General

The use of electronic power supplies (hereinafter EPS or simply ballasts) will bring substantial benefits to the operation of UV lamps:

- Small dimensions
- Less cabling
- Constant power output over entire input voltage range
- Gentle lamp start without flickering
- No compensation necessary
- Display of operating status by LED
- Automatic shutdown in case of failures
- Report of failures via error signalling contacts
- High frequency operation eliminates flickering of cathode
- Energy savings compared to conventional ballasts
- Increased lamp efficiency due to high frequency operation
- Low heat generation
- Increased switching frequency possible
- Energy savings and adaptation to environmental conditions by means of dimming possible

In the future, the operation of UV lamps will mainly be done with electronic power supplies. Appropriate rules are put in place in the EU.

While using electronic ballasts some things have to be considered in order to avoid adverse effects and dangers. Therefore, please read the information in the product information/ data sheets of the equipment as well as the following information for operation and installation carefully. Clarify questions with us before setting the devices into operation.

We do not assume any liability for damages of electronic ballasts, lamps and/or for consequential damages due to failure to observe the information and notes in this document.

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1 EPS types

Electronic ballasts can basically be classified as follows:

Distinction based on the starting behaviour

Cold start device (instant start)
Devices of this type start the lamps immediately without preheating of the filaments. They usually have only two wires to the lamp. A coil heating during operation does not take place. This ballast is not gentle on lamps and therefore made for continuous operation with a maximum of one switch-on per day.

Please note that a part of our EPS UVT- devices are cold start devices, but have four wires to the lamp. This solution makes it possible to verify the presence of the lamp prior to ignition. If no coil is detected, there will be no ignition. So, we avoid high voltages at the terminals and reduce stress on the power supplies.

Instant start equipment (rapid start)
Devices of this type start the lamps also without visible preheating. They have four wires to the lamp. During operation, a heating of the coil is performed. This type is suitable for continuous operation up to 3 starts per day.

Devices with pre-heating (pre heat start)
Devices of this type start the lamps after a pre-heating of the filaments of the lamp. They are very gentle on lamps and are also suitable to start lamps safely at low temperatures. A precise adjustment of the devices to the lamps used and their coils is necessary in this type. Otherwise, the lamps can be damaged in a very short time and/or the proper function is not guaranteed; for example by ignition problems. Devices of this type have four wires to the lamp. They are suitable for all applications including those with more than 3 cycles per day.

UV ballasts technologies are for the most part accomplished with preheating devices and adapted to our lamps. Please note if you do not use our lamps that we need samples to adjust the EPS.

The pre-heating type is mentioned in the data sheet.

Distinction based on the mains supply

Low Voltage units
The supply voltage is in the range up to 60 V direct current or alternating current voltage. Typical voltages are 12/24 V DC (lead-acid batteries from vehicles, boats or solar systems). Due to the high current at low voltage from the supply, these devices are only available for small wattages up to 40W.

Devices for standard mains voltages
The supply voltage is 230 V AC or 110 V AC. The majority of our equipment belongs to this category. Please note especially the permissible tolerance ranges. It may for example lead to problems if in the American supply 208 V AC is used between the phases to supply 230 V AC devices and an under-voltage is present. Normally, the devices respond with a shutdown. It is also possible that defects or malfunctions may result from a faulty mains voltage.

3- Phase-Units
Electronic ballasts of this category use the three-phase system as mains supply. The advantage of these devices is the uniform distribution of the load on all three phases by a three - phase rectification. Moreover, due to less strict regulations regarding the system perturbation effects of such devices, a PFC (Power Factor Corrector) can be omitted. Hence, the required electrolyte capacitor is not necessary, which results in approximately a doubling of the life expectancy of the unit. When using these devices, please note that the error message of a phase loss has to be evaluated or a separate phase-loss monitoring must be installed. In the case of the failure of one phase, the ballast must be immediately disconnected from the mains supply in order to prevent overloading and malfunction. Failure to comply with this notice will result in damage to the unit or the connected lamps.

Only if the limits of the supply voltage which are given in the data sheet are adhered, a stable operation of the connected lamp is guaranteed! Damages caused by incorrect or faulty supply voltage supplies (not sinusoidal, etc.) are not covered by the warranty!

Distinction according to the design

Devices with housing

The vast majority of our ballasts are equipped with a chassis. The case has to fulfil several tasks. It protects the electronics from damage and contact, is part of the cooling and reduces the radiation of electromagnetic interference as a part of the shield. Only with intact unaltered housing, our units comply with the values given in technical standards and levels of protection.

Please do not make any changes to the housings! In particular, do not remove the lid of the device! Changes can be extremely hazardous and may void the warranty!

Devices without housing

Such devices are suitable for customized solutions. Applicable standards, in particular for EMC and shock protection need to be observed during installation.

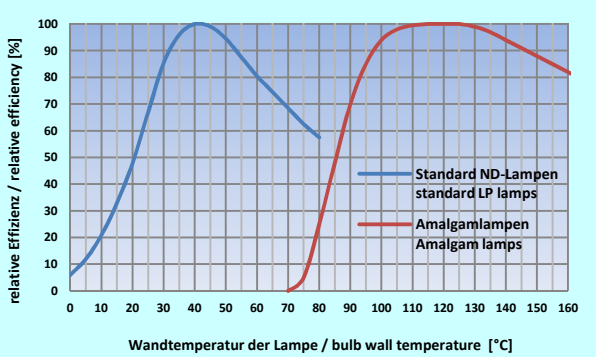
2 Permissible lamp wattages

The permissible lamp values given in the data sheets need to be strictly observed. Otherwise, this results in operational problems. These can range from a shutdown by the response of internal protection circuits to the full destruction of the ballast. Please note that the lamp description often does not comply with the electric power of the lamp. Therefore, compare the mentioned information in the data sheets of lamp electronic and power supply. For multi-lamp ballasts it must also be noted that the total load of the ballast remains within the specified limits, mentioned in the data sheet. To make matters worse, that lamp parameters may also change when operating and environmental conditions change.

Behaviour of low-pressure lamps

Low pressure lamps only comply with the specified values of their datasheets under optimum operating conditions. Should the lamp operate too cool or too warm, significant variations in the lamp voltage will occur. Since most ballasts keep the lamp current constant, the voltage change affects the change in performance. In power-controlled ballasts, the lamp current changes by a voltage change of the lamp.

The following graphic illustrates the behaviour of low pressure lamps. Just in the ideal temperature range of the lamp, the optimum UV output and the specified electrical values are correct.



The optimum temperature of the lamp is to be considered already in the design of the UV system. For example, the cooling effect can be varied in the lamp by means of different diameters of the quartz tube. Should design changes not be enough to meet the optimal temperature, the power supply can be dimmed to meet the requirements (see also 9).

As a manufacturer of both the bulbs and the ballasts we can advise you on this issue and adapt our products within physical limits, specifically to your application.

3 Efficiency

The efficiency is the ratio of the ballast output to the lamp power and the received power from the mains supply. Electronic ballasts have a much better efficiency compared to conventional ballasts (inductor operation). While conventional ballasts only achieve approx. 35%, an efficiency of >90 % can be assumed for our devices with PFC. Our three-phase units achieve up to 95% efficiency. The power loss is dissipated as heat from the ballast and must be removed. Please calculate a small additional safety factor while designing a cabinet.

4 Power factor

The power factor λ is the ratio of the effective power to the apparent power. Influences on this value have both, the phase shift between current and voltage cosϕ as well as the current distortions ε (deviation from the sinusoidal shape). In contrast to conventional ballasts (CPS/ inductive PS) no phase shift exists for EPS. Therefore, no compensation is necessary. However, during the operation of electronic ballasts distortions arise due to the superposition of integral multiples of the frequency (harmonic and harmonics).

Ballast from 40W must be equipped in the EU with a PFC (Power Factor Corrector). This part of the electronic ballast limits, together with the harmonic filter, the conducted repercussions of the devices back in the supply net. Our devices keep the harmonic distortion of the mains current within the specified limits of national and international regulations, as long as the product information and the given specified instructions are followed.

5 Installation

The connection of electronic ballasts is very important for a proper operation. Errors that are made hereby can cause damages of the equipment, cause interferences and even endanger life. Therefore, take care and observe the applicable national standards (*in Germany, for example, VDE 0100, VDE 0107...*).

The connection of the devices should be done only by trained personnel! Our EPSs must be installed and operated only in a dry, chemically and biologically inactive environment. The hints which are given in the product information (IP protection) are to be followed! The assembly may not be in vibrating system parts.

EPSs should be installed as far as possible from other system components. If possible, the cabling to other system components should be done separated from the ballast and especially not in the vicinity of its power and lamp cables. This is especially true for control, signal or sensor cables, which mostly have just small signal voltages or currents.

In general, our electronic ballasts must be mounted vertically on a grounded base plate, which also absorbs and removes a portion of the waste heat from the power supply. For the installation, suitable fixing screws have to be selected. It is necessary to ensure that a distance between the screw head and the PCB of at least 3 mm is kept. In no case, wide flat screw heads may be used, which protrude below the printed circuit board (danger of short cut!).

Connection

Our devices are equipped either with spring terminals or screw terminals, which are optionally provided for the use of rigid or flexible lines. The possible cable cross-sections as well as the necessary length of the wire strip are given in the product information. Please note that national installation standards may limit the availability of cable types/ cross-sections.
In general, rigid cables can be plugged-in without pressing the release button. For flexible cables (wire) the release must be pressed before the cable insertion. Always check the tightness of the wires by gently pulling them. The use of ferrules for flexible cables is not necessary. When using ferrules make sure that the correct length and a smooth crimp is given, because otherwise problems may occur during disassembly and terminals can be destroyed. Depending on the cross-section of the crimp (round, square) limitations of the maximum cable cross-section are possible. A tinning of wires should generally be avoided, since the oxidation of the solder causes contact problems, especially with screw connections.

Cabling

A trouble-free and safe operation of electronic ballasts is significantly based on the wiring. In this connection, the most mistakes are made. Please take exact note of the information listed in the product description, the sticker on the device and the following instructions. Errors in the wiring often cause failures of the device and do not fall under warranty.

Wiring of lamps

The wiring of the lamps shall be made in accordance with the instructions in the product description and the label. Short cuts, incorrect connections and loose connections in the wiring can cause damages and equipment failures. Cable connections to the lamp may not be disconnected during operation. Please never install components such as relays, switches, ignitors and capacitors in the lamp supply cable.

Lamp cables carry a high frequency signal and operate like an antenna. To avoid EMC problems, the lamp leads therefore must be kept as short as possible. The maximum length according to the product information must not be exceeded. Each lamp has to be wired individually with a four-wire cable or two two-wire cables (one for each socket of the lamp). Those lamp supply cables should be assembled in a small distance to each other to avoid interferences between the ballasts. Cables with more than 4 wires, which are used to put multiple EPS/ lamps in a row, are not allowed!

Lamp cables must never be laid in parallel to power or control cables. A minimum distance of 5-10cm is required, otherwise the EMC values for conducted interferences are no longer kept and malfunctions of the EPS may occur due to coupling.

The cable capacitance of the lamp cable should be as low as possible. Its value is derived from the cable capacitance per meter (see cable data sheet) times the length of the cable in meters. The cable capacitance is also increased by the parallel installation of the lamp wires and by metallic mounting surfaces or cable channels or shielded cables. The sums of these parasitic capacitances are added to the built-in capacitor of the ballast and thus tune the resonant circuit. This can have the effect of ignition problems and an altered lamp current. We recommend not to exceed a total cable capacitance of 3nF (note additional details, specified in the product information!). For the wiring of lamps, we recommend cables with a cross-section >0.75 mm² and relatively thick insulation of the individual wires. Thereby a certain minimum distance of the wires to each other is provided and thus a relatively low cable capacitance is achieved.

Control cables with a conductor cross section of 0.5 mm² or less are unsuitable. To reduce noise radiation, shielded cables are permitted. Please note, that additional capacities are therewith created and only use them when absolutely necessary. A grounded cable with a cross section of 4 mm², which is installed in parallel to the lamp cable, also reduces disturbances.

Mains supply cabling

The mains supply cabling must have a low impedance and the installation of the power cable has to be such that interferences by the emission of the lamp cable are minimized. Mains supply cables must be kept short and should not be installed in parallel to the lamp cables or directly along the ballast housings. Intersections with lamp cables should be avoided where possible. If absolutely necessary, such crossings shall be made in right angles and a certain distance. Unavoidable noise interferences can be eliminated by using foldable ferrites. For complex installations, mains filter must be provided if required. Basically, the interference avoidance is preferable to interference elimination.

Grounding

A proper grounding with adequate cable cross-section is essential for the compliance with EMC standards. Only if this is guaranteed, high-frequency disturbances can be derived and thus prevented.

Therefore, always connect all grounding terminals! Ground the mounting base plate! Do not forget to ground the cabinet door! Use toothed washers for reliable contacting of painted surfaces/ housings! Look for a clean earth potential! Avoid ground loops!

Additional information about cabling

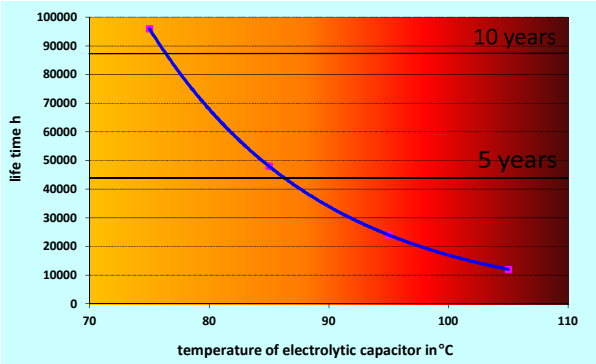
Any damage to the cable must be avoided! Cable penetrations through housings shall have no burs and must be adequately insulated! The same applies to edges, touched by the cable. Use cable strain relieves and bends protection! Consider bending radiuses! The cable specification must comply with the environmental conditions on site! If necessary, special cables need to be used (e.g. cross-protected against water, oil resistant, etc.).

Should cables be exposed to UV radiation or to ozone, generated by UV lamps, they must be insulated with Teflon (PTFE) or fibre glass. All other cable materials are not sufficiently UV-stable and need therefore to be protected in an appropriate manner!

Reduce clamping units of the lamp cable to a minimum! If possible, avoid them totally! Carefully check the terminals and connectors on usability, not just in terms of electrical values, but also in relation to temperature and ambient conditions. Protect the cable connections against corrosion! Loose contacts or sparks on corroded terminals may result in malfunction and failure of the EPS.

6 Temperature behaviour

The lifetime of an electronic device is determined by the error rate of the electronic components of which it consists. Generally spoken, the higher the temperature, the higher the error rate, the shorter the lifespan. In electronic ballasts, the electrolytic capacitor which is part of almost all devices is the lifespan-determining component (see chart).



In compliance with the installation instructions as well as the maximum housing temperature, a lifetime of at least 40,000 hours is realistic (expected value at optimum installation without exceeding the allowed housing temperature). That a temperature change of 10K doubles or halves the life of the capacitor can be seen as a rough calculation. A slight reduction of the components temperature is linked to a huge impact on the resulting lifetime. The resulting heat inside the units must be dissipated by all heat resistors (heat sink, air, housing). With an active cooling via fan this is done at the best, since the hot air is blown away from the components faster than by convection. Since you are not allowed to open the devices as an end user (danger to life and loss of warranty!), we indicate the allowed temperature via tc-point (c=case). This temperature is easily measurable. The easiest way to measure is the assembly of a PT100/1000 sensor on top of the case or at the specified tc-point. You can also use the temperature sensors for lamps which are offered by us. Please make sure that for all devices installed in the control cabinet, the specified maximum case temperature is not exceeded even in extreme operation (worst case). If you measure the temperature contact-free, please make sure that the correction factor for the measured surface is adjusted correctly. Otherwise, significant measurement errors may occur. The housing temperature of an EPS is at approx. 50°C, if you still can touch the unit with your hand for about 10 seconds.

The following notes should help you to plan the installation of our ballast.

The units must be vertically assembled with the mains supply connector on the bottom side. The installation should be done on a heat conductive mounting plate with maximum size. A sufficiently large cabinet should be chosen. The contained air must be able to circulate. If possible, use sheet metal housings. In comparison, plastic and stainless steel are the worse heat conductors. Also with regards to the shielding of electromagnetic radiation caused by the ballasts, the sheet metal is the best choice. When calculating the size of the cabinet, you can expect an overall power loss of about 10% (exact details, please check the data sheet). Assemble the ballasts if possible in the lower part of the cabinet, as it is cooler. The distance between the devices must be at least 1cm. Do not restrict the air convection with other fixtures or installation channels. If you need to assemble the devices above each other, please note that their operation is influenced by heat generation.

The maximum case temperature must not be exceeded even for the upper unit. Avoid the input of heat from the outside. Assemble a roof for shading the control box for example. Decouple warm lamp housings from the ballast housings. Otherwise, it is of course beneficial to couple thermally cold equipment (e.g. reactor with cold water) to the cabinet of the EPS. Turn on active cooling when overheating threatens. Try to keep the case temperature of ballasts for most of the time far below the maximum allowable temperature (approx. 10K less). Hence, you will achieve a longer lifetime and better operating safety. Also, avoid a short-term overheating of the devices. Particularly at risk in this case is not necessarily only the electrolytic capacitor, but also other heat-sensitive components such as transistors and rectifiers. A temperature exceeding from 10K at the tc-point will decrease the lifetime dramatically and lead to equipment failure. Wait long enough while doing temperature tests to reach the thermal balance of the ballasts. This can take up to several hours.

7 Switch

When switching the EPS on an inrush current pulse of very short duration (< 1ms) arises by the up-charge of the integral storage capacitor for the internal power supply. So choose the fuses out not only by the indicated operating currents, but also by the impact load. If possible, use slow-blow fuses. The same applies to the ground fault circuit interrupter (GFCI), which is triggered either by the high temporary inrush current or a low continuous current. Here, the leakage currents arise on the interference suppression capacitors of the EPS. Usually, our electronic ballasts have a leakage current of about 5mA. If allowed, please install a surge resistant, short-delayed GFCI protection switch with 30mA. Should the maximum possible number of EPS be exceeded for fuse or GFCI, you must group them wisely. Pay attention to the uniform load of the phases.

Please avoid repeated switch-on and off cycles of electronic ballasts. Wait at least 10 seconds after shut down before the next switching. Please also refer to the notes in the product descriptions. In extreme switching loads you should check with us first, if the selected device is suitable for your application.

8 Monitoring

Besides the usual operation LEDs, most of our ballasts are equipped with a signal output, which notifies the proper function of the unit. In most cases, this output is a relay that switches once the system ballast/ lamp is in operation. This relay output can be used for displaying/ signalising or switching functions. Please note the specified values in the data sheets for the contact load. Inductive or capacitive loads have to be avoided. In addition to the maximum allowable load, the minimum load must be considered in particular. Since relay contacts are cleaned by the sparks resulting from switching, the permanent operation with too low power or too low voltage can cause contact problems. Especially keep this in mind, when the signal contacts are to be connected directly to a PLC, where only 5V and a few mA are present in the communication circuit. Avoid, if possible, a series of signal contacts. If this is unavoidable, please make signal rings with just as few devices. In this case, select voltages/ currents in the signal circuit, which are significantly above the allowed minimum values. Instead of relays, electronic switches are installed in some EPS types. For these types, it should be noted that a voltage drop occurs between the contacts, since they have an internal resistance. Particularly in series connections, a voltage drop can be caused thereby, which prevents the safe switching of the connected load.

In addition to the relay outlet, some devices have the possibility to connect additional operation LEDs directly. This function is useful, if the ballast operation must be easily displayed in the front panel of the control box. Please note the information in the technical description, because the outlets are not potential-free for all devices, which must be considered during wiring.

EPS without signal contact can be monitored by means of threshold switches. Usually they are assembled in the primary circuit (the mains supply).

9 Dimming

Many of our electronic ballast have a dimming function. In most cases, it can be offered as an option. Dimming can be used to adjust the lamp power precisely to the operating conditions or to save power, but also for a stand-by mode to shorten the ramp-up time of amalgam lamps. Devices with dimming usually have an isolated 0-10 VDC input, which can be used to adjust the lamp current in the range of about 50..100%. Alternatively, some devices are equipped with digital interfaces like RS232/485/422 or Ethernet. Please note that the lamp output is not proportional to the lamp current, but strongly dependent on lamp characteristics and operating conditions (cooling of the lamp). It is the responsibility of the manufacturer of the complete system to check the suitable dimming range. If necessary, the operating temperature of the lamp as well as its possible dimming range can be influenced by the diameter adaption of the lamp protection tube. Especially for amalgam lamps, it must be considered that they should be operated at full power for a certain time from the start, before they can be dimmed. The surface temperature of such lamps must not fall below approx. 90°C, since the mercury is settling down on the amalgam spot and thereby, the UV output will drastically decrease. Even with normal low-pressure lamps, mercury can condense at the coldest point of the lamp and thus, cause lower UV outputs in the dimmed mode. Therefore, it is worthwhile to test the UV system carefully at all operating conditions before using the dimming function. You can use the possibility of dimming optimal, by including a UV sensor signal in your control system.

Some of our ballasts allow fixed settings for different lamps currents in comparison to the dimming function. Please use such devices, if a dynamic control is not necessary.

Please never try to dim electronic ballasts by changing the mains supply voltage. In almost all of our electronic ballasts, the integral PFC regulates fluctuations in the supply voltage, so that there is no influence on the output power. Mains voltages out of specification may cause damages on the ballast.

10 Electromagnetic compatibility

Since our ballasts are defined as special equipment for UV lamps, they are not subject to all regulations which have to be fulfilled by a standard ballast for lighting applications. Additionally, not all approvals as known for standard EPS may be acquired, since such tests are very price intensive and would make our special EPS much more expensive. Nevertheless, certain requirements must be met. In general, our devices are considered to comply with the following key features:

- Low Voltage Directive/ Safety
- Mains-borne disturbances (harmonics)
- Radio interference suppression (industry standard)
- Immunity (against external interference)

Please refer to the product information of our ballasts as well as the CE declaration of conformity to figure out which standards are met by the different EPS. With type approvals on reference lamps, we guarantee the compliance with EMC standards at the end of each development. In general, our electronic ballasts are tested with the most powerful lamps, which are approved for the suitable device. Thus, we ensure that our EPS do not interfere with other devices that are operated in the same supply or are installed in the vicinity. When properly installed, the emissions of the devices are kept within the allowed limits for industrial applications.

Please note that our technical information are just valid for individually driven EPS and for cable lengths of less than 3m. If multiple EPS are installed in one system, additional measures for interference suppression usually become necessary. The ballast is to be considered as a part of the plant construction. It is in the responsibility of the equipment manufacturer, his installing personnel or the end user to check the final system in accordance with the applicable rules.

11 Additional information

We point out that the operator (customer) is responsible that the system is operated on a power supply which meets the applicable rules. In particular, the voltage limits for the EPS must be kept, and the supply network must not contain any harmonic distortion, burst and surge disturbances. Should the quality of the power supply not be known, we recommend the installation of line filters and surge suppressors/ lightning protection. An interference-free supply is required for a proper operation!

EPS are complex electronic assemblies. They must be handled with care and must be installed only by authorized personnel. Repairs may only be carried out at our factory. Any modification to the equipment will invalidate the CE/ EN certificates as well as warranty claims.

The technical parameters of the equipment are only valid, if all the product information and installation instructions shall be stated. The built- in electronic ballast safety circuits which switch off the devices in case of malfunction only operate correctly if the installation instructions are followed.

Please note that electronic ballasts have no galvanic isolation between input and output. When not connected lamp or unit malfunctions, a high voltage can occur on the lamp outputs of the device consequently. Make sure that the mains supply is disconnected during maintenance and assembly work. Moreover, please note in this context that the entire system is properly grounded and secured, because otherwise, e.g. in the case of water contact of the lamp, lethal voltages can occur on the system.

Devices with transport damage must not be put into operation. Transport damage has to be reported immediately, otherwise the shipping insurance is void. Please note that after the start of EPS and during the ignition of the lamps, very high voltages (up to 1200 V_{eff}) may occur for a few milliseconds at the lamp connectors. These voltages are usually lower, when intact lamps are connected. Especially the operation of ballasts without a bulb or with damaged or old lamps can lead to overload, damage or breakdown. A change of the lamps according to the specified lifetime by the lamp manufacturer is therefore urgently needed.

Despite all care with development and production as well as during transportation, installation and operation, an error of technical devices can never be completely eliminated. For installations that require very high reliability, we therefore suggest to provide redundancy. If necessary, a safety stock at the OEM should be provided for the end customer.

We accept no responsibility for any damage or loss, caused by the operation or by defects of our ballast. The same applies to losses caused by delays in delivery.

In addition to the known technical contexts, all given instructions of this document are based on our experiences. We take no guarantee of completeness and correctness.