STD.NEMA C82.1-ENGL 1997 ■ 6470247 0513301 18T ■

AMERICAN NATIONAL STANDARD



ANSI C82.1-1997

AMERICAN NATIONAL STANDARD

FOR ELECTRIC LAMP BALLAST—

LINE FREQUENCY FLUORESCENT LAMP BALLAST

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
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ANSI C82.1-1997
Revision of ANSI C82.1-1985 (R1992)

American National Standard

for lamp ballast—

Line Frequency Fluorescent Lamp Ballast

Secretariat
National Electrical Manufacturers Association

Approved July 11, 1997
American National Standards Institute, Inc.

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Foreword

(This Foreword is not part of American National Standard C82.1-1997 (Revision of ANSI C82.1-1985).

The satisfactory performance of fluorescent lamps is contingent to a considerable extent upon the characteristics of the ballast with which they are used. This American National Standard for Ballasts for Fluorescent Lamps—Specifications, ANSI C82.1-1997 (Revision of ANSI C82.1-1985), describes the ballast characteristics that have been found necessary for the proper operation of fluorescent lamps. This standard is based on American National Standard C82.1-1972 and its supplement C82.1a-1973.

The first edition of the standard was originally published in 1950 as a proposed standard for trial use and criticism. A revised edition was similarly published in 1953. In 1956 the proposed standard was revised and approved as an American National Standard. Two revisions were approved and published in 1958. The standard was again revised in 1960, 1968, 1972, and 1977. The 1977 revision clarified marking requirements and ballast heating requirements. It also reflected changes in minimum output tolerance limits of 30-watt and 40-watt RS lamps and changes in maximum rapid start cathode voltage limits. The 1985 revision included the ballast required for the 32-watt, T-8 lamp.

1997 revisions include not only the consolidation of all supplements, but also the additions of input voltages (Table 8), compact fluorescent lamp requirements, and of the definition of "modified rapid-start ballast." Dimensions in this standard are given in inches; millimeter conversions are given in parentheses and have been rounded.

Suggestions for improvement of this standard will be welcome. They should be sent to Secretariat C82, National Electrical Manufacturers Association.

This standard was processed and approved for submittal to ANSI by the Accredited Standards Committee on Lamp Ballasts, C82. Committee approval of the standard does not necessarily imply that all committee members voted for its approval. At the time it approved this standard, the C82 Committee had the following members:

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Gil Forrler, Technical Coodinator
Randolph N. Roy, Secretariat
Jeanne L. Spicer, Coordinating Editor

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AMERICAN NATIONAL STANDARD **ANSI C82.1-1997**
(Revision of ANSI C82.1-1985)

for Lamp Ballast—

Line Frequency Fluorescent Lamp Ballast

1 Scope

This standard is intended to cover ballasts which have rated open-circuit voltages of 2000 volts[1] or less and are intended to operate lamps at a frequency of 50 Hz or 60 Hz.[2] This comprises ballasts for hot-cathode fluorescent lamps, either switch-start (preheat-start), rapid-start (continuously heated cathodes), modified rapid start (cathode cutout), or instant-start, and also ballasts for cold-cathode fluorescent lamps, used primarily for lighting purposes, which come within this voltage range. The ballast and lamp combinations covered by this specification normally are intended for use in room ambient temperatures of 10°C to 40°C. At ambient temperatures outside this range, certain special operating characteristics may be required.

2 Normative references

This standard is intended to be used in conjunction with the following American National Standards. When these standards are superseded by a revision approved by the American National Standards Institute, Inc., the revision shall apply:

ANSI/NFPA 70-1996	*National Electrical Code*
ANSI C78.1-1991 (R1996)	*American National Standard for Fluorescent Lamps—Rapid-Start Types—Dimensional and Electrical Characteristics*
ANSI C78.2-1991 (R1996)	*American National Standard for Fluorescent Lamps—Preheat—Start Types—Dimensional and Electrical Characteristics*
ANSI C78.3-1991 (R1996)	*American National Standard for Fluorescent Lamps—Instant-Start and Cold-Cathode Types—Dimensional and Electrical Characteristics*
ANSI C82.2-1984 (R1995)	*American National Standard for Fluorescent Lamp Ballasts—Methods of Measurement*
ANSI C82.3-1983 (R1995)	*American National Standard for Reference Ballasts for Fluorescent Lamps*
ANSI C82.11-1993	*American National Standard—High Frequency Fluorescent Lamp Ballast*
ANSI/UL 935-1995	*Standards for Safety—Fluorescent Lamp Ballasts*

[1]See ANSI/NFPA 70-1993 or related standards for requirements for various voltage classifications.

[2]See ANSI C82.11-1993 for high frequency fluorescent ballast specifications.

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3 Definitions

Ballast: Devices which, by means of inductance, capacitance, or resistance, singly or in combination, limit the lamp current of fluorescent lamps to the required value for proper operation. Also, where necessary, provide the required starting voltage and current and, in the case of ballasts for rapid-start lamps, provide for low-voltage cathode heating. In the case of modified rapid-start systems, the cathode heating may include a variety of electronic and magnetic components that are used to sense the operational status of the lamps and control the flow of current or voltage to the lamp filaments. For the purpose of this specification, ballasts consisting of resistance only are not considered. In many instances, radio-interference-suppression capacitors, capacitors for power factor correction, and capacitor-discharge resistors may form a part of such ballasts.

Cold-cathode lamp: An electric discharge lamp in which the electrodes, operating at less than incandescent temperatures, furnish an electron current by field emission, and in which the cathode fall is relatively high (75 volts to 150 volts). The current density at the cathodes is relatively low, and cathodes become impractically large for currents greater than a few hundred milliamperes.

Hot-cathode lamp: An electric discharge lamp in which the electrodes operate at incandescent temperatures and the cathode fall is relatively low (10 volts to 20 volts). The current density at the cathodes is relatively high, and lamps may be designed to carry any desired current up to several amperes. The energy to maintain the cathodes at incandescence may come either from the arc (arc heating), from circuit elements, or from both.

Instant-start systems: Those systems in which an electric discharge lamp is started by the application to the lamp of a voltage sufficiently high to eject electrons from the electrodes by field emission, initiate electron flow through the lamp, ionize the gases, and start a discharge through the lamp without previous heating of the electrodes.

Rapid-start systems: Those systems in which hot-cathode electric discharge lamps are operated under the following conditions: (1) the lamps are started with the cathodes heated to a temperature sufficient for adequate electron emission and without establishing local ionization across the cathodes; (2) such heating is accomplished either by means of low-voltage heater windings in the ballast itself or by separate low-voltage transformers; (3) sufficient voltage is applied across the lamp and between the lamp and the starting aid (usually the fixture itself) to initiate the discharge when the cathodes reach a temperature high enough for adequate emission; and (4) cathode heating voltage is maintained even after the lamp is in full operation.

Modified rapid-start type systems: Those systems in which hot-cathode electric discharge lamps are operated under the following conditions: (1) the lamps are started with the cathodes heated to a temperature sufficient for adequate electron emission and without establishing local ionization across the cathodes; (2) such heating is accomplished either by means of low voltage heater windings in the ballast itself, by separate low-voltage transformers, or by other means of heating the cathodes; (3) sufficient voltage is applied across the lamp and between the lamp and the starting aid (usually the fixture itself) to initiate the discharge when the cathodes reach a temperature high enough for adequate emission; and (4) cathode heating is reduced or removed after the lamp is in full operation.

NOTE: Two types of rapid-start systems have evolved: (1) those for lamps with nominal 3.6-volt cathodes (low resistance) and (2) those for lamps with nominal 8.0-volt cathodes (high resistance). In some cases the same lamp can be suitable for operation in either rapid-start or switch-start (preheat-start) systems.

Reference ballasts: Series-reactor-type ballasts, which are designed, manufactured, and maintained for the purpose of providing comparison standards for use in testing ballasts or lamps. They are also used in selecting the *reference lamps* that are needed in the work of testing ballasts. Reference ballasts are characterized by constant impedance over a wide range of operating current and also by constant characteristics that are relatively uninfluenced by time, temperature, magnetic surroundings, etc. The

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general specification for reference ballasts are given in ANSI C82.3. The value of reference ballasts to be used with each size and rating of lamps is given in American National Standards for Dimensional and Electrical Characteristics of Fluorescent Lamps, ANSI C78.1, C78.2, C78.3.

Reference lamps: Seasoned lamps which, under stable operating conditions and operated in conjunction with the specified reference ballast, operate at values of lamp voltage. Lamp wattage (for rapid-start lamps arc wattage is to be used and not total wattage), and lamp current, each within 2-1/2% of the values given in the appropriate lamp standard (see American National Standard Dimensional and Electrical Characteristics of Fluorescent Lamps, ANSI C78.1, C78.2, and C78.3). Reference lamps of the rapid-start type are operated in circuits in which their cathodes are continuously heated by appropriate low-voltage power sources.

Switch-start (preheat-start) systems: Systems in which hot-cathode electric discharge lamps are started with the cathodes preheated through the use of a starting switch, either manual or automatic in its operation. The starting switch, when closed, connects the two cathodes, in series, in the ballast circuit so that current flows to heat the cathodes to emission temperature. When the switch is opened, a voltage surge is produced, which initiates the discharge. Only the arc current flows through the cathodes after the lamp is in operation.

Ballast factor (BF): The output of a ballast delivered to a reference lamp(s) in terms of discharge power or light divided by the output of the relevant reference ballast delivered to the same reference lamp(s).

Ballast efficiency factor (BEF): The ballast factor of a ballast in percent divided by the power input to the ballast.

NOTE: This term was developed solely for regulatory purposes. It is not necessarily a measurement of ballast efficiency.

Input power factor: Power factor is dependent upon the current's wave shape as well as the phase relationship between the current and voltage. The power factor is to be calculated by determining the ratio of the active power to the apparent power. The active power is to be measured with a wattmeter capable of indicating the true rms power in watts. The apparent power is to be the product of the true rms values of the input voltage and current.

$$\text{Power Factor} = \frac{\text{Active Power (watts)}}{\text{Apparent Power (volt-amperes)}}$$

4 Ballast marking

4.1 Marking

Ballasts shall be marked to indicate the supply voltage and frequency, the input current, the manufacturer, the ballast type designation, and the number, type, and wattage or current of fluorescent lamps the ballast shall operate.

4.1.1 Power factor

Ballasts operating with an average power factor of 90% or above shall be labeled as high-power factor type. Ballasts of the corrected type and operating at a power factor of less than 90% shall indicate the average operating power factor. Ballasts of the uncorrected type need not be marked for power factor.

4.1.2 Open-circuit voltage

The value of the open-circuit voltage, when over 300 volts, shall be marked.

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4.1.3 Required grounding

All ballasts providing voltages in excess of 150 volts shall be marked to indicate that the ballast case must be grounded.

4.1.4 Supplementary marking

Except for single-lamp series-reactor type ballasts, supplementary marking shall be included to indicate the correct point of connection for various leads. Any necessary restrictions or conditions concerning operation of a ballast shall be so indicated as part of the supplementary marking.

4.2 Color coding of ballasts leads

4.2.1 Line leads

The following color coding shall be used for the line leads of ballasts:

a. On ballasts with only one line lead, such as the series-reactor type, the lead shall be *black.*

b. On ballasts with two line leads, when one lead connects to a neutral wire, that lead shall be *white or natural gray* and the other shall be *black.*[3]

c. On ballasts with two line leads, which connect to ungrounded supply lines, both leads shall be *black.*

4.2.2 Lamp leads

The following color coding is for the lamp leads of ballasts:

a. On single-lamp series-reactor type ballast, the lamp lead shall be *blue.*

b. An unprotected version of a single-lamp series reactor type ballast, the lamp lead shall have the option to be *black.*

c. On a single-lamp or multi-lamp ballast (except series-reactor type) where lamps are operated independently and lamp currents are essentially in phase with each other, the lamp leads shall be *blue.*

d. On multi-lamp ballast, where a lead-lag type circuit is used, the leading-lamp lead shall be *red,* and the lagging-lamp lead shall be *blue.*

e. On ballasts with a compensator winding, compensator leads shall be yellow-blue tracer or *yellow.* [4]

f. On a two-lamp instant-start ballast of the series-sequence type, lamp leads shall be *red* and blue, respectively. Circuit arrangements shall be such that *red and white* leads are connected to respective ends of one lamp and *black and blue* leads to the other lamp. If the circuit arrangement is such that both lamps do not connect back to the line leads, this paragraph shall be followed insofar as possible.

---

[3]For single identification of single lamp ballast leads in switching schemes, a 15% or less white tracer stripe may be used on the black lead.

[4]Choice is given depending upon the type of wire utilized by the manufacturer and its ability to be distinguished from white.

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g. On a single-lamp ballast of the continuously heated cathode type (rapid-start), the leads to that lamp cathode operated at the maximum voltage with reference to either of the line leads shall be *red.* The leads to the cathode at the other extreme of voltage relative to the red cathode shall be *blue.*

h. On multi-lamp ballast of the series-sequence continuously heated cathode type (rapid-start), the leads to that cathode operated at the maximum voltage with reference to either of the line leads, shall be *red.* The leads to the cathode at the other extreme of voltage relative to the *red* shall be *blue.* For two-lamp ballasts, the leads to the pair of common cathodes shall be either *yellow-blue* tracer or *yellow.*[5]

When more than two lamps are involved, the leads to each cathode or pair of cathodes, beginning at the high voltage (or *red)* end, shall have colors used in the order shown in Table 1.

4.2.3 Other ballast types

Ballasts not covered by 4.2.1 and 4.2.2 shall comply with these requirements insofar as possible.

Table 1–Color coding for multi-lamp ballasts leads

3-Lamp*	4-Lamp*	5-Lamp*	6-Lamp*
Red	Red	Red	Red
Yellow	Yellow	Yellow	Yellow
Blue/White 50/50	Blue/White 50/50	Blue/White 50/50	Orange
Blue	Brown	Brown	Blue/White
	Blue	Orange	Orange/Black
		Blue	Brown
			Blue

*C78 specifications for more than three lamps in series are not available at present.

5 Ballast performance

5.1 General

Measurements necessary to determine ballast performance shall be made in accordance with ANSI C82.2.

5.2 Starting conditions

5.2.1 Starting

For satisfactory lamp starting, a ballast, when operated at any voltage between 90% and 110% of its rated primary voltage and at rated frequency, shall provide the starting characteristics specified in ANSI C78.1, C78.2, C78.3.

When ballasts are designed to operate lamps in parallel circuits, the relevant requirements shall be met for each separate lamp, both with and without lamps operating or preheating in other circuits.

5.2.2 Fixture and circuit grounding

Rapid-start lamps, and switch-start (preheat-start) lamps when operated in circuits of the rapid-start type, require a starting aid consisting of a metal strip (usually a conventional part of the fixture), the surface of which shall be at least 1 inch (25 mm) wide. This surface shall extend essentially the full length of the lamp

[5]Choice is given depending upon the type of wire utilized by the manufacturer and its ability to be distinguished from white.

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and *shall be connected to ground.* The distance from the starting aid to the bulb wall, as measured in a direction normal to the surface of the starting aid, shall be specified in appropriate C78 lamp standards. Ballasts circuits and connections (including ground connections) shall be such that the potential difference between the starting aid and one of the cathodes of each lamp will be greater than the minimum specified in ANSI C78.1, C78.2, C78.3.

(If operation on ungrounded power supplies is contemplated, the necessary starting-aid potential should be maintained regardless of accidental grounds on either side of line. In some types of circuits this may require the use of a two-winding transformer.)

5.2.3 Required starting current

Instant-start types of ballasts shall meet the requirements for starting currents as listed in 5.2.3.1 through 5.2.3.3.

If the normal wiring of the ballast being tested is such that the primary circuit of the ballast is normally closed by the insertion of lamps into the lamp holders, the primary circuit shall be completed by some other means when these tests are being made.

5.2.3.1 Single-lamp ballasts

With the specified test resistor (see Table 2) connected to the ballast in place of the lamp, the rms current through the resistor, at any supply voltage between 90 % and 110% of rated voltage, shall not be less than that shown in Table 2.

5.2.3.2 Multi-lamp ballasts

Multi-lamp ballasts, other than those covered in 5.2.3.3, shall meet the following requirements, which apply to *each lamp position:* With specified test resistor (see table 2) connected to the ballast in place of one of the lamps, and with all other positions connected to reference lamps, the rms current through the resistor, at any supply voltage between 90% and 110% of rated voltage, shall not be less than the value shown in Table 2.

In addition, if one or more of the lamp positions are such that it can start and operate a lamp (not necessarily at rated current) *without* lamps in the other positions, the resistor current in this position shall also meet the specifications given in Table 2 *without* lamps in the other circuits.

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Table 2–Required starting current for instant-start ballasts

Lamp Size	Lamp Operating Current (mA)	Test Resistor* (ohms)	Minimum Starting Current (mA)
42-inch T-6	120	3000	75
	200	3000	90
	300	3000	100
64-inch T-6 and 72-inch T-8	120	4000	75
	200	4000	90
	300	4000	100
96-inch T-8	120	5000	75
	200	5000	90
	300	5000	100
40 W T-12 IS	425	2750	100
48-inch T-12	425	2750	100
72-inch T-12	425	3400	100
96-inch T-12	425	4000	100
40 W T-171S	425	2750	100

*The values given in this column include the resistance of the ammeter and should be held within ± 2%.

5.2.3.3 Other multi-lamp ballasts

Two-lamp series-sequence type ballasts for the operation of any of the types of lamps shown in tables 3 and 4 shall be tested with two resistors as specified in Tables 3 and 4. These resistors shall be connected in the ballast circuit as specified in the tables, and the current through the specified measurement resistor, at any supply voltage between 90% and 110% of rated voltage, shall not be less than that shown in the appropriate table.

Table 3–Required starting current for two-lamp series-sequence type ballasts for 96-inch T-12 instant-start lamps

Resistor Value (ohms)		Minimum Current through the 4000-Ohm Resistor (mA)
No. 1 Lamp Position (Red-White Leads)	No. 2 Lamp Position (Blue-Black Leads)	
4000	9000	90
1200	4000	100

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Table 4–Required starting current for two-lamp series-sequence type ballasts for 48-inch T-12, 40 watt T-12, or 40-watt T-17 instant-start lamps

Resistor Value (ohms)		Minimum Current through the 2750-Ohm Resistor (mA)
No. 1 Lamp Position (Red-White Leads)	No. 2 Lamp Position (Blue-Black Leads)	
2750	750	90
750	2750	100

5.3 Ballast output

A ballast shall provide the operating characteristics given in 5.3.1 and 5.3.2 when connected to any specified complement of reference lamps.

5.3.1 Switch-start and instant-start ballasts

Ballasts of these types shall deliver power and current to a reference lamp, as measured in percent of the power and current delivered to the same lamp by a reference ballast, within the limits given in table 5. Both the reference ballast and the ballast under test shall be operated at their rated voltage and frequency.

Power and current measurements of the ballast under test shall be made when it is connected to a full complement of reference lamps.

Table 5–Minimum ballast factor and maximum current requirements for switch-start and instant-start ballasts

Ballast Types	Percent of Values Delivered by Reference Ballast	
	Ballast Factor (Power)	Maximum Current
Switch-Start	Not < 92.5	Not > 115.0
Instant-Start	Not < 92.5	Not > 120.0
Instant-Start 60W/96T12/SP*	Not < 85.0	Not > 120.0
Compact Fluorescent	Not < 92.5	Not > 107.5

*A ballast is rated for use with both 75W/96T12/SP and 60W/96T12/SP lamps and meets the 75W/96T12/SP operation need not be tested with a 60 watt lamp.

5.3.2 Rapid-start ballasts

Rapid-start ballasts shall provide the operating characteristics given in 5.3.2.1 and 5.3.2.2 when connected to a full complement of normally-operating lamps.

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5.3.2.1 Ballast factor

With rated voltage applied to the primary of the ballast, the light output delivered by a reference lamp shall be equal to the light output delivered by the same reference lamp when operated on its reference ballast at its rated primary voltage, subject to the minimum values in Table 6.

The maximum light output shall be limited by the maximum permissible lamp current as specified in 5.3.2.2.

Table 6–Minimum ballast factor for rapid start circuits

Lamp Type	Minimum Ballast Factor (Light) Output (percent)
Linear Lamps	
4, 6, 8WT5	90
14WT8	90
15WT8	90
14, 15, 20WT20	90
17, 25, 32, 40WT8	92.5
30, 40WT10, 40WT12	92.5
*34WT12	85
0.800A and 1.0A T12	95
**95W T12-0.800 A	88
1.5A T12 and PG17	95
Circular Lamps	
20WT9	90
22, 32, 40WT9	90
32WT10	90
40WT10	90
U-Shaped lamps	
16, 24, 32WT8	92.5
40WT12	92.5
Single-based Lamps with 2G11 bases 18W, 24-27W, 36-39W, 40W	92.5

* A ballast that is rated for use with both a 40-watt and a 34-watt lamp and meets the 40-watt lamp requirements need not be tested with a 34-watt lamp.

** A ballast that is rated for use with both 113 and 95 watt lamp and meets the 113 watt lamp operation need not be tested with a 95 watt lamp.

5.3.2.2 Lamp current

With rated voltage applied to the primary of the ballast, the lamp current in a reference lamp shall not exceed 115% of the current delivered to the same lamp by a reference ballast at its rated primary voltage.

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5.3.3 Compact fluorescent lamp ballasts

Ballasts for compact fluorescent lamps shall deliver current to a reference lamp, as measured in percent of the current delivered to the same lamp by a reference ballast, within the limits 92.5% to 107.5%. Both the Reference ballast and the ballast under test shall be operated at their rated voltage and frequency.

5.4 Cathode preheating current

Ballasts designed for the operation of switch-start lamps shall provide preheating current within the limits required by ANSI C78.1, C78.2, and C78.3.

When ballasts are designed to operate more than one lamp, each circuit shall meet this requirement, both with and without lamps operating or preheating in the other circuits.

5.5 Regulation

5.5.1 Ballasts for rapid-start lamps

Ballasts for rapid-start lamps shall, at 90% and 110% of rated line voltage, operate a reference lamp at a level of light output of the same not less than 75% or greater than 125%, respectively, of the light output of the same lamp when it is operated with the same ballast at *rated* primary voltage.

5.5.2 Ballasts for switch-start lamps and instant-start lamps

Ballasts for switch-start lamps and instant-start lamps shall, at 90% and 110% of rated line voltage, deliver to a reference lamp not less than 85% or more than 115%, respectively, of the power delivered by a reference ballast to the same lamp at corresponding voltages.

5.5.3 Ballasts for compact fluorescent lamps

Ballasts for compact fluorescent lamps shall at 90% and 106% of rated line voltage, deliver to a reference lamp not less than 75% nor more than 115% current, respectively, of the current delivered by a reference ballast at rated voltage and frequency.

5.6 Operating-current waveshape

5.6.1 Normal operating conditions

With rated voltage applied to the primary of the ballast, the current waveshape supplied to a warmed-up reference lamp shall have a crest factor (ratio of peak current to RMS current) that does not exceed the values shown on the appropriate lamp data sheets.

5.7 Supplementary cathode heating

5.7.1 Switch-start ballasts

Switch-start ballasts shall not furnish a current greater than 100% of the arc discharge current to any cathode terminal of a lamp in normal operation.

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5.7.2 Rapid-start ballasts

Rapid-start ballasts shall provide supplementary cathode heating as follows: (1) When two cathodes are supplied from a common winding, they shall be connected in parallel. (2) The cathode heating voltage shall be measured using a dummy load resistor. All cathode windings must be loaded during this measurement. With the rated voltage applied to the primary of the ballast, the cathode heating windings shall deliver voltages to the dummy load resistors within the limits shown on the appropriate lamp data sheets. (3) When reference lamps are in normal operation at rated primary voltage, the voltage across any cathode shall be within the limits shown on the appropriate lamp data sheets.

5.7.3 Modified rapid-start ballasts

Rapid-start ballasts shall provide supplementary cathode heating as follows: (1) When two cathodes are supplied from a common winding, they shall be connected in parallel. (2) The cathode heating voltage shall be measured using a dummy load resistor. All cathode windings must be loaded during these measurements. With the rated voltage applied to the primary of the ballast, the cathode heating windings shall deliver voltages to the dummy load resistors within the limits shown on the appropriate lamp data sheets. (3) When reference lamps are in normal operation at rated primary voltage, the voltage across any cathode is reduced or removed after the lamp is in full operation.

5.8 Voltage across starter terminals

Ballasts for switch-start lamps, when operated at any voltage between 90% and 110% of their rated primary voltage and at rated frequency, shall meet the requirements of 5.8.1 and 5.8.2.

5.8.1 Voltage—with reference lamps

When operating reference lamps the ballasts shall not furnish at the starter terminals a voltage in excess of the value listed in Table 7. This limit applies when the lamps are first lighted and after they have warmed up.

5.8.2 Voltage—with deactivated lamps

When connected to non-reference lamps having one or both cathodes deactivated, the ballast shall not furnish at the starter terminals a voltage in excess of the value listed in Table 7.

Table 7–Maximum RMS volts across starter terminals

Lamp Rating (watts)	Normal Lamp	Deactivated Lamp
4,6,8,14,15,20	70	*
30,40	128	265
32,90	95	*

*To be Determined

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5.9 Radio-interference suppression

Fluorescent lamps may be a source of electromagnetic radiation at radio frequencies. Several means of available for suppressing the interference caused by such radiation. The starters for use with switch-start lamps shall contain capacitors which assist in this suppression.

Switch-start ballasts which contain a compensating winding shall include a capacitor of 0.0048 μF (minimum) connected across such winding. Instant-start ballasts, with the exception of ballasts for operating slim-line lamps at 120 mA, shall contain 0.008 μF (minimum) capacitors (low-inductance) for this purpose, either connected across each lamp or across the line, or both. Further suppression of conducted radio interference may be obtained through the use of the delta-capacitor or the inductor-inductor type of filter at the line connection of the ballast.

5.10 Ballast safety

Ballast shall comply with ANSI/UL 935.

6 Design center voltages[6]

The following voltages are the design center input voltage for fluorescent lamp ballasts:

Table 8–Design center voltages

120	127	208	220	240	254	277	347	440	480

7 Application requirements

7.1 Limits for contact resistance

Even relatively small resistance in series with the cathode of the rapid-start lamp, because of the low heater-circuit voltage, may seriously interfere with the lamp starting or operation. The added resistance in any cathode circuit shall not exceed at any time the following values:

Table 9–Maximum contact resistance

Lamp Type (mA)	Maximum Added Resistance Any Cathode Circuit (ohms)
500 or less	0.5
800 (high output)	0.2
1500	0.2

[6]See ANSI/NFPA 70-1993 or related standards for maximum voltage-to-ground limitations and ground requirements.

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7.2 Operating temperature limits

The service installation must be designed so that the temperature at the hottest spot on the ballast case shall not exceed 90°C under actual operating conditions.

7.3 Supply voltage limits

7.3.1 Average voltage

The average voltage of the supply system should not depart more than -7.5 % or more than + 5 % from the primary voltage rating shown in the ballast label.

7.3.2 Voltage excursions

For satisfactory ballast operation, the supply voltage excursions must not exceed ± 10% of the ballast primary rating.

7.4 Equipment grounding

Exposed non-current-carrying metal part of fluorescent lamp ballasts (such as the ballast case) shall be grounded if the open-circuit voltage of the ballast exceeds 150 volts.

7.5 Audible sound level

Noise is an inherent characteristic of electromagnetic devices and cannot be completely eliminated.

Care should be exercised in the selection of the ballast location and the method of mounting because ballast noise can be amplified by reflections from surrounding objects and by resonance of the mechanical mounting and electrical connections. This unintentional amplification can make the ballast appear to produce considerably more noise than the noise generated by the ballast. The ballast or luminaire manufacturer, or both, should be consulted for specific recommendations for a quiet installation.

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