11 cl. 10.2).

For this apparatus the maximum ambient temperature is 60 °C.

Schematic of battery test



Conclusion

The maximum temperature rise measured during short circuit at 60 °C ambient temperature was 86,0 K (resulting in maximum surface temperature of 146 °C), which confirms with temperature class T3 requirements. To comply with T4, the maximum ambient temperature is 40 °C.

There was no leakage of electrolyte from any sample.

The maximum peak current measured during short circuit was 19,9 A.

The details of the test are shown on the next pages.

Appendix D to: NL/DEK/ExTR13,0075/02

Applicant's name: Riken Keiki Co, Ltd,

Test item: Alkaline cell size AA type MN1500 by Duracell

Duracell MN1500:

Cell number	10.5.1 capacity of the cell	10.5.2 Elektrolyte leakage	10.5.3 a) Short circuit current (A)	10.5.3 b) Temperature test	
				Tamb	DeltaT (Tmax - Tamb)
1	N / A	No		60	77,4
2	N / A	No		60	79,2
3	N / A	No		60	74,4
4	N / A	No		60	70,5
5	N / A	No		60	74,7
6	N / A	No		60	72,3
7	N / A	No		60	86,0
8	N / A	No		60	76,6
9	N / A	No		60	80,5
10	N / A	No		60	76,8
1	N / A		17,8		
2	N / A		19,2		
3	N / A		19,0		
4	N / A		19,8		
5	N / A		17,8		
6	N / A		19,7		
7	N / A		19,3		
8	N / A		19,9		
9	N / A		18,2		
10	N / A		18,2		

Appendix D to: NL/DEK/ExTR13.0075/02
 Applicant's name: Riken Keiki Co. Ltd.
 Test item: Alkaline cell size AA type MN1500 by Duracell

Figure of delta Temperature graph (samples 2, 4, 8, 10):

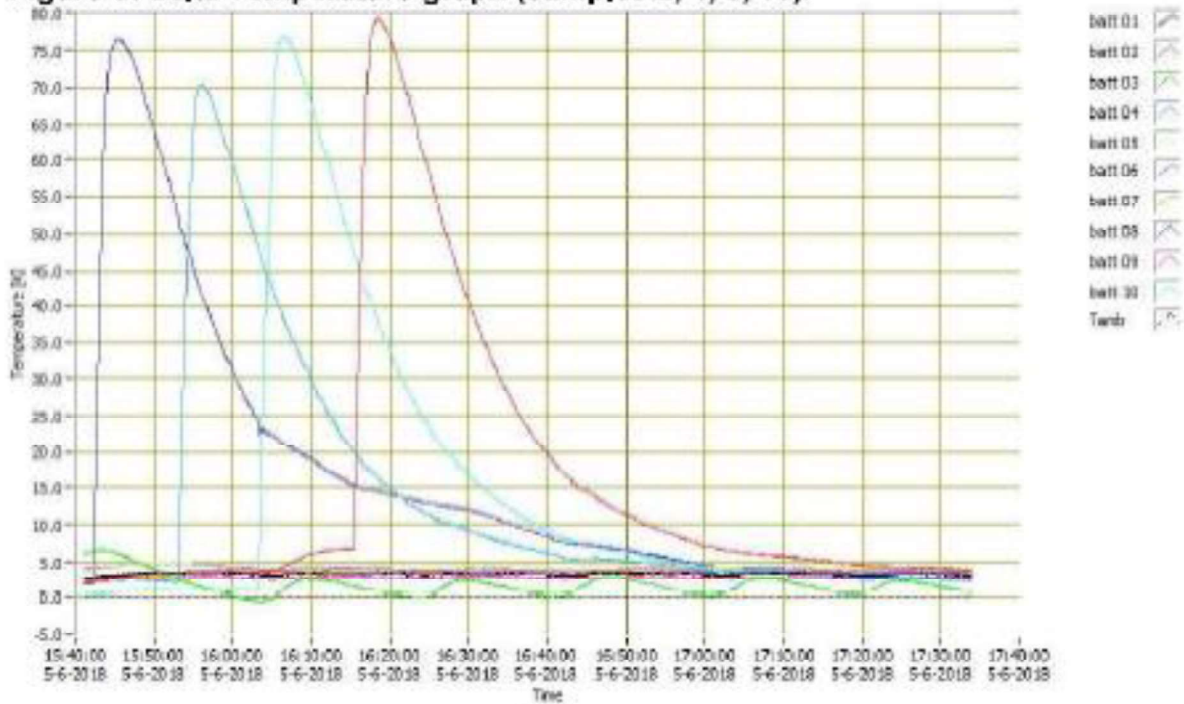
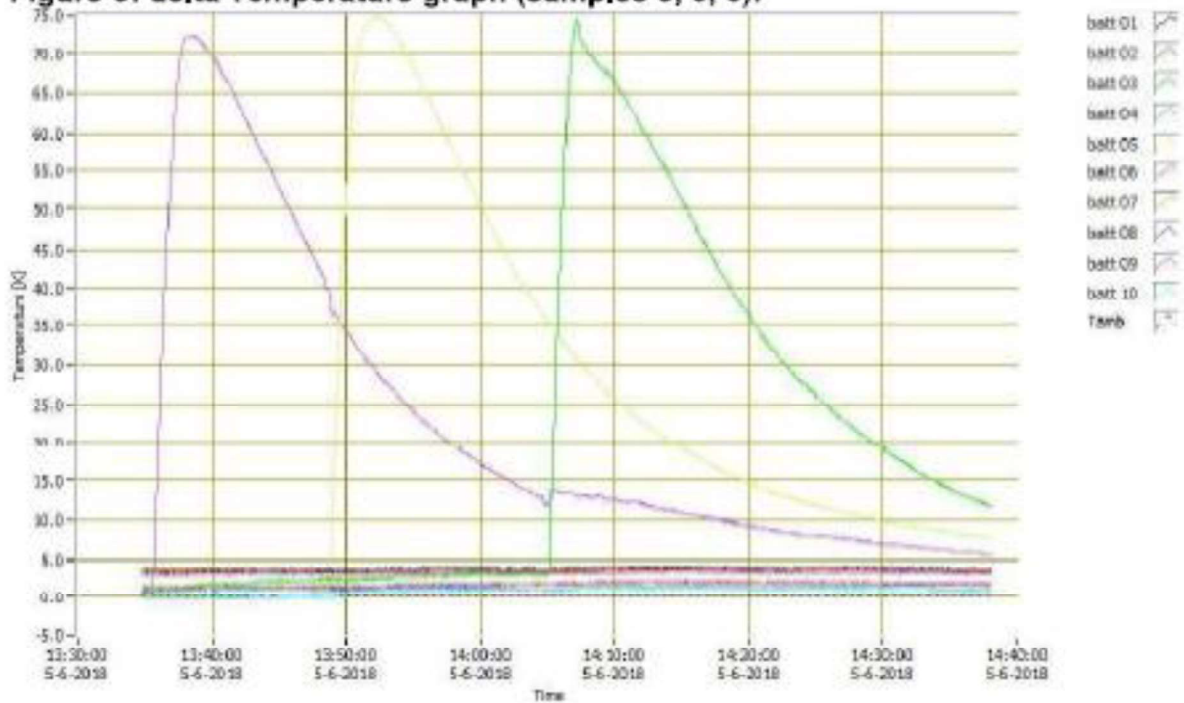


Figure of delta Temperature graph (samples 3, 5, 6):



Appendix D to: NL/DEK/ExTR13.0075/02
 Applicant's name: Riken Keiki Co, Ltd.
 Test item: Alkaline cell size AA type MN1500 by Duracell

Figure of delta Temperature graph (samples 1, 7, 9):

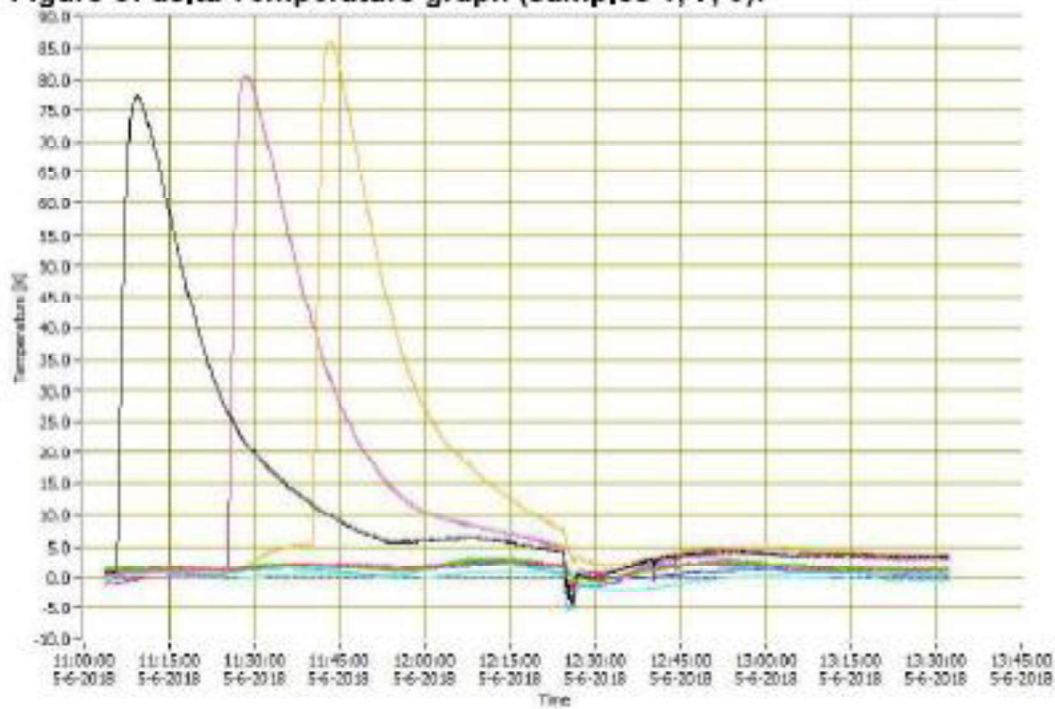
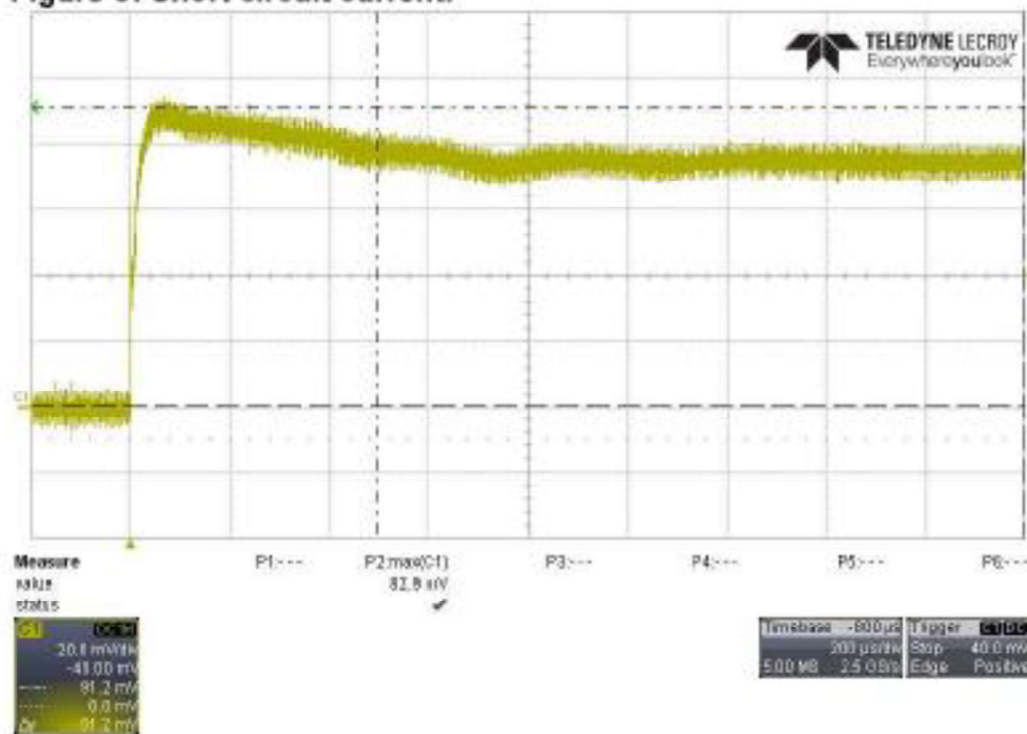


Figure of Short circuit current:



Appendix D to: NL/DEK/ExTR13,0075/02
Applicant's name: Riken Keiki Co, Ltd,
Test item: Alkaline cell size AA type MN1500 by Duracell

Test Setup:



Temperature and leakage test



Duracell MN1500 AA




Short circuit current resistor (5 mOhm)



Short circuit current measurement



IECEx TEST REPORT COVER


ExTR Reference Number.....:	NO/PRE/ExTR15.0012/02	<i>ke shan</i>
ExTR Free Reference Number	PRJN-184491-2020-PA-NOR	
Compiled by + signature (ExTL)	Ke Shen	<i>Arne Hortman</i>
Reviewed by + signature (ExTL).....:	Arne Hortman	
Approved by + signature (ExCB):	Asle Kaastad	<i>Asle Kaastad</i>
Date of issue	2020-08-18	
Ex Testing Laboratory (ExTL)	DNV GL Presafe AS	
Address	Veritasveien 3, 1363 Høvik, Norway	
Ex Certification Body (ExCB)	DNV GL Presafe AS	
Address	Veritasveien 3, 1363 Høvik, Norway	
Applicant's name.....:	RIKEN KEIKI Co., Ltd.	
Address	2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan	
Standards associated with this ExTR package	IEC 60079-0: 2011 6th Edition IEC 60079-11: 2011 6th Edition	
Clauses considered	All clauses considered	
Test Report Form Number	ExTR Cover_7 (released 2018-02)	
Related Amendments, Corrigenda or ISHs	N/A	
Test item description	Portable Gas Monitor	
Model/type reference	GX-6000	
Code (e.g. Ex __ II__ T__).....:	 II 1 G Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C	
Rating	Battery operated. Battery units BUL-6000 & BUD-6000. Charger modules BC-6000 or SDM-6000: U _m = 250V	

ExTR Package Contents

Assembled ExTR documents and Additional reference material:

IECEx Test Report Cover

IECEx Test Report: ExTR Addendum report

Manufacturer's name	RIKEN KEIKI Co., Ltd.
Address	2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan
Additional locations	RIKEN KEIKI Co., Ltd. 2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan RIKEN KEIKI NARA MFG. Co., Ltd. 49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan
Trademark	
Certificate No. (optional)	IECEX PRE 14.0061
QAR Reference No. (optional)	NO/PRE/QAR19.0018/01
Particulars: Test item vs. Test requirements	
Classification of installation and use	(<u>portable</u> / <u>hand-held</u>)
Ingress protection	Min. IP 20
Rated ambient temperature range (°C)	-20°C ≤ Ta ≤ +50°C
Rated service temperature range (°C) for Ex Components	Not applicable
General remarks:	
<p>The test results presented in this ExTR package relate only to the item or product tested.</p> <ul style="list-style-type: none"> ▪ "(See Attachment #)" refers to additional information appended to the ExTR package. ▪ "(See appended table)" refers to a table appended to the ExTR package. ▪ Throughout this ExTR package, a point is used as the decimal separator. ▪ <i>Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.</i> ▪ <i>In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.</i> <p>The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.</p>	
General product information:	
<p>The test results presented in this ExTR package relate only to the item or product tested.</p> <ul style="list-style-type: none"> ▪ "(see Attachment #)" refers to additional information appended to the ExTR package. ▪ "(see appended table)" refers to a table appended to the ExTR package. ▪ Throughout this ExTR package, a point is used as the decimal separator. ▪ <i>Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.</i> ▪ <i>In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.</i> ▪ The majority of test results presented in this ExTR package are extracted from the respective certification which are listed in appended tables for reference. <p>The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.</p> <p>The standard IEC 60079-26: 2006 2nd Edition make reference to IEC 60079-0: 2004 4th edition. However since IEC 60079-0: 2004 4th edition is withdrawn, IEC 60079-0: 2011 6th edition is considered for this investigation.</p> <p>This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.</p> <p>Equipment under test hereby referred to as EUT is a portable gas monitor model GX-6000 manufactured by Riken Keiki Co., Ltd. EUT is used for measuring flammable gas concentration in hazardous location. EUT is build up in major by approximately same parts of similar models (e.g. models GX-2012GT, GX-2009 or GX-8000 which all are manufactured by Riken Keiki) and has same Ex protection concept (intrinsic safe). These similar models are separately Ex certified devices. This investigation is therefore based on</p>	

former evaluation of the used parts. Test results and safety info are extracted from respective test reports of similar models and are documented in this report package. Additional evaluation are performed for relevant requirements which may not be covered by these certifications.

EUT is an battery-operated handheld portable device and is built up by plastic enclosure with minor metal parts such as assembly screws. The display is located in front/top of EUT. At the bottom/rear side is the battery unit. Two alternative battery units may be used with EUT. BUD-6000 is the alkaline dry battery unit and BUL-6000 is the Li-ion battery unit. Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. More technical details of design is explained in Appendix A.1 of the associated IEC60079-11 test report. See also Photos below.

Several safety instructions are found in attached manual. Specific safe instructions are also marked on labels. See Copy of marking plate in addition.

- Warning: "Do not charge in hazardous location"
- Warning: "Do not charge it except by genuine charger"
- Warning: "Do not replace battery unit in hazardous location"
- Warning: "Do not replace dry batteries in hazardous location"
- Warning: "Do Not attempt to disassemble or alter the instrument"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba, or use chargeable battery unit type BUL-6000.

EUT is consisting of a main part and a battery unit (BUL-6000 or BUD-6000). No tools is needed to remove battery units from the main part. The BUL-6000 battery unit is an encapsulated device. The enclosure used anti-electrostatic material with minor smaller parts of other regular plastic material. Small accessible metal parts are built-in to the anti-electrostatic material and therefore are not considered to be isolated. Inside the main part is electronics including small internal pump RP-12, DC vibration motor and piezoelectric device BZ-9K. These devices are used in similar models which have been separately certified with regards to Ex requirements. The majority of this investigation is based on test reports and associated appendix with inter alia Test report no. NL/KEM/ExTR11.0038 & NL/DEK/ExTR13.0075/00. However report reference to extracted test results will be detailed in associated test reports of this certification.

The charger modules BC-6000 & SDM-6000 are assessed and included in this investigation but not the AC/DC power adapter. Electronic design concept of charger modules are identically. The difference between the two charger modules made no impact to the type of protection. Assessment of module BC-6000 is representative for module SDM-6000 as well.


Included in this certification are following parts which comprise EUT:

- GX-6000: Portable Gas Monitor
- BUL-6000: Rechargeable Li-ion battery unit
- BUD-6000: Alkaline battery unit. Only type Toshiba LR6 AA size is allowed.
- BC-6000: Charge module
- SDM-6000: Charge module
- NC-6264A: Combustible gas sensor
- Toxic gas sensor
- Oxygen sensor
- Smart sensor type DES
- Smart sensor type ESS
- Smart sensor type PIS
- Smart sensor type OSS

Details of change (applicable only when revising an existing ExTR package):

Add additional manufacturing location.

Copy of Marking Plate:

 <p style="font-size: 1.2em; margin: 0;">II 1G Ex ia IIC T4 Gd Presafe15ATEX6171X IECEX PRE 15.0011 -20°C ≤ T_a ≤ +50°C WARNING Read manual for safety info. Do not open in haz.loc.</p>	<p>GX-6000(LABEL A)</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;"> MODEL GX-6000 INST.No. RIKEN KEIKI Co., Ltd. 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan </div> <p>BUL-6000(LABEL B) RIKEN KEIKI Co., Ltd.</p> <div style="border: 1px solid black; padding: 2px; margin-bottom: 5px;"> MODEL BUL-6000 INST.No. RIKEN KEIKI Co., Ltd./2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan WARNING Do not charge battery in haz.loc. </div> <p>BUD-6000(LABEL C) RIKEN KEIKI Co., Ltd.</p> <div style="border: 1px solid black; padding: 2px;"> MODEL BUD-6000 INST.No. RIKEN KEIKI Co., Ltd./2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan WARNING Use only battery types: LR6 TOSHIBA </div>
Details regarding ‘trade agent’ / ‘local assembler’ application in accordance with OD 203: N/A	
Testing not fully performed by ExTL staff at the above ExTL address: N/A	
National differences considered as part of this evaluation: N/A	
“Specific Conditions of Use” / “Schedule of Limitations”: No ‘Specific condition of use’ are claimed.	
Routine tests: N/A	
<p>Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEX System), Geneva, Switzerland. All rights reserved.</p> <p>This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEX System is acknowledged as copyright owner and source of the material. The IECEX system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.</p>	

Technical Documents			
Title:	Drawing No.:	Rev. Level:	Date:
E3-6991-5470-70-01K	INDEX GX-6000	4	2020.3.31

Note: An * is included before the title of documents that are new or revised.



IECEx TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/02
ExTR Free Reference Number : PRJN-184491-2020-PA-NOR
Compiled by + signature (ExTL) : Ke Shen
Reviewed by + signature (ExTL) ... : Arne Hortman
Date of issue : 2020-08-18

Ex Testing Laboratory (ExTL) : DNV GL Presafe AS
Address : Veritasveien 3, 1363 Høvik, Norway

Applicant's name : RIKEN KEIKI Co., Ltd.
Address : 2-7-6, Azusawa, Itabashi-ku, Tokyo, 174-8744, Japan

Standards : IEC 60079-0: 2011 6th Edition
IEC 60079-11: 2011 6th Edition
Test Report Form Number : ExTR Addendum_3 (released 2018-02)
Related Amendments, Corrigenda
or ISHS : N/A

Copyright © 2018 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : N / A
- test item does meet the requirement : Pass

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "(see Attachment #)" refers to additional information appended to this document.
- "(see appended table)" refers to a table appended to this document.
- Throughout this document, a point is used as the decimal separator.

The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.


Clause	Requirement – Test	Result – Remark	Verdict
		<p>Add additional manufacturing location.</p> <p>Additional locations: RIKEN KEIKI Co., Ltd. 2-3, Minamisakae-cho, Kasukabe-shi, Saitama, 344-0057, Japan</p> <p>RIKEN KEIKI NARA MFG. Co., Ltd. 49-1, Abe, Sakurai-shi, Nara, 633-0054, Japan</p>	Pass

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

N/A



IECEx TEST REPORT COVER

ExTR Reference Number.....:	NO/PRE/ExTR15.0012/01
ExTR Free Reference Number	D0001494-01
Compiled by + signature (ExTL)	Hien Van Le Thanh
Reviewed by + signature (ExTL).....:	Arne Hortman
Approved by + signature (ExCB) ...:	Asle Kaastad
Date of issue	2015-06-16
Ex Testing Laboratory (ExTL)	Presafe AS
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway
Ex Certification Body (ExCB)	Presafe AS
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway
Applicant's name.....:	Riken Keiki Co., Ltd
Address	2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan
Standards associated with this ExTR package	IEC 60079-0: 2011 6th Edition IEC 60079-11: 2011 6th Edition IEC 60079-26: 2006 2nd Edition
Clauses considered	All clauses
Test procedure	IECEx System
Test Report Form Number	ExTR Cover_5 (released 2014-01)
Test item description	Portable Gas Monitor
Model/type reference	GX-6000
Code (e.g. Ex __ II__ T__).....:	 II 1 G Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C
Rating	Battery operated. Battery units BUL-6000 & BUD-6000. Charger modules BC-6000 or SDM-6000: U _m = 250V
All testing fully performed by ExTL staff at ExTL address above:	No. See General product information and below for additional details.

Instructions for Intended Use of ExTR Cover:

An ExTR Cover is the sole top-level document to associate together all other parts of an IECEx Test Report (ExTR) package. An ExTR package is comprised of an ExTR Cover and one or more associated ExTR documents (which may include Ex Test Reports, ExTR Addendums and ExTR of National Differences). All ExTR package documents are compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the overall ExTR package on this ExTR Cover.

Copyright © 2014 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Manufacturer's name: Riken Keiki Co., Ltd
 Address: 2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan
 Trademark.....:



Particulars: Test item vs. Test requirements

Classification of installation and use: portable / hand-held
 Ingress protection: Min. IP 20
 Rated ambient temperature range (°C): $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$
 Rated service temperature range (°C) for Ex Components.....: Not applicable

General remarks:

The test results presented in this ExTR package relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to the ExTR package.
- "(see appended table)" refers to a table appended to the ExTR package.
- Throughout this ExTR package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.*
- The majority of test results presented in this ExTR package are extracted from the respective certification which are listed in appended tables for reference.

The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

The standard IEC 60079-26: 2006 2nd Edition make reference to IEC 60079-0: 2004 4th edition. However since IEC 60079-0: 2004 4th edition is withdrawn, IEC 60079-0: 2011 6th edition is considered for this investigation.

This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.

Copy of Marking Plate:

MODEL BUL-6000
 INST.NO.
 RIKEN KEIKI Co.,Ltd./2-7-6Azusawa.
 Itabasi-ku,Tokyo 174-8744,Japan
 WARNING
 Do not charge battery in haz.loc.

MODEL BUD-6000
 INST.NO.
 RIKEN KEIKI Co.,Ltd./2-7-6Azusawa.
 Itabasi-ku,Tokyo 174-8744,Japan
 WARNING
 Use only battery types:LR6 TOSHIBA

MODEL GX-6000
 INST.No.
 RIKEN KEIKI CO.,LTD
 2-7-6 Azusawa,Itabashi-ku,Tokyo174-8744,Japan

CE 1180 **Ex**
 II 1 G Ex ia IIC T4 Gd
 Presafe15ATEX6171
 IECEX PRE 15.0011
 $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$
 WARNING
 Read manual for safety info.
 Do not open in haz.loc.

Charger's markings

⚠ 警告 WARNING
 ・本来の使用目的以外の使用はしないでください。
 ・Do not use for any purpose other than original intended use.
 ・落下や水は故障の原因となります。
 ・Protect from impact and moisture.
 ・充電は非危険場所にて行なってください。
 ・Not for use in hazardous area.
 ・指定のACアダプタを使用してください。
 ・Use only with exclusive AC adaptor.

⚠ 注意 CAUTION
 ・ご使用前に取扱説明書を必ずお読みください。
 ・Read and understand operation manual before use.

MODEL _____
 INST. No. _____
 DATE _____
CE DC INPUT : 12V \equiv 0.8A
 DC OUTPUT : 6V \equiv 1.6A
RIKEN KEIKI Co.,Ltd. JAPAN

WARNING
 ・Not for use in hazardous area.
 ・Use only with exclusive AC adaptor.
 Um=250V

General product information:

Equipment under test hereby referred to as EUT is a portable gas monitor model GX-6000 manufactured by Riken Keiki Co., Ltd. EUT is used for measuring flammable gas concentration in hazardous location. EUT is built up in major by approximately same parts of similar models (e.g. models GX-2012GT, GX-2009 or GX-8000 which all are manufactured by Riken Keiki) and has same Ex protection concept (intrinsic safe). These similar models are separately Ex certified devices. This investigation is therefore based on former evaluation of the used parts. Test results and safety info are extracted from respective test reports of similar models and are documented in this report package. Additional evaluation are performed for relevant requirements which may not be covered by these certifications.

EUT is an battery-operated handheld portable device and is built up by plastic enclosure with minor metal parts such as assembly screws. The display is located in front/top of EUT. At the bottom/rear side is the battery unit. Two alternative battery units may be used with EUT. BUD-6000 is the alkaline dry battery unit and BUL-6000 is the Li-ion battery unit. Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. More technical details of design is explained in Appendix A.1 of the associated IEC60079-11 test report. See also Photos below.

Several safety instructions are found in attached manual. Specific safe instructions are also marked on labels. See Copy of marking plate in addition.

- Warning: "Do not charge in hazardous location"
- Warning: "Do not charge it except by genuine charger"
- Warning: "Do not replace battery unit in hazardous location"
- Warning: "Do not replace dry batteries in hazardous location"
- Warning: "Do Not attempt to disassemble or alter the instrument"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba, or use chargeable battery unit type BUL-6000.

EUT is consisting of a main part and a battery unit (BUL-6000 or BUD-6000). No tools is needed to remove battery units from the main part. The BUL-6000 battery unit is an encapsulated device. The enclosure used anti-electrostatic material with minor smaller parts of other regular plastic material. Small accessible metal parts are built-in to the anti-electrostatic material and therefore are not considered to be isolated. Inside the main part is electronics including small internal pump RP-12, DC vibration motor and piezoelectric device BZ-9K. These devices are used in similar models which have been separately certified with regards to Ex requirements. The majority of this investigation is based on test reports and associated appendix with inter alia Test report no. NL/KEM/ExTR11.0038 & NL/DEK/ExTR13.0075/00. However report reference to extracted test results will be detailed in associated test reports of this certification.

The charger modules BC-6000 & SDM-6000 are assessed and included in this investigation but not the AC/DC power adapter. Electronic design concept of charger modules are identically. The difference between the two charger modules made no impact to the type of protection. Assessment of module BC-6000 is representative for module SDM-6000 as well.

Included in this certification are following parts which comprise EUT:

- GX-6000: Portable Gas Monitor
- BUL-6000: Rechargeable Li-ion battery unit
- BUD-6000: Alkaline battery unit. Only type Toshiba LR6 AA size is allowed.
- BC-6000: Charge module
- SDM-6000: Charge module
- NC-6264A: Combustible gas sensor
- Toxic gas sensor
- Oxygen sensor
- Smart sensor type DES
- Smart sensor type ESS
- Smart sensor type PIS
- Smart sensor type OSS

Photos. GX-6000 main unit & Battery units



Details of change (applicable only when revising an existing ExTR package):

The changes concerned:

- Changed layout of DES sensor PCB in order to change the optical path length. The infrared sensor is then able to measure additional gas type.
- Minor changes of non-safety components on charger module SDM-6000

This report is used in conjunction with all former test reports which are associated to Presafe project no. D0001494 (ExTR Reference No. NO/PRE/ExTR15.0012 including all associated Addendum report).

Due to the similarity with previously tested equipment, only the evaluation in Addendum report was considered necessary for the changes concerned.

In accordance with OD 024, testing not fully performed by ExTL staff at the above ExTL address:

The majority of test results presented in this ExTR package are extracted from the test reports which are associated to separate IECEx certification.

National differences considered as part of this evaluation, if any:

No national differences included.

“Specific Conditions of Use” for Ex Equipment or “Schedule of Limitations” for Ex Components, if any:

No ‘Specific condition of use’ are claimed.

Routine tests, if any:

No routine tests are required by the applicable requirements

Manufacturer’s Documents

Title:	Drawing No.:	Rev. Level:	Date:
Index GX-6000	E3-6991-5470-70-01K	3	2015-06-12

Revision History

Issue No.	Date of revision	Description
0	2015-04-21	Origin report
1	2015-06-16	- Changed layout of DES sensor PCB in order to change the optical path length. The infrared sensor is then able to measure additional gas type. - Minor changes of non-safety components on charger module SDM-6000

Supplementary information:



IECEX TEST REPORT ADDENDUM

ExTR Reference Number : NO/PRE/ExTR15.0012/01

ExTR Free Reference Number : D0001494-01

Compiled by + signature (ExTL) : Hien Van Le Thanh

Reviewed by + signature (ExTL) ... : Arne Hortman

Date of issue : 2015-06-16

Ex Testing Laboratory (ExTL) : Presafe AS

Address : Gaustadalléen 30, NO - 0373 Oslo, Norway

Applicant's name : Riken Keiki Co., Ltd

Address : 2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan

Standards : IEC 60079-0: 2011 6th Edition
IEC 60079-11: 2011 6th Edition
IEC 60079-26: 2006 2nd Edition

Test procedure : IECEX System

Test Report Form Number : ExTR Addendum_2 (released 2010-08)

Instructions for Intended Use of ExTR Addendum:

An ExTR Addendum is to supplement a previously issued ExTR package. Only those clauses applicable to the supplemental issue being addressed are to be tabulated and remarked upon as part of this document. An ExTR of National Differences may also supplement this document. An ExTR Addendum is to be compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the ExTR Addendum as part of the overall ExTR package on the associated ExTR Cover.

Copyright © 2010 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEX System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEX System is acknowledged as copyright owner and source of the material. The IECEX system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item : **N/A** Not applicable

- test item does meet the requirement : **P** Pass

General remarks:

The test results presented in this ExTR Addendum relate only to the item or product tested, and are only valid when considered together with the related Ex Test Report that was previously issued, along with any previously issued ExTR Addendums for the same item or product.

Only clauses and manufacturer's documents impacted by this document are detailed.

- "See Attachment #" refers to additional information appended to this document.
- "See appended table" refers to a table appended to this document.
- Throughout this document, a point is used as the decimal separator.

The technical content of this ExTR Addendum shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

IEC 60079-11

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

APPENDIX A: Description of product

A.1 General Technical description

The changes concerned:

- Changed layout of DES sensor PCB in order to change the optical path length. The infrared sensor is then able to measure additional gas type.
- Minor changes of non-safety components on charger module SDM-6000

Due to the similarity with previously tested equipment, only the evaluation in Addendum report was considered necessary for the changes concerned.

A.3 Thermal ignition considerations.





Non-safety component C4 on charger module SDM-6000 is changed from 0.1 μ F to 0.22 μ F. The charger module is intended to be used in non-hazardous zone. Other minor non-safety changes are documented. The changes make no impact on the type of protection. The changes are reviewed and recognized.

B.6.3 Evaluation & test of sensors:

Layout of DES sensor PCB is changed. No safety components are used on DES sensor PCB, thereof no safety distances/connections are required. The layout was checked and is considered to make no contribution to temperature rise of equipment. The change with regards to thermal aspects is negligible. The change is reviewed and recognized.



IECEx TEST REPORT COVER

ExTR Reference Number.....:	NO/PRE/ExTR15.0012/00
ExTR Free Reference Number	D0001494-00
Compiled by + signature (ExTL)	Hien Van Le Thanh 
Reviewed by + signature (ExTL).....:	Arne Hortman 
Approved by + signature (ExCB):	Asle Kaastad 
Date of issue	2015-04-21
Ex Testing Laboratory (ExTL)	Presafe AS
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway
Ex Certification Body (ExCB)	Presafe AS
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway
Applicant's name.....:	Riken Keiki Co., Ltd
Address	2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan
Standards associated with this ExTR package	IEC 60079-0: 2011 6th Edition IEC 60079-11: 2011 6th Edition IEC 60079-26: 2006 2nd Edition
Clauses considered	All clauses
Test procedure	IECEx System
Test Report Form Number	ExTR Cover_5 (released 2014-01)
Test item description	Portable Gas Monitor
Model/type reference	GX-6000
Code (e.g. Ex _ II _ T _).....:	 II 1 G Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C
Rating	Battery operated. Battery units BUL-6000 & BUD-6000. Charger module BC-6000 (or SDM-6000): U _m = 250V
All testing fully performed by ExTL staff at ExTL address above:	No. See General product information and below for additional details.

Instructions for Intended Use of ExTR Cover:

An ExTR Cover is the sole top-level document to associate together all other parts of an IECEx Test Report (ExTR) package. An ExTR package is comprised of an ExTR Cover and one or more associated ExTR documents (which may include Ex Test Reports, ExTR Addendums and ExTR of National Differences). All ExTR package documents are compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the overall ExTR package on this ExTR Cover.

Copyright © 2014 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Manufacturer's name: Riken Keiki Co., Ltd
 Address: 2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan
 Trademark.....:



Particulars: Test item vs. Test requirements

Classification of installation and use: portable / hand-held
 Ingress protection: Min. IP 20
 Rated ambient temperature range (°C): $-20^{\circ}\text{C} \leq T_a \leq +50^{\circ}\text{C}$
 Rated service temperature range (°C) for Ex Components.....: Not applicable

General remarks:

The test results presented in this ExTR package relate only to the item or product tested.

- "(see Attachment #)" refers to additional information appended to the ExTR package.
- "(see appended table)" refers to a table appended to the ExTR package.
- Throughout this ExTR package, a point is used as the decimal separator.
- *Where the term "N/A" appears in any part of an ExTR package, it indicates that the associated issue was considered "Not applicable" to the involved evaluation.*
- *In accordance with IECEx 02, a Receiving ExCB may request a sample of the Ex equipment and copies of the documentation referred to in an ExTR Cover.*
- The majority of test results presented in this ExTR package are extracted from the respective certification which are listed in appended tables for reference.

The technical content of this ExTR package shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

The standard IEC 60079-26: 2006 2nd Edition make reference to IEC 60079-0: 2004 4th edition. However since IEC 60079-0: 2004 4th edition is withdrawn, IEC 60079-0: 2011 6th edition is considered for this investigation.

This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.

Copy of Marking Plate:

MODEL BUL-6000
INST.No.
RIKEN KEIKI Co.,Ltd./2-7-6Azusawa.
Itabasi-ku,Tokyo 174-8744,Japan
WARNING
Do not charge battery in haz.loc.

MODEL BUD-6000
INST.No.
RIKEN KEIKI Co.,Ltd./2-7-6Azusawa.
Itabasi-ku,Tokyo 174-8744,Japan
WARNING
Use only battery types:LR6 TOSHIBA

MODEL GX-6000
INST.No.
RIKEN KEIKI CO.,LTD
2-7-6 Azusawa,Itabashi-ku,Tokyo174-8744,Japan

CE 1180 **Ex**
II 1 G Ex ia IIC T4 Gd
Presafe15ATEX6171
IECEX PRE 15.0011
-20℃≤T_a≤+50℃
WARNING
Read manual for safety info.
Do not open in haz.loc.

Charger's markings

⚠ 警告 WARNING
・本来の使用目的以外の使用はしないでください。
・Do not use for any purpose other than original intended use.
・落下や水は故障の原因となります。
・Protect from impact and moisture.
・充電は非危険場所にて行なってください。
・Not for use in hazardous area.
・指定のACアダプタを使用してください。
・Use only with exclusive AC adaptor.

⚠ 注意 CAUTION
・ご使用前に取扱説明書を必ずお読みください。
・Read and understand operation manual before use.

MODEL _____
INST. No. _____
DATE _____
CE DC INPUT : 12V \equiv 0.8A
DC OUTPUT : 6V \equiv 1.6A
RIKEN KEIKI Co.,Ltd. JAPAN

WARNING
・Not for use in hazardous area.
・Use only with exclusive AC adaptor.
Um=250V

General product information:

Equipment under test hereby referred to as EUT is a portable gas monitor model GX-6000 manufactured by Riken Keiki Co., Ltd. EUT is used for measuring flammable gas concentration in hazardous location. EUT is built up in major by approximately same parts of similar models (e.g. models GX-2012GT, GX-2009 or GX-8000 which all are manufactured by Riken Keiki) and has same Ex protection concept (intrinsic safe). These similar models are separately Ex certified devices. This investigation is therefore based on former evaluation of the used parts. Test results and safety info are extracted from respective test reports of similar models and are documented in this report package. Additional evaluation are performed for relevant requirements which may not be covered by these certifications.

EUT is an battery-operated handheld portable device and is built up by plastic enclosure with minor metal parts such as assembly screws. The display is located in front/top of EUT. At the bottom/rear side is the battery unit. Two alternative battery units may be used with EUT. BUD-6000 is the alkaline dry battery unit and BUL-6000 is the Li-ion battery unit. Replacement or charging of battery unit can be performed by end-users and is only allowed in non-hazardous areas. More technical details of design is explained in Appendix A.1 of the associated IEC60079-11 test report. See also Photos below.

Several safety instructions are found in attached manual. Specific safe instructions are also marked on labels. See Copy of marking plate in addition.

- Warning: "Do not charge in hazardous location"
- Warning: "Do not charge it except by genuine charger"
- Warning: "Do not replace battery unit in hazardous location"
- Warning: "Do not replace dry batteries in hazardous location"
- Warning: "Do Not attempt to disassemble or alter the instrument"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba, or use chargeable battery unit type BUL-6000.

EUT is consisting of a main part and a battery unit (BUL-6000 or BUD-6000). No tools is needed to remove battery units from the main part. The BUL-6000 battery unit is an encapsulated device. The enclosure used anti-electrostatic material with minor smaller parts of other regular plastic material. Small accessible metal parts are built-in to the anti-electrostatic material and therefore are not considered to be isolated. Inside the main part is electronics including small internal pump RP-12, DC vibration motor and piezoelectric device BZ-9K. These devices are used in similar models which have been separately certified with regards to Ex requirements. The majority of this investigation is based on test reports and associated appendix with inter alia Test report no. NL/KEM/ExTR11.0038 & NL/DEK/ExTR13.0075/00. However report reference to extracted test results will be detailed in associated test reports of this certification.

The charger modules BC-6000 & SDM-6000 are assessed and included in this investigation but not the AC/DC power adapter. Electronic design concept of charger modules are identically. The difference between the two charger modules made no impact to the type of protection. Assessment of module BC-6000 is representative for module SDM-6000 as well.

Included in this certification are following parts which comprise EUT:

- GX-6000: Portable Gas Monitor
- BUL-6000: Rechargeable Li-ion battery unit
- BUD-6000: Alkaline battery unit. Only type Toshiba LR6 AA size is allowed.
- BC-6000: Charge module
- SDM-6000: Charge module
- NC-6264A: Combustible gas sensor
- Toxic gas sensor
- Oxygen sensor
- Smart sensor type DES
- Smart sensor type ESS
- Smart sensor type PIS
- Smart sensor type OSS

Photos. GX-6000 main unit & Battery units



Details of change (applicable only when revising an existing ExTR package): Origin report
In accordance with OD 024, testing not fully performed by ExTL staff at the above ExTL address: The majority of test results presented in this ExTR package are extracted from the test reports which are associated to separate IECEx certification.
National differences considered as part of this evaluation, if any: No national differences included.
“Specific Conditions of Use” for Ex Equipment or “Schedule of Limitations” for Ex Components, if any: No ‘Specific condition of use’ are claimed.
Routine tests, if any: No routine tests are required by the applicable requirements

Manufacturer's Documents			
Title:	Drawing No.:	Rev. Level:	Date:
Index GX-6000	E3-6991-5470-70-01K	2	2015-03-27



IECEx TEST REPORT
IEC 60079-0
Explosive atmospheres – Part 0:
Equipment – General requirements

ExTR Reference Number.....:	NO/PRE/ExTR15.0012/00	
ExTR Free Reference Number	D0001494-00	
Compiled by + signature (ExTL)	Hien Van Le Thanh	<i>Hien Van Le Thanh</i>
Reviewed by + signature (ExTL).....	Arne Hortman	<i>Arne Hortman</i>
Date of issue	2015-04-21	
Ex Testing Laboratory (ExTL)	Presafe AS	
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway	
Applicant's name.....	Riken Keiki Co., Ltd	
Address	2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan	
Standard.....	IEC 60079-0:2011, 6 th Edition	
Test procedure	IECEx System	
Test Report Form Number	ExTR60079-0_6B (released 2014-08)	

Instructions for Intended Use of Ex Test Report:

An Ex Test Report provides a clause-by-clause documentation of the initial evaluation and testing that verified compliance of an item or product with an IEC Ex standard. This Ex Test Report is part of an ExTR package that may include other Ex Test Report, Addendum, National Differences and Partial Testing documents, along with a single ExTR Cover. An Ex Test Report is to be compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the Ex Test Report as part of the overall ExTR package on the associated ExTR Cover.

Copyright © 2011 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item	N/A	Not applicable
- test item does meet the requirement	P	Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "See Attachment #" refers to additional information appended to this document.
- "See appended table" refers to a table appended to this document.
- "See General product information" refers to item 'General product information' in ExTR Cover report.
- "See Copy of marking plate" refers to item 'Copy of marking plate' in ExTR Cover report.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope		
2	Normative references		
3	Terms and definitions		
4	Equipment grouping		P
4.1	Group I		N/A
4.2	Group II	Equipment under test hereby referred to as EUT is portable gas monitor GX-6000 including charger modules BC-6000/SDM-6000. See General product information. Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C	P
4.3	Group III		N/A
4.4	Equipment for a particular explosive atmosphere	No particular explosive atmosphere specified.	N/A
5	Temperatures		
5.1	Environmental influences		
5.1.1	Ambient temperature	Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C	P
5.1.2	External source of heating or cooling		N/A
5.2	Service temperature	Not required due to exclusion of cl. 7.2 by Table 1 of IEC60079-11: 2011.	N/A
5.3	Maximum surface temperature		
5.3.1	Determination of maximum surface temperature	Maximum surface temperature is considered taken into account requirements of thermal ignition compliance of cl.5.6 of IEC 60079-11. Evaluation documented in Appendix A.3 & B.3 of associated IEC60079-11 test report.	P
5.3.2	Limitation of maximum surface temperature		
5.3.2.1	Group I electrical equipment		N/A
5.3.2.2	Group II electrical equipment	See 5.3.1. T4 temperature class assigned and recognized. See Copy of marking plate.	P
5.3.2.3	Group III electrical equipment		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
5.3.2.3.1	Maximum surface temperature determined without a dust layer	Not Group III electrical equipment.	N/A
5.3.2.3.2	Maximum surface temperature with respect to dust layers		N/A
5.3.3	Small component temperature for Group I or Group II electrical equipment	Considered taken into account requirements of thermal ignition compliance cl. 5.6 of IEC 60079-11. Evaluation documented in Appendix A.3 & B.3 of associated IEC60079-11 test report.	P

6	Requirements for all electrical equipment		
---	-------------------------------------------	--	--

6.1	General	Requirements of IEC60079-11: 2011 considered. Code Ex ia IIC T4 Ga.	P
-----	---------	---------------------------------------------------------------------	----------

6.2	Mechanical strength of equipment	Excluded by Table 1 of IEC60079-11: 2011 except for the drop test which is documented in appended Table 26.4.3. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	P
-----	----------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------

6.3	Opening times	Excluded by Table 1 of IEC60079-11: 2011	N/A
-----	---------------	------------------------------------------	------------

6.4	Circulating currents in enclosures (e.g. of large electrical machines)	Excluded by Table 1 of IEC60079-11: 2011	N/A
-----	------------------------------------------------------------------------	------------------------------------------	------------

6.5	Gasket retention	Excluded by Table 1 of IEC60079-11: 2011	N/A
-----	------------------	------------------------------------------	------------

6.6	Electromagnetic and ultrasonic energy radiating equipment	EUT is not electromagnetic or ultrasonic energy radiating equipment	N/A
6.6.1	Radio frequency sources	No radio frequency sources.	N/A
6.6.2	Lasers or other continuous wave sources	The lamp OL-8270BPA is separately Ex certified, test report TxTR12.0033 is documented. See Appendix D in associated IEC60079-11 test report.	P
6.6.3	Ultrasonic sources	No ultrasonic sources	N/A

7	Non-metallic enclosures and non-metallic parts of enclosures		
---	--------------------------------------------------------------	--	--

7.1	General		
7.1.1	Applicability	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N/A
7.1.2	Specification of materials		
7.1.2.1	General	See above and clauses 7.4 & 24.	P
7.1.2.2	Plastic materials	See above.	P
7.1.2.3	Elastomers	O-ring used but not for Ex safety purpose.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
7.2	Thermal endurance		
7.2.1	Tests for thermal endurance		N/A
7.2.2	Material selection	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N/A
7.2.3	Alternative qualification of elastomeric sealing O-rings	See above.	N/A
7.3	Resistance to light	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N/A
7.4	Electrostatic charges on external non-metallic materials		
7.4.1	Applicability	Applied.	P
7.4.2	Avoidance of a build-up of electrostatic charge on Group I or Group II electrical equipment	Material ESC9448N & LCD panel sheet PET 300R. All material have surface resistance of less than 1GΩ. See appended table 26.13. All smaller parts of regular plastic material have surface area less than 400mm ² . Refer to drawing M2-4777-01-01K.	P
7.4.3	Avoidance of a build-up of electrostatic charge on equipment for Group III	Not Group III equipment.	N/A
7.5	Accessible metal parts	Small accessible metal parts exist but enclosure's conductive plastic materials are used so the mentioned parts are not isolated. However small metallic parts are considered to represent not more than 3pF. Refer to Note 2 of cl. 7.5 of this standard. See appended Table 26.13	P
8	Metallic enclosures and metallic parts of enclosures		
8.1	Material composition	See 8.3 & 24.	P
8.2	Group I	Not Group I equipment.	N/A
8.3	Group II	Small parts of stainless steel material used such as air inlets. Less than 10 % in total of Al, Mg, Ti & Zr and less than 7.5% in total of Mg, Ti & Zr. See also 7.5	P
8.4	Group III	Not Group III equipment.	N/A
9	Fasteners		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
9.1	General	Excluded by Table 1 of IEC60079-11: 2011. See 7.5 and 8.3.	N/A
9.2	Special fasteners	No such parts. See 9.1	N/A
9.3	Holes for special fasteners		
9.3.1	Thread engagement		N/A
9.3.2	Tolerance and clearance		N/A
9.3.3	Hexagon socket set screws		N/A
10	Interlocking devices	No such parts.	N/A
11	Bushings	No such parts.	N/A
12	Materials used for cementing	No such parts.	N/A
13	Ex Components		
13.1	General	EUT is not investigated as Ex component.	N/A
13.2	Mounting		N/A
13.3	Internal mounting		N/A
13.4	External mounting		N/A
13.5	Ex Component certificate		N/A
14	Connection facilities and termination compartments		
14.1	General	Requirements of this clause is excluded by Table 1 of IEC60079-11. Gas monitor GX-6000 and charger module BC-6000 are treated as the entire EUT. Connection between them is intrinsic safe and is assessed according to requirements of IEC60079-11. Charging in safe area only. Refer to associated IEC60079-11 test report.	N/A
14.2	Termination compartment		N/A
14.3	Type of protection		N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
14.4	Creepage and clearance		N/A
15	Connection facilities for earthing or bonding conductors		
15.1	Equipment requiring earthing		
15.1.1	Internal	Handheld portable equipment which does not require earthing.	N/A
15.1.2	External	Handheld portable equipment	N/A
15.2	Equipment not requiring earthing	Excluded by Table 1 of IEC60079-11: 2011.	N/A
15.3	Size of conductor connection	Excluded by Table 1 of IEC60079-11: 2011.	N/A
15.4	Protection against corrosion	Excluded by Table 1 of IEC60079-11: 2011.	N/A
15.5	Secureness of electrical connections	Excluded by Table 1 of IEC60079-11: 2011.	N/A
16	Entries into enclosures		
16.1	General	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable	N/A
16.2	Identification of entries		N/A
16.3	Cable glands		N/A
16.4	Blanking elements		N/A
16.5	Thread adapters		N/A
16.6	Temperature at branching point and entry point		N/A
16.7	Electrostatic charges of cable sheaths		N/A
17	Supplementary requirements for rotating machines		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
17.1	Ventilation		
17.1.1	Ventilation openings	Excluded by Table 1 of IEC60079-11: 2011. However EUT's built-in micro pump type RP-12 is assessed for intrinsic safe requirements. Refer to associated IEC60079-11 test report.	N/A
17.1.2	Materials for external fans		N/A
17.1.3	Cooling fans of rotating machines		
17.1.3.1	Fans and fan hoods		N/A
17.1.3.2	Construction and mounting of the ventilating systems		N/A
17.1.3.3	Clearances for the ventilating system		N/A
17.1.4	Auxiliary motor cooling fans		N/A
17.1.5	Ventilating fans		
17.1.5.1	Applicability		N/A
17.1.5.2	General		N/A
17.1.5.3	Fan and fan hoods		N/A
17.1.5.4	Construction and mounting		N/A
17.1.5.5	Clearances for rotating parts		N/A
17.2	Bearings		N/A
18	Supplementary requirements for switchgear		
18.1	Flammable dielectric	No such parts.	N/A
18.2	Disconnectors		N/A
18.3	Group I – Provisions for locking		N/A
18.4	Doors and covers		N/A
19	Supplementary requirements for fuses	Excluded by Table 1 of IEC60079-11: 2011.	N/A
20	Supplementary requirements for plugs, sockets outlets and connectors		
20.1	General	Excluded by Table 1 of IEC60079-11: 2011.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
20.2	Explosive gas atmospheres		N/A
20.3	Explosive dust atmospheres		N/A
20.4	Energized plugs	No batteries are allowed to be replaced in hazardous zone. Warnings are provided. See 29.12	N/A
21	Supplementary requirements for luminaires		
21.1	General	No such parts.	N/A
21.2	Covers for luminaires of EPL Mb, EPL Gb, or EPL Db		N/A
21.3	Covers for luminaires of EPL Gc or EPL Dc		N/A
21.4	Sodium lamps		N/A
22	Supplementary requirements for caplights and handlights		
22.1	Group I caplights	No such parts.	N/A
22.2	Group II and Group III caplights and handlights		N/A
23	Apparatus incorporating cells and batteries		
23.1	General	Refer to associated IEC60079-11 test report for detailed assessments and testing of battery units.	P
23.2	Batteries	BUD-6000 & BUL-6000 units & SR616 button cell assessed. See 23.1	P
23.3	Cell types	Refer to associated IEC60079-11 test report	P
23.4	Cells in a battery	Refer to associated IEC60079-11 test report	P
23.5	Ratings of batteries	Refer to associated IEC60079-11 test report	P

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
23.6	Interchangeability	Warnings provided. See General product information and Copy of marking plates. For alkaline batteries only Toshiba LR6 (AA size) is allowed to be used. See also 29.12. No other batteries are interchangeable.	P
23.7	Charging of primary batteries	No charging circuits for dry battery unit BUD-6000	P
23.8	Leakage	Refer to associated IEC60079-11 test report	P
23.9	Connections	Refer to associated IEC60079-11 test report	P
23.10	Orientation	Refer to associated IEC60079-11 test report	P
23.11	Replacement of cells or batteries	Warnings provided. See 29.12 and Copy of marking plates and associated IEC60079-11 test report.	P
23.12	Replaceable battery pack	See 23.11	P
24	Documentation	Documentation concerning explosion safety aspects of EUT is prepared by the manufacturer and is reviewed as part of this investigation. Documentation is kept in file at DNV Nemko Presafe AS.	P
25	Compliance of prototype or sample with documents	EUT is checked for compliance with documentation required by clause 24.	P
26	Type tests		
26.1	General	Type tests performed accordingly. Refer to Measurement section of this report and Appendix section of the associated IEC 60079-11: 2011 test report.	P
26.2	Test configuration	Least favorable test condition considered for each test.	P
26.3	Tests in explosive test mixtures	Refer to associated IEC60079-11 test report.	P
26.4	Tests of enclosures		
26.4.1	Order of tests		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.4.1.1	Metallic enclosures, metallic parts of enclosures and glass parts of enclosures	Considered taking into account requirements of IEC60079-11: 2011.	P
26.4.1.2	Non-metallic enclosures or non-metallic parts of enclosures	Considered taking into account requirements of IEC60079-11: 2011.	P
26.4.1.2.1	Group I electrical equipment		N/A
26.4.1.2.2	Group II and Group III electrical equipment	See below and associated IEC60079-11 test report.	P
26.4.2	Resistance to impact	Impact test is exempted for enclosure but is performed according to the testing of the built-in piezoelectric device, buzzer type BZ-9K. Refer to associated IEC60079-11 test report.	P
26.4.3	Drop test	See appended table 26.4.3.	P
26.4.4	Acceptance criteria	Considered.	P
26.4.5	Degree of protection (IP) by enclosures		
26.4.5.1	Test procedure	Requirements of IP20 is checked and recognized for compliance. Higher IP rating is not covered by this investigation.	P
26.4.5.2	Acceptance criteria	See above.	P

26.5	Thermal tests		
26.5.1	Temperature measurement		
26.5.1.1	General	Refer to associated IEC60079-11 test report.	P
26.5.1.2	Service temperature	See 5.2.	N/A
26.5.1.3	Maximum surface temperature	Modified requirements considered. See 5.3.1 to 5.3.3.	P
26.5.2	Thermal shock test	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N/A
26.5.3	Small component ignition test (Group I and Group II)		
26.5.3.1	General	See 5.3.1 to 5.3.3 and associated IEC60079-11 test report	P
26.5.3.2	Procedure	See above.	P
26.5.3.3	Acceptance criteria	See above.	P

26.6	Torque test for bushings		
26.6.1	Test procedure	No such parts.	N/A
26.6.2	Acceptance criteria		N/A

26.7	Non-metallic enclosures or non-metallic parts of enclosures		
26.7.1	General	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable. See General product information.	N/A
26.7.2	Test temperatures	See above.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
26.8	Thermal endurance to heat	See 26.7.1	N/A
26.9	Thermal endurance to cold	See 26.7.1	N/A
26.10	Resistance to light		
26.10.1	Test procedure	See 7.3	N/A
26.10.2	Acceptance criteria		N/A
26.11	Resistance to chemical agents for Group I electrical equipment	Not Group I equipment. Also excluded by Table 1 of IEC60079-11: 2011.	N/A
26.12	Earth continuity	Handheld portable equipment.	N/A
26.13	Surface resistance test of parts of parts of enclosures of non-metallic materials	See appended table 26.13.	P
26.14	Measurement of capacitance		
26.14.1	General	See 7.5	N/A
26.14.2	Test procedure	Considered.	N/A
26.15	Verification of ratings of ventilating fans	Excluded by Table 1 of IEC60079-11: 2011.	N/A
26.16	Alternative qualification of elastomeric sealing O-rings	Excluded by Table 1 of IEC60079-11: 2011. Requirement of cl. 6.1.2.3 a) of IEC60079-11: 2011 is not applicable.	N/A
27	Routine tests	No routine verification and tests are required for any used components by clause 11 of IEC60079-11: 2011	N/A
28	Manufacturer's responsibility		
28.1	Conformity with the documentation	The manufacturer is held responsible to carry out necessary tests and verifications to ensure that each produced items is in compliance with the documentation which is provided for this investigation. Such verifications should be part of the procedures incorporated in the QA system of manufacturer.	P
28.2	Certificate	Certificate is issued in due course of this investigation.	P

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
28.3	Responsibility for marking	Compliance with applicable requirements of relevant standards is documented.	P
29	Marking		
29.1	Applicability	Marking applied.	P
29.2	Location	Marking labels are visible on external enclosure.	P
29.3	General	See below.	P
29.4	Ex marking for explosive gas atmospheres	Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C See Copy of marking plate.	P
29.5	Ex marking for explosive dust atmospheres		N/A
29.6	Combined types (or levels) of protection	See 29.4. One type/level of protection employed.	N/A
29.7	Multiple types of protection		N/A
29.8	Ga equipment using two independent Gb types (or levels) of protection	No such application.	N/A
29.9	Ex Components	Ex equipment considered.	N/A
29.10	Small equipment and small Ex Components		N/A
29.11	Extremely small equipment and extremely small Ex Components		N/A
29.12	Warning markings	Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information.	P
29.13	Alternate marking of equipment protection levels (EPLs)	No alternative marking used.	N/A

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
29.13.1	Alternate marking of type of protection for explosive gas atmospheres		N/A
29.13.2	Alternate marking of type of protection for explosive dust atmospheres		N/A
29.14	Cells and batteries	Properly marked internally.	P
29.15	Converter-fed electrical machines	No such parts.	N/A
29.16	Examples of marking	See Copy of marking plate.	P
30	Instructions		
30.1	General	Documentation required by clause 24 of IEC60079-0 & clause 13 of IEC60079-11 is reviewed and recognized for compliance.	P
30.2	Cells and batteries	Specific safety instructions are provided with regards to brand & type of battery.	P
30.3	Electrical machines	No such parts.	N/A
30.4	Ventilating fans	No such parts.	N/A
Annex A (Normative)	Supplementary requirements for cable glands		
A.1	General	No cable glands.	N/A
A.2	Constructional requirements		
A.2.1	Cable sealing		N/A
A.2.2	Filling compounds		N/A
A.2.3	Clamping		
A.2.3.1	General		N/A
A.2.3.2	Group II or III cable glands		N/A
A.2.4	Lead-in of cable		
A.2.4.1	Sharp edges		N/A
A.2.4.2	Point of entry		N/A
A.2.5	Released by a tool		N/A
A.2.6	Fixing		N/A
A.2.7	Degree of protection		N/A
A.3	Type tests		
A.3.1	Tests of clamping of non-armoured and braided cables		

IEC 60079-0			
Clause	Requirement – Test	Result – Remark	Verdict
A.3.1.1	Cable glands with clamping by the sealing ring		N/A
A.3.1.2	Cable glands with clamping by filling compound		N/A
A.3.1.3	Cable glands with clamping by means of a clamping device		N/A
A.3.1.4	Tensile test		N/A
A.3.1.5	Mechanical strength		N/A
A.3.2	Tests of clamping of armoured cables		N/A
A.3.2.1	Tests of clamping where the armourings are clamped by a device within the gland		N/A
A.3.2.1.1	Tensile test		N/A
A.3.2.1.2	Mechanical strength		N/A
A.3.2.2	Tests of clamping where the armourings are not clamped by a device within the gland		N/A
A.3.3	Type test for resistance to impact		N/A
A.3.4	Test for degree of protection (IP) of cable glands		N/A
A.4	Marking		
A.4.1	Marking of cable glands		N/A
A.4.2	Marking of cable-sealing rings		N/A

Annex B (Normative)	Requirements for Ex components.		
Table B.1	Clauses with which Ex Components shall comply	Ex equipment considered.	N/A

Annex C (Informative)	Example of rig for resistance to impact test		
--------------------------	----------------------------------------------	--	--

Annex D (Informative)	Motors supplied by converters		
--------------------------	-------------------------------	--	--

Annex E (Informative)	Temperature rise testing of electric machines		
--------------------------	-----------------------------------------------	--	--

Annex F (Informative)	Guideline flowchart for tests of non-metallic enclosures or non-metallic parts of enclosures (26.4)		
--------------------------	-----------------------------------------------------------------------------------------------------	--	--

Measurement Section, including Additional Narrative Remarks (as deemed applicable)

Clause 26.4.2 Impact test is exempted for enclosure but is performed according to the testing of the built-in piezoelectric device, buzzer type BZ-9K. Refer to associated IEC60079-11 test report.

§ 26.4.3	Drop test		P *)
Part under test	Test condition	Remarks	
GX-6000 w/ BUD-6000	*)	No visible damages or scratch	
GX-6000 w/ BUL-6000	*)	No visible damages or scratch	

Supplementary information.

*) Samples were pre-conditioned in cold chamber with temperature of 30°C. Conditioning time: from 2015-01-12 time 09.00 to 2015-01-14 time 08.00. The samples were dropped on horizontal concrete surface in the cold chamber. Drop performed four times for each sample in different positions. The samples were functioning normal after test.

§ 26.13	Surface resistance test		P
Part under test	Test condition *)	Remarks	
ESC 9448N (black). Middle case	*)	155Ω (<1GΩ)	
PET 300R. Panel sheet	*)	1.3MΩ (<1GΩ)	

Supplementary information.

*) 24h pre-conditioning: 23.1°C & 47.8% rth. 500V insulation test in 60s duration. 10s rise/fall time. All other smaller parts of regular plastic material are checked for surface area less than 400mm². Test performed on 2014-10-27

α) 24h pre-conditioning: 22.4°C & 26.4% rth. 500V insulation test in 60s duration. 10s rise/fall time. Test performed 2015-02-05



IECEx TEST REPORT
IEC 60079-11
Explosive atmospheres – Part 11:
Equipment protection by intrinsic safety "i"

ExTR Reference Number	NO/PRE/ExTR15.0012/00	
ExTR Free Reference Number.....	D0001494-00	
Compiled by + signature (ExTL).....	Hien Van Le Thanh	<i>Hien Van Le Thanh</i>
Reviewed by + signature (ExTL).....	Arne Hortman	<i>Arne Hortman</i>
Date of issue.....	2015-04-21	
Ex Testing Laboratory (ExTL)	Presafe AS	
Address	Gaustadalléen 30, NO - 0373 Oslo, Norway	
Applicant's name	Riken Keiki Co., Ltd	
Address	2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan	
Standard	IEC 60079-11:2011, 6 th Edition	
Test procedure	IECEx System	
Test Report Form Number	ExTR60079-11_6A (released 2011-08)	

Instructions for Intended Use of Ex Test Report:

An Ex Test Report provides a clause-by-clause documentation of the initial evaluation and testing that verified compliance of an item or product with an IEC Ex standard. This Ex Test Report is part of an ExTR package that may include other Ex Test Report, Addendum and National Differences documents, along with a single ExTR Cover. An Ex Test Report is to be compiled and reviewed by the ExTL. The Issuing ExCB indicates final approval of the Ex Test Report as part of the overall ExTR package on the associated ExTR Cover.

Copyright © 2011 International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx System), Geneva, Switzerland. All rights reserved.

This blank publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx System is acknowledged as copyright owner and source of the material. The IECEx system takes no responsibility for, and will not assume liability for, damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item	N/A	Not applicable
- test item does meet the requirement.....	P	Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "See Attachment #" refers to additional information appended to this document.
- "See appended table" refers to a table appended to this document.
- "See General product information" refers to item 'General product information' in ExTR Cover report.
- "See Copy of marking plate" refers to item 'Copy of marking plate' in ExTR Cover report.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
1	Scope		
2	Normative references		
3	Terms and definitions		
4	Grouping and classification of intrinsically safe apparatus and associated apparatus	Equipment under test (EUT) is portable gas monitor GX-6000 and charger module BC-6000. See General product information. Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C	P
5	Levels of protection and ignition compliance requirements of electrical apparatus		
5.1	General		P
5.2	Level of protection "ia"	Refer to Appendix A.1 for details.	P
5.3	Level of protection "ib"	Suitable for application of 'ib' type of protection.	N/A
5.4	Level of protection "ic"	Suitable for application of 'ic' type of protection.	N/A
5.5	Spark ignition compliance	Refer to Appendix A.2 & B.2 for details.	P
5.6	Thermal ignition compliance		
5.6.1	General	Refer to Appendix A.3 & B.3 for details.	P
5.6.2	Temperature for small components for Group I and Group II	Refer to Appendix A.3.1 & B.3 for details.	P
5.6.3	Wiring within intrinsically safe apparatus for Group I and Group II	Refer to Appendix A.3.2 for details.	P
5.6.4	Tracks on printed circuit boards for Group I and Group II	Refer to Appendix A.3.3 for details.	P
5.6.5	Intrinsically safe apparatus and component temperature for Group III	Not Group III equipment.	N/A
5.7	Simple apparatus	Not simple apparatus.	N/A
6	Apparatus construction		

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
6.1	Enclosures		
6.1.1	General	Considered.	P
6.1.2	Enclosures for Group I or Group II apparatus		
6.1.2.1	General	See below.	P
6.1.2.2	Apparatus complying with Table 5	Enclosure complying with minimum IP20 provided. Compliance with table 5 considered.	P
6.1.2.3	Apparatus complying with Annex F	See above.	N/A
6.1.3	Enclosures for Group III apparatus	Not group III apparatus.	N/A

6.2	Facilities for connection of external circuits		
6.2.1	Terminals	No external connections other than charging facilities. Charging protection circuit and connection is provided and is evaluated in 7.4.	N/A
6.2.2	Plugs and sockets		N/A
6.2.3	Determination of maximum external inductance to resistance ratio (L_o/R_o) for resistance limited power source	AC/DC power adapter is not covered by this investigation. See also above.	N/A
6.2.4	Permanently connected cable	No such parts.	N/A
6.2.5	Requirements for connections and accessories for IS apparatus when located in the non-hazardous area	Charging is only allowed in non-hazardous area. Charging is evaluated and is documented throughout sub-clauses of 7.4 of this report.	N/A

6.3	Separation distances		
6.3.1	General	Considered. See Appendix A.1 & B.4 for details	P
6.3.2	Separation of conductive parts	Current limiting resistors is used in major part of internal electronics. Fuses are used in different parts and are documented in measurement section	P
6.3.2.1	Distances according to Table 5	Distances according to Table 5 are considered.	P
6.3.2.2	Distances according to Annex F	Not used.	N/A
6.3.3	Voltage between conductive parts	Voltage of battery units considered. See Appendix A.1 to A.4 for details	P
6.3.4	Clearance	Considered.	P
6.3.5	Separation distances through casting compound	Considered for the moulded BUL-6000 (Li-ion battery pack). See also 7.3	P
6.3.6	Separation distances through solid insulation	Suitable internal wiring considered. See also above and 6.3.12	P
6.3.7	Composite separations	No composite separations	N/A
6.3.8	Creepage distance	See Appendix A.1 & B.4 for details	P
6.3.9	Distance under coating	No coating used.	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
6.3.10	Requirements for assembled printed circuit boards	Complied with requirements of 6.3.2. See Appendix A.1 & B.4 for details.	P
6.3.11	Separation by earthed screens	No earthed screens.	N/A
6.3.12	Internal wiring	See Appendix A.3.2 & B.4 to B.5	P
6.3.13	Dielectric strength requirement	Suitable insulated wiring is used. Dielectric strength test is considered to be unnecessary.	N/A
6.3.14	Relays	No relays.	N/A
6.4	Protection against polarity reversal	Provided for BUL-6000 & button cell Sony SR616. Appropriate internal markings provided for BUD-6000. See Appendix A.1 to A.4.	P
6.5	Earth conductors, connections and terminals	Portable handheld equipment. No earthing required.	N/A
6.6	Encapsulation		
6.6.1	General	See Appendix A.5	P
6.6.2	Encapsulation used for the exclusion of explosive atmospheres	BUL-6000 Li-ion battery pack is encapsulated and therefore is exempted from requirements of spark ignition assessment. See Appendix A to C	P
7	Components on which intrinsic safety depends		
7.1	Rating of components	Refer to Appendix A.4 for details.	P
7.2	Connectors for internal connections, plug-in cards and components	Incorrect connection of battery units is not possible due to the design. Removal or replacement of battery is not allowed in hazardous area. Warnings and adequate markings are provided.	P
7.3	Fuses	A fuse is provided at the input of charger circuit. The charging is only allowed in safe area. This fuse is therefore not required to be encapsulated. See 7.5.2-7.5.3 & 10.6.2 & Appendix A.6	P
7.4	Primary and secondary cells and batteries		
7.4.1	General	EUT is powered by batteries. Batteries have therefore several aspects of safety concern. See Appendix B.6 & C.	P
7.4.2	Battery construction	Adequate protection concept investigated and recognized. See throughout Appendix A to C	P
7.4.3	Electrolyte leakage and ventilation	See Appendix B.6 & C.	P

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
7.4.4	Cell voltages	See throughout Appendix A to C. Alkaline/BUD-6000 $V_{\text{peak open-circuit}}=1.65\text{V}$, $V_n=1.5\text{V}$ Li-ion/BUL-6000: $V_{\text{peak open-circuit}}=4.2\text{V}$, $V_n=3.8\text{V}$ Button cell (silver oxide) Sony SR616: $V_{\text{peak open-circuit}}=1.63\text{V}$, $V_n=1.55\text{V}$	P
7.4.5	Internal resistance of cell or battery	Test according to cl. 10.5.3 is documented. See Appendix C.	P
7.4.6	Batteries in equipment protected by other types of protection	Intrinsic safe protection concept.	N/A
7.4.7	Batteries used and replaced in explosive atmospheres	Batteries are used but replacement is not allowed in explosive atmospheres.	N/A
7.4.8	Batteries used but not replaced in explosive atmospheres	Proper protection concept provided for charging & discharging. Charger input is based on $U_m=250\text{V}$ and is evaluated accordingly.	P
7.4.9	External contacts for charging batteries	Complied with option a) of this requirement. Safe circuit using current limiting resistors and blocking diodes provided.	P

7.5	Semiconductors		
7.5.1	Transient effects	Adequate means of limiting transients provided. See below & Appendix A.6.	P
7.5.2	Shunt voltage limiters	By use of fuse F1 and triplicate controllable semiconductors (Field Effect Transistor), the shunt voltage limiters (Q1, Q2, Q3, ZD1, ZD2, ZD3, R1, R2, R3 in charger circuit) are composed and the voltage supplied to the charger circuit is limited. See Appendix A.6	P
7.5.3	Series current limiters	D1-D3 are used in line with the components which are described above. See Appendix A.1	P

7.6	Failure of components, connections and separations	Considered. See Measurement section of this report.	P
-----	----------------------------------------------------	-----------------------------------------------------	----------

7.7	Piezoelectric devices	The buzzer is considered. See Appendix A.2.6.	P
-----	-----------------------	-----------------------------------------------	----------

7.8	Electrochemical cells for the detection of gases	See Appendix B.6 and Appendix D to F for documented testing of different sensors	P
-----	--------------------------------------------------	----------------------------------------------------------------------------------	----------

8	Infallible components, infallible assemblies of components and infallible connections on which intrinsic safety depends		
---	-------------------------------------------------------------------------------------------------------------------------	--	--

8.1	Level of Protection “ic”	‘ia’ protection concept. See Appendix A to C	P
-----	--------------------------	----------------------------------------------	----------

8.2	Mains transformers		
8.2.1	General	No transformers. See 8.4	N/A
8.2.2	Protective measures		N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
8.2.3	Transformer construction		N/A
8.2.4	Transformer type tests		N/A
8.2.5	Routine test of mains transformers		N/A
8.3	Transformers other than mains transformers	No transformers. See 8.4	N/A
8.4	Infallible windings		
8.4.1	Damping windings	See below.	N/A
8.4.2	Inductors made by insulated conductors	Windings of pump is not considered as infallible. Refer to assessments of pump circuits.	N/A
8.5	Current-limiting resistors	See Appendix A.1 & A.4	P
8.6	Capacitors		
8.6.1	Blocking capacitors	No such components.	N/A
8.6.2	Filter capacitors		N/A
8.7	Shunt safety assemblies		
8.7.1	General	Minimum two parallel paths of zener diodes used.	P
8.7.2	Safety shunts	See 7.5.2 and Appendix A.1 & A.4	P
8.7.3	Shunt voltage limiters	See 7.5.2 and Appendix A.1 & A.4	P
8.8	Wiring, printed circuit board tracks, and connections	See Appendix A.1 & A.3 & A.4 & B.4 with regards to wiring and PCB	P
8.9	Galvanically separating components		
8.9.1	General	No galvanically separating components.	N/A
8.9.2	Isolating components between intrinsically safe and non-intrinsically safe circuits		N/A
8.9.3	Isolating components between separate intrinsically safe circuits		N/A
9	Supplementary requirements for specific apparatus		
9.1	Diode safety barriers		
9.1.1	General	No diode safety barriers. See 7.5.2	N/A
9.1.2	Construction		

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
9.1.2.1	Mounting		N/A
9.1.2.2	Facilities for connection to earth		N/A
9.1.2.3	Protection of components		N/A
9.2	FISCO apparatus	No such parts.	N/A
9.3	Handlights and caplights		N/A
10	Type verifications and type tests		
10.1	Spark ignition test		
10.1.1	General	Higher safety factor achieved. Spark ignition test is found un-necessary.	N/A
10.1.2	Spark test apparatus		N/A
10.1.3	Test gas mixtures and spark test apparatus calibration current		
10.1.3.1	Explosive test mixtures suitable for tests with a safety factor of 1.0 and calibration current of the spark test apparatus		N/A
10.1.3.2	Explosive test mixtures suitable for tests with a safety factor of 1.5 and calibration current of the spark test apparatus		N/A
10.1.4	Tests with the spark test apparatus		
10.1.4.1	Circuit test		N/A
10.1.4.2	Safety factors		N/A
10.1.5	Testing considerations		
10.1.5.1	General		N/A
10.1.5.2	Circuits with both inductance and capacitance	See through Appendix A.2 for details.	
10.1.5.3	Circuits using shunt short-circuit (crowbar) protection	No crowbar protection. However the charger circuit is functioned similarly.	N/A
10.1.5.4	Results of spark test		N/A
10.2	Temperature tests	See Appendix A.3 & B.3 & B.6 & C to F	P
10.3	Dielectric strength tests	Not needed for this investigation.	N/A
10.4	Determination of parameters of loosely specified components	Max voltage of Li-ion batteries during charging has been determined by measuring the voltage of the batteries in BUL-6000 on 10 samples.	P

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
10.5	Tests for cells and batteries		
10.5.1	General	See Appendix B.6 & C.	P
10.5.2	Electrolyte leakage test for cells and batteries		P
10.5.3	Spark ignition and surface temperature of cells and batteries		P
10.5.4	Battery container pressure tests		P
10.6	Mechanical tests		
10.6.1	Casting compound	Internal encapsulation. No exposed surface.	N/A
10.6.2	Determination of the acceptability of fuses requiring encapsulation	F1 in battery charger circuit is used in safe area and is protected for reversed current by D1-D3 in BUL-6000	P
10.6.3	Partitions		N/A
10.7	Tests for intrinsically safe apparatus containing piezoelectric devices	Buzzer BZ-9K considered. See Appendix A.2.6.	P
10.8	Type tests for diode safety barriers and safety shunts	Adequate transient protection provided. See Appendix A.6	N/A
10.9	Cable pull test	No external cable.	N/A
10.10	Transformer tests	No transformers	N/A
10.11	Optical isolators tests		
10.11.1	General	No such parts.	N/A
10.11.2	Thermal conditioning, dielectric and carbonisation test		N/A
10.11.2.1	Overload test at the receiver side		N/A
10.11.2.2	Overload test at the transmitter side		N/A
10.11.2.3	Thermal conditioning and dielectric strength test		N/A
10.11.2.4	Carbonisation test		
10.11.2.4.1	Receiver side		N/A
10.11.2.4.2	Transmitter side		N/A
10.11.3	Dielectric and short-circuit test		N/A
10.11.3.1	General		N/A
10.11.3.2	Pre-test dielectric		N/A
10.11.3.3	Short-circuit current test		N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
10.11.3.4	Current limited short-circuit current test		N/A
10.11.3.5	Dielectric strength test		

10.12	Current carrying capacity of infallible printed circuit board connections	Suitable PCB are used and are well documented.	N/A
-------	---------------------------------------------------------------------------	------------------------------------------------	------------

11	Routine verifications and tests		
----	---------------------------------	--	--

11.1	Routine tests for diode safety barriers		
11.1.1	Completed barriers	No barriers.	N/A
11.1.2	Diodes for 2-diode "ia" barriers		N/A

11.2	Routine tests for infallible transformers	No transformers.	N/A
------	-------------------------------------------	------------------	------------

12	Marking		
----	---------	--	--

12.1	General	See Copy of marking plate.	P
12.2	Marking of connection facilities	Appropriate internal markings provided for BUD-8000. See Appendix A.1 to A.4.	P
12.3	Warning markings	Warnings provided with regards to specific instructions of type of battery, replacement & charging, and safety instructions in User manual. See Copy of marking plate and General product information.	P
12.4	Examples of marking	See Copy of marking plate.	P

13	Documentation	Documentation concerning explosion safety aspects of EUT is prepared by the manufacturer and is reviewed as part of this investigation. Documentation is kept in file at DNV Nemko Presafe AS. See also Copy of marking plate	P
----	---------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------

Annex A (Normative)	Assessment of intrinsically safe circuits		
A.1	Basic criteria	See Appendix A.1 to A.2	P
A.2	Assessment using reference curves and tables	See above.	P
A.3	Examples of simple circuits		P
A.4	Permitted reduction of effective capacitance when protected by a series resistance	Considered.	N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
Annex B (Normative)	Spark test apparatus for intrinsically safe circuits		
B.1	Test methods for spark ignition		
B.1.1	Principle	See Appendix D to F for thermal ignition test of lamp part and sensors. Separate documented testing was reviewed and recognized.	N/A
B.1.2	Apparatus	See above.	N/A
B.1.3	Calibration of spark test apparatus		N/A
B.1.4	Preparation and cleaning of tungsten wires		N/A
B.1.5	Conditioning a new cadmium disc		N/A
B.1.6	Limitations of the apparatus		N/A
B.1.7	Modifications of test apparatus for use at higher currents		N/A
Annex C (Informative)	Measurement of creepage distances, clearances and separation distances through casting compound and through solid insulation		
Annex D (Normative)	Encapsulation		
D.1	Adherence	See Appendix A.5	P
D.2	Temperature	See above	P
Annex E (Informative)	Transient energy test		
Annex F (Normative)	Alternative separation distances for assembled printed circuit boards and separation of components		
F.1	General	Not used.	N/A
F.2	Control of pollution access		N/A
F.3	Distances for printed circuit boards and separation of components		
F.3.1	Level of protection “ia” and “ib”		N/A
F.3.2	Level of protection “ic”		N/A
Annex G (Normative)	Fieldbus intrinsically safe concept (FISCO) – Apparatus requirements		
G.1	Overview	No FISCO apparatus.	N/A
G.2	Apparatus requirements		
G.2.1	General		N/A

IEC 60079-11			
Clause	Requirement – Test	Result – Remark	Verdict
G.2.2	FISCO power supplies		
G.2.2.1	General		N/A
G.2.2.2	Additional requirements of 'ia' and 'ib' FISCO power supplies		N/A
G.2.2.3	Additional requirements of 'ic' FISCO power supplies		N/A
G.3	FISCO field devices		
G.3.1	General		N/A
G.3.2	Additional requirements of 'ia' and 'ib' FISCO field devices		N/A
G.3.3	Additional requirement of 'ic' FISCO field devices		N/A
G.3.4	Terminator		N/A
G.3.5	Simple apparatus		N/A
G.4	Marking		N/A
G.4.1	Examples of marking		N/A

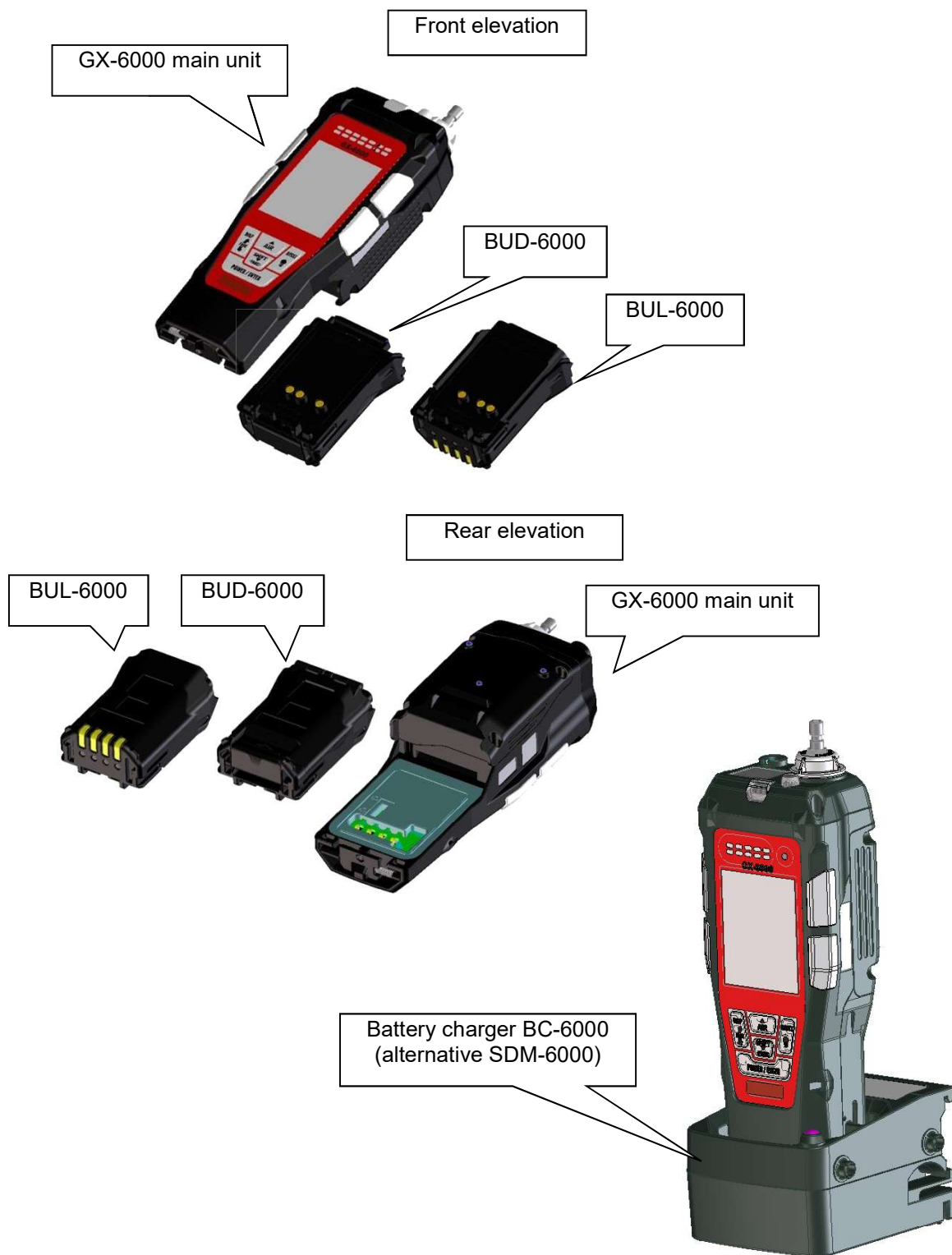
Annex H (Informative)	Ignition testing of semiconductor limiting power supply circuits
--------------------------	------------------------------------------------------------------

Measurement Section, including Additional Narrative Remarks

APPENDIX A: Description of product

A.1 General Technical description

GX-6000 main unit & Battery unit



EUT (equipment under test) is the portable gas monitor GX-6000 intended to measure maximum six gases with six sensors. Standard type of EUT unit measures four gases with four sensors for general combustible gases (LEL), Oxygen (O₂), Hydrogen Sulfide (H₂S) and Carbon Monoxide (CO). Remaining two slots are used for Smart Sensors which consist of sensor part and dedicated circuit board. Different types of detection principle are applied for Smart Sensors which up to two sensors can be installed into the GX-6000. Gas is sampled by a built-in micro pump.

Ambient temperature range for use: -20°C to 50°C

Ambient temperature range during charging: 0 °C to 40°C (Non-hazardous area only)

The battery can be selected between either Li-ion battery or alkaline dry battery. Li-ion battery unit is called BUL-6000 and alkaline dry battery unit is called BUD-6000. BC-6000 is battery charger module. Both battery units are designed so replacement can be performed by the end user with no use of tools. However replacement is only allowed in non-hazardous areas. Warnings and safety info are provided.

BUL-6000 Li-ion battery unit

Two parallel connected Li-ion cells used in battery pack BP-6000 are of type 18650, two parallel cells size Ø18x65mm from manufacturer:

- MAXELL model INR18650PB1
- SONY model US18650VT3
- SDI model INR18650-15M

The cells are placed in plastic (PC) case. The case is filled with epoxy resin, or silicon compound.

Encapsulation prevent the battery to have any contact with external gases. Nominal battery voltage is 3.8V and the peak open circuit voltage is 4.2V according to table 11 of IEC60079-0.

Hence $U_{bat_therm} = 3.8V$ (for thermal ignition assessment and rating of components),

$U_{bat_spark} = 4.2V$ (for spark ignition assessment)

This battery unit is charged at less than 4.2V (CCCV) by the exclusive battery charger BC-6000, alternative SDM-6000. Electronic design of both charger modules are identically. The difference is module's shape/form. Assessments performed for BC-6000 is representative for SDM-6000 module.

BUD-6000 alkaline battery unit


Three series connected alkaline manganese AA batteries, type LR6 manufactured by TOSHIBA. Nominal battery voltage is 1.5V and the peak open circuit voltage is 1.65V according to table 11 of IEC60079-0.

Eventual occurring of battery cell leakage cannot invalidate the creepage distances of the safety components, since no safety components are placed on the battery PCB.

Hence $U_{bat_therm} = 1.5 \times 3 = 4.5V$, and $U_{bat_spark} = 1.65 \times 3 = 4.95V$

Backup battery type SR616 manufactured by SONY

The apparatus is legibly marked (ref. drawing M4-4777-01-01K) with the following:

-  II 1 G Ex ia IIC T4 Ga
- Ambient temperature range
- Manufacturers Model/Type designation
- Serial number (coded in INST. No. on the label and explained in the safety information)
- Name of the manufacturer
- IECEx Certificate number
- Read manual for safety info

The instruction manual contains the following warnings:

- WARNING: "DO NOT CHARGE IN HAZARSOUS LOCATION"
- WARNING: "DO NOT CHARGE IT EXCEPT BY GENUINE CHARGER"
- WARNING: "DO NOT REPLACE BATTERY UNIT IN HAZARDOUS LOCATION"
- WARNING: "DO NOT REPLACE DRY BATTERIES IN HAZARDOUS LOCATION"
- WARNING: "DO NOT ATTEMPT TO DISASSEMBLE OR ALTER THE INSTRUMENT"
- Use only battery unit type BUD-6000 with three series connected Alkaline Manganese AA batteries, type LR6 manufactured by Toshiba, or use chargeable battery unit type BUL-6000.

The following block diagrams are demonstrating complete protection concept of EUT, E3-6991-5361-10-01K & E4-6991-5395-80-01K. Refer also to general block diagram document E3-6991-5393-30-01K

EUT are divided in following parts, BC-6000/SDM-6000 charger, BUL-6000 (Li-ion) & BUD-6000 (alkaline) battery units & main unit. Main unit consists of Main PCB, Sensor PCB and LCD. They are then divided into following blocks of circuits for assessments, Main circuit including backup-battery, Pump circuit (pump type RP-12), Buzzer circuit (piezoelectric device Buzzer type BZ-9K), Motor circuit (vibration motor type A3BE-MT4), LCD circuit (LCD module type BTD-128160B-FBWB) and Sensor-circuit (S_sen1 and S-sen2 circuits are identical)









Series resistors are used for current and power limitation of the battery and for segregation between the various voltage areas on the main PCB and battery PCB. Several double zener diode combinations are used for voltage limitation of the internal circuits.

By use of triplicate controllable semiconductors (Field Effect Transistor), the shunt voltage limiters (Q1, Q2, Q3, ZD1, ZD2, ZD3, R1, R2, R3 on the Li-ion battery PCB) are composed and the voltage supplied to the charger circuit is limited. This application is considered to be adequate protection in term of limiting transients. Refer to Appendix A.6 for assessments of the charger circuit by which reference voltage for assessments of internal circuits behind the charger circuits is determined to be 4.2V. And also that fault conditions of charger circuit cause no risk which invalidates the type of protection.

S-SEN1 & S_SEN2 circuits are identical, therefore assessments for Sensor1 circuit are representative for both of S-SEN1 & S_SEN2.

The charger modules BC-6000 & SDM-6000 are included in this investigation and are assessed based on $U_m = 250V$. The AC/DC power adapter is not part of this investigation..

Table list of sensors

		Measuring gas	Sensor type	Detection principle	
Standard four gas	1	Combustible gas (LEL)	Combustible gas sensor type NC-6264A	Catalytic combustion	
	2	Oxygen (O2)	Oxygen sensor	Galvanic cell	
	3	Hydrogen Sulfide (H2S)	Toxic gas sensor	Electrochemical	
	4	Carbon Monoxide (CO)	Toxic gas sensor	Electrochemical	
Smart Sensor	5	VOC	Smart sensor type PIS (Mini PID sensor used)	PID	
	6	Toxic gases	Smart sensor type ESS (Internal toxic gas sensor)	Electrochemical	
	7	Carbon Dioxide (CO2) or Combustible gas	Smart sensor type DES (T- 3/4 BPA Lamp used)	Infrared ray (IR)	
	8	Oxygen	Smart sensor type OSS (Internal oxygen sensor used)	Galvanic cell	

A.2 Spark ignition considerations

Assessment performed for BUD-6000 only and is representing the least favourable situation with highest U_{bat} . Assessment cover the use of BUL-6000 as well

A.2.1 Resistive spark ignition

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The maximum output voltage U_{o_sens11} available from the battery is 4.95V.

The maximum voltage from the IC11 (TPS61020 Step-up DC/DC converter) is limited by ZD11, ZD12, to maximum voltage of $U_{o_sens12} = 5.36V$, which should be taken into account for the spark ignition compliance.

The output current I_{o_sens1} is limited by R_{i_sens1}

$$R_{i_sens1} = (RS11 + RS12 + RS13 + RS14 + RS15) - 1\% = 6.435\Omega.$$

$$I_{o_sens1} = U_{bat_spark} / R_{i_sens1} = 4.95V / 6.435\Omega = 0.770A.$$

$$P_{o_sensor} = U_{bat_therm}^2 / (4 \times R_{i_sens1}) = 4.5V^2 / (4 \times 6.435\Omega) = 787mW.$$

Pump circuit (Pump type RP-12)

The maximum output voltage U_{o_pump1} available from the battery is 4.95V.

The maximum voltage of $U_{o_pump2} = U_{o_main2} = 5.36V$, which should be taken into account for the spark ignition compliance.

$$R_{i_pump} = (RS31 + RS32 + RS33 + RS34 + RS35) - 1\% = 6.435\Omega.$$

$$I_{o_pump} = U_{bat_spark} / R_{i_pump} = 4.95V / 6.435\Omega = 0.770A.$$

$$P_{o_pump} = U_{bat_therm}^2 / (4 \times R_{i_pump}) = 4.5V^2 / (4 \times 6.435\Omega) = 787mW.$$

Motor circuit (Vibration motor type A3BE-MT4)

The maximum output voltage U_{o_motor1} available from the battery is 4.95V.

The maximum voltage of $U_{o_motor2} = U_{o_main2} = 5.36V$

$$R_{i_motor} = (RS51 + RS52) - 1\% = 23.76\Omega.$$

$$I_{o_motor} = U_{bat_spark} / R_{i_motor} = 4.95V / 23.76\Omega = 0.209A.$$

$$P_{o_motor} = U_{bat_therm}^2 / (4 \times R_{i_motor}) = 4.5V^2 / (4 \times 23.76\Omega) = 214mW.$$

Buzzer circuit (Buzzer type BZ-9K)

The maximum output voltage $U_{o_buzzer1}$ available from the battery is 4.95V.

The maximum input voltage U_{i_buzzer} available from main circuit is 5.36V. However the max voltage is clamped down to 5.2V by ZD41 to ZD48. Hence, the maximum output voltage $U_{o_buzzer2} = 5.20V$.

The maximum voltage from the IC41 (TPS61041 Step-up DC/DC converter) is limited by ZD45, ZD46 to maximum voltage of $U_{o_buzzer3} = 12.3V$

$$R_{i_buzzer} = (RS41 + RS42 + RS43) - 1\% = 13.95\Omega.$$

$$I_{o_buzzer} = U_{bat_spark} / R_{i_buzzer} = 4.95V / 13.95\Omega = 0.355A.$$

$$P_{o_buzzer} = U_{bat_therm}^2 / (4 \times R_{i_buzzer}) = 4.5V^2 / (4 \times 13.96\Omega) = 259mW.$$

Main circuit

The maximum output voltage U_{o_main1} available from the battery is 4.95V.

The maximum voltage from the IC71 (TPS61020 Step-up DC/DC converter) is limited by ZD71, ZD72. Hence maximum voltage of $U_{o_main2} = 5.36V$, which should be taken into account for the spark ignition compliance.

$$R_{i_main} = (RSA1 - RSA5 // RSB1 - RSB5 // RSC1 - RSC5) - 1\% = 4.455\Omega.$$

$$I_{o_main} = U_{bat_spark} / R_{i_main} = 4.95V / 4.455\Omega = 1.112A.$$

$$P_{o_main} = U_{bat_therm}^2 / (4 \times R_{i_main}) = 4.5V^2 / (4 \times 4.455\Omega) = 1137mW.$$

LCD circuit

The maximum input voltage U_{i_lcd1} available from main.cir 5.36V.

Input 5.36V from MAIN.circuit to LCD.circuit is clamped down to 5.20V by ZD61 to ZD68.

Hence, the maximum output voltage $U_{o_lcd1} = 5.20V$.

The charge pump circuit is built in the LCD driver (ST75256), and the voltage is boosted to a maximum of ± 10 times. The maximum output voltage $U_{o_lcd2} = 5.20V \times 10 = 52.0V$ and $-52.0V$.

In order to reduce the voltage of the capacitor C62 in the LCD driver, zeners ZD57 to ZD60 is used.

The maximum output voltage (for C62) $U_{o_lcd3} = 17.7V$ and $-17.7V$.

$R_{i_lcd} = (RS61 // RS62 // RS63 // RS64 // RS65) - 1\% = 24.31\Omega$.

$I_{o_lcd} = U_{bat_spark} / (R_{i_main} + R_{i_lcd}) = 4.95V / (4.455\Omega + 24.31\Omega) = 0.173A$.

$P_{o_lcd} = U_{bat_therm}^2 / (4 \times (R_{i_main} + R_{i_lcd})) = 4.5V^2 / (4 \times (4.455\Omega + 24.31\Omega)) = 176mW$.

Backup battery (placed on Main PCB)

The maximum open circuit voltage for Silver oxide battery, type SONY SR616, according to table 11 of IEC60079-0 is $U_{backup_spark} = 1.63V$.

Normal voltage according to table 11 of IEC60079-0 is $U_{backup_therm} = 1.55V$ which should be used for thermal analysis and rating of components.

The output current I_{o_backup} is limited by RS10.

The backup battery is protected from charging by diode D7

$R_{i_backup} = R10 - 1\% = 990\Omega$.

$I_{o_backup} = U_{o_backup_spark} / R_{i_backup} = 1.63V / 990\Omega = 1.7mA$.

$P_{o_backup} = U_{backup_therm}^2 / (4 \times R_{i_backup}) = 1.55V^2 / (4 \times 990\Omega) = 0.7mW$.

Battery charger circuit (For BUL-6000 only in safe area)

The exclusive chargers of GX-6000 are BC-6000 and SDM-6000.

For power input of battery charger, AC adaptor with 12Vdc output shall be used. The input of AC adaptor is specified to max 220Vac but has $U_m = 250V$. A shunt voltage limiting circuit together with a fuse is used as protection from U_m . Fuse $I_n = 1.6A$ is used. The maximum current of charging circuit is limited to

$I_{o_charge} = 1.6A \times 1.7 = 2.72A$.

The charge current of the battery is functional limited to 1.5A by charging control IC during recharge. The battery voltage is limited to 4.2V by function of charging control IC at recharging. $U_{bat_charge} = 4.2V$.

Ref. drawing no. E3-6991-5361-10-01K

Based on the highest assessed current 1.112A which max source voltage higher than 5V is allowed (ref figure A.1 of IEC60079-11), the result is therefore within the acceptable level.

A.2.2 Inductive spark ignition**Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)**

The effective internal inductance is $L_{sens1} = 13\mu H$

Based on $I_{o_sens1} = 0.770A$, the maximum allowed inductance is $L = 59.9\mu H$ ($L = 2E / I^2 = 2 \times 40\mu J / (1.5 \times 0.770A)^2$) according to figure A.6 of IEC60079-11.

Pump circuit (Pump type RP-12)

The effective internal inductance of the pump motor is 59.8uH maximum.

Taken into account the minimum resistance of the motor, the current through the windings is $I_{o_pump} = 4.95V / (6.435\Omega + 11.0\Omega) = 0.284A$. The maximum allowed inductance is $L = 440\mu H$ ($L = 2E / I^2 = 2 \times 40\mu J / (1.5 \times 0.284A)^2$).

Motor circuit (Vibration motor type A3BE-MT4)

The effective internal inductance of the vibration motor is 350uH maximum.

Taken into account the minimum resistance of the motor, through a windings is $I_{o_motor} = 4.95V / (23.76\Omega + 80\Omega) = 0.048A$. The maximum allowed inductance is $L = 15622\mu H$ ($L = 2E / I^2 = 2 \times 40\mu J / (1.5 \times 0.048A)^2$).

Buzzer circuit (Buzzer type BZ-9K)

The effective internal inductance is $L_{\text{buzzer}} = 13\mu\text{H}$

Based on $I_{\text{o_buzzer}} = 0.355\text{A}$, the maximum allowed inductance is $L = 2E / I^2 = 2 \times 40\mu\text{J} / (1.5 \times 0.355)^2$.

Main circuit

The effective internal inductance is $L_{\text{mainr}} = 6.11\mu\text{H}$

Based on $I_{\text{o_main}} = 1.112\text{A}$, the maximum allowed inductance is $L = 2E / I^2 = 2 \times 40\mu\text{J} / (1.5 \times 1.112\text{A})^2$.

A.2.3 Capacitive spark ignitionSensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The effective internal capacitance is $C_{\text{sens1}} = 41.2\mu\text{F}$ (Type-ESS)

Based on $U_{\text{o_sens12}} = 5.36\text{V}$, the maximum allowed external capacitance is $C = 65\mu\text{F}$ (ref. Table A.2 of IEC60079-11. This capacitance in smart sensor1 circuit is effectively separated from the main circuit by RS81 – RS87 (of min 1k Ω each)

Pump circuit (Pump type RP-12)

The effective internal capacitance is $C_{\text{pump}} = 5.0\mu\text{F}$

Based on $U_{\text{o_pump2}} = 5.36\text{V}$, the maximum allowed external capacitance is $C = 61\mu\text{F}$.

This capacitance in pump circuit is effectively separated from the other circuit by RS37 - RS39 (of min 10k Ω each)

Motor circuit (Vibration motor type A3BE-MT4)

The effective internal capacitance is $C_{\text{motor}} = 2.2\mu\text{F}$

Based on $U_{\text{o_motor2}} = 5.36\text{V}$, the maximum allowed external capacitance is $C = 61\mu\text{F}$.

This capacitance in motor circuit is effectively separated from the main circuit by RS59 (10k Ω).

Buzzer circuit (Buzzer type BZ-9K)

The effective internal capacitance is $C_{\text{buzzer}} = 12.1\mu\text{F}$ (including buzzer capacitance).

Based on $U_{\text{o_buzzer2}} = 5.2\text{V}$, the maximum allowed external capacitance is $C = 79\mu\text{F}$.

Based on $U_{\text{o_buzzer3}} = 12.3\text{V}$, the maximum allowed external capacitance is $C = 1.28\mu\text{F}$.

Since the capacitance of the buzzer circuit is above the maximum allowed value of table A.2 at 12.3V, capacitor C41 with a value of 11 μF is infallibly connected to input resistance RS43 and can hence be deducted from the capacitance that could be charged to a 12.3V level which results in a

$C_{\text{buzzer_12.3V}} = 1.02\mu\text{F}$.

This capacitance in buzzer circuit effectively separated from the main circuit by RS47 – RS49 (of min 10k Ω each)

Main circuit

The effective internal capacitance is $C_{\text{main}} = 38.4\mu\text{F}$ (Main PCB + Sensor PCB)

Based on $U_{\text{o_main2}} = 5.36\text{V}$, the maximum allowed external capacitance is $C = 61\mu\text{F}$.

LCD circuit

The effective internal capacitance is $C_{\text{lcd1}} = 5.17\mu\text{F}$ (C61).

Based on $U_{\text{o_lcd1}} = 5.20\text{V}$, the maximum allowed external capacitance is $C = 79\mu\text{F}$.

The effective internal capacitance is $C_{\text{lcd2}} = 200\text{pF}$ (internal capacitor of LCD driver).

Based on $U_{\text{o_lcd2}} = 52\text{V}$, the maximum allowed external capacitance is $C = 0.0183\mu\text{F}$ (18300pF).

The effective internal capacitance is $C_{\text{lcd3}} = 36.3\text{nF}$ (C62).

Based on $U_{\text{o_lcd3}} = 17.7\text{V}$, the maximum allowed external capacitance is $C = 0.327\mu\text{F}$ (327nF)

A.2.4 Combination of inductive and capacitive spark ignition

Sensor1 circuit

It is not possible that L and C are combined after step up.

$U_{o_sens11} = 4.95V$, allowed $C = 100\mu F$, used $C = 41.2\mu F$, used / allowed ratio = 41.2%.

$I_{o_sens1} = 0.770A$, allowed $L = 59.9\mu H$, used $L = 13\mu H$, used / allowed ratio = 21.8%.

Pump circuit

$U_{o_pump1} = 4.95V$, allowed $C = 100\mu F$, used $C = 5.0\mu F$, used / allowed ratio = 5.0%.

$I_{o_pump} = 0.284A$, allowed $L = 440\mu H$, used $L = 59.8\mu H$, used / allowed ratio = 13.6%.

Motor circuit

$U_{o_motor1} = 4.95V$, allowed $C = 100\mu F$, used $C = 2.2\mu F$, used / allowed ratio = 2.2%.

$I_{o_motor} = 0.048A$, allowed $L = 15622\mu H$, used $L = 350\mu H$, used / allowed ratio = 22.4%

Buzzer circuit

Same as that of a sensor circuit, it is not possible that L and C are combined after step up.

$U_{o_buzzer1} = 4.95V$, allowed $C = 100\mu F$, used $C = 12.1\mu F$, used / allowed ratio = 12.1%.

$I_{o_buzzer} = 0.355A$, allowed $L = 282\mu H$, used $L = 13\mu H$, used / allowed ratio = 4.7%.

Main circuit

Same as that of a sensor circuit, it is not possible that L and C are combined after step up.

$U_o = 4.95V$, allowed $C = 100\mu F$, used $C = 38.4\mu F$ used / allowed ratio = 38.4%.

$I_o = 1.112A$, allowed $L = 28.7\mu H$, used $L = 6.11\mu H$ used / allowed ratio = 21.3%.

The maximum values of L_i and C_i are less than 50% of each allowed value

A.2.5 Shunt short-circuit (crowbar) spark ignition

No crowbar device used.

A.2.6 Other spark ignition considerations

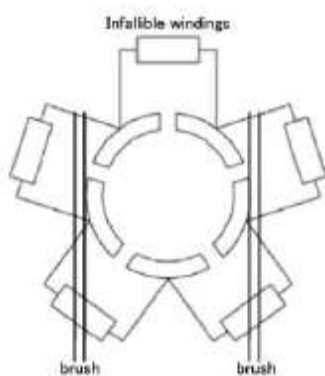
Pump RP-12: (Internal motor of pump type A12B-09-SS)

Pumps are not assessed as infallible windings. However max and min of inductance & resistance is taken into account in assessments of the most severe ignition condition (situation where the winding is disconnected or short-circuited).

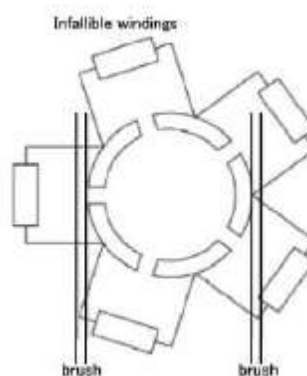
The motor coil resistance is taken as an infallible resistance to protect its inductance. The minimum motor coil resistance and maximum motor coil inductance of A12B-09-SS are as follows:

case1: one commutator segment active.

case2: two commutator segments active.



$R_{min} 13.1 \text{ } _ / L_{max} 59.8 \mu H$



$R_{min} 11.0 \text{ } _ / L_{max} 49.8 \mu H$

The range of the motor coil resistance and the motor coil inductance are as follows.

$R_{min} = 11.0 \text{ } _ - 13.1 \text{ } _ , L_{max} = 49.8 \mu H - 59.8 \mu H$

The worst value is $R_{min} = 11.0 \text{ } _$ and $L_{max} = 59.8 \mu H$ respectively.

Vibration motor is assessed as for pump motor by which worst combination of internal inductance and resistance have been considered. See Appendix A.2.1 to A.2.4.

Piezoelectric device: Buzzer type BZ-9K. $C_i = 22nF @ 30\% \rightarrow 28.6nF$

The buzzer is infallible connected to protective zener diodes ZD49, 50, 51 and 52. This is assessed against open circuit failure by the following:

- The infallible connection consists of two wires in parallel. These wires are soldered to a 2 mm track, which is infallible connected to zener diodes ZD49, 50, 51 and 52.
- The buzzer has been verified to comply with IEC 60079-11 clause 10.7 by applying an impact of 1 kg weight dropped from a height of 0.7 m on the outside of the enclosure twice. Buzzer wires did not break and the protective components were not affected.
- Spark energy assessment.
 - Voltage across buzzer is clamped by ZD40 to ZD52, $V = 17.5V (V_z + V_f)$
 - $E = \frac{1}{2} \times C \times V^2 = \frac{1}{2} \times 28.6nF \times 17.5V^2 = 4.38\mu J < 50\mu J$ (limit for IIC. Ref clause 10.7 of IEC60079-11: 2011). Buzzer wiring is documented in Appendix A.3.2

A.3 Thermal ignition considerations

A.3.1 Refer to temperature measurements which are performed and are documented in Appendix B.3. Only least favourable cases are considered.

A.3.2 Wiring within intrinsically safe apparatus for Group I and Group II

Ref. ExTR11.0038.00

Battery (BUD-6000)

Connection to alkaline batteries by means of a number of spring which have a diameter of 0.6mm. The maximum permissible current according to table 3 of IEC 60079-11 for temperature class T4 at an ambient of 40 °C for a wire with a diameter of 0.5mm is 7.7 A and therefore is acceptable for temperature class T4.

Battery (BUL-6000)

Connection to battery units by means of a number of internal spring which have a diameter of 2.5mm. The maximum permissible current according to table 3 of IEC 60079-11 for temperature class T4 at an ambient of 40 °C for a wire with a diameter of 0.5mm is 7.7 A and therefore is acceptable for temperature class T4. BUL-6000 is totally encapsulated.

Pump wire

Ref. M4-4181-61-01K Pump RP-12. Information reviewed and recognized. Wire type is UL style 1571 AWG28, max length 48mm.

Buzzer wire

Ref. E4-6991-5008-70-01K. Information reviewed and recognized. Wire type is UL1571 AWG32, max length 45mm, two wires in parallel for the connection of the buzzer.

EUT used in general suitable wiring and connectors.

A.3.3 Tracks on printed circuit boards for Group I and Group II

Suitable PCB used. PCB info are documented in different PCB drawings, e.g. E3-6991-5372-80-01A (Main PCB). Thickness: 1.6mm. Two layers and multi layers PCB used. CTI : 100 above. Thickness copper film & VIA's : 35um. Minimum conductor width : 0.2mm. Information reviewed and recognized.

A.3.4 Intrinsically safe apparatus and component temperature for Group III

Not group III equipment

A.4 Rating of components

Series resistors are used for current and power limitation of the battery and for segregation between the various voltage areas on the main PCB and battery PCB. Several double zener diode combinations are used for voltage limitation of the internal circuits. Safety factor ($W1 / W2$) ≥ 1.5 is documented in the tables below.

Component designation	Value	Rating used (W2)	Maximum rating (W1) @ 60 °C	W1 W2	Calculation
Sensor1_circuit (Same as S_SENS2)					
RS11...RS15	1.3Ω / 1% 1W	0.630 W	1 W	1.58	$Pd = U_{bat_therm}^2 / (RS11...RS15)$ $= 4.5^2 / (1.3 \times 5) - 1\% / 5$
RS81,82,85 RS86,87	10k Ω / 0.5%, 0.33W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / RS81 = 4.5^2 / 10k - 0.5\%$
RS83,84	1k Ω / 1% 0.25 W	21 mW	0.25 W	11	$Pd = U_{bat_therm}^2 / RS83 = 4.5^2 / 1 k - 1\%$
ZD11,12	1SMB5918 Uzmax = 5.36V / 3W Tjmax = 150 °C	0.787 W	1.538 W	1.9	$Pd = P_{o_sens1}$ $R_{th(l-a)} = 33.5 \text{ °C / W}$, $R_{th(j-l)} = 25.0 \text{ °C / W}$, $R_{th(j-a)} = 58.5 \text{ °C / W}$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (150-60) / 58.5 = 1.538$
Pump circuit					
RS31...RS35	1.3Ω / 1% 1W	0.630 W	1 W	1.58	$Pd = U_{bat_therm}^2 / (RS31...RS35)$ $= 4.5^2 / (1.3 \times 5) - 1\% / 5$
RS37,38,39	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / RS37$ $= 4.5^2 / 10 k - 0.5\%$
Buzzer circuit					
RS41...RS43	4.7Ω / 1% 0.75W	0.484 W	0.75 W	1.54	$Pd = U_{bat_therm}^2 / (RS41...RS43)$ $= 4.5^2 / (4.7 \times 3) - 1\% / 3$
RS47,48,49	10k Ω / 0.5% 0.33W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / RS47$ $= 4.5^2 / 10k - 0.5\%$
ZD41,42,43, ZD44,47,48	KDZ4.7B Uzmax = 5.2V / 1W	0.363 W	0.72 W	1.9	$Pd = P_{o_buzzer}$ $W1 = 0.72W \text{ @ } 60^\circ C \text{ (see.datasheet Pd-Ta)}$
ZD45,46	KDZ11B Uzmax = 12.3V / 1W	0.363 W	0.72 W	1.9	$Pd = P_{o_buzzer}$
ZD49,50 ZD51,52	KDZ15B Uzmax = 16.5V / 1W	0.363 W	0.72 W	1.9	$Pd = P_{o_buzzer}$
Motor circuit					
RS51,52	12Ω / 1% 0.75W	0.427 W	0.75 W	1.7	$Pd = U_{bat_therm}^2 / (RS51...RS52)$ $= 4.5^2 / (12 \times 2) - 1\% / 2$
RS59	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / RS59$ $= 4.5^2 / 10 k - 0.5\%$
Main circuit					
RSA1...RSA5 RSB1...RSB5 RSC1...RSC5	2.7Ω / 1% 0.5W	0.304 W	0.5 W	1.6	$Pd = U_{bat_therm}^2 / (RSA1...RSA5)$ $= 4.5^2 / (2.7 \times 5) - 1\% / 5$
RS78,79	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / R61$ $= 4.5^2 / 10 k - 0.5\%$
ZD71,72	1N5338B Uzmax = 5.36V / 5W Tjmax = 200°C	1.137 W	3.733 W	3.2	$Pd = P_{o_main}$ $R_{th(l-a)} = 27.5 \text{ °C / W}$ (measured) and $R_{th(j-l)} = 10 \text{ °C / W}$ (manufacturers datasheet and wires of 0.1 inch) $R_{th(l-a)} + R_{th(j-l)} = R_{th(j-a)} = 37.5 \text{ °C / W}$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (200-60) / 37.5 = 3.733$
LCD circuit					

RS61	62Ω / 1% 1W	0.351 W	1 W	2.8	$Pd = (U_{nat_therm} / (R_{i_main} + RS61))^2 \times RS61$ $= 4.5 / (4.455 + 62)^2 \times 62$
RS62,65	10k Ω / 0.5% 0.33W	2.1 mW	0.33 W	>100	$Pd = U_{o_therm}^2 / RS62$ $= 4.5^2 / 10\ k - 0.5\%$
RS63,64	82Ω / 1% 0.75W	0.275 W	0.75 W	2.7	$Pd = (U_{nat_therm} / (R_{i_main} + RS63))^2 \times RS63$ $= 4.5 / (4.455 + 82)^2 \times 82$
ZD61...70	TFZ5.1B Uzmax = 5.2V / 0.5W	0.176 W	0.36 W	2.0	$Pd = P_{o_buzzer}$ W1 = 0.36W @60°C (see.datasheet Pd-Ta)
ZD57...60	TFZ18B Uzmax = 17.7V / 0.5W	0.176 W	0.36 W	2.0	$Pd = P_{o_buzzer}$
Backup battery circuit					
RS10	1k Ω / 1% 0.25W	2.5 mW	0.25 W	100	$Pd = U_{backup_therm}^2 / RS10$ $= 1.55^2 / 1k - 1\%$
D7	MMSD301 Vr = 30V, If = 200mA	5.36 V 1.7 mA	30 V 200 mA	5.5 >100	$U = U_{o_main2}$ $I = I_{o_backup}$
BUD-6000					
R1	10k Ω / 0.5% 0.33 W	2.1 mW	0.33 W	>100	$Pd = U_{bat_therm}^2 / R1$ $= 4.5^2 / 10\ k - 0.5\%$
BUL-6000					
R1,2	200Ω / 1% 0.25W	0.073 W	0.25 W	3.4	$Pd = U_{bat_therm}^2 / R1$ $= 3.8^2 / 200 - 1\%$
R3	470Ω / 1% 0.25W	0.032 W	0.25 W	7.8	$Pd = U_{bat_therm}^2 / R3$ $= 3.8^2 / 470 - 1\%$
R10	10k Ω / 0.5% 0.33 W	1.5 mW	0.25 W	>100	$Pd = U_{bat_therm}^2 / R10$ $= 3.8^2 / 10\ k - 1\%$
R11	2.2k Ω / 1% 0.25 W	0.007 W	0.25 W	35	$Pd = U_{bat_therm}^2 / R11$ $= 3.8^2 / 2.2\ k - 1\%$
D1,2,3	MBRD1045 Vr = 45V, If = 10A	3.8 V	30 V	7.8	$U = U_{bat_therm}$

During battery charging or use with charging. (non-hazardous area only)

Component designation	Value	Rating used (W2)	Maximum rating (W1) @ 60 °C	W1 W2	Calculation
BUL-6000					
R1,2	200Ω / 1% 0.25W	0.071 W	0.25 W	3.5	$Pd = (U_{i_charge} / (R1 + R28_{BC-6000}))^2 \times R1$ $= (17.8 / (200 + 750))^2 \times 200$
R3	470Ω / 1% 0.25W	0.074W	0.25 W	3.3	$Pd = (U_{i_charge} / (R3 + R1 + R28_{BC-6000}))^2 \times R3$ $= (17.8 / (470 + 200 + 750))^2 \times 470$
R10	10k Ω / 1% 0.25 W	1.8 mW	0.25 W	>100	$Pd = U_{bat_charge}^2 / R10$ $= 4.2^2 / 10\ k - 1\%$
R11	2.2k Ω / 1% 0.25 W	0.146 W	0.25 W	1.7	$Pd = U_{i_charge}^2 / R11$ $= 17.8^2 / 2.2\ k - 1\%$
D1,2,3	MBRD1045 Vr = 45V, If = 10A R _{TH-JC} = 2.43 °C/W T _{rise} = 24.6 °C VF@10A = 0.57 V, Tjmax = 175 °C.	17.8 V 2.72 A 1.56 W	30 V 10 A 45 W	1.7 3.6 28	$U = Um$ $I = Im$ $Pd = Vf \times Im = 0.57\ V \times 2.72\ A = 1.56\ W$ $P_{max-diode@65^\circ C} = (T_{jmax} - Ta - T_{diode-rise}) / R_{TH-JC} = (175 - 40 - 24.6) / 2.43 = 45\ W$
BC-6000					
R1...3	120 Ω / 1%	0.034W	0.75 W	22	$Pd = V_{gs_threshold}^2 / R1 = 2.0^2 / 120 - 1\%$

	0.75 W				
ZD1...3	1SMB5918 $U_{zmax} = 15.8V / 3W$	0.266 W	1.538 W	5.7	$P_d = I_{zd} \times U_{zmax}$, $I_{zd} = V_{gs_threshold} / R_1$ $P_d = 2.0 / 120-1\% \times 15.8$
Q1...3*	TPCA8107-H $V_{gs(th)} = 2.0V$ $R_{onmax} = 37m\Omega$ $P_d = 30W$ $T_{jmax} = 150^\circ C$	2.74 W 97A ² S	1.152 W 1.005A ² S	22 96	$P_d = (\ln \times 1.7)^2 \times R_{onmax} = (1.6 \times 1.7)^2 \times 37m$ $R_{th(j-a)} = 78.1 K/W$ $W1 = (T_{jmax} - T_a) / R_{th(j-a)} = (150-60) / 78.1 = 1.152W$ $I_t^2 = ((T_{jmax} - T_a) / R_{th_transient}) / R_{onmax} \times t$ $= ((150-60) / 25) / 37m \times 1$ (see datasheet , fig $R_{th} - T_w$)
R28,29	750 Ω / 1% 0.75 W	0.427W	0.75 W	1.7	$P_d = U_{i_charge}^2 / R_{28}$ $= 17.8^2 / 750 -1\%$

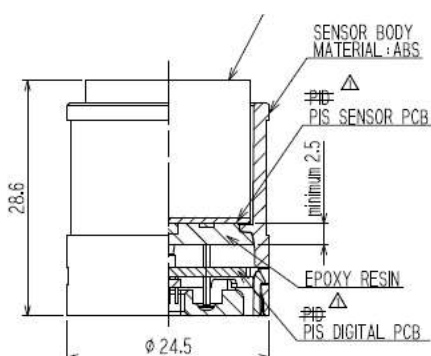
A.5 Encapsulation

A.5.1 The BUL-6000 contains two parallel battery cells, Maxell model INR18650PB (Lithium-ion battery), size : $\phi 18 \times 65$ mm (cylindrical shape), rating 3.8V & 1450mAh, max open circuit voltage according to manufacturer = 4.25 V.

This lithium-ion battery has manganese acid on positive electrode side, which prevent the battery from generating heat. This lithium-ion battery does not have a built in "Protection Component (PTC)". The maximum open-circuit voltage for the Li-ion battery is determined according to IEC 60079-11, clause 10.4:

Determination of parameters of loosely specified components. Testing 10 samples of batteries resulted in value of 4.2V which then be used for spark energy analysis. The nominal battery voltage is used for thermal analysis and rating of components. Hence $U_{BATTherm} = 3.8$ V and $U_{BATTspark\ energy} = 4,2$ V. However assessments of EUT used with BUD-6000 (max 4.95V) are covering assessments of EUT used with BUL-6000.

The two batteries are placed in a plastic (PC) case. The case is filled with epoxy resin, or silicon-compound, Epoxy resin DP-270 black (3M). Encapsulation prevent ingress of external gases. The compound thickness is significant greater than the required 0.5 mm solid insulation.



A.5.2 The smart sensor type PIS has also partly encapsulation in term of requirements for safety distances. Epoxy resin is used as shown in the dedicated drawing. The encapsulation is checked for compliance with applicable requirements e.g. minimum thickness of 1mm.

A.6 Fuses.

A.6 Fuses and Charging mode

Charging of the batteries is only permitted outside the hazardous area.

Recognized fuse used. Littelfuse 216 series (5 x 20mm) Axial lead, fast acting. UL recognized E10480. In accordance to IEC60127-2, VDE approval 4001383.

The fuse used in battery charger circuit has a rating of $I_N = 1.6 \text{ A}$; $I_{Break} = 1500 \text{ A}$; $U_m = 250 \text{ V}$. The charge input is protected against U_m by the fuse and a shunt voltage limiting circuit with safety components R1, R2, R3, FETs Q1, Q2, Q3 and zener diodes ZD1, ZD2, ZD3. This circuit is designed to have similar function as a crowbar circuit which handles overvoltage fault condition.

The maximum gate threshold voltage of the FET is -2.0 V which means that at this voltage the gate will be triggered and the FET will be switched on. In overvoltage fault condition the $1.7 \times 1.6 \text{ A}$ will be dissipated for a short period to earth reference (BAT – pol). The fuse will break fault current in short time. Any failure will shut down the charging mode and thereof the charging voltage.

By the shunt voltage limiting circuit, the maximum voltage is limited to be $V_{zd} + V_{gs(th)} = 15.8 \text{ V} + 2.0 \text{ V} = 17.8 \text{ V}$ but under charging mode the Lithium-ion battery pack will pull down the charger voltage to 4.2 V . Refer to Appendix C for charging test of batteries. Infallible connections to batteries are provided.

The lithium-ion cells are parallel connected by which one single cell at a time is considered for failure. Total collapse of the charger circuit and failure of both cells at the same time are considered to be unlikely.

Failure of short-circuited R1 $\rightarrow V_{gs(th)} < 2.0 \text{ V} \rightarrow$ this leads to normal charging.

Failure of short-circuited ZD1 $\rightarrow V_{gs(th)} > 2.0 \text{ V} \rightarrow$ Q1 is triggered leading high current for a short time by which the fuse will break the fault current. Fuse breaks the fault current also when Q1 is short-circuited.

Diodes D1-D3 and safety resistors in line are preventing discharging back to charger circuit or other circuits as well.

Since fault conditions of charging circuit cause shutdown of charger voltage and current break or is leading fault current to earth reference. Internal circuits beyond the charger circuit (ref. Diagram For I. S. Keep For GX-6000 E3-6991-5361-10-01K) will not be impacted.

BUL-6000 battery pack is encapsulated and therefore is exempted for spark ignition requirements. Thermal aspects have been documented by assessments of short-circuited cell.

Due to the assessed situations as mentioned above no safety distances are found necessary for safety components of the charger circuit. Positive terminal of DC input to other circuits is across the recognized fuse which is an appropriate certified device. Wiring is documented in Appendix A.3.2. Internal circuits beyond this charging level (ref. Diagram For I. S. Keep For FI-8000 E3-6991-5361-10-01K) will have 4.2 V as reference voltage for assessments.

APPENDIX B: Tests

B.1 Tests of applicable standards

Refer to associated IEC60079-0 test report for documented drop test & surface resistance test.

See General product information. The design used components from similar models which are separately tested and approved. Reference to associated ExTR test reports is indicated in the documented testing. The testing of these specific components is reviewed and recognized. See throughout Appendix B to F of this report.

B.2 Spark ignition test

Higher safety factors achieved and are documented. No spark ignition test is necessary. However see throughout Appendix A to F for evaluation of internal electronics and testing of specific components e.g. batteries and piezoelectric device.

See Appendix A.2.4 to A.2.6. For internal circuits the assessed values of combination of capacitance & inductance are below 50% of the max allowed values. Ref IEC60079-11 cl. 10.1.5.2 b) 2).

See Appendix A.2.6. Internal pump is not assessed as infallible windings. However max inductance and minimum resistance is taken into account in assessments of the most severe ignition condition (situation where the winding is disconnected or short-circuited).

See Appendix A.2.6. Assessments of ignition energy were performed for buzzer (piezoelectric device).

B.3 Temperature measurements

Only least favourable cases are tested taken into account max ambient and other conditions as well. The following listed temperature measurements below are considered as worst situations where highest temperatures of components were achieved. Some specific components are in addition tested for thermal ignition capabilities. Other components should have lower temperatures in fault conditions. See also Appendix A.3

B.3.1 Measured internal temperatures of EUT (For information only. No service temperature is required. See 5.2 of associated IEC60079-0 test report).

Measured Location	ΔT °C	T_{corr} °C ¹⁾	Remark
GX-6000. Main unit. Normal use	8	58	$T_{a\ max} = 50^{\circ}\text{C}$
GX-6000. Main unit. Charging	10	50	$T_{a\ max} = 40^{\circ}\text{C}$
GX-6000. Main unit. Charging & use	14	54	$T_{a\ max} = 40^{\circ}\text{C}$
BUL-6000. Charging	18	58	$T_{a\ max} = 40^{\circ}\text{C}$
BUL-6000. Charging & use	18	58	$T_{a\ max} = 40^{\circ}\text{C}$
Supplementary information: ¹⁾ Max temperature is corrected for $T_{a\ max}$			

B.3.2 Temperature for small components for Group I and Group II

Only highest achieved temperature for small components is listed.

Maximum power in this circuit is $P_{o\ main} = 1.137\text{W}$. According to Table 3a&b of IEC 60079-0 a maximum of 1.2W is allowed at an ambient of 60°C for small components ($\geq 20\text{mm}^2$), wiring and PCB tracks (including the FPC between main PCB to LCD). The temperature test result of the small components of each circuit is as follows.

Sensor1 circuit (representative results for both S-SEN1 & S_SEN2 circuits)

The surface temperature of the small components <20mm² measured while dissipating 0.787W.

This resulted in a maximum temperature rise is 185°C (on ESS SENSOR PCB – D1).

At ambient temperature of 60°C the maximum surface temperature would hence be 245°C which is below the 275°C limit.

1. D1 on ESS SENSOR PCB : Trise = 185°C

2. L1 on ESS SENSOR PCB : Trise = 147°C

3. ZD13 on MAIN PCB : Trise = 122°C

Pump circuit

The surface temperature of the small components <20mm² measured while dissipating 0.787W.

This resulted in a maximum temperature rise is 88°C (MAIN_PCB – Q3). At ambient temperature of 60°C the maximum surface temperature would hence be 148°C which is below the 275°C limit.

Motor circuit

The surface temperature of the small components <20mm² measured while dissipating 0.214W.

This resulted in a maximum temperature rise is 17°C (MAIN_PCB – ZD5). At ambient temperature of 60°C the maximum surface temperature would hence be 77°C which is below the 275°C limit.

Buzzer circuit

The surface temperature of the small components <20mm² measured while dissipating 0.363W.

This resulted in a maximum temperature rise is 49°C (MAIN_PCB – D4).

At ambient temperature of 60°C the maximum surface temperature would hence be 110°C which is below the 275°C limit.

1. D4 on MAIN PCB : Trise = 49°C

2. IC41 on MAIN PCB : Trise = 48°C

Main circuit

The surface temperature of the small components <20mm² measured while dissipating 1.137W.

This resulted in a maximum temperature rise is 204°C (SENSOR_PCB – NF3). At ambient temperature of 60°C the maximum surface temperature would hence be 264°C which is below the 275°C limit.

1. NF1 on MAIN PCB : Trise = 204°C

2. PT1 on MAIN PCB : Trise = 178°C

3. D9 on MAIN PCB : Trise = 156°C

4. Q16 on MAIN PCB : Trise = 127°C

5. Q3 on SENSOR PCB : Trise = 127°C

LCD circuit

The surface temperature of the small components <20mm² measured while dissipating 0.176W.

This resulted in a maximum temperature rise is 33°C (MAIN_PCB – NF4). At ambient temperature of 60°C the maximum surface temperature would hence be 93°C which is below the 275°C limit.

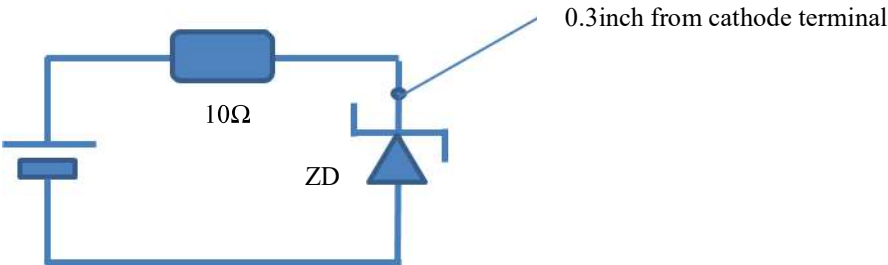
B.3.3 Temperature measurement of shunt zeners

For all shunt zeners used in internal electronics, only worst case of testing of shunt zeners is considered taken into account layouts and other influences with regards to thermal aspects. Max measured values of the worst case is considered to be representative result.

Worst case of shunt zeners for EUT is ZD71 type 1N5338B which is used in Main circuit with max dissipated power 1138mW (from BUD-6000).

The same zener type 1N5338B was used in another model GX-8000 which was tested and covered by test report NL/KEM/ExTR10.0035/00. This testing was reviewed and recognized as representative for the worst case of shunt zeners of this investigation.

Test procedure	Standard reference	Results	Test report ref.
Determination of R_{th} of ZD1	IEC 60079-11 Clause 10.2	$\Delta T = 39.4K$ with $P = 1.14\text{ W} \Rightarrow R_{th(j-a)} = 34.6K/W$. Measuring point is 0.3 inch from cathode terminal.	NL/KEM/ExTR10.0 035/00 2009-09-25



$U_{zmax} = 5.36V / 5W$, manufacturer ON specification:
 $R_{th(j-l)} = 16\text{ K/W}$ with 0,3 inch lead length.
 $T_{jmax} = 200^{\circ}C$

$T_a = 50^{\circ}C$
 $dT = 10K$
 $T_{amax} = 60^{\circ}C$
 $T_{jmax} = 200^{\circ}C$
 $P_d = 5W$

$P_{o_max} = 1.14W$
 $R_{th(j-l)} = 16.0K/W$. See Fig. 1
 $R_{th(j-l)} = 34.6K/W$. See result sheet
 $R_{th(j-a)} = 50.6K/W$
Max rating $2.767W$
2/3 rating $1.84W$

$T_j = 40.8 + 50 + 1.2 \cdot 16 = 110^{\circ}C$

Measuring point 0.3 in from cathode terminal.

MAXIMUM RATINGS			
Rating	Symbol	Value	Unit
Max. Steady State Power Dissipation (1) $T_L = 75^{\circ}C$, Lead Length = 3/8 in Derate above $75^{\circ}C$	P_D	5 40	W mW/ $^{\circ}C$
Operating and Storage Temperature Range	T_J, T_{stg}	-65 to +200	$^{\circ}C$

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

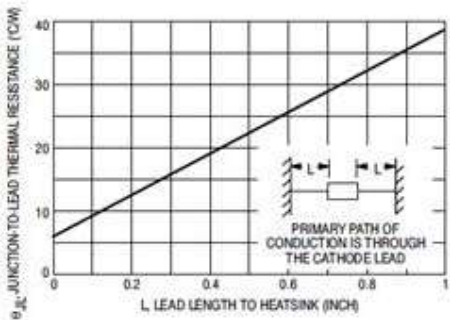


Figure 1. Typical Thermal Resistance

Measured lead temperatures of zener diode "1N5338B" (0.5W to 1.2W). Results from test report no. NL/KEM/ExTR10.0035/00

	V _Z (V)	V _R (V)	I _Z (A)	P _{Zd} (W)	T _a (degC)	dT (K)	R _{th} (1-a)
No. 1	0	0	0	0	25, 5	0, 0	0
	5, 094	0, 973	0, 0973	0, 496	40, 9	15, 4	31, 07
	5, 104	1, 16	0, 116	0, 595	45, 7	20, 2	33, 97
	5, 113	1, 356	0, 1356	0, 693	49, 3	23, 8	34, 33
	5, 121	1, 554	0, 1554	0, 796	52, 6	27, 1	34, 05
	5, 130	1, 756	0, 1756	0, 901	56, 6	31, 1	34, 52
	5, 137	1, 946	0, 1946	1, 000	59, 3	33, 8	33, 81
	5, 145	2, 133	0, 2133	1, 097	62, 4	36, 9	33, 62
	5, 148	2, 212	0, 2212	1, 139	63, 7	38, 2	33, 55
	5, 152	2, 328	0, 2328	1, 199	65, 4	39, 9	33, 27

	V _Z (V)	V _R (V)	I _Z (A)	P _{Zd} (W)	T _a (degC)	dT (K)	R _{th} (1-a)
No. 2	0	0	0	0	27, 0	0, 0	0
	5, 032	0, 99	0, 099	0, 498	42, 2	15, 2	30, 51
	5, 041	1, 189	0, 1189	0, 599	46, 8	19, 8	33, 03
	5, 053	1, 389	0, 1389	0, 702	51, 2	24, 2	34, 48
	5, 060	1, 572	0, 1572	0, 795	54, 4	27, 4	34, 45
	5, 069	1, 778	0, 1778	0, 901	58, 0	31, 0	34, 40
	5, 076	1, 967	0, 1967	0, 998	61, 1	34, 1	34, 15
	5, 082	2, 155	0, 2155	1, 095	64, 0	37, 0	33, 78
	5, 085	2, 238	0, 2238	1, 138	65, 5	38, 5	33, 83
	5, 090	2, 358	0, 2358	1, 200	67, 8	40, 8	33, 99

Max 34, 52

B.3.4 Other temperature measurements and thermal ignition test of specific components

Part / Location	V (V)	I (mA)	P (mW)	ΔT (°C)	T (°C) ¹⁾	Limit	Remark
R12-30Ω size 1005 (ESS sensor PCB)	5.06	156	789	72.8	118.5	275	P
R1-10Ω size 1005 (DES digital PCB)	3.14	257	807	105.9	155.9	275	P
R3-3Ω size 3216 (Sensor PCB)	2.44	474	1157	62.3	112.3	275	P
Supplementary information:							
1) The measured temperature was corrected for max rated ambient (50°C). Only a few cases which may represent the least favourable situations are tested. Test performed on 2015-03-13 in ambient of 22.9°C							

See Appendix B.6 for test of specific components

B.4 Infallible distance & connection measurements

B.4.1 Infallible distances: CR & CL → creepage & clearance. All values are in mm.

Maximum voltage of circuit on the following is below 10V and therefore the following segregation distances shall be applied according to table 5 of IEC 60079-11:

Location *)	CL	CR	Min. ⌘)	CTI
Sensor circuits. Voltage area < 10V.				
RS11...RS15 Sens1 circuit to battery	3.2	3.2	1.5	>100
RS21...RS25 Sens2 circuit to battery	3.2	3.2	1.5	>100
RS81...RS87 Sens1 to other circuits	1.6	1.6	1.5	>100
RS91...RS97 Sens2 to other circuits	1.6	1.6	1.5	>100
Pump circuit. Voltage area < 10V.				
RS31...RS35 (to battery)	3.2	3.2	1.5	>100
RS37...RS39 (to other circuits)	1.6	1.6	1.5	>100
Solid insulation (pump body and wiring) >0.5 ¹⁾	—	—	0.5	>100
Motor circuit. Voltage area < 10V.				
RS51, RS52 (to battery)	3.2	3.2	1.5	>100
RS59 (to other circuits)	1.6	1.6	1.5	>100
Buzzer circuit. Voltage area < 10V.				
R41...R43 (to battery)	3.2	3.2	1.5	>100
RS47...RS49 (to other circuits)	1.6	1.6	1.5	>100
Solid insulation (buzzer body and wiring) >0.5 ¹⁾	—	—	0.5	>100
Buzzer. ²⁾	—	—	—	—
Main circuit. Voltage area < 10V.				
RSA1...RSA5	1.6	1.6	1.5	>100
RSB1...RSB5	1.6	1.6	1.5	>100
RSC1...RSC5	1.6	1.6	1.5	>100
RS61...RS65	1.6	1.6	1.5	>100
Backup circuit. Voltage area < 10V.				
D7	2.4	2.4	1.5	>100
RS10	1.6	1.6	1.5	>100
BUD-6000. Voltage area < 10V.				
R1	1.6	1.6	1.5	>100
Encapsulated BUL-6000. V_{bat} = 4.2V considered.				
D1-D3 measured across components	1.0	1.0	0.5	>100
R1 to adjacent tracks	1.3	1.3	0.5	>100
R2 to adjacent tracks	1.3	1.3	0.5	>100
R3 measured across components	2.3	2.3	0.5	>100
R10 measured across components	2.3	2.3	0.5	>100
R11 to adjacent tracks	0.5	0.5	0.5	>100
Voltage areas of Um				
Charger circuit	³⁾	³⁾	³⁾	>175

Supplementary information:

*) Distances across component and to adjacent tracks are checked.

⌘) Wiring & body material insulation.

¹⁾ All internal wiring aspects such as arrangement or solid insulation are checked and recognized. See also Appendix A.3.2.

²⁾ The buzzer and it's wiring is assessed and is documented in Appendix A.3.2 and A.2.6.

³⁾ Assessment of charger circuit is documented in Appendix A.6. No safety distances are required for R1 to R3. Positive terminal of DC input to other circuits is across the recognized fuse which is an appropriate certified device. Wiring is documented in Appendix A.3.2.

B.4.2 Infallible connections

Connection	Method *)	Comment
Sensor circuits		
ZD11, ZD12 to IC11	2 mm track	35 µm
ZD21, ZD22 to IC12	2 mm track	35 µm
ZD11, ZD12, ZD21, ZD22 to 0V	2 mm track	35 µm
Buzzer circuit		
ZD45 – ZD46 to safety resistors in line	2 mm track	35 µm
ZD45 – ZD46 to 0V	2 mm track	35 µm
ZD41 – ZD44 & ZD47 – ZD48 to safety resistors in line	2 mm track	35 µm
ZD41 – ZD44 & ZD47 – ZD48 to 0V	2 mm track	35 µm
ZD49 – ZD52 to CN4 (Main PCB)	2 mm track	35 µm
ZD49 – ZD52 to 0V (Main PCB)	2 mm track.	35 µm
Main circuit		
ZD71 – ZD72 to IC71	2 mm track & single 2 mm circumference via	35 µm
ZD71 – ZD72 to 0V	2 mm track & single 2 mm circumference via	35 µm
LCD circuit		
ZD57 – ZD60 to CN6 (LCD) & 0V	2 mm track.	35 µm
ZD61 – ZD70 to safety resistors in line	2 mm track.	35 µm
ZD61 – ZD70 to 0V	2 mm track.	35 µm
BC-6000		
R1, R2, R3 to F1 and source terminal of Q1, Q2, Q3	2 mm track	35 µm
R1, R2, R3 to ZD1, ZD2, ZD3	2 mm track	35 µm
R1, R2, R3 to gate terminal of Q1, Q2, Q3	1mm track ¹⁾	35 µm
ZD1,ZD2,ZD3 and Q1,Q2,Q3 to 0V	2 mm track	35 µm
BUL-6000		
D1-D3 & R1, R2, R11 to B+	2 mm track ²⁾	35 µm
R10 & CN1-1 to B+	2 mm track	35 µm
B- to 0V	2 mm track	35 µm
Wiring to buzzer & pump	³⁾	-
Supplementary information: *) Required minimum width of track/connection is checked. Larger track width is documented in Layout-documents. Refer to List of Descriptive documents ¹⁾ Use of triplicate controllable semiconductors. Open-circuiting is considered as one countable fault. Situations of two countable faults at a time is assessed. ²⁾ Min 2mm track/connections between those components are not required but are used. The connections help to reduce temperature on components. ³⁾ Wiring is documented in Appendix A.3.2		

B.5 Dielectric strength test

Suitable (UL approved) insulated wiring used. No dielectric strength test is found necessary.

B.6 Test of specific components.

- Appendix C: Testing of batteries
- Appendix D: Testing of lamp part (T- 3/4 BPA in DES sensor)
- Appendix E: Testing of combustible sensor NC6264A
- Appendix F: Assessment of the smart sensor type PIS

B.6.1 Test of batteries

Battery testing is documented by Test reports NL/KEM/ExTR10.0035/00 & NL/DEK/ExTR13.0075/00. See Appendix C.

B.6.2 Test of Lamp part type OL-82708PA

Testing of Lamp part type OL-82708PA which is used in DES sensor, is documented by Test report NL/DEK/ExTR12.0033/00. See Appendix D.

B.6.3 Test of sensors

Listed below are different types/models of sensors which are included in this investigation. They are sorted into following detection principles (See Appendix A.1 for details). Electrochemical, Galvanic cell, Catalytic combustion, PID, Infrared ray (IR). The sensor types in a) and b) are standard gas sensors (See Appendix A.1 for details).

- a) The Oxygen sensor used "Galvanic cell" detection principle, ref. M4-4080-82-07K. The toxic gas sensors used "Electrochemical" detection principle, ref. M4-4084-92-03K & M4-4084-30-08K. These type of sensors consist of no energy storing/generating components/parts in the sensors. Only internal wiring has been considered and is included in temperature assessment/test in Appendix A.3 & B.3. Based on the design and dedicated application these types of sensor need no further assessment.
- b) The combustible gas sensor NC6264A used "Catalytic combustion" detection principle. This sensor type consists only internal coil but no other components. The NC6264A sensor is a separately Ex certified device and the testing is documented in NL/KEM//ExTR07.0057. Applicable requirements are considered for this sensor. Associated test reports were reviewed and recognized for compliance of this investigation. Results of testing are copied to Appendix E.
- c) The smart sensor type ESS consists of a small electronic PCB and a toxic gas sensor. The toxic gas sensor is considered in a), "Electrochemical" detection principle is used. The ESS sensor circuit/electronics consists no safety components and therefore is treated as part of the Sensor circuit. This circuit is included in temperature assessment/test in Appendix A.3 & B.3. Refer to dedicated files in List of descriptive documents.
- d) The smart sensor type DES consist of small DES digital PCB & DES sensor PCB including the T-3/4 BPA Lamp, "Infrared ray (IR)" detection principle is used. Refer to files numbered 28 to 31 in List of descriptive documents. Both circuits of DES digital PCB & DES sensor PCB used no safety components and therefore are treated as part of the main circuit. These circuits are included in temperature assessment/test in Appendix A.3 & B.3. The T- 3/4 BPA Lamp is a separately Ex certified device which testing is documented in ExTR12.0033. Associated test reports were reviewed and recognized for compliance of this investigation. The testing is extracted and copied into this report, see Appendix D of this report.
- e) The smart sensor type OSS consists of a small electronic PCB and Oxygen sensor. The Oxygen sensor is considered in a), "Electrochemical" detection principle is used. The OSS sensor circuit/electronics consists no safety components and therefore is treated as part of the Sensor circuit. This circuit is included in temperature assessment/test in Appendix A.3 & B.3. Refer to dedicated files in List of descriptive documents.
- f) The smart sensor type PIS consist of two small PCB, PIS digital PCB and PIS sensor PCB, and the separately certified Mini PID sensor. The Mini PID sensor is covered by certificate 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00. Additional assessment for intrinsic safe connection is documented in Appendix F.

Appendix C

Appendix C.1 Separately tested batteries

Results from test report no. NL/KEM/ExTR10.0035/00

B.3 Determination of parameters of loosely specified components

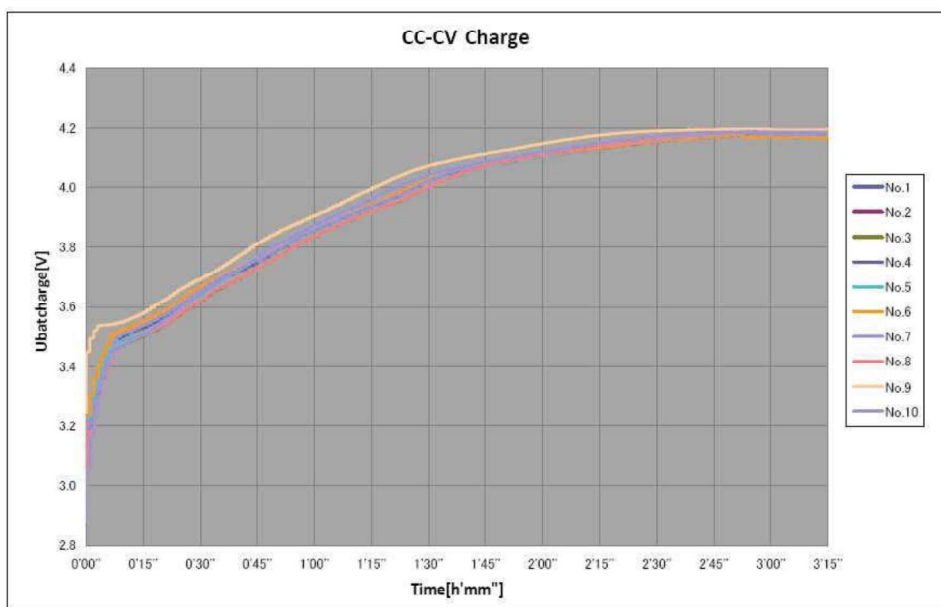
Test procedure	Standard reference	Results	Test report ref. (date of test)
Determination of maximum battery voltage during charging	IEC 60079-11 Clause 3.6.6	A voltage measurement has been done over the two batteries inside the GX-8000 on 10 different cells and combination while charging the batteries. The maximum voltage was: 4.25 V	2009-11-02, 2009-06-3,4,5

Measurement result of Ubatchcharge

Charge current (CC): 1.5A
Charge voltage (CV): 4.2V
Charger IC: TC4002-4.2(LT)

2009/11/2
RIKEN KEIKI Co., Ltd.

	Umax
No.1	4.187V
No.2	4.180V
No.3	4.187V
No.4	4.181V
No.5	4.188V
No.6	4.198V
No.7	4.188V
No.8	4.180V
No.9	4.198V
No.10	4.189V
MAX	4.198V
AVG	4.188V
sigma	0.0065V
AVG+3σ	4.204V



The maximum voltage during battery charge with 1,5 A, is verified in section B.5.

B.3 Battery test report

Test procedure	Standard reference	Results	Test report ref. (date of test)
Determination of maximum battery temperature when shorted and leakage	IEC 60079-11 Clause 10.5 and 23.8	On 3 types of batteries:, Primary battery Alkaline LR6 manufactured by Toshiba, secondary Lithium-ion battery type INR18650PB manufactured by Maxell and primary battery Lithium manganese dioxide, type CR1220.	2008-04-22, 2009-06-3,4,5, 2010-04-19
Determination of maximum battery temperature when shorted and leakage	IEC 60079-11 Clause 10.5	Secondary Lithium-ion battery type US18650VTC3 manufactured by Sony and type INR18650-15M manufactured by SDI. No leakage after testing.	NUDEK/ExTR 13.0075/00

B.2.1 Test conducted

Equipment Tested:	Primary Battery cell Alkaline type LR6 manufactured by Toshiba
Date of Test (yyyy/mm/dd):	2008-04-22 (refer to report NL/KEM/ExTR08.0019/00)
Clause and Standards:	Clause 10.5, IEC 60079-11

B.5.1 Test procedures*10.5.1 General:*

- [X] Non rechargeable cells shall be checked if they are newly supplied cells from the cell manufacturer and fully charged (e.g. with a voltage test for a short period with a certain load)

10.5.2 Electrolyte leakage test for cells and batteries:

Ten test samples are subjected to the most onerous of the following: [X]

- short circuit until discharged;
 [NA] application of input or charging currents within the manufacturer's recommendations; [NA]
 charging a battery within the manufacturer's recommendations with one cell fully discharged or suffering from polarity reversal.

The test samples shall be placed with any case discontinuities, for example seals, (the + pole in most cases) facing downward or in the orientation specified by the manufacturer of the device, over a piece of blotting paper for a period of **at least 12 h** after the application of the above tests.

10.5.3 Spark ignition and surface temperature test of cells and batteries:

- [NA] Spark ignition assessment or testing shall be carried out at the cell or battery external terminals using a gas mixture for Gas group IIA/IIB/IIC including/excluding safety factor.
- [X] The short circuit current is determined taking the most onerous value of short-circuit current from a test of 10 samples of the cell/battery
- [X] The maximum surface temperature is determined as follows. All current-limiting devices external to the cell or battery shall be short-circuited for the test. Any external sheath (of paper or metal, etc.) not forming part of the actual cell enclosure shall be removed for the test. The temperature shall be determined on the outer enclosure of each cell or battery and the maximum figure taken.

10.5.4 Battery container pressure test:

- [NA] Five samples of the battery container shall be subjected to a pressure test to determine the venting pressure. Pressure shall be applied to the inside of the container. The pressure is to be gradually increased until venting occurs. The maximum venting pressure shall be recorded and shall not exceed 30 kPa. The maximum recorded venting pressure shall be applied to a sample of the battery container for a period of at least 60 s.

B.1.2 Test conditions*10.5.1 General:*

When a short-circuit is required for test purposes the resistance of the short-circuit link, excluding connections to it, either shall not exceed 3 mΩ or have a voltage drop across it not exceeding 200 mV or 15 % of the cell e.m.f. The short-circuit shall be applied as close to the cell or battery terminals as practicable. This resistance should be measured before and after a short circuit test and recorded in the lab report.

10.5.2 Electrolyte leakage test for cells and batteries:

The electrolyte leakage test shall be conducted at the most onerous temperature for this type of cell which might require a number of additional test (and hence additional samples) before the real test can be started. For this cell the most onerous temperature is determined at 55 °C.

10.5.3 Spark ignition and surface temperature test of cells and batteries:

Since the temperature behavior of batteries is considered to be non-linear the temperature test is conducted at the highest ambient temperature (see IEC 60079-11 cl. 10.2). For this apparatus the maximum ambient temperature is 55 °C.

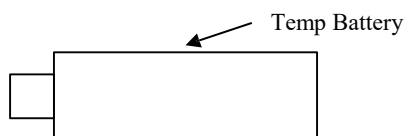
10.5.4 Battery container pressure test:

Not applicable

B.1.3 Results

The wire resistance of the shorted batteries was 2 mΩ before the test and remained 2 mΩ after test.

Cell number	10.5.2 Electrolyte leakage	10.5.3 a) Short circuit current	10.5.3 b) Temperature test			
			Temp Battery	Toven	Tamb	deltaT
1	Y	8,2 A	114,8	54,1		61,7
2	N	7,5 A	120	55,4		65,8
3	N	8,8 A	108,1	58,8		54,7
4	Y	8,5 A	115,9	55,7		60,5
5	N	8,4 A	111,5	55,1		57,3
6	N	8,2 A	112	58,2		54,1
7	N	7,8 A	114,1	58,3		57,1
8	N	9 A	116,3	58,1		59,2
9	N	8,5 A	116,3	55,3		62,5
10	N	8 A	120,9	60,5		62,3



- [] no electrolyte leakage
- [] no ignition during spark ignition test
- [] no drop in pressure during battery container test
- [] no visible damage or permanent deformation after battery container test

B.5 Battery pack test report (continued)

Equipment Tested:	Secondary Lithium-ion battery cell INR18650PB manufactured by Maxell
Date of Test (yyyy/mm/dd):	2009-06-3,4,5
Clause and Standards:	Clause 10.5, IEC 60079-11

IEC 60079-11 – Clause 10.5 Test for Lithium ion cells (chargeable)

Project no.: 212431400**Product:** Li-ion pack test**technician:** R.Rouwenhorst**Test conducted on:** June 3, 4, 5, 2009**no.:****Manufacturer:** EMC Systems Corp.**Type designation:** Lab**Sample no.:** 107452**Test report page****Cell types***60079-0 : 2007, clause 23.3 Cell types:*

- [x] Only cell types referred to in published IEC cell standards having known characteristics shall be used. Tested Lithium-ion cell types not in table 11 **secondary cells**. Manufacturing battery cell type **with negative electrode material is Lithium, nominal voltage is 3,7 V, maximum open-circuit voltage is 4,17 V (measured), by manufacturer 4,25 V.**

60079-11:2006 – Clause 10.4 Determination of parameters of loosely specified components

- [x] Tests are in accordance with the appropriate international standard, being: IEC60079-11, sub 7.1 and 10.4 Ten unused samples of the component shall be obtained from any source or sources of supply and their relevant parameters shall be measured. Tests shall normally be carried out at, or referred to, the specified maximum ambient temperature, for example 40 °C, but where necessary, temperature-sensitive components, for example nickel cadmium cells/batteries, shall be tested at lower temperatures to obtain their most onerous conditions.

The most onerous values for the parameters, not necessarily taken from the same sample, obtained from the tests on the 10 samples shall be taken as representative of the component.

Lithium-ion battery tested on 10 samples during charge cycles: **nominal voltage is 3,7V (just after fully charged), maximum open-circuit voltage is 4,17 V, maximum current is not measured.**

Test procedure:*10.5.1 General:*

- [x] Rechargeable cells or batteries shall be fully charged with a current of **0,870 A** for a period of at least **100 min** and then discharged at least twice with a current of **1,45 A** before any tests are carried out. On the second discharge, or the subsequent one as necessary, the capacity of the cell or battery shall be confirmed as being within its manufacturer's specification to ensure that tests can be carried out on a fully charged cell or battery which is within its manufacturer's specification.
- Discharge duration = Capacity / Discharge Current = **1450 mAh / 1450 mA = 60 min.**
 Charge duration = Capacity / Charge Current = **1450 mAh / 0,870 mA = 100 min.**

10.5.2 Electrolyte leakage test for cells and batteries:

Ten test samples are subjected to the most onerous of the following:

- [x] short circuit until discharged; at an ambient temperature from 50 + 5 degrees, without the external battery protection components, this according to EN 60079-11, clause 10.5.3 b). Prepare cells with caution:

- Prepare single cells, each with a switch for shortage ($< 3\text{m}\Omega$ resistance end-to-end)
- Prepare, mount thermocouples on each cell. Put cells each in blotting paper.
- Pre heat prepared cells in oven on ambient temperature + 5 degrees.
- After all cells are at ambient temperature, put all prepared cells outside the building.
- Connect thermocouples to temperature storage equipment, and start measurement.
- Close the switch(es) and leave the cells immediately.
- Wait until temperature drops around room temperature.
- Store all temperature results and check cell leakage on blotting paper.

The test samples shall be placed with any case discontinuities, for example seals, (the + pole in most cases) facing downward or in the orientation specified by the manufacturer of the device, over a piece of blotting paper for a period of **at least 12 h** after the application of the above tests.

10.5.3 Spark ignition and surface temperature test of cells and batteries:

- [] Spark ignition assessment or testing shall be carried out at the cell or battery external terminals using a gas mixture for Gas group IIA/IIB/IIC including/excluding safety factor.
- [] The short circuit current is determined taking the most onerous value of short-circuit current from a test of 10 samples of the cell/battery
- [] The maximum surface temperature is determined as follows. All current-limiting devices external to the cell or battery shall be short-circuited for the test. Any external sheath (of paper or metal, etc.) not forming part of the actual cell enclosure shall be removed for the test. The temperature shall be determined on the outer enclosure of each cell or battery and the maximum figure taken.

10.5.4 Battery container pressure test:

- [] Five samples of the battery container shall be subjected to a pressure test to determine the venting pressure. Pressure shall be applied to the inside of the container. The pressure is to be gradually increased until venting occurs. The maximum venting pressure shall be recorded and shall not exceed 30 kPa. The maximum recorded venting pressure shall be applied to a sample of the battery container for a period of at least 60 s.

Test equipment: see attached equipment list

Test conditions:

10.5.1 General:

When a short-circuit is required for test purposes the resistance of the short-circuit link, excluding connections to it, either shall not exceed $3\text{ m}\Omega$ or have a voltage drop across it not exceeding 200 mV or 15 % of the cell e.m.f. The short-circuit shall be applied as close to the cell or battery terminals as practicable.

This resistance should be measured before and after a short circuit test and recorded in the lab report.

10.5.2 Electrolyte leakage test for cells and batteries:

The electrolyte leakage test shall be conducted at the most onerous temperature for this type of cell which might require a number of additional test (and hence additional samples) before the real test can be started.

For this cell the most onerous temperature is determined at **55 °C**.

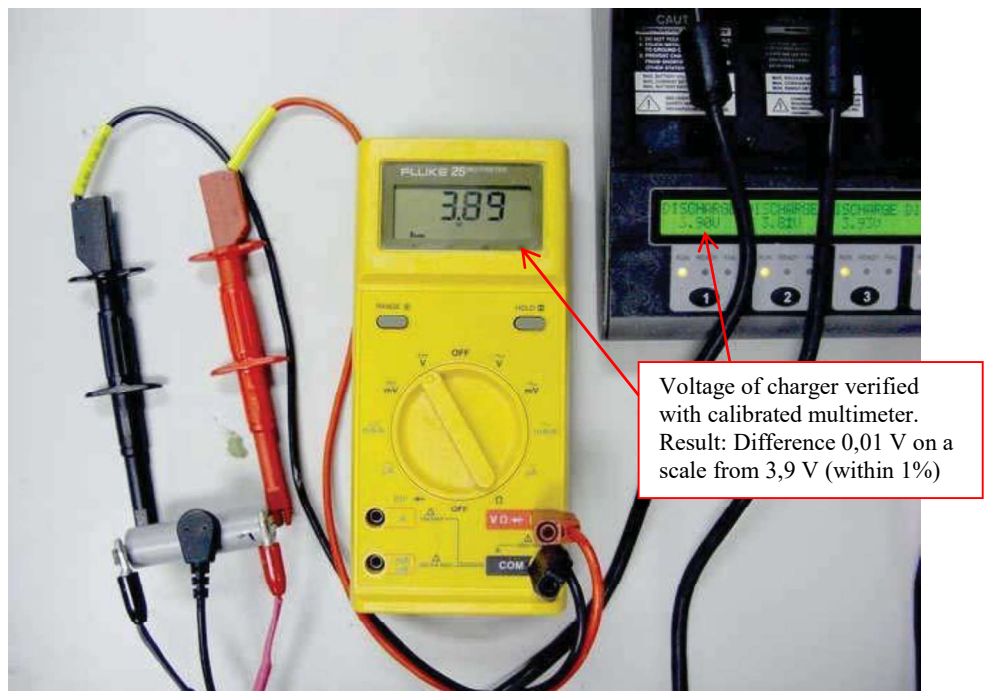
10.5.3 Spark ignition and surface temperature test of cells and batteries:

Since the temperature behaviour of batteries is considered to be non-linear the temperature test is conducted at the highest ambient temperature (see IEC 60079-11 cl. 10.2).

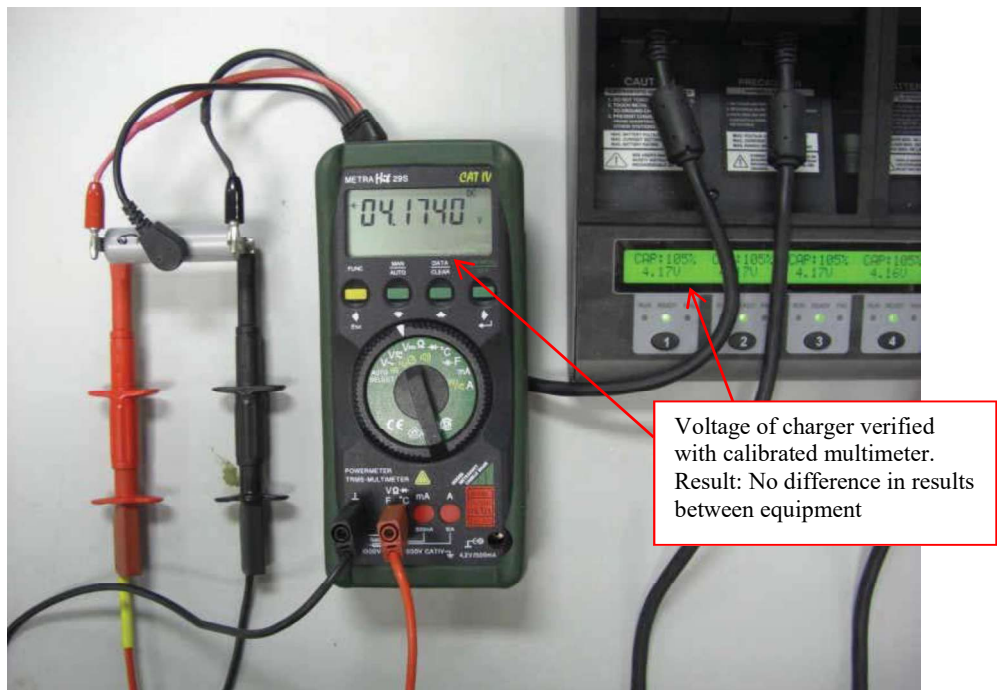
For this apparatus the maximum ambient temperature is **50 °C**.

Test results charging batteries
(60079-11:2006 – Clause 10.4 Determination of parameters of loosely specified components)

Measurement of current and voltages by li-ion charger (when discharging with 1,5 A)

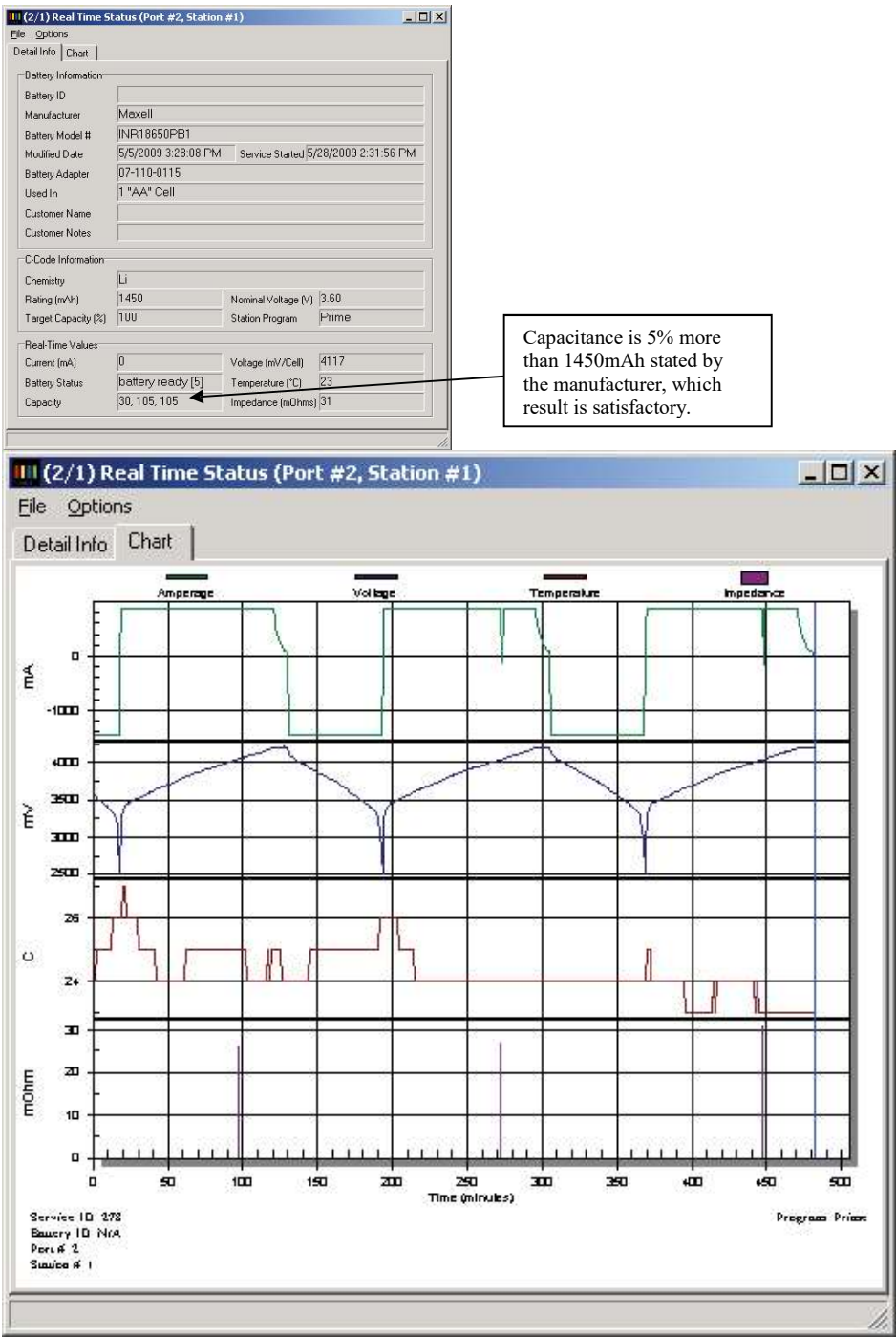


Measurement of current and voltages by li-ion charger (battery 9, fully charged)



Multimeter, number: ORS 118263, Calibrated on 2008-06-30 (due July 2009)

Charging results Battery 1:



battery results of batteries 2 to 10 are comparable.
The maximum voltage at 1,5 A battery charge remain below 4,2 V.

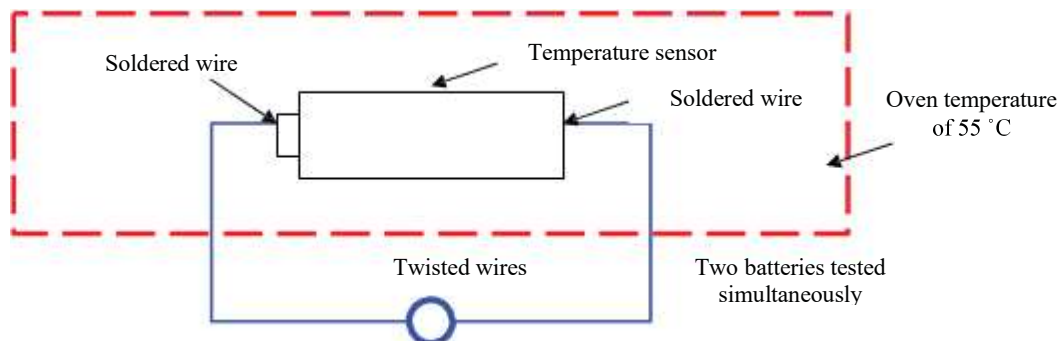
Battery capacitance
Discharge duration = Capacity / Discharge Current = 1450 mAh / 1500 mA = 58 min, actually measured 61 min.
Thus the capacitance is 61 min / 58 min = 5% more capacitance than 1450mAh, which result is satisfactory.

Test results (10.5.2 Electrolyte leakage test for cells and batteries)

Short circuit resistance is 2 mΩ measured before and after test.

Cell no.	10.5.2 Electrolyte leakage	Battery cell discharge graph no. / reference number	10.5.3 b) Temperature test		
			temperature [°C]		Oven* "ambient" Temperature [°C] Absolute
			Max.	delta	
1	none	1 / 13332	69,5	14,5	55,0
2	yes	1 / 13332	94,0	40,5	53,5
3	none	2 / 13335	65,4	10,5	54,9
4	none	2 / 13335	65,7	10,3	55,4
5	yes	3 / 13339	125,7	70,6	55,1
6	none	3 / 13339	130,1	74,5	55,6
7	none	4 / 13346	70,6	16,2	54,4
8	none	4 / 13346	66,8	11,0	55,8
9	none	5 / 13367	64,0	10,1	53,9
10	none	5 / 13367	128,7	74,8	53,9

* Note: measured just before the short from each battery cell

Schematic of battery test**Conclusion**

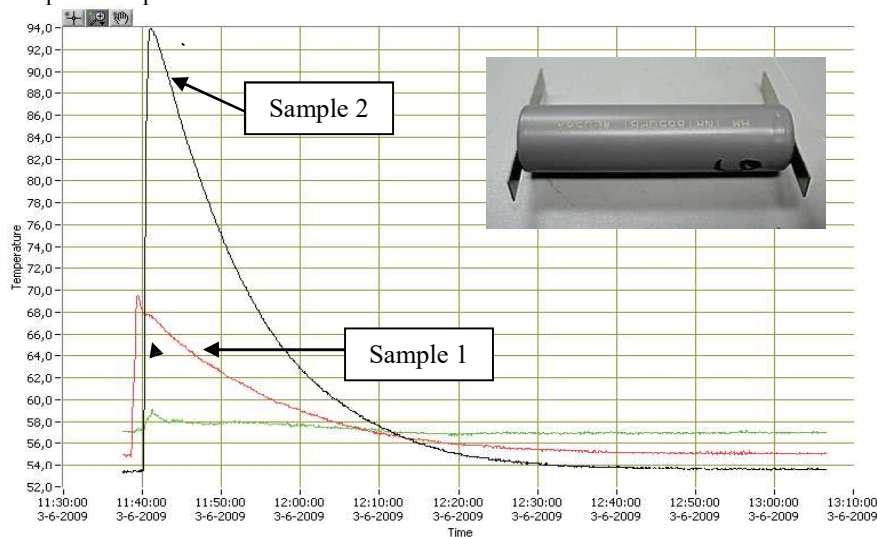
The maximum temperature rise because cell short is **74,8 °K**, measured at an ambient temperature of 55 °C. **Two samples showed some electrolyte leakage after test.**

- [] no electrolyte leakage
- [] no ignition during spark ignition test
- [] no drop in pressure during battery container test
- [] no visible damage or permanent deformation after battery container test [x]
- [x] other: **FAIL on electrolyte leakage on two samples.**

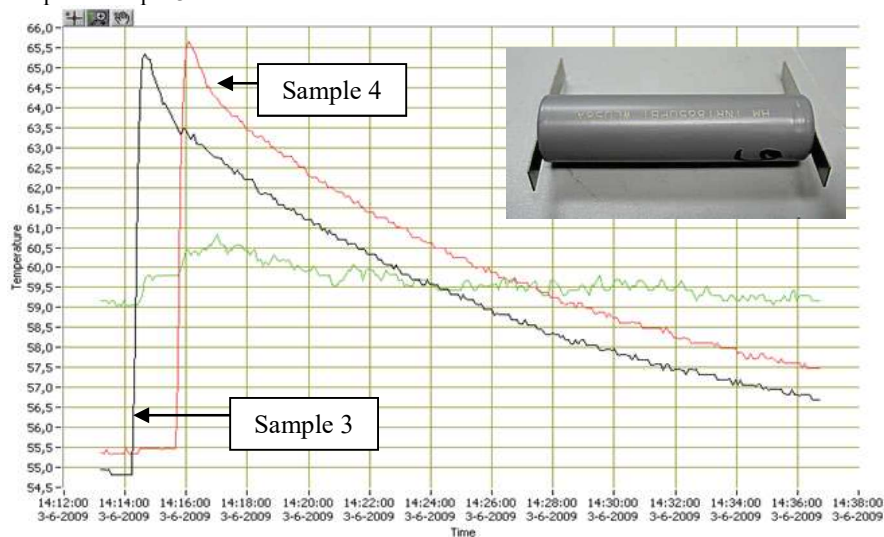
Equipment:

Temperature measurement: LabDAQ 2 2.5.1, TS-043, Calibrated on 2009-01-27 (due date 2010-01) Other equipment: Oven, multimeter ORS 110570

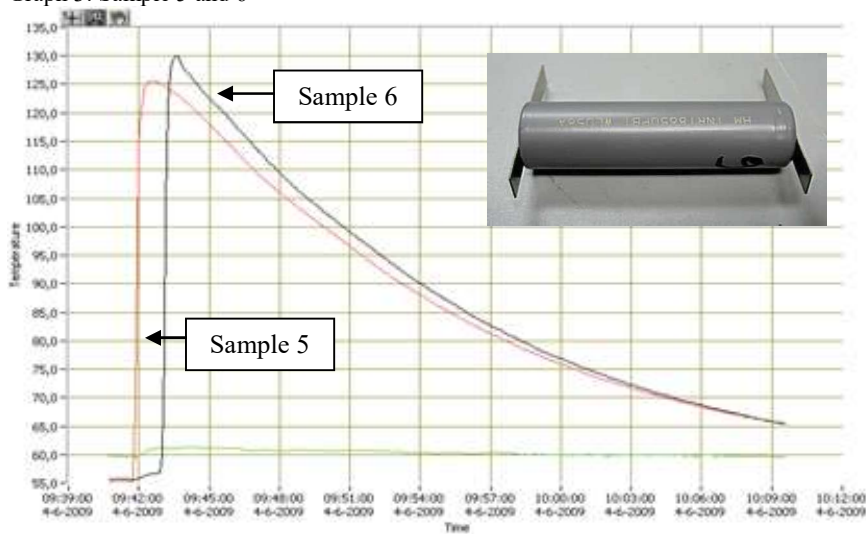
Graph 1: Sample 1 and 2



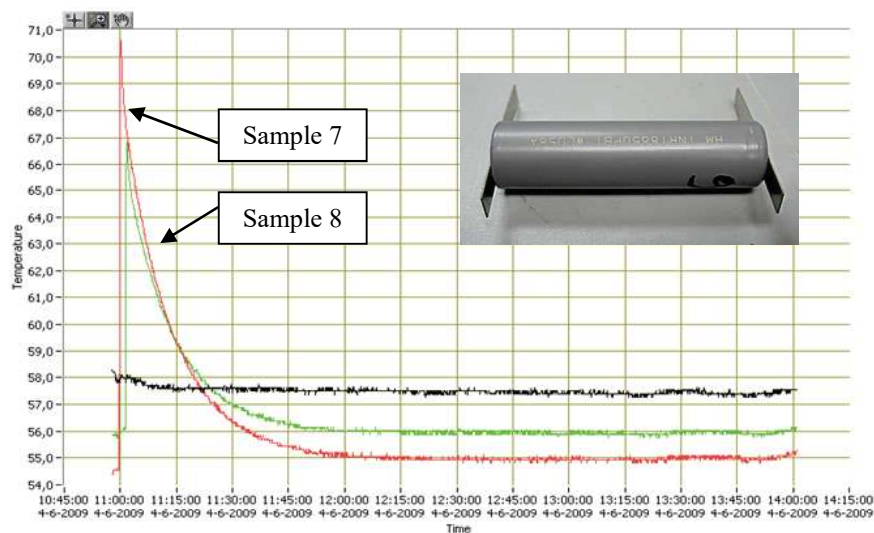
Graph 2: Sample 3 and 4



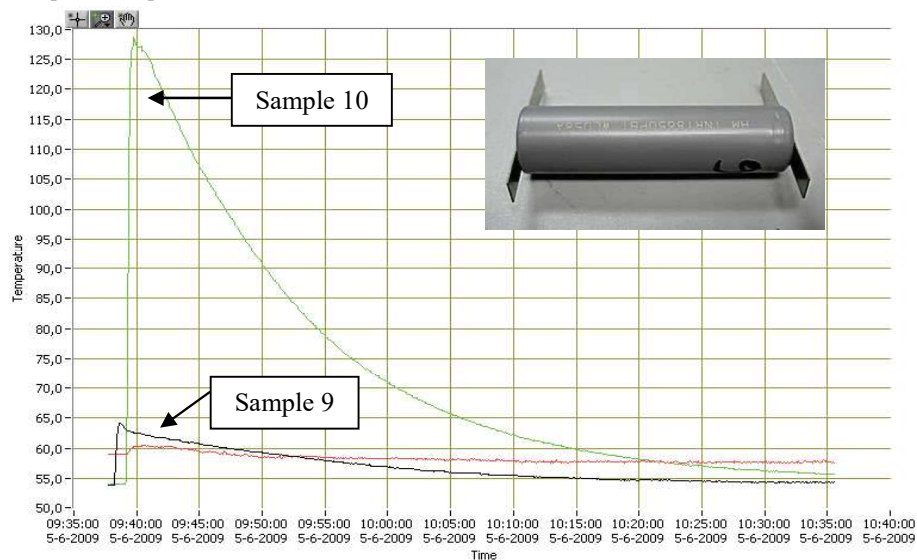
Graph 3: Sample 5 and 6



Graph 4: Sample 7 and 8

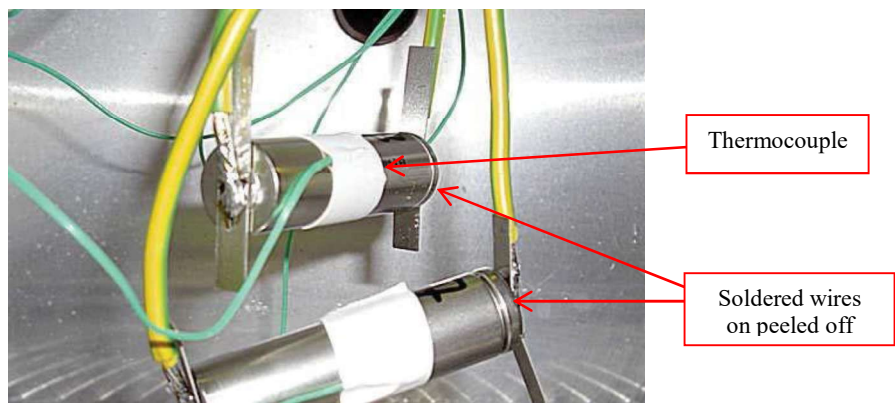


Graph 5: Sample 9 and 10

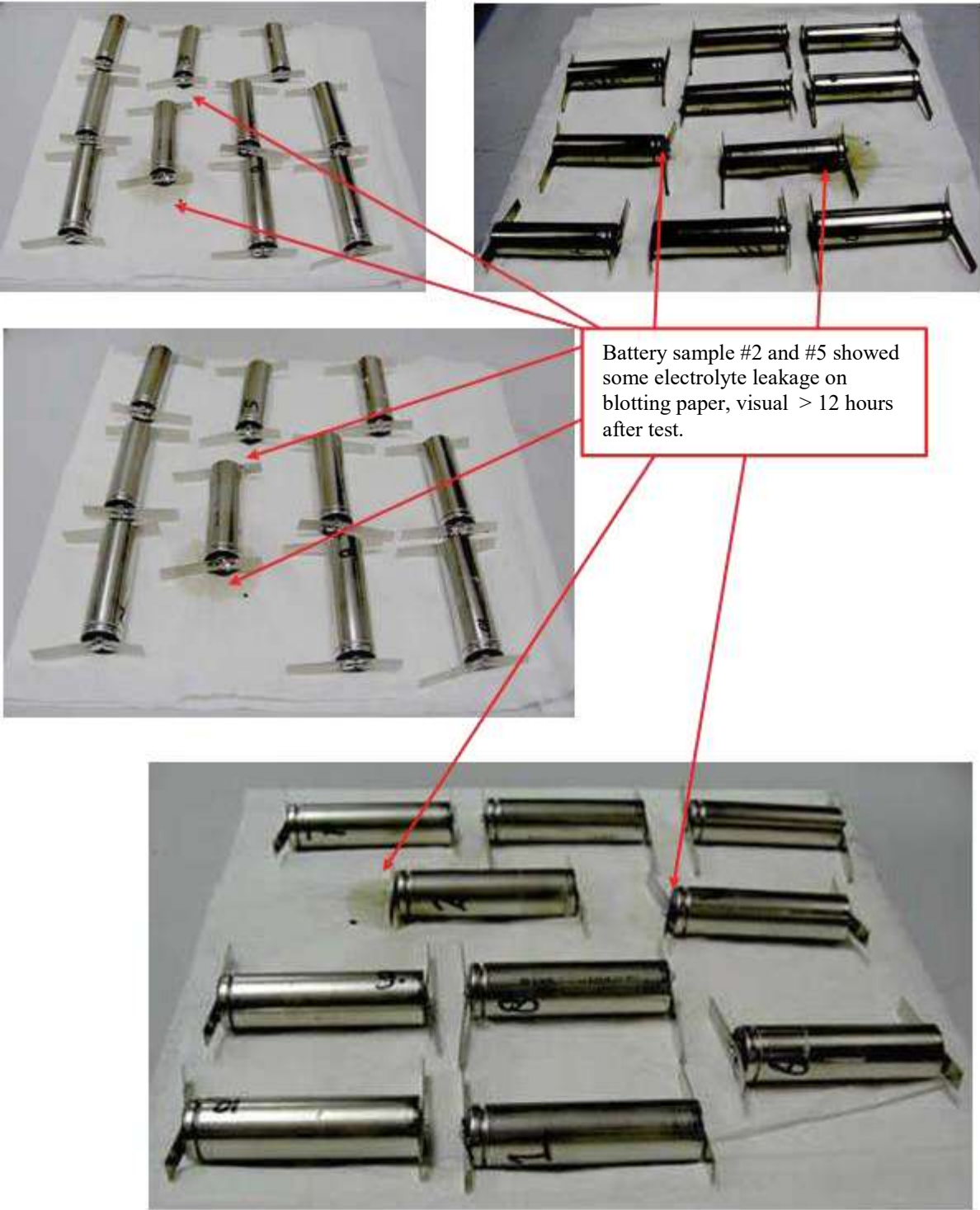


Pictures during test

Batteries 7 and 8 just before start of temperature test



Electrolyte Leakage test, minimal 12 hours after test.



Temperature test at $T_{amb} = 60^{\circ}\text{C}$

The battery packs have been tested with following result: Maximum temperature

rise of the cell under encapsulation: $40,2^{\circ}\text{K}$

Maximum temperature rise for the safety diode components inside the encapsulation: $24,6^{\circ}\text{K}$

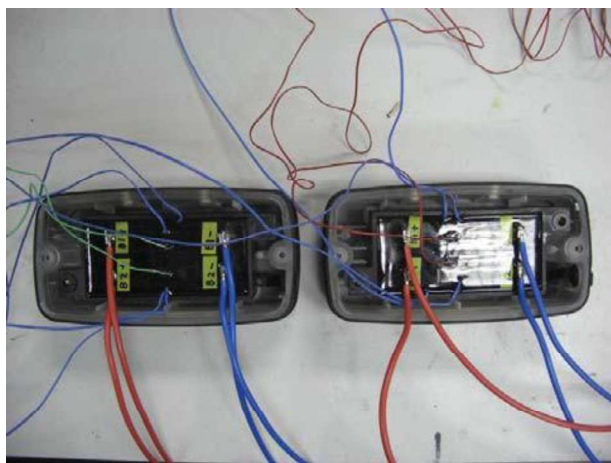
Maximum temperature rise for the safety R5A to R5F components inside the encapsulation: $21,5^{\circ}\text{K}$ Maximum temperature rise of the battery pack on the surface of the encapsulation: $30,1^{\circ}\text{K}$.

Unfortunately has one cells failed during the test (probably we have made a short prior to the short circuit of the test) but the result of the other three cells is satisfactory.

See also pictures and graphs below:

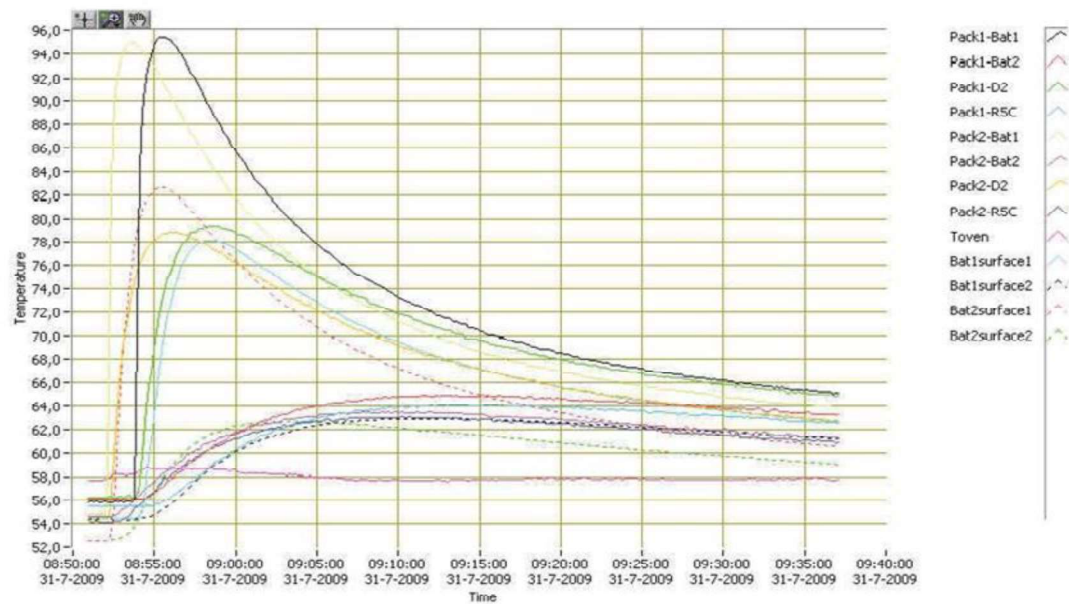


The temperature of the batteries is measured direct after the batteries are completely charged and shorted instantly, to realize the highest possible power dissipation during short of a battery.

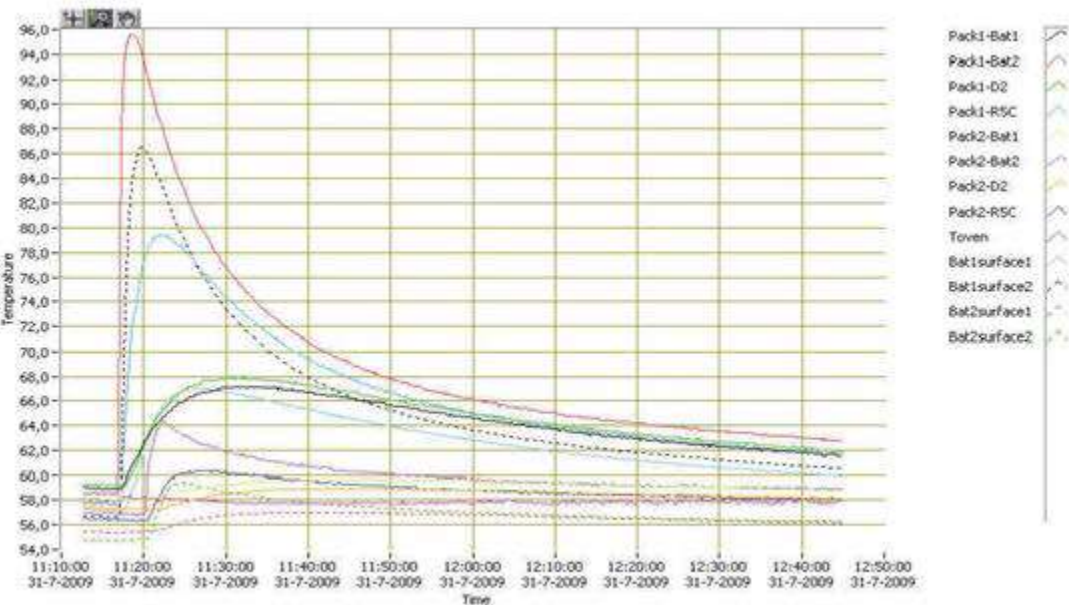


During test the battery pack BP-8000 part has been placed inside of the BUL-8000 enclosure at an ambient temperature of 60°C .

Temperature measurements at ambient temperature of 60 °C Temperature graph when battery 1 in the battery pack 1 and 2 is shorted.



Temperature graph when battery 2 in the battery pack 1 and 2 is shorted.



Results from test report no. NL/DEK/ExTR13.0075/00**Tests of IEC 60079-11****1.1 Tests for cells and batteries**

Equipment Tested:	10 cells of each type
Date of Test (dd/mm/yyyy):	2013-08 to 2013-09
Standard and Clause:	IEC 60079-11:2011. clause 10.5

Description

The following cells are measured:

Li-Ion cells::	
Manufacturer:	Type:
Sony	US18650VTC3
Samsung - SDI	1NR18650-15M

Test procedure:*10.5.1 General:*

- [X] Rechargeable cells or batteries are fully charged with a current of 750 m A (0.5 C) for a period of at least 2 hours min and then discharged at least twice with a current of 300 mA (0.2 C) before any tests are carried out. On the second discharge, or the subsequent one as necessary, the capacity of the cell or battery was confirmed as being within its manufacturer's specification to ensure that tests can be carried out on a fully charged cell or battery which is within its manufacturer's specification.

10.5.2 Electrolyte leakage test for cells and batteries:

Ten test samples are subjected to the most onerous of the following: [X]

- short circuit until discharged;
- [] application of input or charging currents within the manufacturer's recommendations; [] charging a battery within the manufacturer's recommendations with one cell fully discharged or suffering from polarity reversal.

The test samples shall be placed with any case discontinuities, for example seals, (the + pole in most cases) facing downward or in the orientation specified by the manufacturer of the device, over a piece of blotting paper for a period of **at least 12 h** after the application of the above tests.

10.5.3 Spark ignition and surface temperature test of cells and batteries:

- [] Spark ignition assessment or testing shall be carried out at the cell or battery external terminals using a gas mixture for Gasgroup IIA/IIB/IIC including/excluding safety factor.
- [] The short circuit current is determined taking the most onerous value of short-circuit current from a test of 10 samples of the cell/battery
- [X] The maximum surface temperature is determined as follows. All current-limiting devices external to the cell or battery shall be short-circuited for the test. Any external sheath (of paper or metal, etc.) not forming part of the actual cell enclosure is removed for the test. The temperature is determined on the outer enclosure of each cell or battery and the maximum figure taken.

10.5.4 Battery container pressure test:

- [] Five samples of the battery container shall be subjected to a pressure test to determine the venting pressure. Pressure shall be applied to the inside of the container. The pressure is to be gradually increased until venting occurs. The maximum venting pressure shall be recorded and shall not exceed 30 kPa. The maximum recorded venting pressure shall be applied to a sample of the battery container for a period of at least 60 s.

Test conditions:

10.5.1 General:

When a short-circuit is required for test purposes the resistance of the short-circuit link, excluding connections to it, either shall not exceed 3 m Ω or have a voltage drop across it not exceeding 200 mV or 15 % of the cell e.m.f. The short-circuit shall be applied as close to the cell or battery terminals as practicable.

The 3 m Ω is achieved by connecting/soldering short wires directly to the poles.

10.5.2 Electrolyte leakage test for cells and batteries:

The electrolyte leakage test shall be conducted at the most onerous temperature for this type of cell which might require a number of additional test (and hence additional samples) before the real test can be started.

For this apparatus the maximum ambient temperature is 60 °C.

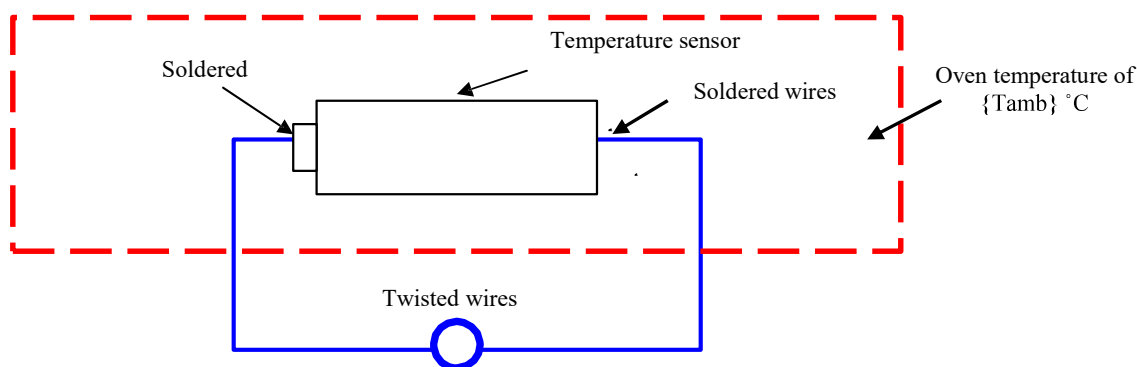
10.5.3 Spark ignition and surface temperature test of cells and batteries:

The short circuit current measurement is determined by measuring the peak voltage over a resistor of 5 m Ω .

Since the temperature behaviour of batteries is considered to be non-linear the temperature test is conducted at the highest ambient temperature (see IEC 60079-11 cl. 10.2).

For this apparatus the maximum ambient temperature is 60 °C.

Schematic of battery test



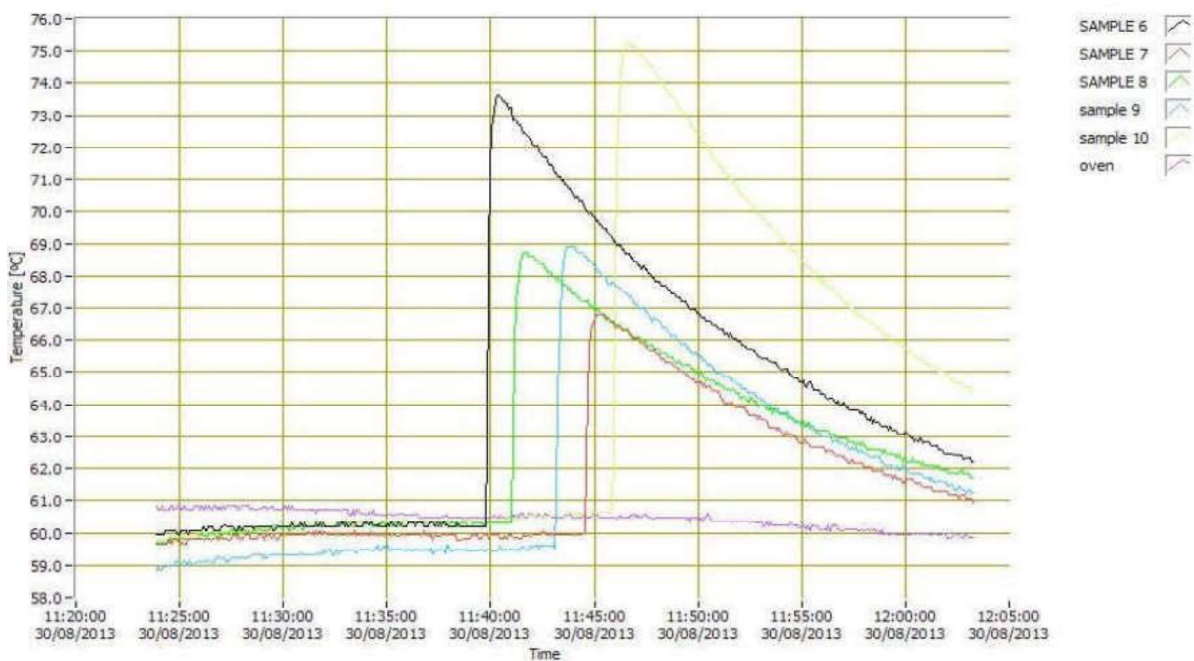
Conclusion

The maximum temperature rise of one of the types during short circuit at 60 °C ambient temperature is 24.6 K. No samples have leaked their electrolyte. The details of the test are shown on the next pages.

Sony US18650VTC3:

Cell number	10.5.1 capacity of the cell	10.5.2 Elektrolyte leakage	10.5.3 a) Short circuit current	10.5.3 b) Temperature test			
				T Cell start	T Cell max	T amb	DeltaT (Tmax - Tstart)
1	> 100 %	No		60.0	69.5	60.2	9.5
2	> 100 %	No		59.3	73.5	60.2	14.2
3	> 100 %	No		59.3	77.0	60.2	17.7
4	> 100 %	No		59.6	75.4	60.2	15.8
5	> 100 %	No		60.2	69.0	60.2	8.8
6	> 100 %	No		60.2	73.6	60.9	13.4
7	> 100 %	No		60.0	66.8	60.9	6.8
8	> 100 %	No		60.3	68.7	60.9	8.4
9	> 100 %	No		59.6	68.9	60.9	9.3
10	> 100 %	No		60.6	75.3	60.9	14.7

Figure of Temperature graph:

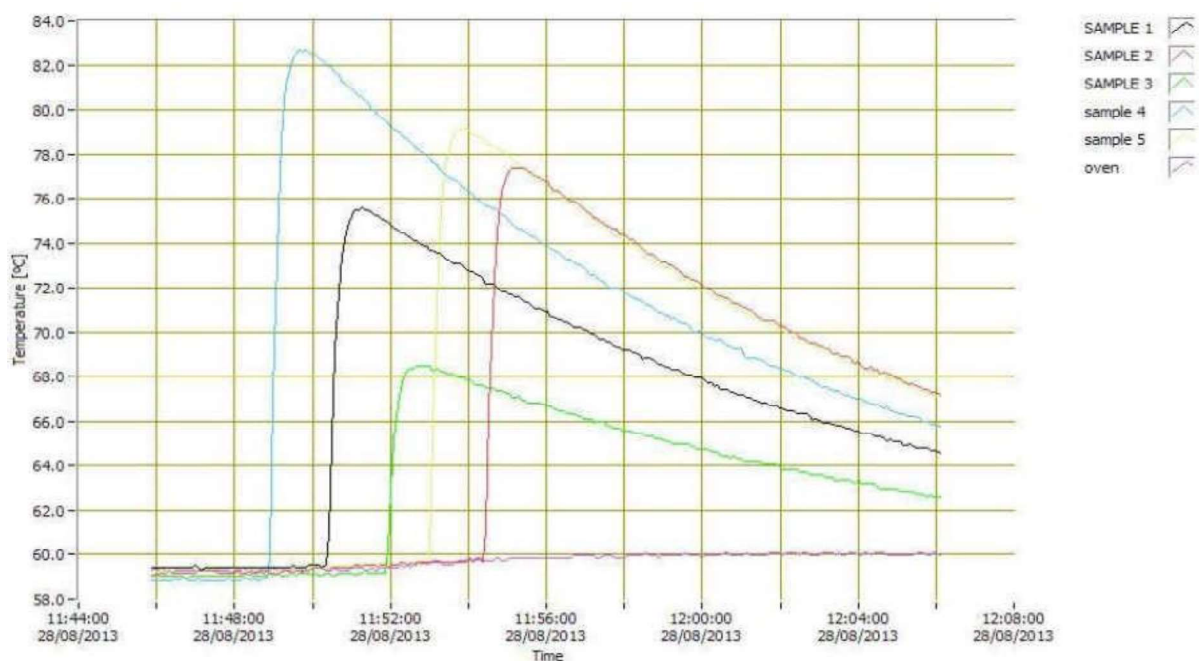


Samsung - SDI

1NR18650-15M:

Cell number	10.5.1 capacity of the cell	10.5.2 Elektrolyte leakage	10.5.3 a) Short circuit current	10.5.3 b) Temperature test			
				T Cell start	T Cell max	T amb	DeltaT (Tmax - Tstart)
1	>100 %	No		59.3	75.6	60.1	16.3
2	>100 %	No		59.1	77.4	60.1	18.3
3	>100 %	No		59.0	68.5	60.1	9.5
4	>100 %	No		58.8	82.7	60.1	23.9
5	>100 %	No		59.3	79.2	60.1	19.9
6	>100 %	No		59.8	75.7	61.2	15.9
7	>100 %	No		59.8	71.9	61.2	12.1
8	>100 %	No		59.9	72.0	61.2	12.1
9	>100 %	No		59.3	69.5	61.2	10.2
10	>100 %	No		60.1	84.7	61.2	24.6
11	>100 %	No		60.4	77.6	60.2	17.2

Figure of Temperature graph:



Appendix C.2 Testing of batteries type Sony SR616 performed by Presafe AS

Equipment Tested:	Batteries type Sony SR616 (Silver oxide)
Date of Test:	All tests performed in period 2015-03-10 to 2015-03-13
Clause and Standards:	Clause 10.5 of IEC60079-11: 2011 (EN60079-11: 2012)

Cl. 10.5.3. a) Spark ignition of cells.

All cells are measured to 1.597V open-circuit. No spark ignition assessment is required since peak open-circuit voltage is less than 4.5V

Cl. 10.5.3 Two test case were considered. Ten new samples are used for each test case (total 20 samples used). The linear correction for max rated ambient is considered to give worst results than if test was performed at max rated ambient.

Case 1: Surface temperature of cells during short-circuiting. Ambient = 23.6°C.										
Case 1. Sample no.	1	2	3	4	5	6	7	8	9	10
Measured T (°C) ¹⁾	29.2	28.8	28.6	28.2	27.7	27.4	29.9	30.3	27.2	31.2
ΔT	5.6	5.2	5.0	4.6	4.1	3.8	6.3	6.7	3.6	7.6
Corrected T (°C) ²⁾	55.6	55.2	55	54.6	54.1	53.8	56.3	56.7	53.6	57.6
Leakage ³⁾	No	No	No	No	No	No	No	No	No	No
Case 2: Surface temperature of cells during abnormal charging. Ambient = 22.6°C										
Case 2. Sample no.	1	2	3	4	5	6	7	8	9	10
Current (mA) ⁴⁾	3.50	3.54	3.51	3.52	3.54	3.51	3.51	3.50	3.52	3.52
Measured T (°C) ⁵⁾	23.8	23.9	23.8	23.9	23.9	23.8	23.8	23.8	23.8	23.9
ΔT	1.2	1.3	1.2	1.3	1.3	1.2	1.2	1.2	1.2	1.3
Corrected T (°C) ²⁾	51.2	51.3	51.2	51.3	51.3	51.2	51.2	51.2	51.2	51.3
Leakage ³⁾	No	No	No	No	No	No	No	No	No	No
Supplementary information: 1) The measured maximum temperature is achieved at the start of test due to the peak short-circuited current, then it is falling during the discharging. The measured peak current were in the range of 55-65mA but is falling very fast to about 3mA (after approximately 30s) 2) T is corrected for max rated ambient 3) Refer to Cl. 10.5.2 of IEC60079-11: 201. All samples were placed in 50°C heat chamber in 12h after the short-circuiting test. 4) Abnormal charging current at input of 5.37V. Diode D7 at backup battery Sony SR616 was short-circuited. Abnormal charging current is slowly falling during test. 5) Test performed until achieved thermal equilibrium										

Cl. 10.5.4 Battery container pressure test. No external container other than the cell itself. No test is found necessary based on review of design.

Appendix D


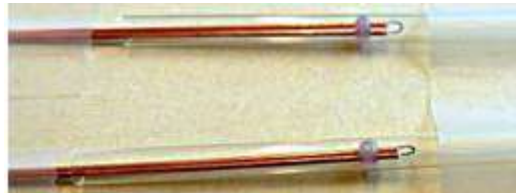

Results from test report no. NL/DEK/ExTR12.0033/00

Test item: Lamp part type OL-82708PA, "lamp with bulb" and "lamp without bulb", for IR DETECTOR type DE-3123.

TABLE OF CONTENTS

1	Test Samples and test sequence	3
1.1	Overview of samples.....	3
1.2	Test sequence	3
1.3	Small component ignition test	4

1.1 Overview of samples

No	Description
#1	 <p>Only the lamp part OL-8270BPA with the glass bulb (received 10 pcs, used a total of 5 pcs for test)</p>
#2	 <p>The lamp part OL-8270BPA without the glass bulb (received 10 pcs, used a total of 5 pcs for test)</p>
#3	 <p>NL/DEK/ExTR12.0033/00 Picture of complete sample IR DETECTOR type DE-3123, containing lamp part #1. For information only.</p>

1.2 Test sequence

The following tests are performed, see table below.

Sample no	#1	#2	#3
Test			
60079-0			
Small component ignition test	X	X	N/A

1.3 Small component ignition test

Equipment Tested:	Sample No #1 and #2. For each Sample No #X five identical sample parts are tested. The lamp part OL-8270BPA are part of IR DETECTOR type DE-3123. A current through the lamp-wire caused the lamp-wire to break, which showed the lamp-
Date of Test (yyy/mm/dd):	2012-04-13
Standard and Clause:	IEC 60079-0:2011. clause 26.5.3

Description

The samples were tested to demonstrate that they do not cause thermal ignition of a flammable mixture in accordance with clause 5.3.3 item a). The test has been performed in the presence of a specified gas/air mixture for T4 as described below

The component shall be tested under normal operation, or under the fault conditions specified in the standard for the type of protection which produces the highest value of surface temperature. The test shall be continued either until thermal equilibrium of the component and the surrounding parts is attained or until the component temperature drops. Where component failure causes the temperature to fall, the test shall be repeated five times using five additional samples of the component. Where, in normal operation or under the fault conditions specified in the standard for the type of protection, the temperature of more than one component exceeds the temperature class of the equipment, the test shall be carried out with all such components at their maximum temperature.

Test conditions

The purpose of this test is to determine at which conditions the gas sensor would not cause a thermal ignition. The results of this test should give the conditions for the circuits of the apparatus in which the sensor is intended to be used. A program has been set up to determine which various conditions would apply.

Test sequence for the lamp part, Sample No #1 and #2:

- Heat up the explosion proof enclosure to 75 °C (25 K above maximum ambient temperature)
- Inject 1cc of diethyl ether into the explosion proof enclosure
- Wait 15 seconds so the diethyl ether can create an explosive atmosphere
- Switch on the power supply to the sensor and turn up the power supply up slowly till the wire of the lamp wire lights up (to a certain voltage up to a point where the wire will not break yet).
- Turn up the power supply slowly till the wire of the lamp breaks.
- Switch on power source for the spark generator
- Ignition should occur within 15 seconds.

This sequence is repeated 5 times on 2 different samples (#1 with bulb and #2 without bulb) of the lamp part. The appearance of a cool flame is considered as an ignition. Detection of ignition is either:

- [x] audio / visual, for ignition and breaking the lamp wire.
- [x] Ampere meter, showing an interruption of the current through the lamp wire.
- [] by measurement of temperature.

If no ignition occurs during a test, the presence of the flammable mixture is verified by igniting the mixture by some other means.

Pictures of test bench for small component ignition test.



Results of sensors

5 samples of the lamp part with bulb (#1) and 5 samples without bulb (#2) are tested. The sensor voltage could be turned up till the lamp wire was broken at about 17 V for lamp with bulb and about 4 V for lamp without bulb. To test if an explosive mixture was still present; it was successfully ignited by a spark plug after the test. In total 10 samples were tested in this way.

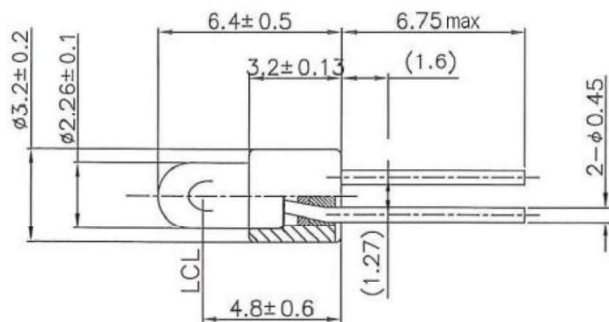
Conclusion

Pass, the results meet the requirements:

- None of the 2 x five samples caused an ignition during the test.
- After each test it was shown that the mixture was ignitable

The lamp cannot become an ignition source for gas group T4, because the lamp wire will break without ignition.

Model	: OL-8270BPA
Design Voltage	: 5V
Design Current	: 115mA±10%
Brightness (MSCP):	0.15MSCP±25%
Filament Shape	: C-2R
Base color	: WHITE
Manufacturer	: Oshino Lamps Limited



Appendix E

Results from test report no. NL/KEM/ExTR07.0057/00

Test item: Sensor type NC-6264A

Total 15 samples, provided with the sensor wire but without the sintered metal cover, were used for testing. The absence of cover allows immediate access of the test gas to the sensor wire.

Functionally the sintered metal cover will be placed, but for compliance with the requirements for intrinsic safety it is not required.

The wire of the gas sensor is a small air coil and its resistance increases at increasing temperature (i.e. at increasing current). Capacitance is not present between the connections, so the inductance is the decisive factor.

The maximum current which flow through the coil without causing the open-circuit, is less than 150mA at 4V. At this level and higher values the coil will be open-circuited. For this condition maximum 1.5mH is allowed. The coil inductance is 20 μ H and is negligible low with respect to the limit of 1.5mH.

Higher current might appear for a very short time (just at the moment of open-circuiting of the coiled wire). When dissipated power is increased by more than (4Vx0.150A) 0.6W, the coiled wire will be open-circuited, having at that moment an inductance of 20 μ H.

Ignitibility of an inductive circuit:

Based on a value of 20 μ H per Figure A.6 of IEC 60079-11 the following combinations would be allowed (including safety factor of 1.5):

Voltage U [V]	4	8	12	16	18	20	22	24 & up
Current I [mA]	1730	1300	1270	670	440	320	250	180

In each case the supplied power is much higher than 0.6 W. Consequently the coil will be open circuited (at maximum 20 μ H) before any ignition due to an inductive spark would occur.

Ignitability of a resistive circuit

For a maximum power dissipation of $P = 0.6$ W that will occur in the coiled wire, the following combinations of maximum voltage and current would apply ($I=0.6/U$):

Voltage U [V]	4	12	15	20	25	30	35	40	45	50	55	60
Current I [mA]	150	20	40	30	24	20	17	15	14	12	11	10

Maximum allowed combinations per Figure A.1 of IEC 60079-11:

Voltage U [V]	4	12	15	20	25	30	35	40	45	50	55	60
Current I [mA]	3300	3330	900	309	158	101	73	57	45	40	36	30

The values of the combinations based on the 0.6 W are far below the ones per Figure A.1 of IEC 60079-11 (including safety factor of 1.5), consequently ignition will not occur.

In addition, when the coiled wire would be compared with a fuse, its cold resistance may be used for determining the current that flows at a specific voltage. The cold resistance of the wire is 4.6 Ohm (see Section B1.1). This would lead at 4 V to a current of 870 mA (4V/4.6Ohm). According to the table above based on the maximum inductance of 20 μ H of the coiled wire this is not ignitive.

At currents above 150 mA, so certainly at the aforementioned value the coil evaporated or melted already, making the inductance ineffective.

Small component ignition test

- Gas sensor type N 6264A which sintered metal cover were removed (i.e. the sensor "wire" is directly accessible for the environment).

- For pre-tests a number of units have been used. As the unit broke down just above the desired conditions, the final conclusive tests were performed on five samples.

Date of test: 2007.06.07 and 28.06.07

Standards: IEC 60079-0:2004 and IEC 60079-11: 2006

Test Procedure

The purpose of this test is to determine at which conditions the gas sensor would not cause a thermal ignition (note: for avoidance of spark ignition annex A of IEC 60079-11 has been used).

The results of this test should give the conditions for the circuits of the apparatus in which the sensor is intended to be used. A program has been set up to determine which various conditions would apply.

Pre-tests:

- The cold resistance of the wire is about 4.6 Ohm (measured at about 23°C and <5 mA).
- With increasing current the resistance of the wire raised up to about 25Ω (order of magnitude at 75°C ambient temperature, just before open circuit).
- Just before open circuit the current is about 140 mA
- The sensor were open-circuited when voltages above 3V were applied.
- The inductance of the coiled wire of the sensor is approximately 20μH (at 23°C ambient temperature)
- The capacitance is negligible.

Test conditions:

- The sensor was connected with wires soldered to the copper connection plates.
- The sensor was placed in the center of the test chamber.
- The supply was capable of delivering 10V and 5A.
- Temperature in the test chamber 75°C (safety factor achieved by increasing the applicable ambient temperature of 50°C by a factor of 1.5).
- A small quantity of diethyl ether was released in the test chamber.
- After the diethyl ether was evaporated sufficiently, the voltage was gradually raised from 0V up to break down (open-circuit) of the wire occurred.
- Immediately after break down of the wire, the mixture in the test chamber was tested for its ignition ability

B.1.1 Results

At the pre-tests the following typical values were noted

Voltage across the sensor wire [V]	1	2	3	3.3	> 3...4
Current [mA]	85	125	145	135	Open-circuited

The voltage is raised gradually within a few seconds and is measured across the sensor wire.

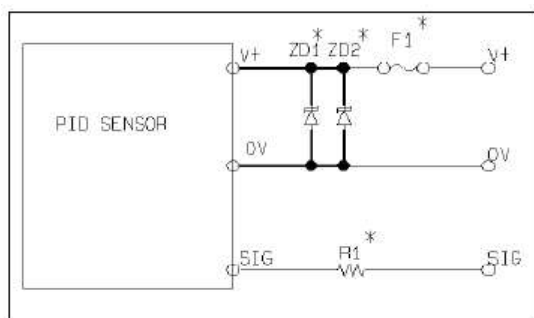
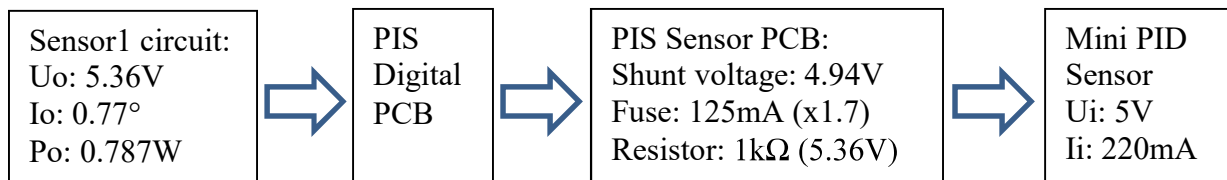
Sample No.	1	2	3	4	5
Voltage [V]	3.0	3.0	3.0	3.1	3.0
Current [mA]	130	130	130	145	145

None of the five samples caused ignition during this process.

The mixture of each test were verified for ignition after the open-circuiting of coil.

Appendix F: Smart sensor type PIS Assessment

The Mini PID sensor used inside smart sensor type PIS, is separately Ex certified device which is covered by certificate 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00. Marking code of Mini PID sensor is Ex ia IIC T4 for ambient range up to 60°C. The device is investigated for intrinsic safe connection to EUT.



The PIS sensor is provided with two PCB as shown above whereof protection is located in PIS sensor PCB. Zeners, fuse and safety resistor is provided as power limiting devices.

Input line:

$$I_{\max} = 125\text{mA} \times 1.7 = 213\text{mA}$$

$$P_{\max} = 4.94\text{V} \times 213\text{mA} = 1.05\text{W}$$

Signal line:

$$I = 5.36\text{V} / 1\text{k}\Omega @ 1\% = 5.42\text{mA} \rightarrow P_{R1} = 30\text{mW}$$

$U_o < U_i$	$I_o < I_i$	$P_o < P_i$	Remark
$4.94\text{V} < 5\text{V}$	$213\text{mA} < 220\text{mA}$	$0.787\text{W} < 1.1\text{W}$	Safe connection
I_{R1}	P_{R1}	P (rating of R1)	Safety factor
5.42mA	30mW	250mW	8.7x
Supplementary information:			

Safety distances of R1 is documented. Voltage area 5.36V:

Location	Measured CR	Measured CL	Required	Remark
R1 (measured to adjacent tracks)	0.85	0.85	> 0.5 *)	Pass. CTI ≥ 100
Supplementary information:				
*) Encapsulated part. See Appendix A.5.2				

Another shunt device (double zeners) is also provided internal in Mini PID sensor so in fact this connection has two times of double zeners (total four zeners used at input lines).

The PIS digital PCB used no safety components and therefore are treated as part of the Sensor circuit which is covered by the temperature assessment/test in Appendix B.3.

Intrinsic safe connection to Mini PID sensor is hereby documented. Refer also to certificate 07ATEX0060U and associated test reports GB/BAS/ExTR07.0056/00.



IECEx TEST REPORT
IEC 60079

Electrical equipment for explosive gas atmospheres
Part 26: Equipment with equipment protection level (EPL) Ga

ExTR Reference Number.....: NO/PRE/ExTR15.0012/00

ExTR Free Reference Number: D0001494-00

Complied by + signature (ExTL): Hien Van Le Thanh

Reviewed by + signature (ExTL).....: Arne Hortman

Date of issue: 2015-04-21

Ex Testing Laboratory (ExTL): Presafe AS

Address: Gaustadalléen 30, NO - 0373 Oslo, Norway

Applicant's name.....: Riken Keiki Co., Ltd

Address: 2-7-6 Azusawa, Itabashi, Tokyo 174-8744, Japan

Standard.....: IEC 60079-26:2006, Second edition

Test procedure: IECEx Scheme

Test Report Form No.: ExTR60079-26

TRF Originator.....: DEKRA EXAM

Master TRF: dated 2006-09

Instructions for Intended Use of Ex Test Report:

This ExTR blank document is to be compiled and reviewed by the ExTL. The ExTR package in which this ExTR is incorporated (comprised of a single ExTR document or multiple ExTR documents) is to be accompanied by a single ExTR Cover Sheet, which is to be approved by the ExCB. ExTR Addendum(s) and/or ExTR Report of National Differences may also supplement this ExTR.

Copyright © 2006 International Electrotechnical Commission Scheme for Certification to Standards Relating to Equipment for use in Explosive Atmospheres (IECEx), Geneva, Switzerland. All rights reserved.

This publication may be reproduced in whole or in part for non-commercial purposes as long as the IECEx is acknowledged as copyright owner and source of the material. IECEx takes no responsibility for and will not assume liability for damages resulting from the reader's interpretation of the reproduced material due to its placement and context.

Possible test case verdicts:

- test case does not apply to the test item: **N/A** Not applicable

- test item does meet the requirement: **P** Pass

General remarks:

The test results presented in this Ex Test Report relate only to the item or product tested.

- "See Attachment #" refers to additional information appended to this document.
- "See appended table" refers to a table appended to this document.
- "See General product information" refers to item 'General product information' in ExTR Cover report.
- "See Copy of marking plate" refers to item 'Copy of marking plate' in ExTR Cover report.
- Throughout this document, a point "." is used as the decimal separator.

The technical content of this Ex Test Report shall not be reproduced except in full without the written approval of the Issuing ExCB and ExTL.

The standard IEC 60079-26: 2006 2nd Edition make reference to IEC 60079-0: 2004 4th edition. However since IEC 60079-0: 2004 4th edition is withdrawn, IEC 60079-0: 2011 6th edition is considered for this investigation.

This investigation is valid for both IECEx and ATEX certification which is handled by Presafe AS. The Ex codes for both ATEX and IECEx certification may appear in associated test reports.

IEC 60079-26			
Clause	Requirement – Test	Result – Remark	Verdict
1	SCOPE		P
2	NORMATIVE REFERENCES		
3	TERMS AND DEFINITIONS		
4	REQUIREMENTS FOR DESIGN AND CONSTRUCTION		P
4.1	General	Equipment under test is portable gas monitor GX-6000 hereby referred to as EUT. See General product information. Ex ia IIC T4 Ga -20°C ≤ Ta ≤ +50°C	P
4.2	Protection measures against ignition hazards of the electrical circuits		
4.2.1	General	EUT is tested for requirements of IEC60079-11: 2011 which the test report is part of this investigation.	P
4.2.2	Intrinsic safety as a sole means of protection		P
4.2.3	Encapsulation as a sole means of protection		N/A
4.2.4	Application of two independent types of protection providing EPL Gb		N/A
4.2.5	Application of a type of protection providing EPL Gb and a separation element		
4.2.5.1	General	See 4.1 and 4.2.1	N/A
4.2.5.2	Partition walls		N/A
4.2.5.3	Requirements depending on the thickness of the partition wall		N/A
4.2.5.4	Partition wall combined with a flameproof joint		N/A
4.2.5.5	Partition wall combined with an airgap with natural ventilation		N/A
4.3	Equipment with moving parts		P
4.3.1	Frictional heating	See below.	P
4.3.2	Damage arising from failure of moving parts	See 4.2.1. The internal pumps are assessed and are documented in associated IEC60079-11: 2011 test report.	P
4.3.3	Light metals		N/A
4.4	Isolated conductive components		N/A
4.5	Non-conductive enclosures and accessible non-conductive components		N/A

IEC 60079-26			
Clause	Requirement – Test	Result – Remark	Verdict
4.5.1	General	Conductive enclosure material is documented in the associated IEC60079-0 test report	N/A
4.5.2	Limitation of the size of chargeable non-conductive surfaces		N/A
4.5.3	Limitation of the thickness of chargeable non-conductive layers		N/A
4.5.4	Provision of a conductive coating		N/A
4.6	Process connection		N/A
5	TYPE TESTS		P
5.1	Standardized types of protection	EPL Ga type of protection. EUT is tested for requirements of IEC60079-11: 2011 as part of this investigation.	P
5.2	Separation elements	No such application or parts.	N/A
5.3	Temperature evaluation	See 5.1	P
6	MARKING		P
6.1	General	See 4.1 & Copy of marking plate.	P
6.2	Examples of marking		
6.2 a)	Equipment which is intended to be completely installed inside the area requiring EPL Ga	EPL Ga employed for GX-6000. Charger (charging) is located in safe areas. See Copy of marking plate.	P
6.2 b)	Associated apparatus, which is installed outside the hazardous area and providing external electrical circuits protected by intrinsic safety "ia", which can be connected to equipment providing EPL Ga	Intrinsically safe portable device is intended use in the hazardous area. Charger circuit is adequately protected and charging is only allowed to be performed in safe areas.	N/A
6.2 c)	Equipment which is installed in the boundary wall between an area requiring EPL Ga and the less hazardous area	No such intended use.	N/A
7	INFORMATION FOR USE		P
ANNEX A (informative)	INTRODUCTION OF AN ALTERNATIVE RISK ASSESSMENT METHOD ENCOMPASSING "EQUIPMENT PROTECTION LEVELS" FOR EX EQUIPMENT		N/A
A 0	Introduction		N/A
A.1	Historical background		N/A

IEC 60079-26			
Clause	Requirement – Test	Result – Remark	Verdict
A.2	General		N/A
A.2.1	Coal mining (group I)		N/A
A.2.1.1	EPL Ma		N/A
A.2.1.2	EPL Mb		N/A
A.2.2	Gases (group II)		N/A
A.2.2.1	EPL Ga		N/A
A.2.2.2	EPL Gb		N/A
A.2.2.3	EPL Gc		N/A
A.2.3	Dusts (group III)		N/A
A.2.3.1	EPL Da		N/A
A.2.3.2	EPL Db		N/A
A.2.3.3	EPL Dc		N/A
A.3	Risk of ignition protection afforded		N/A
A.4	Implementation		N/A

APPENDIX: Additional construction remarks

- 4 Requirements for design and construction**
 - 4.1 General**
 - 4.2 Protection measures against ignition hazards of the electrical circuits**
 - 4.2.1 General**
 - 4.2.2 Intrinsic safety as a sole means of protection**
 - 4.2.3 Encapsulation as a sole means of protection**
 - 4.2.4 Application of two independent types of protection providing EPL Gb**
 - 4.2.5 Application of a type of protection providing EPL Gb and a separation element**
 - 4.2.5.1 General**
 - 4.2.5.2 Partition walls**
 - 4.2.5.3 Requirements depending on the thickness of the partition wall**
 - 4.2.5.4 Partition wall combined with a flameproof joint**
 - 4.2.5.5 Partition wall combined with an airgap with natural ventilation**
 - 4.3 Apparatus with moving parts**
 - 4.3.1 Frictional heating**
 - 4.3.2 Damage arising from failure of moving parts**
 - 4.3.3 Light metals**
 - 4.4 Isolated conductive components**
 - 4.5 Non-conductive enclosures and accessible non-conductive components**
 - 4.5.1 General**
 - 4.5.2 Limitation of the size of chargeable non-conductive surfaces**
 - 4.5.3 Limitation of the thickness of chargeable non-conductive layers**
 - 4.5.4 Provision of a conductive coating**
 - 4.6 Process connection**
- 5 Type tests**

- 5.1** **Standardized types of protection**
- 5.2** **Separation elements**
- 5.3** **Temperature evaluation**
- 6** **Marking**
- 6.1** **General**
- 6.2** **Examples of marking**
- 6.2 a)** **Equipment which is intended to be completely installed inside the area requiring EPL Ga**
- 6.2 b)** **Associated apparatus, which is installed outside the hazardous area and providing external electrical circuits protected by intrinsic safety “ia” which can be connected to equipment providing EPL Ga**
- 6.2 c)** **Equipment which is installed in the boundary wall between an area requiring EPL Ga and the less hazardous area**
- 7** **Information for use**