FERROVAC GMBH

ULTRA HIGH VACUUM TECHNOLOGY

LSA2.0/LSA2.1

Battery Operated High Voltage Controller for UHV suitcases and Ion Getter Pumps

INSTRUCTION MANUAL

Version 3.0

August 2017

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Warranty

FERROVAC GMBH warrants this product to be free of defects in material and workmanship for a period of 12 months from the date of shipment. In case of proof of any defective parts in the product, we will at our option, either repair the product or replace it.

Warranty limitations

The warranty for this product does not apply to defects resulting from the following:

- non-observance of operational- and safety instructions
- natural wear of components
- consumables
- modifications to our products without our written consent
- misuse of any product or part of the product

This warranty stands in place of all other warranties, implied or expressed, including any implied warranty of implied merchantability or fitness for a particular use. The remedies provided herein are buyer's sole and exclusive remedies.
Neither the company FERROVAC GMBH *nor any of its employees shall be liable for any direct, indirect, incidental, consequential or special damages arising out of the use of it's products, even if the company* FERROVAC GMBH *has been advised in advance of the possibility of such damages. Such excluded damages shall include but are not limited to: Costs of removal and installation, losses sustained as the result of injury to any person, or damage to property.*

Copyright

Terms and symbols

The information in this document represents the state of the product at the date of print. Technical changes may be made without notice. FERROVAC GMBH makes no warranties or representations with respect to accuracy or completeness of the contents of this publication. Figures and photos are not binding. The product names used are for identification purposes and may be trademarks of their respective companies.

A triangle with explanation mark indicates a passage in the manual with information that is crucial for the operator. READ THESE PARAGRAPHS CAREFULLY or the product might be damaged by misuse.

The high voltage symbol, if found on a product or accessory of a product, indicates voltages that are potentially lethal. READ THESE PARAGRAPHS CAREFULLY in order to protect the operator from any injury.

WARNING! The WARNING heading in a manual explains dangers that may result in personal injury or death. Always read the associated information very carefully.

CAUTION! The CAUTION heading in a manual explains hazardous situations that could damage the product. Such damage may invalidate warranty.

Normal use

The product described in this manual must always be used:

- With original cable sets supplied by FERROVAC which are explicitly specified for the use with the product described in this publication
- With all cabling connected and secured, if applicable
- With all electronic equipment switched on after all cables are connected properly
- In an indoor research laboratory environment
- By personnel qualified for operation of delicate scientific equipment
- In accordance with all related manuals.

CAREFULLY READ THE SAFETY INFORMATION AND ALL RELEVANT MANUALS BEFORE USING THE PRODUCT AND ANY RELATED INSTRUMENTATION!

WARNING: High voltages up to 5 kV
Any adjustment, fault finding procedure, installation and maintenance of the products described in this manual must be carried out only by authorized service personnel, fully qualified to handle potentially lethal voltages.

Safety precautions

The following safety precautions must be observed at all times before using the product described in this manual and any associated instrumentation.
The product described in this manual is intended for use by qualified personnel who recognize shock hazards and are familiar with the precautions necessary to avoid possible injury.

Responsible body is the individual or group of persons that are responsible for the proper use and maintenance of the product, ensuring that the product is operated within its specifications and operating limits. The responsible body must ensure that users of the product are adequately trained.

Operators are using the product for its intended purpose. Users must be trained in basic laboratory safety, basic electrical safety and adequate use of scientific instruments. They must be protected from electric shock and contact with potentially dangerous situations.

Maintenance Personnel perform routine tasks on the product to keep it in proper operating conditions i.e. setting up the line voltage or replacing consumables. Maintenance procedures are described in the manual and must be followed at all times.

Service Personnel are trained to work on live circuits as well as perform fault finding measurements and repair work to the product. Only fully trained service personnel qualified to handle potentially lethal voltages may perform servicing and repair.

The American National Standards Institute states that **a shock hazard exists when voltage levels are greater than 30 V RMS, 42.2 V peak or 60 VDC**. A good safety practice is to assume that hazardous voltages are present in any unknown circuitry.

CAUTION: Always check for correct mains voltage before connecting any equipment!

WARNING: High Voltages! Adjustments and fault finding measurements may only be carried out by authorised service personnel being trained to handle high voltage devices and work on live circuits.

WARNING:

- **Always** observe and strictly follow the safety notes and regulations given in this and related documentations.
- **Always** use the configured cables delivered with the product for electrical connections.
- **Always** switch off the device in case of disconnecting cables, in particular in case of the high voltage (HV) connection.
- **Always** observe and strictly follow the safety notes and regulations given in this and related documentations.
- **Never** operate the high voltage supply when the ion pump is not connected and under vacuum.
- **Never** operate the ion pump in a pressure range above 1×10^{-5} mbar.
- **Never** operate the device outside its dedicated usage and settings.
- **Read** safety instructions first and be familiar with general safety precautions.
- **Always** strictly follow the safety notes and regulations.

CAUTION:
Do not open the device unless you fulfill the requirements of a fully trained service personnel and you are familiar with live circuits and potentially lethal voltages.

Ambient conditions and environments: This product is only to be used indoors, in laboratories meeting the following requirements:

- Room temperature lies between 5°C/41°F and 40°C/104°F.
- Relative humidity up to maximum of 80% for temperatures up to 31°C decreasing linearly to 5% relative humidity at 40°C.
- Altitudes up to 2000 m.
- Pollution Degree 2 environments.
- Mains supply voltage fluctuations must not exceed ± 10% of the nominal voltage.
- The device should only be operated at the **indicated mains supply voltage**.

Technical Specifications

Pump capacity:	Diode ion pumps with a load current < 20 µA Please refer to the current to pressure diagram of the pump manufacturer
Input (battery charge):	
Voltage	+12V DC (± 5%)
Output:	
High Voltage Output	+5 kV DC (± 10%)
Current	max. 20 µA
Source resistance	70 MΩ
Output connector	Huber & Suhner SHV connector
Battery:	
Type	Ni-MH (Nickel-metal hydride)
Discharge time LSA2.0	~60 h at 5 µA load current
Discharge time LSA2.1	~55 h at 5 µA load current
Charging time	about 8 hours
Battery life span	about 1000 cycles
Ambient conditions:	
Temperature	0°C to 40 °C
Relative Humidity	maximum 80 % for temperatures up to 31°C decreasing linearly to 5% relative humidity at 40°C
Mains fluctuations	± 10 %
Altitude	up to 2000 m
Charging device:	
Input	100 VAC - 240 VAC ~ 50/60 Hz
Output	+12VDC (± 5%)
Other specifications	
Display current LSA2.0	20 µA – 10 nA
Display current LSA2.1	20 µA – 1 nA

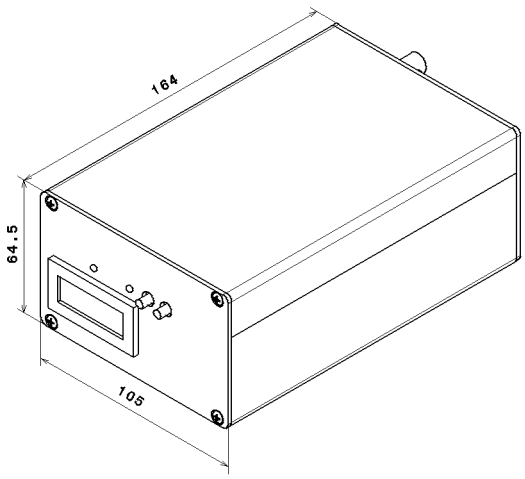

Figure 1: Outer dimensions of the LSA2.

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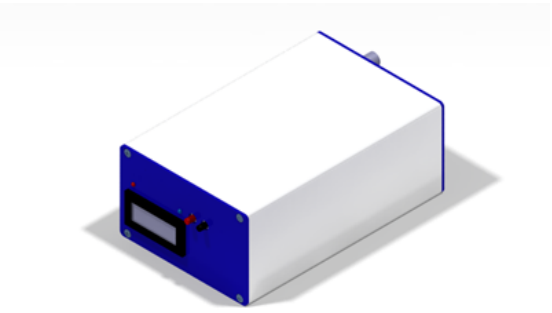

Figure 2: LSA2 Ion pump controller.

1 Introduction

The LSA2 is a battery powered ion pump controller which allows an operation of an ion pump without mains power supply for many hours. This is in particular suitable for mobile ultra high vacuum chambers which are connected to different systems in a laboratory.
The LSA2 is designated to operate ion pumps which fulfill the respective requirements for a supply voltage of 5 kV and a maximum current of 20 µA. The device is powered by a Nickel-metal hydride (Ni-MH) rechargeable battery such that the controller can run up to 60 h independently of an external electricity supply. The battery is charged by an external power supply. The LSA2 measures the current of the ion pump. The current is shown on the display in µA. From the current the pressure in the ion pump (and therefore vacuum chamber) can be deduced by the respective graph for the ion pump giving the pressure as a function of current.
The LSA2 is designed to operate diode ion pumps which require positive output polarity. (An optional version for triode ion pumps which require negative output polarity is available as well.) The LSA2 is optimized for a NEXTorr®D-100-5 or NEXTorr®D-200-5 pump from SAES, but other pumps fulfilling the specifications can be run as well.

WARNING: Please note that the polarity and high voltage (HV) has to be correct for your pump!

2 Unpacking and inspection

Before unpacking, inspect the parcel for any visible damage. If any evidence for damage of the package is found take pictures of the parcel and send them to FERROVAC GMBH immediately.
Prepare a clean and large enough workspace. Carefully unpack the device and perform a visual check for any damage of the package, its contents and accessories.

Compare the contents of the package with the delivery note. **Any damage or missing items must be reported to Ferrovac within 48 hours after delivery.**
The package should contain:

1. Battery Powered Ion Pump Controller
2. Battery Charger including different (country specific) power adapters
3. This manual and any manuals of additional subunits if applicable

Please keep the shipping boxes for warranty cases.

3 Overview and description

3.1 Panel description and connections

The LSA2 controller front and rear panel controls are shown in Fig. 3.

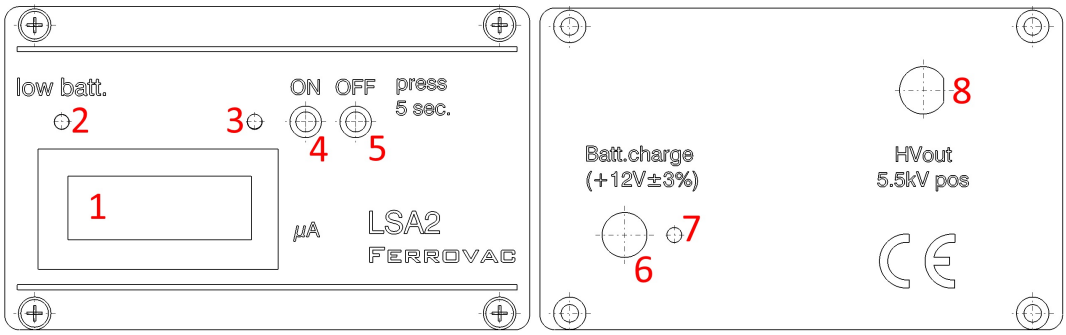

Figure 3: LSA2 front (left) and back (right) view.

In Fig. 3:

1. Display
2. Alarm LED indicating an alarm for low battery
3. Status LED indicating power availability
4. Power ON switch
5. Power OFF switch
6. External Power entry connector
7. Charging power LED
8. High voltage output connector (HUBER&SUHNER SHV type)

For more detailed characteristics, please see section 10.

4 Setup and installation

4.1 Installation

Please put the LSA on a solid support, like a solid table, such that it cannot easily fall down. When connecting any cable, make sure that they cannot become a falling hazard for other people working nearby or that anybody could tear down the LSA by running into a cable.

Installing the battery charger:

- The LSA must be charged using the delivered 12VDC ± 5% power adapter
- Make sure the correct mains connector for your country is installed on the power adapter
- Connect the power adapter to a suitable mains socket (not exceeding voltage fluctuations of ± 10 %)
- Connect the cable of the power adapter to the LSA power input socket # 6 in Fig. 3

The red LED # 3 in Fig. 3 should light up when the power adapter is connected.

4.2 Controller power management

Before using the Ion Pump controller, the internal battery must be charged for approximately 5 h. The fully charged controller will run up to 60 h on internal battery supply. The battery lifetime, with correct charging and discharging, is approximately 1000 cycles.

4.3 Connecting the Ion Pump

Make sure that the LSA is switched off. Connect the pump to the “HVout” output connector using a suitable high voltage cable with the correct SHV coaxial connector. The cable must be fully intact, the shield should not be damaged.

CAUTION: Only connect or disconnect the HV cabling when the LSA is switched off.
Only use a suitable cable rated for at least 5 kV DC with the appropriated connectors.

5 Operation, startup and shutdown

Before starting the controller you must reassure the following:

- The internal battery must have been charged for approximately 5 h before the first usage
- The HV output polarity selection (factory defined) is correct for the connected pump

- An Ion Pump is connected with the correct cable
- Vacuum conditions are sufficiently good to run the Ion Pump (see Ion Pump specifications)

5.1 Controller start-up

For starting the controller, press and hold the controller power ON switch (Fig. 3) for 5 seconds. At the same time the status LED (# 3) should light up.
NOTE: The LSA2 controller output is short circuit proof. Current overload >20 µA will result in an approximately linear decrease of the output voltage (see also performance data in section 10).
NOTE: At start-up of a pump it might take some time, until the pump reaches its normal working condition. Therefore the current drops usually during the first minutes from a high value. Please refer to the respective manual of the pump.

5.2 Controller shutdown

For shutting down the controller press and hold the power OFF switch for 5 seconds. The high voltage at the output connector will decrease to zero level after approximately 1 minute, depending on the load current.

5.3 Low battery

When the controller detects a low battery voltage it will begin to beep incessantly and the red LED (# 2 in Fig. 3) turns on. The remaining battery power lasts for about 3 h.

6 Display and functionality

6.1 Display

Basically the display shows the measured value of the ion current in µA. If the display reads ”0.00 µA” (or ”.000 µA” for LSA2.1), the ion current is out of range (underrange: i.e. vacuum $< 2\times10^{-10}$ mbar (or $< 2\times10^{-11}$ mbar for LSA2.1) [1]) or the high voltage cable is not connected to the device. ”1. µA” on the other hand means overrange (i.e. vacuum $> 1 \times 10^{-7}$ mbar [1]).

6.2 Alarms

When the controller detects a low battery voltage it will begin to beep incessantly and the red LED (# 2 in Fig. 3) turns on.

[1] Pressure data are valid for SAES NEXTorr® pumps of the types D100-5, D200-5, D300-5 and D500-5

6.3 Display light

The display background light illuminates when the “ON” button is pressed. It’ll switch off when the “ON” button is released again.

7 Transport and packing

During Transport outside a laboratory environment, the device should be switched off. All cables need to be removed. The LSA2 can be carried by hand or in an appropriate package for longer distances. The operator needs to make sure that the LSA2 is packed in such a way that the device is not switched on unintentionally. In addition no wires or thin pointed metallic parts should be able to touch the inner contact of the HV connector. The device should be protected from mechanical shocks.

8 Storing, disposal

Before removal of the HV cabling, the LSA should be switched off.
The device should be stored in a safe place where it cannot fall down or be switched on unintentionally (nothing should be able to press the ON button for a couple of seconds). The cabling can be gently coiled without making any kinks.
The device shall be disposed into electrical waste according to the local law and not into the general trash.

9 Maintenance

It is very important that the shield of the HV cable is intact. Please check the cable regularly for damages on the outer insulation or any kinks. The HV cable should be checked regularly to make sure that the insulation is not damaged and there are no kinks in the cables. The outer shield of the HV cable has to be intact which can be easily verified by measuring the resistance between outer metallic parts from one plug to the other. It must be below 100 mΩ.
With time of use, the battery storage capacity will decrease. The battery should be replaced after a period of 1000 charge/discharge cycles, as the number of discharge and charge cycles has an effect on the lifetime.
Please return the controller for a battery swap to Ferrovac GmbH. If this is not possible please contact Ferrovac GmbH for instructions.

WARNING:
The outer shield of the HV cable has to be intact which can be easily verified by measuring the resistance between outer metallic parts from one plug to the other. It must be below 100 mΩ.

WARNING:
The operator is not allowed to open the device and perform any maintenance tasks.

Only in exceptional cases FERROVAC GMBH and the **Responsible Body** can agree that a fully trained **Service Personnel** will receive special instructions to perform a particular maintenance task.

10 Performance Data

10.1 Battery Charge, Discharge and Output Voltage

It takes about 8 hrs to fully charge the LSA2 (see Fig. 4). The battery holds for about 40 hrs (see Fig. 4)

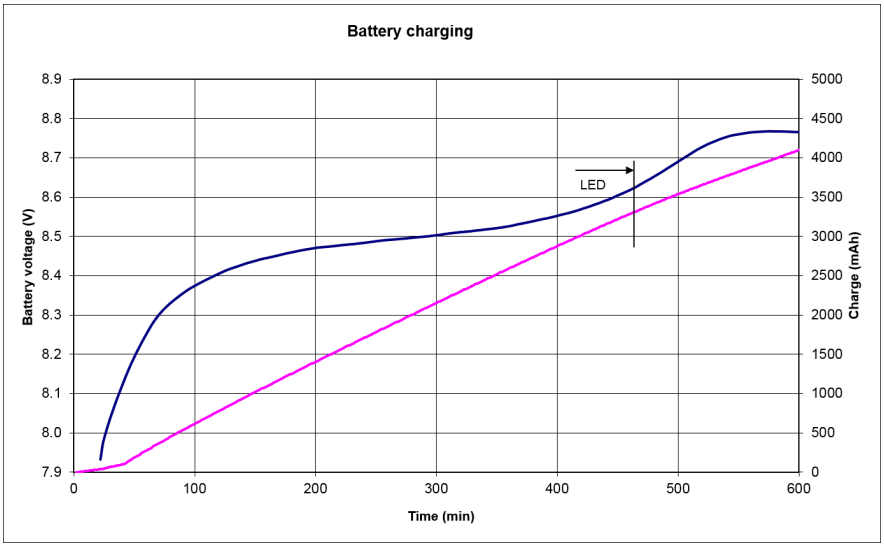

Figure 4: LSA2 battery charging and discharging curve (taken while LSA2 was switched off).

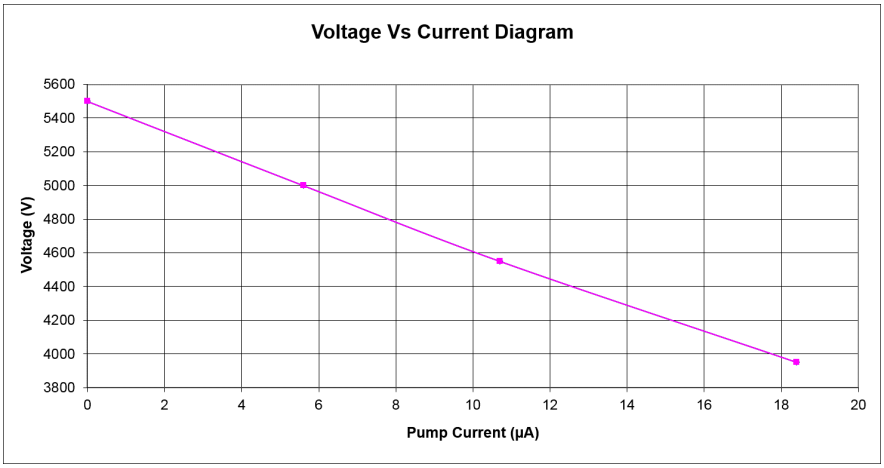

Figure 5: LSA2 output voltage as a function of output current.

10.2 Current Pressure Relation

When the LSA is switched on and an ion pump is connected, the ion current is displayed. For most pumps the current is directly proportional to the pressure in the pump (vacuum system).

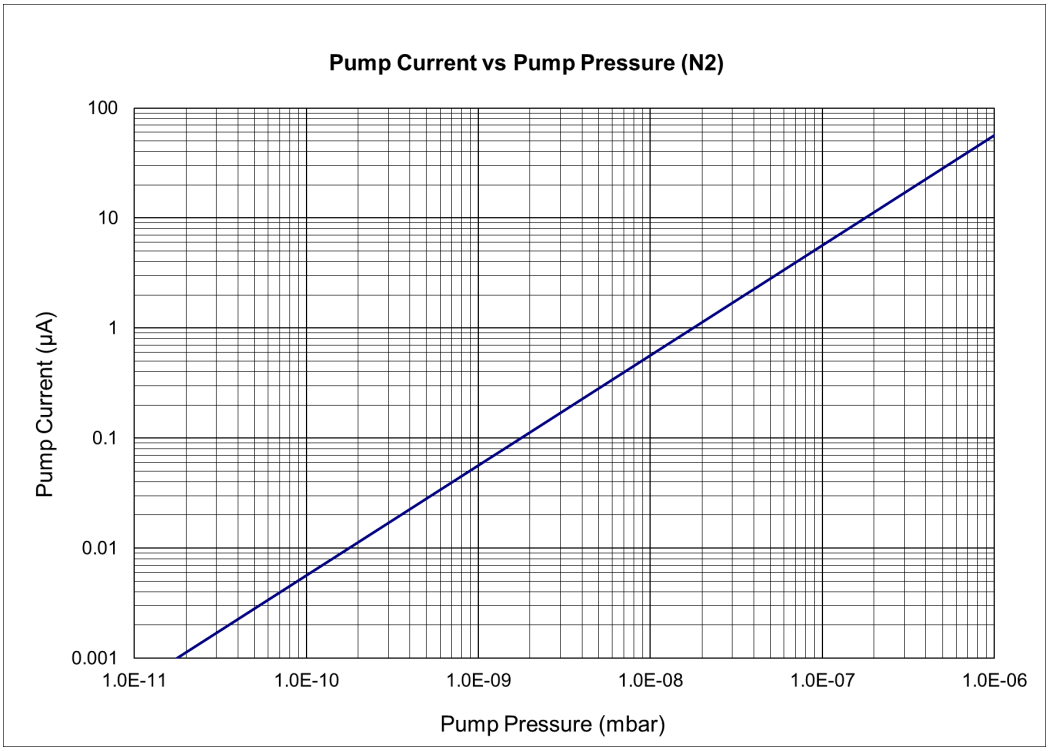

Figure 6: Current versus pressure graph for the afore mentioned pumps (valid for N_2).

The diagram in Fig. 6 provides the current to pressure conversion curve of the following pump models:
SAES NEXTorr®pumps:

- D100-5
- D200-5
- D300-5
- D500-5

For other ion pump models, please refer to their manual.

11 Upgrades

A variety of additional options and upgrades for the UHV suitcase are available. For details visit also our website www.ferrovac.com. If you have any questions please do not hesitate to contact us (sales@ferrovac.com).

11.1 LSA 2.1

The LSA2.1's pumping current display has a resolution of 1 nA (standard LSA2.0 has 10 nA). This allows to determine if the base pressure is truly in the 1^{-11} mbar range. See LSA2.1 page on our homepage.

11.2 LSA 3.0

The LSA3 is a battery powered ion pump controller with advanced features compared to the LSA2. It displays the pressure directly in mbar (for SAES NEXTorr®pumps of the types D100-5, D200-5, D300-5 and D500-5) and has an integrated temperature sensor input.
More information can be found at the LSA3 page.

12 Additional information

12.1 Return of defective items

Ferrovac GmbH will require an **RMA (Return of Materials Authorization) number** and **a complete declaration of contamination** to be issued, before any item is returned to us. Please contact us therefore. You will be given an RMA number and information on how to proceed with the return of your defective items.

12.2 Download

This manual can be downloaded from our website. It can be found via the specifications of the vacuum suitcase VSN40S or LSA2.0.

For any suggestions or questions considering this manual, please contact us and write an e-mail to sales@ferrovac.com.

A Supplemental Information

A.1 CE conformity sheet

EU declaration of conformity

FERROVAC GMBH
ULTRA HIGH VACUUM TECHNOLOGY

The manufacturer / authorised representative

FERROVAC GMBH
THURGAUERSTRASSE 72
8050 ZÜRICH
SWITZERLAND

hereby declares that the following product

Product designation: Battery Powered Ion Pump Controller
Make: LSA2.0/LSA2.1
Series/type designation: V2 R0, V2 R1
Description:
The LSA2 is a battery powered ion pump controller designated to operate ion pumps which fulfill the respective requirements for a supply voltage of 5kV and a maximum load current of 20uA. The device is powered by a Ni-MH rechargeable battery such that the controller can run up to 70h independently of an external electricity supply. The battery is charged by an external power supply which can be connected to the LSA2.

fulfills the regulations of the directive 2011/65/EU of the European Parliament and Council from 8th June 2011 on the restriction of the usage of certain hazardous substances in electrical and electronic devices.

The following additional EU directive has been applied:
EMC Directive 2014/30/EU

The following harmonised standards have been applied:

EN 50581:2012 Technical documentation for the assessment of electrical and electronic products with respect to the restriction of hazardous substances

EN 55011:2016 Industrial, scientific and medical equipment - Radio-frequency disturbance characteristics - Limits and methods of measurement (CISPR 11:2015 modified)

EN 61010-1:2010 Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements (IEC 61010-1:2010)

Place: Zurich, Switzerland
Date: 2017-08-31

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