NATIONAL LIGHTING PRODUCT INFORMATION PROGRAM

Specifier Reports

Power Reducers

Fluorescent lighting power reduction products

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Contents

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Background

Power reducers include a diverse group of products that reduce the active power demand of a fluorescent lighting system. This issue of *Specifier Reports* focuses on power reducers that reduce the power demand of a fluorescent lighting system by a fixed amount. In this type of power reducer, a reactive current-limiting element (typically a capacitor) is connected in series with the lamp circuit. This electrical element reduces the lamp current, which causes a reduction in lamp power. Power reducers also reduce lamp light output, although not quite as much as they reduce power demand. Depending on factors such as cost of electricity, number of operating hours per year, and power reduction level, a single power reducer can save annually from 80 to 700 kWh of electricity and from $5 to $80 in electricity costs.

Several power reducer manufacturers make products for various ballast and lamp combinations. These products are designed to reduce the total active power demand from a ballast and connected lamps by 20 to 50 percent. Products require one of three installation methods: replacement of lamps, installation of lamp holder inserts, or installation of hardwired components. All the products tested for this report are similar in shape to a ballast but smaller in size and are hardwired between a ballast and lamps. Total retrofit costs may range from $20 to $65 per power reducer.

Power reducers should only be used in retrofit situations where illuminance is excessive for the visual task being performed and where some or all of the following conditions exist:

- The magnetic ballasts are regular power output, rather than high or very high output.
- Light distribution patterns are to be maintained.
- Electricity prices are high.
- Lighting systems are operated extensively.

Inappropriate applications include new installations and retrofit situations where existing illuminances are satisfactory or where ballasts or luminaires are being replaced.

Is there too much light for the visual tasks being performed?

Lighting specifiers should ask this important question when considering the installation of power reducers. If illuminances are not excessive, power reducers should not be used. If illuminances are excessive, specifiers should compare power reducers with other products that save electricity and reduce illuminance (see p. 7 of this report for alternate approaches). If power reducers are preferred, then, at a minimum, specifiers should ask the following questions:

- Is the power reducer that is being considered listed with either Underwriters Laboratories or the Canadian Standards Association?
- What is the warranty on the power reducer?
- How would the use of the power reducer affect the warranties of the lamps and ballasts with which it will be used?

Other performance aspects of concern to specifiers are detailed in this report.

The reduction in light output observed in the tests for this report was not as great as the reduction in power. For example, the rapid start products designed for a 50 percent power reduction averaged a 45 percent reduction in power and a 36 percent reduction in light. Thermal factors, discussed in the text, contributed to this effect.

Power reducers can affect lighting systems in several ways. This issue of *Specifier Reports* examines the following performance characteristics:

- Illuminance and light distribution
- Energy and efficiency
- Power quality
- Human response
- Effects on lamps and ballasts
- Life and reliability

Illuminance and Light Distribution

The primary purpose of power reducers is to reduce the active power demand of fluorescent lighting. Illuminance is also reduced, generally in proportion to the reduction in power. Because worker productivity can be affected if lighting is inadequate, illuminance should not be reduced below levels recommended by the Illuminating Engineering Society of North America (IESNA). It is financially unsound to institute measures that compromise the productivity and satisfaction of employees; in a commercial office, the cost of employee salaries is usually several hundred times greater than the cost of electricity to operate fluorescent lights. Where existing illuminance is excessive, the use of power reducers may be a viable solution.

Power reducers maintain existing light distribution patterns, so they are valuable in cases where the patterns are acceptable but illuminance is excessive for the intended task. Some alternatives to power reducers, such as delamping, may affect light distribution.

Energy and Efficiency

Some manufacturers of power reducers assert that their products do not significantly reduce light output, implying that they greatly increase efficacy. These claims of insignificant light reductions are based on the effects of lamp replacement and luminaire cleaning at the time of retrofit. The temporary effect of these maintenance efforts may offset the initial loss in illuminance due to power reducer installation. However, the long-term result will be a reduction in illuminance that is roughly proportional to the reduction in active power.

Thermal interactions among the lighting system components (power reducer, lamps, ballast, and luminaire) affect light output, power reduction, and efficacy. Figure 1 shows the dependence of light output, active power, and efficacy on minimum bulb wall temperature (MBWT). MBWT is determined by the ambient temperature, the heat generated within the luminaire, and the luminaire's heat dissipation effectiveness. Because the power reducer lowers the MBWT, it may either increase *or* decrease efficacy. If the original MBWT and the MBWT that results from installing the power reducer are above the optimal temperature for maximum efficacy, the power reducer will *increase* efficacy. This can occur in enclosed fluorescent luminaires, particularly surface-mounted ones. If the original MBWT and resulting MBWT are below the optimal temperature for maximum efficacy, the power reducer will *decrease* efficacy. This can occur in open strip luminaires where the ambient temperature is at or below 10 to 15°C (50 to 60°F). If the original MBWT drops from a temperature above optimal to one below optimal after power reducer installation, the power reducer will produce a negligible effect on the luminaire's efficacy. This can occur in an open strip luminaire at an ambient temperature of approximately 20°C (68°F) or in a luminaire enclosed with a lens at an ambient temperature of 10 to 15°C (50 to 60°F).

Decreased power demand affects the thermal performance of a building and causes a reduction in internal heat gain, because electric power consumed by a fluorescent lighting system is ultimately dissipated as heat. This reduction provides an energy benefit in buildings when excessive heat gain requires mechanical cooling. When heating is needed, the reduced internal heat gain from the lighting system must be offset by the heating system. Nonetheless, central heating systems typically provide heat more efficiently and economically than do lighting systems. If power reducers are installed in a building, cooling costs usually decrease.

Power Quality

Power reducers can affect the power quality of lighting circuits. Electric utility companies are concerned about the quality of the power they supply to customers; poor power quality can interfere with data communications, cause inefficient operation or failure of other electrical equipment, and result in excessive current in electrical distribution lines. The desired pure sinusoidal shape of the current and voltage wave forms can be distorted by electrical equipment that incorporates electronic technology. Exam-ples of such electronic equipment include variable speed motors, uninterruptible power supplies, and personal computers. Fluorescent lighting systems can also distort supply power. Three power quality concerns exist for fluorescent lighting systems: power factor, harmonics, and electromagnetic interference.

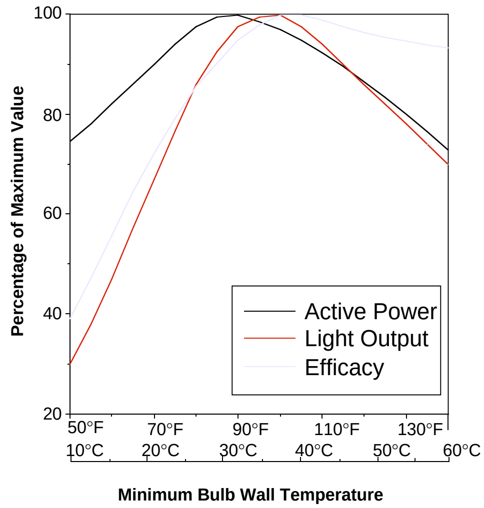
Power factor. Power factor is defined as a ratio:

$$\text{Power Factor } (F_p) = \frac{\text{Watts}}{\text{RMS Volt-Amperes}} = \frac{\text{Active Power}}{\text{Apparent Power}}$$

This metric indicates the amount of current and voltage that the utility must supply with respect to the power which produces useful work. A power factor of 1.0 means that the volt-amperes supplied are equal to the watts used. When the power factor is less than one (apparent power > active power), the customer pays only for the power used and not for the volt-amperes that the utility must supply. Most fluorescent lighting systems have power factors above 0.9. Less than half of the power reducers tested for this report maintained the power factor above 0.9.

Low power factors cause unusable circuit capability. Many utilities penalize customers whose facilities have power factors lower than 0.8 to 0.9. Supply equipment (including conductors, transformers, and switchgear) must be oversized to handle loads with low power factors.

Figure 1. Effect of Temperature on Performance Characteristics



As the temperature of a fluorescent bulb increases, both the light output (red curve) and the active power consumption (black curve) also increase. However, as the temperature rises above 32°C, the power consumption gradually begins to decrease. The light output continues to increase until the temperature reaches approximately 38°C, at which point it begins to drop dramatically. The system efficacy (pink curve), defined as light output divided by active power, is therefore maximized at approximately 40°C. (Adapted from the *IES Lighting Handbook*: *Reference Volume,* 1984.)

Power quality refers to the "cleanliness" of electric power. In this report, power quality refers to steady-state characteristics such as harmonics and voltage regulation. It does not refer to transient effects such as switching, lightning, or other short-term phenomena.

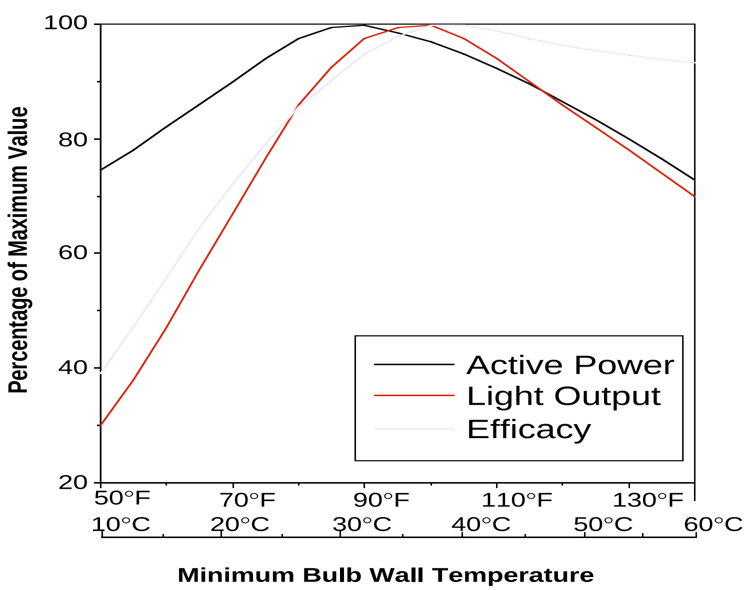
The power factor is lowered by systems that shift the phase of the current with respect to the voltage and/or by systems that distort the sinusoidal wave shape of the input current. A phase shift between the current and voltage can be corrected with an appropriate inductor or capacitor in the line or distribution system. However, changes in the current wave shape are presently difficult and expensive to filter.

Harmonic distortion. Distorted wave shapes contain components with frequencies that are multiples of the fundamental frequency. These higher frequency components are known as harmonics. Total harmonic distortion (THD) is a measure of the degree to which a sinusoidal wave shape is distorted by harmonics, with higher values of THD indicating greater distortion. Figure 2 shows an undistorted voltage wave supplied to ballasts and the distorted current wave shape produced by a magnetic ballast. Mathematically, THD is the root mean square summation of the non-fundamental harmonic components, expressed as a percentage of the fundamental component. Fluorescent lighting systems reflect harmonic currents back into the electrical supply system. The luminaire current THD for magnetically ballasted two-lamp systems typically ranges from 12 to over 20 percent.

Problems that are attributable to harmonics include

- Interference with the operation of other electrical equipment (both nearby and remote);
- Improper operation of power grid protective devices (fuses and relays); and
- Overheating of motors, transformers, capacitors, and neutral conductors.

Figure 2. Total Harmonic Distortion: Magnetic Ballasts



The black curve represents a voltage wave with near-zero distortion, typical of the voltage supplied to ballasts. The red curve represents the current wave shape produced by a magnetic ballast with a total harmonic distortion (THD) of about 27%.

Although no standards are in place for acceptable levels of current THD from fluorescent lighting systems, the American National Standards Institute (ANSI) Fluorescent Lamp and Ballast Committee recommends a limit of 32 percent. This recommendation is based on existing magnetic ballast performance and International Electrotechnical Commission (IEC) standards. The proposed IEC 555-2 Standard has a THD limit of 33.8 percent. The Institute for Electrical and Electronics Engineers (IEEE) is updating the IEEE-519 Recommended Practice to include maximum THD for electric utility voltage (5 percent) and customer current (5 to 20 percent, depending on the electrical demand of the customer's facility), both measured at the "point of common coupling," which is usually the place of metering. Some utilities base their harmonic distortion standards on IEEE-519. Many utilities that rebate electronic ballasts will do so only for ballasts with current THD less than 20 percent. The U.S. Department of Energy, as part of their Federal Relighting Initiative, has proposed a luminaire current THD limit of 20 percent on all retrofit equipment.

Nearly all of the power reducers tested for this report increased luminaire current THD to over 20 percent. The rapid start products increased THD to levels equal to or higher than those of the instant start products, with THD above 32 percent for nearly all rapid start products.

Electromagnetic interference (EMI). The Federal Communications Commission (FCC) sets EMI limits on fluorescent lighting systems in FCC Part 18. All fluorescent lighting systems must meet this regulation. EMI is caused when unwanted electromagnetic signals interfere with desirable signals. EMI may be transmitted in two ways: radiated through space or conducted by wiring. The Electric Power Research Institute (EPRI) has tested some power reducers for conducted and radiated EMI and does not consider EMI to be a significant problem. EMI was not tested for this report.

Human Response

Lighting retrofits have a complex effect on the attitudes and productivity of building occupants. Thus, building occupants may be affected negatively when illuminance is reduced. To offset the immediate reduction in illuminance, many power reducer manufacturers recommend cleaning and relamping luminaires as part of a retrofit. Although this practice can moderate or eliminate the sudden loss in illuminance, in the long term it will not compensate for the lowered illuminance that eventually results from dirty luminaires and lamp element degradation. Reducing illuminance in an attempt to save on operating costs can have the undesired effect of reducing employee productivity, a cost that can greatly exceed the total operating cost of lighting. Specifiers should check IESNA recommendations before reducing illuminances.

Unwanted sound in a building can also cause occupant discomfort. Sources of unwanted sound include environmental systems, office equipment, and people. Power reducers that are designed for rapid start ballasts can generate audible sound because they use a small transformer to bypass the current-limiting capacitor and maintain cathode power. If improperly attached to the luminaire, power reducers can vibrate. They also may affect the sound generated by the ballast. If the working environment is already noisy, then the sound generated by power reducers probably will not be noticed. However, if the environment is quiet, or if the noise from the ballasts is noticeable, then the tendency of a given power reducer to increase sound produced by the lighting system becomes an important issue.

Effects on Lamps and Ballasts

Power reducers can have long-term effects on the performance of a lighting system; they can increase or decrease lamp lumen depreciation (LLD), increase or decrease lamp life, and increase ballast life. LLD due to phosphor degradation may be reduced because of lower lamp current loadings. Typical LLD due to phosphor degradation for an F40T12 lamp operated at nominal power is 10 percent at 10,000 hours (roughly half of a typical lamp's life). By comparison, IESNA data indicate that the same lamp operating at a 50 percent power reduction experiences LLD of 4 to 5 percent at 10,000 hours. Thus, the LLD reduction could conservatively offset 5 percent of the long-term loss in illuminance due to lamp power reductions. A similar effect would be obtained for different levels of power reduction. LLD may also increase with the use of power reducers because lamp ends blacken when the cathode sputters, as discussed below.

Two performance characteristics of power reducers affect lamp life: the voltage applied to the cathodes of rapid start lamps and the lamp current crest factor (CCF). To rate the life of a fluorescent lamp, manufacturers assume, among other things, that the operating cathode voltages of rapid start lamps will be maintained between 2.5 and 4.0 volts and that the lamp CCF is less than or equal to 1.7. Lower operating cathode voltages can increase cathode sputtering, increase lamp-end blackening, and shorten lamp life. All the rapid start type products tested for this report maintained cathode voltage within the above specifications.

Excessively high cathode voltage can shorten lamp life by damaging the emissive coating on lamp cathodes. High CCF can have the same effects on lamps as low cathode voltage. The test data obtained for this report show that rapid start products tend to increase CCF, while instant start products have a negligible effect on CCF.

Power reducers limit lamp current and, as a result, reduce ballast primary and secondary winding currents. Most of the ballast electrical losses occur due to winding resistance. Consequently, power reducers also lower ballast losses and operating temperatures. Because magnetic ballast life is temperature-dependent (a reduction of 10°C typically doubles ballast winding life), power reducers can extend ballast life. Test data for the rapid start products show that the ballast temperatures were reduced by an average of 20°C (36°F). High-loss magnetic ballasts were used for rapid start product testing; ballast temperature reductions would have been less with energy-efficient magnetic ballasts. In the instant start product tests, ballast temperatures were reduced by an average of 4°C (7°F). Energy-efficient ballasts were used for the instant start product tests; the reduction in ballast temperatures would have been greater with high-loss magnetic ballasts.

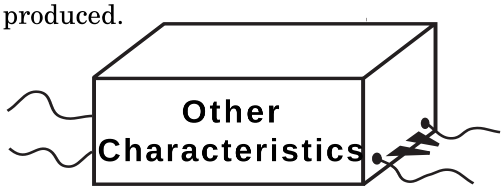
Life and Reliability

Many manufacturers of power reducers offer five-year replacement warranties and suggest that the products have poten-tially unlimited operating lives. These products should be capable of outliving their warranties because their major components are usually conventional electrical elements such as transformers and capacitors. Two failure modes can result from short-circuited or open-circuited power reducer elements. The first failure mode disables the current- limiting ability, causing the lamps to operate at full power and light

Lamp lumen depreciation (LLD) is a measure of reduction in light output throughout the lamp's lifetime.

Current crest factor (CCF) is defined as the ratio of peak lamp current to effective (root mean square) current. A low current crest factor indicates that the wave shape of the current is uniform and does not have high peaks.

output, which eliminates any power savings. The second failure mode opens the lamp circuit so that no light is produced.



Compatibility Considerations

Most power reducer manufacturers recommend that their products be used only with certain types of fluorescent ballasts and/or lamps. No power reducer is compatible with either the electronic or lead-lag magnetic ballast. Lead-lag magnetic ballasts drive two lamps that are wired electrically in parallel, whereas today's typical magnetic ballast operates two lamps in series. Some power reducers are incompatible with low power factor magnetic ballasts. Others are incompatible with energy-saving lamps, especially when operated with energy-efficient magnetic ballasts. Specifiers should compare power reducer, lamp, and ballast manufacturers' recommendations for each proposed application.

Installation

Power reducer retrofits are often conducted by energy service or lighting management companies that specialize in lighting maintenance and retrofit work. However, facility personnel need to understand the installation and maintenance issues because they may be responsible for the lighting system once the retrofit is completed.

The effort needed to install power reducers varies among manufacturers' products. One manufacturer produces a product that is an integral part of a replacement lamp. Another manufacturer produces a product that is inserted between lamps and lamp holders. Most power reducers require some rewiring and mounting. These hard-wired products are similar in shape to magnetic ballasts but are smaller and lighter. Thus, size and weight are not important installation concerns. Rewiring typically requires disconnecting the power supply and making two to six wire splices. Mounting methods include self-adhesive tape and/or sheet metal screws. The installation cost for power reducer models requiring rewiring is similar to the cost to replace an existing ballast, roughly $10 to $20 per ballast. Power reducers that do not require rewiring are less expensive to install.

Many power reducer manufacturers recommend relamping and luminaire cleaning at the time the power reducer is installed. A cost of $2 to $10 per lamp should be included in the project estimate if group relamping and luminaire cleaning have not been done in the previous three to six months. The price of power reducers varies from $10 to $25. Therefore, the total retrofit cost ranges from $20 to $65 per power reducer installed.

Maintenance and Disposal

Power reducers have no maintenance requirements and cannot be repaired by users. Power reducers that fail should be replaced.

Power reducers do not affect maintenance significantly except when they increase or decrease lamp and/or ballast lives, as noted previously. Usually, the cost of replacing lamps and/or ballasts is small compared to total lighting energy costs, unless lamp life is shortened drastically.

Specifiers should consider what to do in the event of ballast failure. Many luminaires still contain high-loss ballasts, the manufacture and sale of which were prohibited by the National Appliance Energy Conservation Act Amendment of 1988. If a power reducer is incompatible with presently available energy-efficient magnetic ballasts and with the lamp types in use, then an alternative ballast must be selected. All replacement ballasts and lamps held in stock should be compatible with the power reducer.

Disposal of power reducers is not presently considered to be an environmental issue.

Potential for Snapback

"Snapback" may occur when building occupants or managers complain about a new energy-saving lighting system and request a return to the old system or when an efficient technology is replaced with a less costly, but less efficient technology. The ease with which the various power reducers are installed is a good indicator of the potential for snapback. Some power reducers are more likely to be removed, particularly those that are a part of a replacement lamp or those that are installed between the lamps and lamp holders. Hard-wired products are more difficult to remove because two to six wires must be respliced.

Potential motivations for snapback include reduced illuminance (both short- and long-term reductions), power quality problems (increased harmonic distortion and reduced power factor), increased sound levels, shortened lamp life, and power reducer replacement costs. Short-circuit power reducer failure can cause passive snapback if the defective unit is not replaced. Electric utilities that are evaluating power reducers for their rebate programs should consider only hard-wired products, due to the potential for snapback.

Warranty Considerations

Most power reducer manufacturers provide warranties on defective items, with many offering five-year warranties. Using power reducers to operate lamps outside of the lamp manufacturer's specifications may invalidate lamp warranties. Thus, if premature lamp failures occur, even those not due to power reducer operation, the user may not be reimbursed for the loss. Most of the rapid start products that were tested caused lamp CCF to increase from under 1.8 (bare ballast) to over 2.0, although they all maintained cathode voltages within specifications. The instant start products all kept CCF below 1.7. Fluorescent lamp warranties are usually voided if the CCF exceeds 1.7.

Alternatives to power reducers include energy-saving lamps, delamping, phantom tubes, luminaire de-energization, specular reflectors, ballast replacement, and lighting circuit dimming systems. Alternatives that reduce the operating duration of lighting systems, such as time clocks or occupancy sensors, are not covered in this report.

Energy-Saving Lamps

Energy-saving lamps reduce power demand, typically by 15 percent for rapid start lamps and 20 percent for instant start lamps. Lamp lumen reductions are proportional to power reductions, so luminaire efficacy is unaffected. In spaces where a small light reduction is acceptable, energy-saving lamps are particularly appropriate.

The features of energy-saving lamps differ from those of power reducers in several ways. They do not require rewiring. The costs to install energy-saving lamps are the same as the costs for relamping; relamping is recommended with power reducer installation. They are compatible with most ballasts, although ballast losses will increase slightly. Their use may require stocking additional lamps if energy-saving lamps are not used elsewhere in the facility. Their disadvantages in comparison to power reducers are that they only reduce active power by about 15 to 20 percent, they may shorten ballast life due to increased winding losses, and their snapback potential is higher because they are easily replaced with less expensive, readily available standard lamps.

Delamping, Phantom Tubes, and Luminaire De-energization

Delamping is limited to multi-ballast luminaires. For a two-ballast, four-lamp luminaire, delamping would involve disconnecting one ballast and its two lamps. When delamping is performed, the power supply to the unused ballast should be disconnected because energized magnetic ballasts continue to demand approximately 5 watts when their lamps are removed. Spare ballasts within the luminaire could be useful in the event of ballast failure. Delamping also reduces lamp replacement costs and may be an acceptable option in areas where the existing illuminance is excessive. Building occupants may react negatively, since delamping affects light distribution and may detrimentally affect the appearance of the luminaires.

Phantom tubes are clear tubes that contain an inductor or capacitor. They do not produce light, but they do permit the lighting system to function; light output and power demand may be cut in half. Their characteristics are similar to those of energy-saving lamps, although they may be used on single ballast luminaires. Though popular in the early years of energy conservation, phantom tube retrofits have led to some negative user reactions; consequently, they are seldom used today.

Luminaire de-energization (disconnecting a luminaire) is very similar to delamping, except that light distribution patterns are more significantly affected.

Specular Reflectors

Specular reflectors are often installed in conjunction with delamping to improve luminaire efficiency. When two lamps are removed from a four-lamp luminaire and a reflector is installed, 40 to 50 percent power reductions can be achieved. Light output will also be reduced, usually by at least 20 percent.

Ballast Replacement

Ballast replacement may offer some advantages when compared to power reducer retrofits because installation costs for new ballasts and many power reducers are similar. Advantages of ballast replacements over power reducers include renewed ballast life, higher power factor, lower THD, fewer compatibility concerns, and reduced stockroom requirements.

Electronic ballasts offer an alternate method of saving electricity without sacrificing illuminance. Electronic ballasts are available for a variety of lamp types. They improve efficacy by 20 to 50 percent over magnetic ballasts. Electronic ballasts also produce less noise and flicker than magnetic ballasts. Additional information on electronic ballasts can be found in Volume 1, Issue 1 of *Specifier Reports*.

When illuminances can be lowered, special ballasts are available to reduce light output and power consumption.

Dimmable electronic ballasts provide all of the above benefits in addition to providing the capability to vary illuminance, either through manual or automatic control.

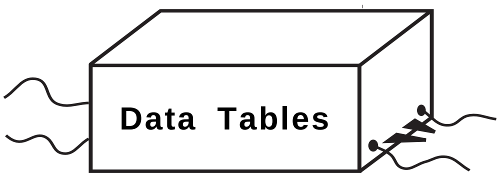
Lighting Circuit Dimming Systems

Two technologies for dimming control are used on dedicated fluorescent lighting circuits. One technology employs an autotransformer that can reduce the magnitude of the voltage wave while maintaining its sinusoidal shape. The other technology uses solid state circuitry to chop out parts of the voltage wave. Both reduce the effective voltage that is supplied to the ballasts connected to the circuit, thus reducing the power demand and light output of the lighting system. Both technologies are compatible only with magnetic ballasts and are usually installed near the circuit breakers serving a lighting circuit.

The amount of power reduction available from these dimming control systems is often variable and controllable, much like dimmable electronic ballasts. Power reductions are generally proportional to light output reductions between 50 and 100 percent of full output. These systems do not affect light distribution.

By reducing the effective voltage supplied to the magnetic ballasts, lighting circuit dimmers also reduce the cathode voltage supplied to the lamps. If excessive reductions in cathode voltage occur, then lamp life will be shortened.

Solid state lighting circuit dimmers increase the amount of current distortion on the lighting circuit. The effects of this technology on lamp CCF are not known, but the CCF is likely to increase, which may reduce lamp life.



The tables show performance data for some fluorescent power reducers that are commercially available. All data are based on independent testing, conducted by Lighting Sciences, Inc. in Scottsdale, Arizona, under the direction of the Lighting Research Center. In compiling these data, an attempt was made to obtain products from all known manufacturers. American Systems and Services, Inc. (manufacturer of the Edison 21 Fluorescent Monitor) and Illumination Control Systems (no product trade name) declined to participate in the program.

Only power reducers that are installed by hard wiring were tested; replacement lamps and lamp holder inserts were not tested. To obtain a representative sampling of power reducers, those that fell in one of four product categories were selected for testing:

- Power reducers used with a rapid start two-lamp ballast and two F40T12 40-watt lamps and designed to reduce power by 30 percent;
- Power reducers used with a rapid start two-lamp ballast and two F40T12 40-watt lamps and designed to reduce power by 50 percent;
- Power reducers used with an instant start two-lamp ballast and two F96T12 75-watt lamps and designed to reduce power by 30 percent; and
- Power reducers used with an instant start two-lamp ballast and two F96T12 75-watt lamps and designed to reduce power by 50 percent.

All products chosen for testing are listed with the Underwriters Laboratories and/or the Canadian Standards Association.

Manufacturers offer power reducers with rated power reductions ranging from 20 to 50 percent; specifiers should contact the manufacturers for information about the different power reductions available. Where possible, all power reducers from each manufacturer that fell within the four product categories were tested. In situations where a manufacturer’s rated power reduction did not match the 30 or 50 percent level, products were acquired that most closely matched these power reduction levels. Four samples of each product were tested, except where noted. The data reported in the following table are based on averages of the tested samples.

Power reducers are grouped according to ballast/lamp application, and within each application they are grouped according to the rated power reduction. Within each different application and power reduction level, products are listed alphabetically according to manufacturer name. No attempt has been made, or should be implied, to “rank” the power reducers because the importance assigned to different performance characteristics will vary depending on the application and the user’s specific interests. Data are reported in a range format because some variability may be observed in a given installation.

Rapid Start Test Results

Testing of the rapid start power reducers was conducted in a two-foot by four-foot troffer enclosed by a lens. It contained two high-loss magnetic series ballasts and four F40T12 40-watt lamps. Even though the manufacture and sale of high-loss magnetic ballasts is now prohibited in the United States, often these ballasts are found in retrofit situations.

The light output reductions were generally less than the power reductions. For example, the rapid start products designed for a 50 percent power reduction averaged a 45 percent reduction in power and a 36 percent reduction in light.

The average increase of efficacy was 9 percent. This improvement in efficacy is most likely due to thermal effects and reduced ballast winding current losses. More than half of the rapid start products maintained the power factor above 0.9. The rapid start products increased THD to levels equal to or higher than those of the instant start products, with THD about 32 percent for nearly all rapid start products.

All rapid start products maintained cathode voltage between 2.5 and 4.0 volts. Most caused lamp CCF to increase from under 1.8 to over 2.0. Average ballast temperature reduction was approximately 20°C (36°F). High-loss magnetic ballasts were used for rapid start product testing; ballast temperature reductions would have been less with energy-efficient magnetic ballasts.

Instant Start Test Results

The instant start power reducers were tested in an open strip luminaire containing one energy-efficient magnetic ballast and two F96T12 75-watt lamps. The energy-efficient ballast was used because a comparable high-loss ballast was not available.

Like the rapid start power reducers, the instant start power reducers exhibited an average increase in efficacy of 9 percent. Again, this improvement in efficacy is most likely due to thermal effects and reduced ballast winding current losses. Less than half of the instant start products maintained the power factor above 0.9. Nearly all of the instant start products increased the luminaire current THD to over 20 percent.

The instant start products had a negligible effect on CCF, which was kept below 1.7. Ballast temperatures were reduced by an average of 4°C (7°F). Energy-efficient ballasts were used for the instant start product tests; the reduction in ballast temperatures would have been greater with high-loss magnetic ballasts.

Rapid Start Power Reducer Table

Manufacturer	Trade Name	Catalog No.	% Power Reduction*	% Light Reduction*	Power Factor*	THD (%)*	Lamp CCF*	Ballast Temp. (°C)*
Performance data without power reducer			------	------	≥0.9	10-20	<1.8	80-85
Rapid start products designed to reduce power by 30%								
Canterra Electronics International Inc.	FRED	QS430	24-28	16-20	≥0.9	32-50	1.8-2.0	65-70
DuraLux Industries, Inc.	DuraLux	RS43030	28-32	16-20	≥0.9	25-32	<1.8	60-65
Fluorescent Technology International	Fluor-Tech	420-50-30	28-32	20-24	≥0.9	32-50	2.0-2.3	60-65
REMTEC SYSTEMS	NO-WATT	BQ-4-30	24-28	20-24	≥0.9	32-50	2.0-2.3	60-65
Tavi Energy & Lighting Management Inc.	Conserva Watt	CW40-30	24-28	16-20	≥0.9	32-50	1.8-2.0	60-65
Trivar Inc.	Economical Lighting	FPR-30-2X4	24-28	16-20	≥0.9	32-50	2.0-2.3	65-70
Rapid start products designed to reduce power by 33%								
Energy Conservation Systems, Inc.	Globe Lite	40WPR33	28-32	16-20	≥0.9	32-50	2.0-2.3	65-70
International Energy Systems Corp.	F.R.E.E.	8601	32-36	20-24	0.7-0.9	32-50	2.0-2.3	60-65
Rapid start products designed to reduce power by 50%								
DuraLux Industries, Inc.	DuraLux	RS43050	44-48	32-36	0.7-0.9	32-50	2.0-2.3	50-55
Energy Conservation Systems, Inc.	Globe Lite	40WPR50**	48-52	36-40	0.7-0.9	≥50	≥2.3	55-60
Fluorescent Technology International	Fluor-Tech	420-50-50	44-48	32-36	0.7-0.9	≥50	2.0-2.3	55-60
REMTEC SYSTEMS	NO-WATT	BQ-4-50	44-48	36-40	0.7-0.9	≥50	≥2.3	55-60

* All ranges include the lower number and exclude the upper number.
** Based on a sample of three products.

Instant Start Power Reducer Table

Manufacturer	Trade Name	Catalog No.	% Power Reduction*	% Light Reduction*	Power Factor*	THD (%)*	Lamp CCF	Ballast Temp. (°C)*
Performance data without power reducer			------	------	≥0.9	10-20	<1.7	70-75
Instant start products designed to reduce power by 20%								
Canterra Electronics International Inc.	FRED	IS820	20-24	12-16	≥0.9	25-32	<1.7	65-70
International Energy Systems Corp.	F.R.E.E.	8604	20-24	12-16	≥0.9	20-25	<1.7	60-65
Trivar Inc.	Economical Lighting	FPR-20-2X8	16-20	12-16	≥0.9	20-25	<1.7	65-70
Instant start products designed to reduce power by 30%								
DuraLux Industries, Inc.	DuraLux	IS42530	28-32	20-24	0.7-0.9	10-20	<1.7	60-65
Energy Conservation Systems, Inc.	Globe Lite	75WPR30	28-32	20-24	0.7-0.9	20-25	<1.7	65-70
Fluorescent Technology International	Fluor-Tech	820-50-30	32-36	24-28	0.7-0.9	20-25	<1.7	65-70
REMTEC SYSTEMS	NO-WATT	SQ-3-30	28-32	20-24	0.7-0.9	20-25	<1.7	65-70
Tavi Energy & Lighting Management Inc.	Conserva Watt	CWSL-30	20-24	12-16	≥0.9	20-25	<1.7	65-70
Instant start products designed to reduce power by 40%								
Energy Conservation Systems, Inc.	Globe Lite	75WPR40	32-36	24-28	0.7-0.9	20-25	<1.7	65-70
Instant start products designed to reduce power by 50%								
DuraLux Industries, Inc.	DuraLux	IS42550	40-44	32-36	0.7-0.9	25-32	<1.7	60-65
REMTEC SYSTEMS	NO-WATT	SQ-3-50**	48-52	40-44	0.5-0.7	10-20	<1.7	65-70

** All ranges include the lower number and exclude upper number.
** Based on a sample of three products.

The *Guide to Performance Evaluation of Efficient Lighting Products* is strongly recommended as a companion publication to *Specifier Reports*. In addition to providing more detail on standards and test methods, it contains a glossary that gives plain-English definitions for many of the technical terms used in the report. Another useful publication is Volume I, Issue I *Specifier Reports: Electronic Ballasts*. See page 12 for ordering information.

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