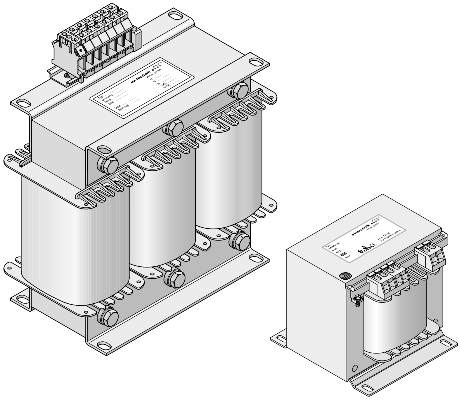

Conventional ballasts

CB

Due to the current-voltage characteristics of mercury lamps, a current-limiting ballast is required that is connected in series to the UV lamp. In UV applications, high-power mercury lamps with a power output of several kilowatts are currently exclusively operated on inductive or capacitive ballasts.

The simplest arrangement consists of a choke and a UV lamp connected in series. If different power outputs are required, a “stepped” circuit can be used. Several chokes are connected in parallel; the lamp current is increased by activating them one after the other.

Transductors enable dimming of up to approx. 50% of the rated power. With lamp arc voltages of more than 280 V, a sufficiently stable operation with a choke and 400 V mains is no longer possible. UV lamps with an arc voltage of 280 to 450 V are in practice mostly operated on a combination of autotransformer and choke or transductor.

As far as the ballasts described so far are concerned, an ignitor is required to ignite the UV lamp. In these cases, ignition devices operating at a maximum ignition voltage of 4 kV are used.

For arc voltages of more than 450 V, leakage transformers are used. Their leakage inductance has a current-limiting effect and at the same time their ratio of turns provides a higher voltage for the operation of the UV lamp. Choke circuits or transductor power stages can also be added.

Chokes

Partial-load chokes

In order to be able to switch the lamp power in steps using leakage-field transformers, e.g. 50% and 100%, one partial-load choke is required per additional step. This choke is connected in series with the transformer on the mains power side (primary side) to reduce the power accordingly. For full-load operation, the choke is bridged by a contactor/switch.

Multiple-step ballasts can be built by connecting several suitable partial-load chokes in series or in parallel.

If the partial-load choke(s) is (are) replaced by a controllable transductor, the result is a continuously variable ballast. Precise tuning of partial-load choke(s) to the transformer and the desired lamp power is also required here.

(Ballasts) Chokes

Low-voltage lamps with a power of up to approx. 5 … 6 kW (in special cases also somewhat higher) can be operated with one or more chokes directly connected to the mains. The resulting lamp voltages are as follows:

< 160 V on 230 V mains,
< 300 V on 400 V mains.

In principle, one choke is sufficient for operating a lamp at a preset power level. The choke limits the lamp current to the desired value. Therefore, the choke must be selected depending on the lamp and on the desired power as well as on the mains voltage and the mains frequency.

By connecting several suitable chokes in parallel (more rarely also in series), a ballast can be switched in different steps to match different lamp power levels. If the choke(s) is (are) replaced by a controllable transductor, this results in continuously adjustable ballast.

In most cases, a separate ignition unit is required for starting/igniting the lamp.

As chokes are inductive components, they generate an undesired phase shift between mains voltage and mains current which must be compensated by “compensation” capacitors.

cos φ choke = usually approx. 0.5 … 0.55
cos φ target = approx. 0.9 due to the capacitors

Autotransformers

Autotransformer-choke ballasts

For lamp output in the range between 6 … 9 kW, an autotransformer-choke ballast usually suits best. In most cases, this solution is less expensive than a leakage-field transformer.

An autotransformer transforms the mains voltage to, typically, 660 Volts. This enables the use of chokes, connected in parallel if necessary, to operate a lamp. Depending on the design of the chokes, the operation at various steps is also possible, up to a lamp operating voltage of approx. 320 to 450 Volts; the typical value is 440 … 450 Volts. Commercially available contactors can still be used up to a voltage of 660 Volts; these are usually also suitable for voltages of up to 690 Volts.

If the choke(s) is (are) replaced by a controllable transductor, the result would be a continuously variable ballast.

An additional ignitor starts the lamp. In spite of the 660 Volts, the commercially available 400 Volts ignition units can be used if the circuit is designed accordingly.

As autotransformers and chokes are inductive components, they generate an undesired phase shift between mains voltage and mains current that must be compensated for by compensation capacitors.

cos φ choke = mostly approx. 0.5 … 0.55
cos φ target = approx. 0.9 due to the capacitors

Transductors

Transductors

Transductors are controllable choke coils with a shaped or curved magnetic characteristic. They are also called magnetic amplifiers. Transductors are mainly used as DC-biased AC chokes that have power amplification between the active winding and control winding.

Although transductors have become redundant in many areas due to the use of modern power electronics and microprocessor technology, some niches remain where these components are still used, e.g. in cathodic corrosion-prevention rectifiers and charging units. In this case, the transductor is preferred despite higher costs as it provides the following benefits:

- High operational reliability
- No maintenance required
- Immediately ready for operation
- Floating active and control windings
- Shock resistance

Leakage-field transformers

Leakage-field transformers

Leakage-field transformers provide the required high ignition and operating voltages for lamps that cannot be connected to the mains directly via chokes due to their higher operating voltage. They differ from „normal“ transformers by their „softness“. They are usually used from a lamp power of approx. 10 kW.

„Soft“ in this context means that the output voltage of the transformer drops to a significantly lower value under load. In this way, it fulfils two functions simultaneously:

1. Without load, i.e. if the lamp has not been started, it outputs its complete open-circuit voltage (also called ignition voltage) which is at a value sufficiently high enough for the connected lamp to start immediately.

2. When the lamp has started, the output voltage drops to the operating-voltage level of the lamp due to the now flowing current. As soon as the lamp has reached its operating temperature, the current adjusts itself to what is needed for the required lamp power.

As the characteristics of the lamps can be different depending on the type and also on the required power, a leakage-field transformer must be tuned exactly to these values and built accordingly. Dependence on the mains voltage and the mains frequency must also be taken into account.

Versions for all mains voltages (AC) and frequencies found worldwide are feasible, also with tappings for different outputs. Due to the design principle, it is not possible to switch during lamp operation, the lamp would extinguish during the switching. Separate “partial-load chokes” which can be switched using contactors are required for switching during operation.

As leakage-field transformers are inductive components, they generate an undesired phase shift between mains voltage and mains current which must be compensated by compensation capacitors.

cos φ transformer = usually approx. 0.5 … 0.55
cos φ target = approx. 0.9 due to the capacitors