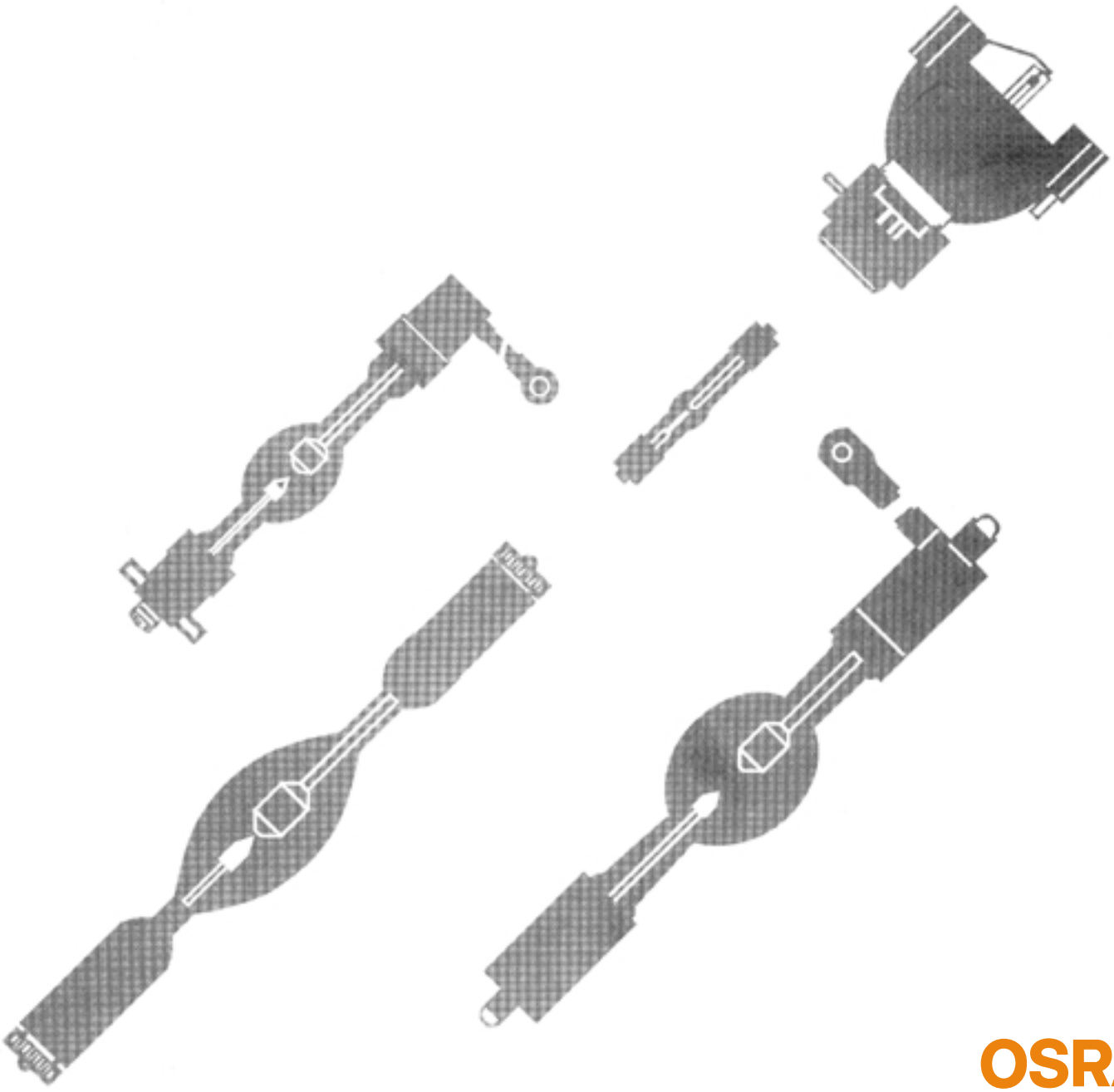
GUIDELINES FOR CONTROL GEAR AND IGNITERS

XENON
SHORT ARC LAMPS
PHOTO OPTICS



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1. Xenon high–pressure lamps

These instructions provide an overview of the properties of XBO lamps, their electrical data and describe the requirements that control gear must meet to ensure correct operation of the lamps.

The behaviour of the XBO lamps must comply with high requirements in an extremely wide variety of applications. Lamp manufacturers can guarantee that their lamps will function correctly if the power supply equipment meets the following requirements.

A notable feature of XBO lamps is the continual spectral distribution of the radiation, very similar to that of natural daylight, and the high luminance and radiance of the arc. These lamps are characterised by their low voltage gradient (V/cm arc length). As a result, the operating current assumes relatively high values. Because of the high currents involved, there is a bright and heavily kinked section of the arc ahead of the cathode. This is known as a cathodic arc spot and it is this that makes XBO lamps ideal as point sources of radiation for equipment with an optical beam path. Because of the loads that occur in dc operation, the electrodes of these XBO lamps for dc operation have different shapes. The spherical cathode is kept relatively short in order to achieve an adequate emission temperature. The anode on the other hand is large so that the heat resulting from the anode power loss can be transferred.

When the lamp is ignited the insulating gas must be ionised with high voltage to initiate arc formation. At the moment of ignition, at least the rated lamp current should be available, if possible with minimum delay, to ensure that the arc is reliably formed.

The ac component that is inevitable with technical dc current should be kept as small as possibe in the interests of good operating behaviour and long lamp life. The average life of XBO lamps is defined as the number of hours of operation after which, at constant current, the loss of luminous flux is approximately 25%. Since the vaporisation of the electrode meterial and hence the loss of luminous flux is determined to a large extent by the ac component in the direct current, smoothing is essential with rectifiers.

The XBO lamps need little maintenance. In view of the long life of the lamps, the control gear should offer the security that current pulsing does not exceed the maximum permissible value during extended operation. If necessary, the equipment description should contain instructions indicating when smoothing capacitors should be changed.

In many applications, great importance is attached to constant radiation intensity and spatial stability of the arc. Since the arc radiation more or less follows the curve of the lamp current, it is important to ensure that the lamp current is properly smoothed so that in demanding applications the radiation intensity is also correspondingly smooth.

XBO Lamps from 75W should be operated at constant current. At rated mains voltage, the units should be set to the reference values of the relevant lamp.

Since the lamp voltage can increase considerably over the life of a lamp, the control gear should limit the current, starting at 120% of rated lamp wattage, so that this wattage is not exceeded.

XBO lamps with a wattage of 450W or more have a relatively large wattage tolerance range which can be used as what is known as a "current control range". Controllable power supply units should enable the specified currents to be set within the current control range even if there are fluctuations in the mains voltage. The static characteristic of the XBO lamps (see Fig. 4) is positive and flat. To achieve operation that is as stable as possible at any current set, the characteristics of the lamp and control gear (see Fig.4) should intersect if possible at right angles.

In addition to normal operation on direct current, XBO lamps offer features for special applications, such as short term overload operation, pulse operation and modulation, depending on the particular design. Such special operating conditions call for a suitable power supply for which additioal recommendations may be given, but not binding instructions.

The above mentioned operating modes may, however, have a serious effect on the life of the lamp.

2. Operating values of the lamps

The attached lamp data sheets contain data essential to the construction of dc power supply units. In addition to rated values, the sheets contain reference data based on the voltage and current values of an average lamp of each type. They deviate only slightly from the rated data, if at all. We recommend setting the units according to the following instructions using the reference values for lamp voltage, lamp current and lamp wattage.

Lampen voltage/current characteristics

The voltage/current characteristics of XBO lamps can be represented by the following equation, once the lamp has reached operating temperature:

$$U_L = U_G + I_L \times R_L \text{ (V)}$$

In other words, the value for lamp voltage U_L is equal to the sum of a fictive basic voltage U_G and the product of the lamp current I_L and the static differential internal resistance R_L of the lamp. The values for U_G and R_L are guide values which are used to make it easier to show the lamp characteristics in the operating current ranges.

The tolerance values specified for lamp voltage are the manufacturing voltage tolerances for the lamps; possible changes in lamp voltage during the life of the lamp are also specified. The equation for U_L applies to the lamp current ranges indicated on the lamp data sheets. These current ranges are due to wattage tolerances.

3. Requirements to be met by control gear

Constant current units (rated wattages from 75W to 180 W)

The power supply unit can be set to the reference current with an equivalent resistance (U_{Ref} : I_{Ref}) instead of a lamp. At U_{100} (100 % mains voltage) the unit must be set so that the current that flows is the reference current specified in the lamp data sheets.

For device manufacture, the setting tolerance should not exceed $\pm$ 3 % since a large setting tolerance would reduce the permissible mains voltage tolerance for constant operation.

The maximum and minimum values (I_{Lmax} and I_{Lmin}) specified in the lamp data sheets represent the limit values for lamp current under standard mains voltage fluctuations. In connections with the permissible device setting tolerance of $\pm$ 3 %, the mains voltage tolerance may generally be $\pm$ 5 %. If mains voltage fluctuations of more than $\pm$ 5% are expected to persist, it is advisable to use power supply units which automatically compensate for the mains voltage fluctuations or which have a switchover facility for such mains conditions. In this latter case, we recommend using a voltage meter to check the mains voltage and setting points at, say, 93%(U_{93}), 100 % (U_{100}) and 107 % (U_{107}) of rated mains voltage. Setting point U_{100} will cover a range from 95 % to 105 % of the rated mains voltage, setting point U_{93} will cover a range from 88 % to 98 % and setting point U_{107} will cover a range from 102 % to 112%.

To ensure that the permissible limit values are not exceeded, devices with low temperature sensitivity are recommended; in other words, the lamp current should not change significantly in response to a temperature rise in the rectifier.

The maximum values for lamp wattage given in the lamp data sheets are given so that the devices can be correctly dimensioned. Depending on the type of lamp, they occur at 5% or 10 % mains overvoltage only if the lamps operated have lamp voltages which were at the upper limit of the manufacturing tolerance and which increased during operation by ΔU_G .

Controllable power supply units (rated wattage: from 250W)

Controllable power supply units should be designed so that the maximum permissible lamp current IL_{max} can be set at U_{90}(90% of the rated mains voltage) and the minimum lamp current IL_{min} can be set at U_{110}(110% of the rated mains voltage (see Fig.4)).

The best way to check these properties is to measure the device output characteristics with the aid of variable resistors:

a) Set the device output characterstic to U_{90} and set the control element to maximum.

b) Set the device output characteristic to U_{110} and set the control element to minimum.

The device characteristics will show the relationship between the output voltage and DC current from zero (no load) to maximum value.

The maximum and minimum currents (IL_{min} and IL_{max}) specified in the lamp data sheets indicate the limit of the current control range for the particular lamp type. In the course of their service lives, XBO lamps exhibit a gradual loss of luminous flux owing to the unavoidable blackening of the discharge tube. To compensate for this deterioration it is best to use power supply units in which the current can be continuously changed.

The maximum values for lamp wattage given in the lamp data sheets are given so that the power supply units can be correctly dimensioned. They occur at maximum current only if the lamps operated have lamp voltages which were at the upper limit of the manufacturing tolerance and which increased during operation.

To ensure that the current selected on a controllable rectifier does not vary, devices with constant current characteristics in the working range of the lamps and with low temperature sensitivity in the control circuit are recommended; in other words, the current set for a called rectifier and a lamp that has just been ignited should not vary significantly after a reasonable length of operation. In power supplies systems with control equipment in which the control variable is determined by the luminous flux of the lamps, this lamp current should not exceed the maximum permissible value either during the first minutes of operation after ignition or, with a blackened blub, at the end of its life. To check the lamp current in the case of controllable power supply units, it is necessary to provide an ammeter in the visual field of the control element so that the current can be read. The operating instructions for the units should include information regarding the quality of ammeter required!

In certain applications the usable control current range is not sufficient to produce the desired reduction in luminous flux. The lamp current can be reduced to a value of I_{limit} if we accept disadvantages such as arc instability and a possible reduction in lamp life.

Lamp current plusation

During operation of the XBO lamps there is erosion of the cathode tip which leads to blackening of the lamp bulb and normally to an increase in the electrode gap; this in turn leads to an increase in lamp voltage.

Wear on the cathode is lowest when the lamp is operated on pure DC current, such as that supplied by a battery. If, however, mains rectifiers are used to supply XBO lamps the load on the electrode and hence the life of the lamp current is less than 5%. The pulsation of the lamp current at U_{90}, U_{100} and U_{110} must be checked with a xenon lamp since an ohmic resistance instead of a lamp would lead to incorrect measurements.

Lamp pulsation is defined as follows:

$$p = \frac{i_{max} - i_{min}}{i_{max}} \times 100\%$$

i_{max} = Maximum value
i_{min} = Minimum value for the lamp current–time–curve

(Notes on measuring procedures are given at the end of this section).

If an extremely stable discharge arc or a low luminous flux pulsation is required it is best to keep the pulsation value for the lamp current as low as economically possible. The relationship between luminous intensity J and lamp current I_L approximates to the function $J \sim I_L^{1,5}$.

Transition to arc discharge

Simple mains rectifiers

During ignition and in the first few milliseconds after ignition, XBO lamps require a supply voltage that is higher than the lamp voltage in order to set up arc discharge. This supply voltage may be supplied directly from the lamp power source (mains rectifier–see Fig. 1). The minimum no–load voltages specified in the lamp data sheets should be applied to the lamps even at mains undervoltages of 10 % (U_{90}). For cold lamps the minimum no–load voltages U_{oc} are sufficient, whereas the higher voltage U_{oh} is needed to restart hot lamps.

The minimum no–load voltage in itself is not sufficient to set up the arc reliably, particularly with power supply units that have a relatively high inductance. If a mains rectifier has, for example, a smoothing reactor at its output a capacitor C_{ai} should be connected to the output of the unit as an ignition aid. The function of the capacitor is to supply current to the lamp with zero delay at the moment of ignition. To ensure that this auxiliary ignition capacitor C_{ai} does not discharge instantly a series resistor R_s is recommended (see also schematic diagram Fig.1). This series resistor prolongs the discharge time of the capacitor to a value that improves ignition and prevents excessive current peaks that would damage the lamps.

Booster rectifiers

Another way of setting up power supply units is shown in Fig. 2. An auxiliary voltage source (booster) is connected in parallel or in series to a main power source which has a no–load voltage U_{oH} below U_{oc} or U_{oh} .

In principle, only no−load voltages U_{oc} or U_{oh} as specified in the lamp data sheets are required to set up the low−voltage arc. For practical reasons, however, higher values are specified for the booster voltage U_{oB}. They apply to the booster capacitors C_B and the associated series resistor R_B. If a higher booster voltage is selected or a lower one down to U_{oh} the booster capacitor C_B and the series resistor R_B must be adjusted so that both the charge $Q = U_{oB} \times C_B$ and the discharge time constant ($R_B \times C_B$) are maintained at around their supposed values. Values for U_{oH}, U_{oB}, C_B and R_B are matched to one another in such a way that reliable setup of the low−voltage arc and a stable $U_L - I_L$ operating point can be achieved. U_{oH} may be undershot in special circumstances.

The values for the booster rectifiers specfied in the lamp data sheets apply only to control gear in which the main rectifier itself complies with the data given under "Startup conditions".

Startup current curve

In view of the need for low lamp current pulsation it is usually necessary to use smoothing elements which may, for example, comprise inductors and capacitors. A large inductance prevents the rapid increase in lamp current needed to ignite the lamps reliably(see Fig. 3a); a large capacitance may supply excessive discharge currents after igniting the lamp which in turn would overload and damage the electrodes.

The current curve with respect to time should meet the following conditions during startup of the lamp:

a) The reference current should be reached after 0.2 ms at the latest (see Fig. 3b)

b) The peak value should not exceed the values specified in the lamp data sheets (see Fig.3c)

c) If low−frequency oscillations occur a current equal to half the reference current must not be exceeded (see Fig. 3c).

(Notes on measuring procedures are given at the end of this section).

Condition a) can normally be fulfilled only with the help of an auxiliary ignition capacitor C_{ai}. Compliance with condition b) can be achieved with a resistor R_S connected in series with the auxiliary ignition capacitor, the resistance of which can be determined with sufficient accuracy from the difference between the average no−load voltage at the auxiliary ignition capacitor and the voltage U_{Ref} of a lamp. Around double the reference current should be selected as the peak value for capacitor discharge.

When the smoothing capacitor discharges via a smoothing reactor the maximum permissible peak value is exceeded when the smoothing reactor is highly saturated as the capacitor discharges. We therefore recommend you ensure an adequate air gap for the smoothing reactors.

Condition c) is crucial to capacitance C_{ai} ; C_{ai} results from the increase in the current of the main power source with respect to time in connection with the value for L and C of the smoothing element. The values for L and C of the smoothing element must be selected so that the resonance frequency is as far as possible from the mains frequency or a multiple thereof.

In order not to overload the cathode during ignition of the lamp, the charges Q_{max} specified in the lamp data sheets must also not be exceeded. These charges should be considered as overcurrents which may occur within t_o = 1 s after ignition beyond the charges defined by the product of $I_{Ref} \times t_o$ (see also Fig. 3c).

These maximum permissible overcurrents must be taken into account, for example, if self–exciting shunt–wound machines that are over–excited to increase the no–load-voltage before igniting the lamps are used as the main power sources. If over–excitation is too great or lasts too long overcurrents may occur which far exceed the permissible values.

Measurement procedures

When the power supply units are checked and adjusted, current and voltage measurements should be carried out with appropriate instruments that comply at least with Class 0,5 % .

If superimposed pulse ignitor is used to ignite XBO lamps they should be demensioned so that the lamp operating data is hardly influenced.

The startup current curve should be determined with the device cold, whereas the other measurements should be taken at operating temperature.

Since a high–frequency superimposed pulse igniter is usually used for igniting the lamp, high–frequency interference voltages may occur at the measurement resistor that will seriously corrupt the oscillograph display of the startup current curve. It is therefore necessary to connect an HF filter with an attenuation above 100 kHz of around 60 dB between the measurement resistor and the oscillograph.

4. Requirements to be met by igniters

Design of superimposed pulse igniters

Fig. 5 is a schematic diagram of a standard superimposed pulse igniter. The device consists essentially of a pulse generator and a superimposing transformer. The purpose of the pulse generator is to generate voltage pulses. In the case of modern devices (known as single–pulse igniters) the supply (terminals 1 and 2 in Fig. 5) comes directly from the DC voltage source (terminal 3 and 4). On older models the supply at terminals 1 and 2 comes from the AC supply system. The pulse in the form of an attenuated oscillation is injected into the lamp circuit by the superimposing transformer.

Minimum number of sparks and minimum peak value for the ignition voltage
The required number of pulses per half–wave depends on the type of lamp and the design of the igniter. DC operated igniters with semiconductor switches need only one pulse. AC operated igniters, on the other hand, need at least three sparks per half wave (F_{imin}) to ensure reliable operation.

The minimum number of sparks per half–wave (F_{imin}) is needed to avoid creepage sparks at the quartz wall and to create a discharge channel within the gas so that a low–frequency arc can be produced.

The number of sparks (F_{imin}) applies to in–phase supply voltages for the lamp and igniter. If a supply is selected for the igniter that lags 120° behind the lamp supply voltage, ignition will be possible with a slightly lower number of sparks. However, as lamp ignition is not possible if the phase leading by 120° of a three–phase system is selected, we recommend using an in–phase supply for safety reasons.

The minimum peak values for surge voltage U_{smin} specified in the lamp data sheets apply to single–spark igniters. Because of the effects of the potential, frequency and wave shape of the surge voltage on the ignition of the lamps, the ignition behaviour must be checked with lamps.

Time limiting switches

Since an igniter operating time of less than 1 s is sufficient to ignite Xenon lamps and the components of the pulse generator are generally demensioned for this short duration. We recommend limiting the igniter operating time. In the case of modern igniters

in which the pulse generator is supplied from the lamp voltage, disconnection is automatic. If the igniter is supplied from a separate source it is best to control the pulse generator with the lamp voltage via terminals a and b (see Fig. 5); in other words, to disconnect the pulse generator automatically as soon as the lamp has ignited (transition from lamp supply voltage U_0 to lamp operating voltage U_L). The possible value of U_0 and U_L are therefore given in the lamp data sheets. If the difference between U_0 and U_L is too small, the lamp current may be used for control purposes.

The time limiting switch should contain a diode to protect the igniter from being operated if the poles are reversed.

Superimposing transformer

The function of the superimposing transformer is to transform the voltages generated in the pulse generator into the surge voltage needed to ignite the lamps and to superimpose this surge voltage on the DC voltage or low–frequency lamp supply voltage.Since the high–voltage winding of the superimposing transformer is in the lamp circuit it must meet the following requirements:

- The secondary side of the superimposing transformer must be designed to handle the maximum permissible lamp current. Although according to the lamp lists or device requirements these lamp currents I_{Lmax} are permissible for only a short time, they should be considered as continuous currents for the superimposing transformer since a "short time" relates to a certain percentage of average lamp life.
- The DC resistance or the impedance of the secondary side of the superimposing transformer should be so small that it can be ignored when designing the power supply units (rectifiers, reactors, high–reactance transformers, etc.). This means that the inductance and ohmic resistance of the coil must be small so that the voltage drop remains below 5 % of the lamp voltage.
- Since some of the surge voltages are very high and a high voltage per winding is needed, only frequencies between around 1 and 10 MHz, depending on the surge voltage, can be considered for the attenuated oscillations.

Capacitance

To achieve the necessary surge voltages, tuning is recommended between the primary oscillating circuit, consisting of the surge capacitor belonging to the pulse generator and the primary winding of the superimposing transformer, and the secondary oscillating circuit at average load capacitance C_i. The secondary oscillating circuit consists of the inductance of the secondary winding of the superimposing transformer and capacitors C_i and C_1 connected in series..

Capacitor C_i represents the load capacitance for the igniter. C_i is formed by the inherent capacitance of an electrode with the base of the lamp, the lampholder and the lead from the igniter to the the lampholder. Since capacitor C_i has to be charged to the necessary surge voltage the load capacitance should not be too high. The capacitance cannot fall below a certain minimum value since the lamp casing or luminaire structure must be granted a certain tolerance for installing the igniter and lamp. For this reason, a range for the load capacitor C_i is given in the lamp data sheets. The surge voltage should not fall below its minimum value within this range.

Capacitor C_1 is needed to prevent the high–frequency surge voltage from reaching the power supply unit. To ensure that capacitor C_1 is effective it must be suitable for high frequency and have a high capacitance with respect to C_i .

Prior to ignition or in the case of non–ignition of the lamp, the lamp supply voltage is applied to capacitor C_1 (DC voltage or 50 or 60 Hz AC voltage). The lamp data sheets attached indicate the lamp supply voltages Uo that can occur. These values should be used to calculate the correct rating for this capacitor.

Capacitor C_2 shown in Fig. 5 is also used to protect the power supply unit or the mains supply and to suppress radio interference. It should short–circuit HF voltage that may occur if there are relatively large capacitative currents between the components carrying high voltage and the earthed luminaire components; it must therefore have similar properties to capacitor C_1 .

Maintenance

Modern igniters use zero–wear semiconductor switches. The quenched spark gaps used in older pulse generators are subject to wear. After lengthy operation they have to be replaced or, in the case of certain types of spark gaps, adjusted.

For safety reasons we recommend you ensure that the pulse generator is automatically disconnected from the mains voltage when the igniter is opened.

Test conditions

To ensure that the lamps ignite reliably the igniters must supply adequate surge voltages under capacitative load conditions, as represented in practice by the inherent capacitance of the high–voltage connection between the igniter and the lamp base. The minimum vales for the surge voltage peaks U_{Smin} should be measured with a 5 cm to 10 cm long sphere spark gap at 90% of the rated mains voltage.

To obtain comparable measured results with a sufficiently small scatter, the sphere spark gap used for the measurements should be irradiated with a UV lamp of sufficient power (e.g. a 5W quartz spotlight from a distance of no more than 20 cm). The surge voltage peak values are measured as a function of the load capacitance for the entire range of C_i.

The values specified for U_{Smin} apply for a relative air density of d = 1 (air pressure 1013 mbar, air temperature 20°). If the air density is other than 1, the measured results must be corrected accordingly.

Setting the equipment with spark gas in air for a relative air density of d = 1 guarantees reliable operation only up to an elevation of 500 m above seal level. At higher elevations the spark gaps must be adjusted accordingly.

To enable hot lamps to restart reliably, the igniter data must not deteriorate even after lengthy loading of the secondary side of the superimposing transformer with the maximum permissible current $I_{Lmax.}$ It is therefore important to check both the surge voltage and the number of sparks of an igniter at the maximum permissible ambient temperature after prolonged loading of the output transformer with the maximum current I_{Lmax} .

Fig. 1: Schematic diagram of a mains rectifier

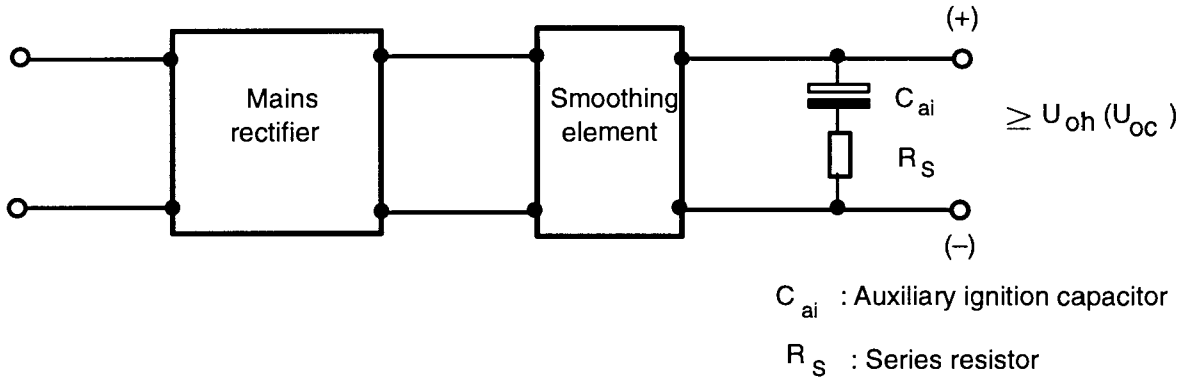


Fig. 2: Schematic diagram of a booster circuit

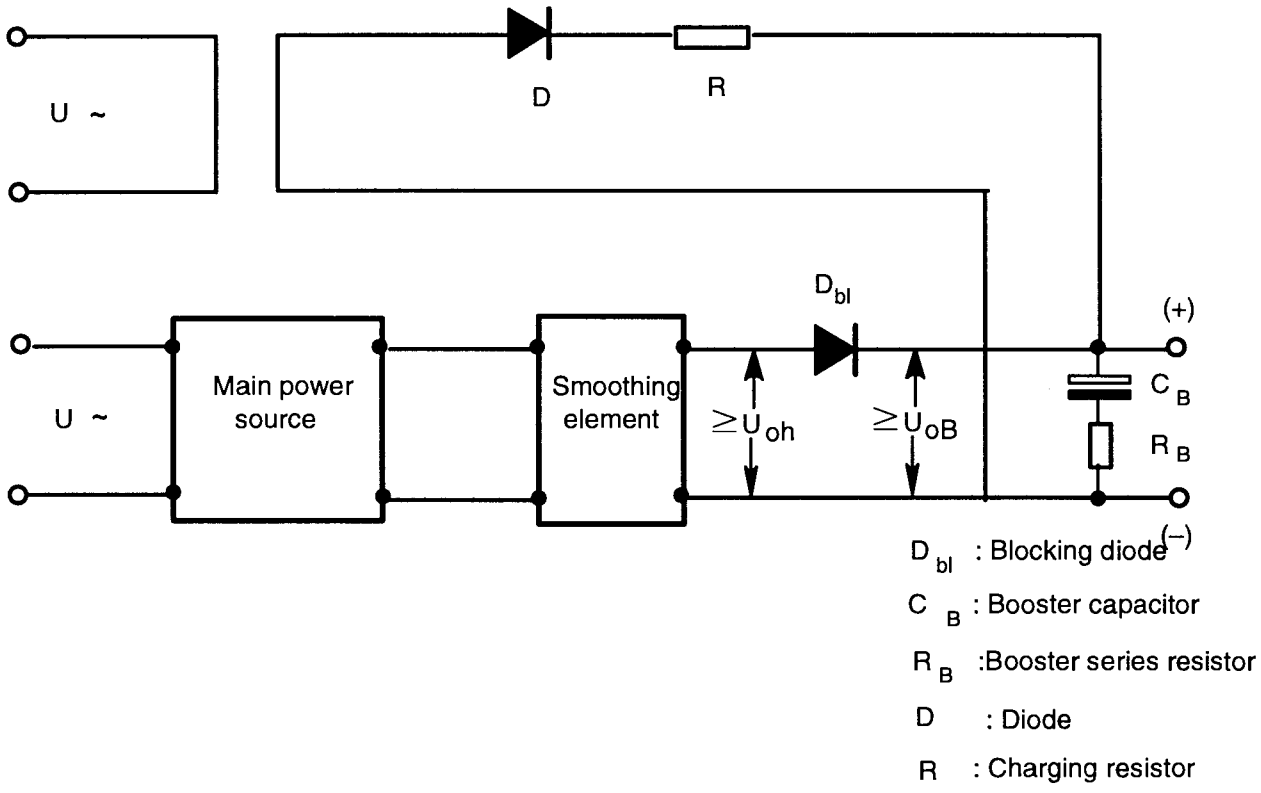


Fig. 3: Startup current curve during ignition of XBO lamps

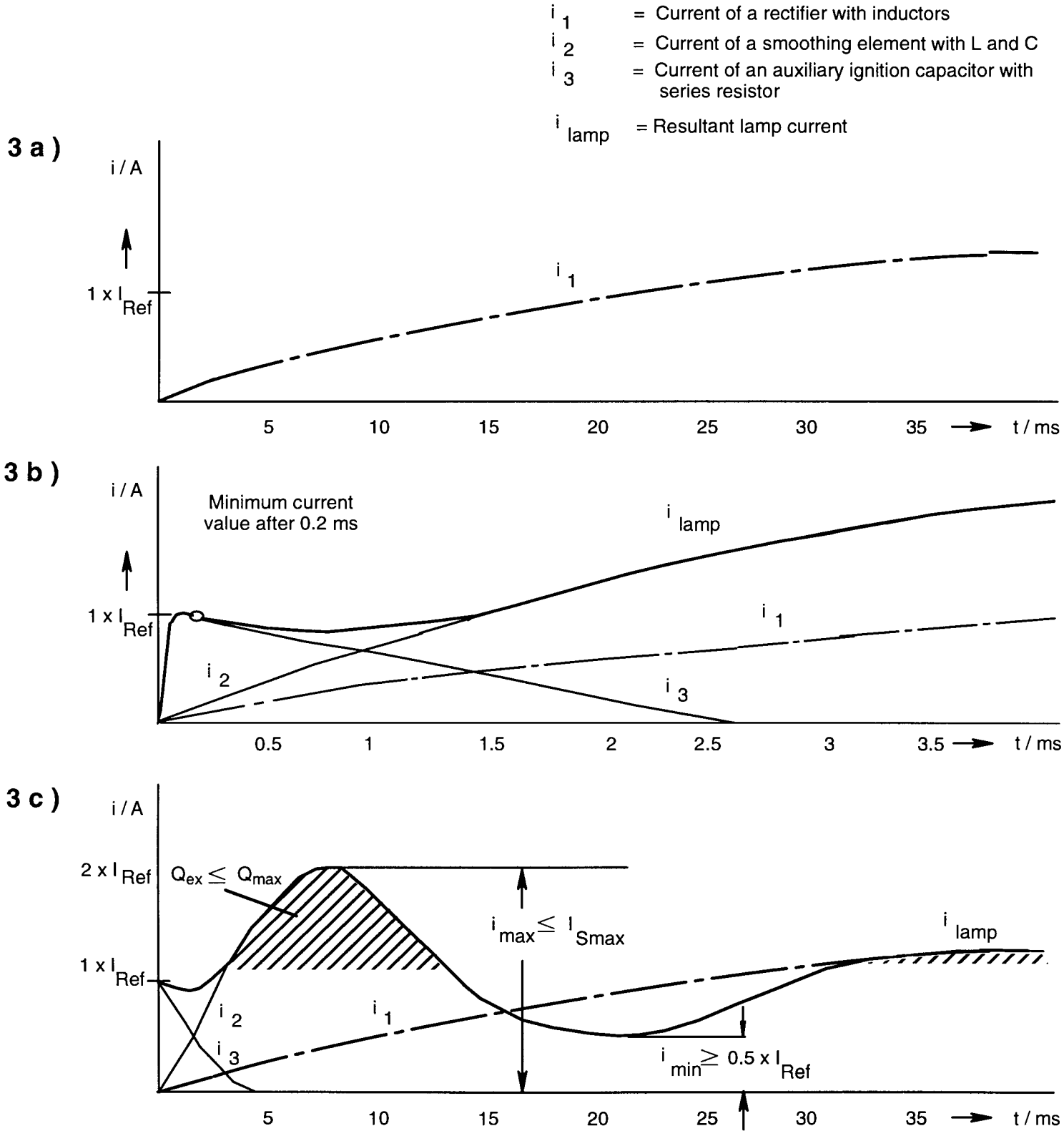


Fig. 4: Lamp and equipment characteristics

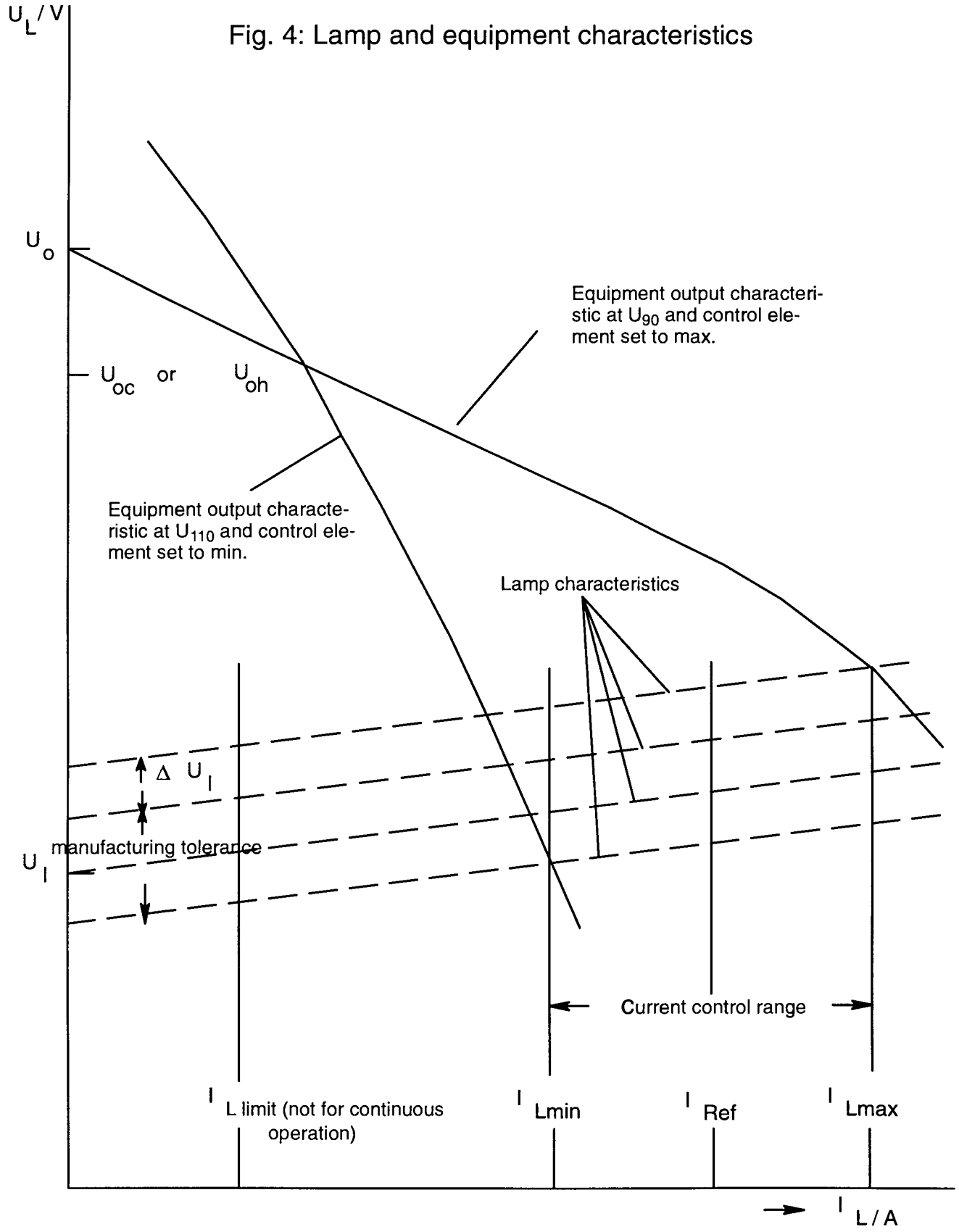
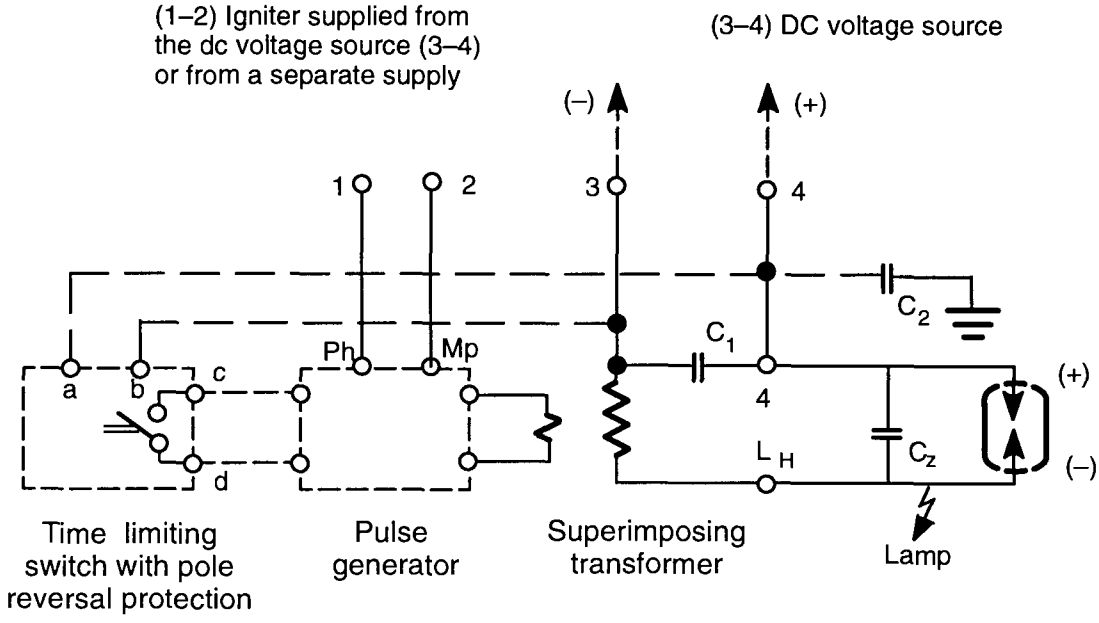


Fig. 5: Schematic diagram of a superimposing transformer



1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	12 – 16
Reference voltage	U_{Ref} /	V	14
Base voltage (computational)	U_B /	V	14
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0
Lamp operating current			
Rated current	I_L /	A	5.4
Reference current	I_{Ref} /	A	5.4
Maximum current	I_{LMax} /	A	5.9
Minimum current	I_{LMin} /	A	4.9
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	75
Reference power	P_{Ref} /	W	75
Maximum power	P_{LMax} /	W	86
Minimum power	P_{LMin} /	W	64

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	45
for ignition of cold or hot lamps	U_{oh} /	V	50
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	28
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	1500
Series resistance to booster capacitor	R_B /	Ω	5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	15
Maximum allowable additional charge during ignition	Q_{max} /	As	3

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	20
Impulse width at 0.9 U_{Stmin} /		µs	0.1
Load capacity range	C_Z /	pF	5–15
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	12.8 – 14,4
Nominal voltage	U_L /	V	13.6
Reference voltage	U_{Ref} /	V	13.6
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	7.0
Reference current	I_{Ref} /	A	7.0
Maximum current	I_{LMax} /	A	7.2
Minimum current	I_{LMin} /	A	
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	100
Reference power	P_{Ref} /	W	100
Maximum power	P_{LMax} /	W	100
Minimum power	P_{LMin} /	W	90

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	45
for ignition of cold or hot lamps	U_{oh} /	V	50
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	30
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	1500
Series resistance to booster capacitor	R_B /	Ω	5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	15
Maximum allowable additional charge during ignition	Q_{max} /	As	3

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	20
Impulse width at 0.9	U_{Stmin} /	µs	0.1
Load capacity range	C_Z /	pF	5–15
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.5

Remarking:
U_{Stmin},F_{Zmin} and T_{Zmin} are valued for convertional AC–operated igniters with pulse generators. For ignitors with single pulse operation,the above given data are applicable. The lamp does not have a separate ignition electrode.

			XBO 150 W/S;	XBO 150 W/1; XBO 150 W/1 OFR XBO 150 W/4
1. Operating data for lamps				
Lamp operating voltage				
Rated voltage	U_L /	V	17 – 21	17 – 21
Reference voltage	U_{Ref} /	V	20	20
Base voltage (computational)	U_B /	V	18.5	14
Maximum increase during life	ΔU_B /	V	3	2
Internal resistance (static)	R_i /	Ω	0.2	0.8
Lamp operating current				
Rated current	I_L /	A	7.5	7.5
Reference current	I_{Ref} /	A	7.5	7.5
Maximum current	I_{LMax} /	A		
Minimum current	I_{LMin} /	A		
Maximum allowable ripple	ri_{max}	%	5	5
Lamp power				
Rated power	P_L /	W	150	150
Reference power	P_{Ref} /	W	150	150
Maximum power	P_{LMax} /	W	200	200
Minimum power	P_{LMin} /	W	120	120
2. Requirements for power supplies				
Minimum open circuit voltage (for power supplies without booster circuit)				
for ignition of cold lamps	U_{oc} /	V	60	65
for ignition of cold or hot lamps	U_{oh} /	V	70	75
No load requirements for power supplies with booster circuits				
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	35	40
Voltage of booster circuit	U_{oB} /	V	100	120
Minimum capacitance of booster capacitor	C_B /	µF	2500	2500
Series resistance to booster capacitor	R_B /	Ω	4	4
Limits of inrush current				
Maximum peak of inrush current	I_{pmax} /	A	25	25
Maximum allowable additional charge during ignition	Q_{max} /	As	5	5
3. Requirements for igniters				
Minimum ignition peak voltage	U_{Stmin} /	kVs	25	25
Impulse width at 0.9	U_{Stmin} /	µs	0.1	0.1
Load capacity range	C_Z /	pF	5 – 20	5 – 20
AC controlled igniters				
Minimum pulse rate per line half wave	F_{Zmin} /	–	3	3
Minimum ignition time	T_{Zmin} /	sec	0.1	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	15 – 18
Reference voltage	U_{Ref} /	V	16.5
Base voltage (computational)	U_B /	V	12.9
Maximum increase during life	ΔU_B /	V	3
Internal resistance (static)	R_i /	Ω	0.6
Lamp operating current			
Rated current	I_L /	A	8.5
Reference current	I_{Ref} /	A	8.5
Maximum current	I_{LMax} /	A	9
Minimum current	I_{LMin} /	A	6
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	150
Reference power	P_{Ref} /	W	153
Maximum power	P_{LMax} /	W	200
Minimum power	P_{LMin} /	W	120

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	55
for ignition of cold or hot lamps	U_{oh} /	V	65
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	35
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	4
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	25
Maximum allowable additional charge during ignition	Q_{max} /	As	5

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	25
Impulse width at 0.9	U_{Stmin} /	µs	0.1
Load capacity range	C_Z /	pF	10 – 40
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	12.8 – 14.8
Reference voltage	U_{Ref} /	V	14
Maximum increase during life	ΔU_B /	V	3.5
Internal resistance (static)	R_i /	Ω	0.1
Lamp operating current			
Rated current	I_L /	A	12
Reference current	I_{Ref} /	A	12
Maximum current	I_{LMax} /	A	12.25
Minimum current	I_{LMin} /	A	11.75
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	180
Reference power	P_{Ref} /	W	180
Maximum power	P_{LMax} /	W	210
Minimum power	P_{LMin} /	W	150

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	60
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	30
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	1500
Series resistance to booster capacitor	R_B /	Ω	5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	20
Maximum allowable additional charge during ignition	Q_{max} /	As	3

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	20
Impulse width at 0.9	U_{Stmin} /	µs	0.1
Load capacity range	C_Z /	pF	5–15
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	11 – 15
Reference voltage	U_{Ref} /	V	14
Base voltage (computational)	U_B /	V	12.5
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.08
Lamp operating current			
Rated current	I_L /	A	18
Reference current	I_{Ref} /	A	18.5
Maximum current	I_{LMax} /	A	20
Minimum current	I_{LMin} /	A	16
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	250
Reference power	P_{Ref} /	W	259
Maximum power	P_{LMax} /	W	340
Minimum power	P_{LMin} /	W	176

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	55
for ignition of cold or hot lamps	U_{oh} /	V	65
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	30
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	4
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	40
Maximum allowable additional charge during ignition	Q_{max} /	As	10

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	20
Load capacity range	C_Z /	pF	10–15
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	15 – 19
Reference voltage	U_{Ref} /	V	18
Base voltage (computational)	U_B /	V	15.5
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.1
Lamp operating current			
Rated current	I_L /	A	25
Reference current	I_{Ref} /	A	25
Maximum current	I_{LMax} /	A	30
Minimum current	I_{LMin} /	A	17
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	450
Reference power	P_{Ref} /	W	450
Maximum power	P_{LMax} /	W	630
Minimum power	P_{LMin} /	W	255

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	70
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	40
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	3
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	50
Maximum allowable additional charge during ignition	Q_{max} /	As	12

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	33(40)
Load capacity range	C_Z /	pF	10 – 25
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

Remarking:

For XBO 450W/1 lamps igniters with peak voltages $\geq$ 40 kV_s are required.

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	15 – 19
Reference voltage	U_{Ref} /	V	17
Base voltage (computational)	U_B /	V	12.4
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.2
Lamp operating current			
Rated current	I_L /	A	28
Reference current	I_{Ref} /	A	25
Maximum current	I_{LMax} /	A	30
Minimum current	I_{LMin} /	A	17
Maximum allowable ripple	ri_{max}	%	10
Lamp power			
Rated power	P_L /	W	500
Reference power	P_{Ref} /	W	425
Maximum power	P_{LMax} /	W	630
Minimum power	P_{LMin} /	W	255

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	80
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	50
Voltage of booster circuit	U_{oB} /	V	120
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	3
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	56
Maximum allowable additional charge during ignition	Q_{max} /	As	15

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	30
Load capacity range	C_Z /	pF	10 – 30
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	12 – 16
Reference voltage	U_{Ref} /	V	14
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	30
Reference current	I_{Ref} /	A	
Maximum current	I_{LMax} /	A	30
Minimum current	I_{LMin} /	A	20
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	420
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	540
Minimum power	P_{LMin} /	W	240

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	55
for ignition of cold or hot lamps	U_{oh} /	V	65
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	320
Voltage of booster circuit	U_{oB} /	V	100
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	4
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	60
Maximum allowable additional charge during ignition	Q_{max} /	As	15

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	30
Load capacity range	C_Z /	pF	10 – 30
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	20 – 24
Reference voltage	U_{Ref} /	V	
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	25
Reference current	I_{Ref} /	A	
Maximum current	I_{LMax} /	A	27
Minimum current	I_{LMin} /	A	17
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	550
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	702
Minimum power	P_{LMin} /	W	340

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	80
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	
Voltage of booster circuit	U_{oB} /	V	
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	3
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	50
Maximum allowable additional charge during ignition	Q_{max} /	As	15

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	30
Load capacity range	C_Z /	pF	10 – 30
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	16 – 20
Reference voltage	U_{Ref} /	V	19
Base voltage (computational)	U_B /	V	14.2
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.135
Lamp operating current			
Rated current	I_L /	A	37
Reference current	I_{Ref} /	A	37
Maximum current	I_{LMax} /	A	45
Minimum current	I_{LMin} /	A	30
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	700
Reference power	P_{Ref} /	W	703
Maximum power	P_{LMax} /	W	990
Minimum power	P_{LMin} /	W	480

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	75
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	50
Voltage of booster circuit	U_{oB} /	V	120
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	2.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	74
Maximum allowable additional charge during ignition	Q_{max} /	As	20

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	30
Load capacity range	C_Z /	pF	10 – 30
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	17 – 21
Reference voltage	U_{Ref} /	V	20
Base voltage (computational)	U_B /	V	14.5
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.12
Lamp operating current			
Rated current	I_L /	A	45
Reference current	I_{Ref} /	A	45
Maximum current	I_{LMax} /	A	53
Minimum current	I_{LMin} /	A	30
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	900
Reference power	P_{Ref} /	W	896
Maximum power	P_{LMax} /	W	1219
Minimum power	P_{LMin} /	W	510

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	60
for ignition of cold or hot lamps	U_{oh} /	V	70
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	50
Voltage of booster circuit	U_{oB} /	V	120
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	2.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	90
Maximum allowable additional charge during ignition	Q_{max} /	As	20

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	30
Load capacity range	C_Z /	pF	10 – 30
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

			XBO 1000 W/HS OFR XBO 1000 W/HSC OFR	XBO 1000 W/HTP OFR
1. Operating data for lamps				
Lamp operating voltage				
Rated voltage	U_L /	V	17 – 21	19 – 23
Reference voltage	U_{Ref} /	V	20	22
Base voltage (computational)	U_B /	V	13.5 ± 2	14.8
Maximum increase during life	ΔU_B /	V	2	2
Internal resistance (static)	R_i /	Ω	0.130	0.16
Lamp operating current				
Rated current	I_L /	A	50	45
Reference current	I_{Ref} /	A	45	45
Maximum current	I_{LMax} /	A	55	55
Minimum current	I_{LMin} /	A	30	30
Maximum allowable ripple	ri_{max}	%	5	5
Lamp power				
Rated power	P_L /	W	1000	1000
Reference power	P_{Ref} /	W	900	990
Maximum power	P_{LMax} /	W	1265	1375
Minimum power	P_{LMin} /	W	510	570
2. Requirements for power supplies				
Minimum open circuit voltage (for power supplies without booster circuit)				
for ignition of cold lamps	U_{oc} /	V	65	65
for ignition of cold or hot lamps	U_{oh} /	V	70	75
No load requirements for power supplies with booster circuits				
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	50	50
Voltage of booster circuit	U_{oB} /	V	100	100
Minimum capacitance of booster capacitor	C_B /	µF	2500	2500
Series resistance to booster capacitor	R_B /	Ω	2.5	2.5
Limits of inrush current				
Maximum peak of inrush current	I_{pmax} /	A	100	90
Maximum allowable additional charge during ignition	Q_{max} /	As	25	20
3. Requirements for igniters				
Minimum ignition peak voltage	U_{Stmin} /	kVs	30	30
Load capacity range	C_Z /	pF	10 – 30	10 – 30
AC controlled igniters				
Minimum pulse rate per line half wave	F_{Zmin} /	–	3	3
Minimum ignition time	T_{Zmin} /	sec	0.1	0.1

			XBO 1600 W OFR XBO 1600 W/CA OFR	XBO 1600 W/HS OFR XBO 1600 W/HSC OFR
1. Operating data for lamps				
Lamp operating voltage				
Rated voltage	U_L /	V	22 – 26	21 – 25
Reference voltage	U_{Ref} /	V	25	24
Base voltage (computational)	U_B /	V	18.5	
Maximum increase during life	ΔU_B /	V	2	
Internal resistance (static)	R_i /	Ω	0.1	
Lamp operating current				
Rated current	I_L /	A	65	65
Reference current	I_{Ref} /	A	65	65
Maximum current	I_{LMax} /	A	75	70
Minimum current	I_{LMin} /	A	45	50
Maximum allowable ripple	ri_{max}	%	5	5
Lamp power				
Rated power	P_L /	W	1600	1550
Reference power	P_{Ref} /	W	1625	1550
Maximum power	P_{LMax} /	W	2100	1890
Minimum power	P_{LMin} /	W	990	1050
2. Requirements for power supplies				
Minimum open circuit voltage (for power supplies without booster circuit)				
for ignition of cold lamps	U_{oc} /	V	65	65
for ignition of cold or hot lamps	U_{oh} /	V	70	75
No load requirements for power supplies with booster circuits				
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	50	50
Voltage of booster circuit	U_{oB} /	V	100	100
Minimum capacitance of booster capacitor	C_B /	µF	2500	2500
Series resistance to booster capacitor	R_B /	Ω	1.5	1.5
Limits of inrush current				
Maximum peak of inrush current	I_{pmax} /	A	130	130
Maximum allowable additional charge during ignition	Q_{max} /	As	35	35
3. Requirements for igniters				
Minimum ignition peak voltage	U_{Stmin} /	kVs	35	30
Load capacity range	C_Z /	pF	10 – 45	10 – 30
AC controlled igniters				
Minimum pulse rate per line half wave	F_{Zmin} /	–	3	3
Minimum ignition time	T_{Zmin} /	sec	0.1	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	25 – 29
Reference voltage	U_{Ref} /	V	29
Base voltage (computational)	U_B /	V	20.6
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.12
Lamp operating current			
Rated current	I_L /	A	70
Reference current	I_{Ref} /	A	70
Maximum current	I_{LMax} /	A	85
Minimum current	I_{LMin} /	A	50
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	2000
Reference power	P_{Ref} /	W	2030
Maximum power	P_{LMax} /	W	2635
Minimum power	P_{LMin} /	W	1250

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	85
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	150
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	140
Maximum allowable additional charge during ignition	Q_{max} /	As	30

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	33
Load capacity range	C_Z /	pF	10 – 50
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	22 – 26
Reference voltage	U_{Ref} /	V	
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	80
Reference current	I_{Ref} /	A	80
Maximum current	I_{LMax} /	A	85
Minimum current	I_{LMin} /	A	50
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	2000
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	2380
Minimum power	P_{LMin} /	W	1100

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	85
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	150
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	2
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	160
Maximum allowable additional charge during ignition	Q_{max} /	As	40

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	33
Load capacity range	C_Z /	pF	10 – 50
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

			XBO 2500 W/HS OFR	XBO 2500 W OFR
1. Operating data for lamps				
Lamp operating voltage				
Rated voltage	U_L /	V	25 – 29	27 – 31
Reference voltage	U_{Ref} /	V	27	30
Base voltage (computational)	U_B /	V	17.2	21
Maximum increase during life	ΔU_B /	V	2	2
Internal resistance (static)	R_i /	Ω	0.12	0.108
Lamp operating current				
Rated current	I_L /	A	90	83
Reference current	I_{Ref} /	A	85	83
Maximum current	I_{LMax} /	A	100	95
Minimum current	I_{LMin} /	A	70	60
Maximum allowable ripple	ri_{max}	%	5	5
Lamp power				
Rated power	P_L /	W	2500	2500
Reference power	P_{Ref} /	W	2295	2490
Maximum power	P_{LMax} /	W	3100	3135
Minimum power	P_{LMin} /	W	2125	1620
2. Requirements for power supplies				
Minimum open circuit voltage (for power supplies without booster circuit)				
for ignition of cold lamps	U_{oc} /	V	75	75
for ignition of cold or hot lamps	U_{oh} /	V	90	85
No load requirements for power supplies with booster circuits				
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55	55
Voltage of booster circuit	U_{oB} /	V	130	120
Minimum capacitance of booster capacitor	C_B /	µF	2500	2500
Series resistance to booster capacitor	R_B /	Ω	1.0	1.5
Limits of inrush current				
Maximum peak of inrush current	I_{pmax} /	A	180	180
Maximum allowable additional charge during ignition	Q_{max} /	As	40	40
3. Requirements for igniters				
Minimum ignition peak voltage	U_{Stmin} /	kVs	33	33
Load capacity range	C_Z /	pF	10 – 40	20 – 60
AC controlled igniters				
Minimum pulse rate per line half wave	F_{Zmin} /	–	3	3
Minimum ignition time	T_{Zmin} /	sec	0.1	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	27 – 31
Reference voltage	U_{Ref} /	V	29
Base voltage (computational)	U_B /	V	16
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.14
Lamp operating current			
Rated current	I_L /	A	100
Reference current	I_{Ref} /	A	90
Maximum current	I_{LMax} /	A	110
Minimum current	I_{LMin} /	A	60
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	3000
Reference power	P_{Ref} /	W	2610
Maximum power	P_{LMax} /	W	3630
Minimum power	P_{LMin} /	W	1620

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	85
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	150
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	1.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	200
Maximum allowable additional charge during ignition	Q_{max} /	As	45

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	36
Load capacity range	C_Z /	pF	10 – 50
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	26 – 30
Reference voltage	U_{Ref} /	V	
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	120
Reference current	I_{Ref} /	A	
Maximum current	I_{LMax} /	A	130
Minimum current	I_{LMin} /	A	80
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	3600
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	4160
Minimum power	P_{LMin} /	W	2080

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	75
for ignition of cold or hot lamps	U_{oh} /	V	100
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	150
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.8
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	240
Maximum allowable additional charge during ignition	Q_{max} /	As	60

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	36
Load capacity range	C_Z /	pF	10 – 40
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

			XBO 4000X	/HS OFR	/HTP OFR
1. Operating data for lamps					
Lamp operating voltage					
Rated voltage	U_L /	V	30 – 34	27 – 31	28 – 32
Reference voltage	U_{Ref} /	V	33	29	30
Base voltage (computational)	U_B /	V	21	13.8	16.7
Maximum increase during life	ΔU_B /	V	2	2	2
Internal resistance (static)	R_i /	Ω	0.1	0.12	0.11
Lamp operating current					
Rated current	I_L /	A	120	135	130
Reference current	I_{Ref} /	A	120	125	120
Maximum current	I_{LMax} /	A	140	150	140
Minimum current	I_{LMin} /	A	80	80	100
Maximum allowable ripple	ri_{max}	%	5	5	5
Lamp power					
Rated power	P_L /	W	4000	4000	4000
Reference power	P_{Ref} /	W	3960	3625	3600
Maximum power	P_{LMax} /	W	5040	4950	4760
Minimum power	P_{LMin} /	W	2400	2160	2800
2. Requirements for power supplies					
Minimum open circuit voltage (for power supplies without booster circuit)					
for ignition of cold lamps	U_{oc} /	V	85	75	85
for ignition of cold or hot lamps	U_{oh} /	V	110	100	110
No load requirements for power supplies with booster circuits					
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55	55	55
Voltage of booster circuit	U_{oB} /	V	120	150	120
Minimum capacitance of booster capacitor	C_B /	µF	2500	2500	2500
Series resistance to booster capacitor	R_B /	Ω	0.8	0.8	0.8
Limits of inrush current					
Maximum peak of inrush current	I_{pmax} /	A	240	270	260
Maximum allowable additional charge during ignition	Q_{max} /	As	55	70	70
3. Requirements for igniters					
Minimum ignition peak voltage	U_{Stmin} /	kVs	36	33	36
Load capacity range	C_Z /	pF	20 – 80	10 – 40	20 – 80
AC controlled igniters					
Minimum pulse rate per line half wave	F_{Zmin} /	–	3	3	3
Minimum ignition time	T_{Zmin} /	sec	0.1	0.1	0.1

			XBO 4200 W/CA OFR	XBO 4200 W/GS OFR
1. Operating data for lamps				
Lamp operating voltage				
Rated voltage	U_L /	V	27 – 31	27 – 31
Reference voltage	U_{Ref} /	V		
Base voltage (computational)	U_B /	V		
Maximum increase during life	ΔU_B /	V	2	2
Internal resistance (static)	R_i /	Ω		
Lamp operating current				
Rated current	I_L /	A	140	140
Reference current	I_{Ref} /	A		
Maximum current	I_{LMax} /	A	160	140
Minimum current	I_{LMin} /	A	80	80
Maximum allowable ripple	ri_{max}	%	5	5
Lamp power				
Rated power	P_L /	W	4200	4200
Reference power	P_{Ref} /	W		
Maximum power	P_{LMax} /	W	5280	5280
Minimum power	P_{LMin} /	W	2160	2160

2. Requirements for power supplies			
Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	75
for ignition of cold or hot lamps	U_{oh} /	V	100
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	150
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.8
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	280
Maximum allowable additional charge during ignition	Q_{max} /	As	70

3. Requirements for igniters			
Minimum ignition peak voltage	U_{Stmin} /	kVs	33
Load capacity range	C_Z /	pF	10 – 40
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	32 – 36
Reference voltage	U_{Ref} /	V	
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	140
Reference current	I_{Ref} /	A	
Maximum current	I_{LMax} /	A	150
Minimum current	I_{LMin} /	A	100
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	5000
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	5700
Minimum power	P_{LMin} /	W	3200

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	85
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	55
Voltage of booster circuit	U_{oB} /	V	120
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.8
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	280
Maximum allowable additional charge during ignition	Q_{max} /	As	70

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	36
Load capacity range	C_Z /	pF	20 – 80
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	38 – 42
Reference voltage	U_{Ref} /	V	38
Base voltage (computational)	U_B /	V	21.8
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	0.12
Lamp operating current			
Rated current	I_L /	A	160
Reference current	I_{Ref} /	A	135
Maximum current	I_{LMax} /	A	160
Minimum current	I_{LMin} /	A	80
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	6500
Reference power	P_{Ref} /	W	5130
Maximum power	P_{LMax} /	W	7040
Minimum power	P_{LMin} /	W	3040

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	85
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	60
Voltage of booster circuit	U_{oB} /	V	130
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	320
Maximum allowable additional charge during ignition	Q_{max} /	As	80

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	44
Load capacity range	C_Z /	pF	20 – 80
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	39 – 43
Reference voltage	U_{Ref} /	V	43
Base voltage (computational)	U_B /	V	27
Maximum increase during life	ΔU_B /	V	+ 2
Internal resistance (static)	R_i /	Ω	0.1
Lamp operating current			
Rated current	I_L /	A	160
Reference current	I_{Ref} /	A	160
Maximum current	I_{LMax} /	A	165
Minimum current	I_{LMin} /	A	110
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	6880
Reference power	P_{Ref} /	W	6600
Maximum power	P_{LMax} /	W	7425
Minimum power	P_{LMin} /	W	4290

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	90
for ignition of cold or hot lamps	U_{oh} /	V	110
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	70
Voltage of booster circuit	U_{oB} /	V	140
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	320
Maximum allowable additional charge during ignition	Q_{max} /	As	80

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	44
Load capacity range	C_Z /	pF	20 – 80
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

1. Operating data for lamps

Lamp operating voltage			
Rated voltage	U_L /	V	57 – 61
Reference voltage	U_{Ref} /	V	
Base voltage (computational)	U_B /	V	
Maximum increase during life	ΔU_B /	V	2
Internal resistance (static)	R_i /	Ω	
Lamp operating current			
Rated current	I_L /	A	160
Reference current	I_{Ref} /	A	
Maximum current	I_{LMax} /	A	170
Minimum current	I_{LMin} /	A	110
Maximum allowable ripple	ri_{max}	%	5
Lamp power			
Rated power	P_L /	W	9600
Reference power	P_{Ref} /	W	
Maximum power	P_{LMax} /	W	10710
Minimum power	P_{LMin} /	W	6270

2. Requirements for power supplies

Minimum open circuit voltage (for power supplies without booster circuit)			
for ignition of cold lamps	U_{oc} /	V	130
for ignition of cold or hot lamps	U_{oh} /	V	150
No load requirements for power supplies with booster circuits			
Minimum open circuit voltage of the main rectifier	U_{oM} /	V	70
Voltage of booster circuit	U_{oB} /	V	170
Minimum capacitance of booster capacitor	C_B /	µF	2500
Series resistance to booster capacitor	R_B /	Ω	0.5
Limits of inrush current			
Maximum peak of inrush current	I_{pmax} /	A	320
Maximum allowable additional charge during ignition	Q_{max} /	As	80

3. Requirements for igniters

Minimum ignition peak voltage	U_{Stmin} /	kVs	45
Load capacity range	C_Z /	pF	20 – 80
AC controlled igniters			
Minimum pulse rate per line half wave	F_{Zmin} /	–	3
Minimum ignition time	T_{Zmin} /	sec	0.1

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