Understanding T8 Fluorescent Ballasts

A comprehensive range of solutions...from GE, the name you trust.

GE introduced the first fluorescent ballast more than 60 years ago. Today we are providing high-frequency electronic ballasts for almost every fluorescent application.

With our UltraMax® and UltraStart® ballasts, we are bringing you the future in ballast performance.

GE revolutionizes lighting again with breakthrough technology. Our patented UltraMax® instant-start and UltraStart® programmed start electronic ballasts transform the power of light into efficiency and savings from store shelves to the installation site. The foundation of the "Ultra" family of ballasts starts with its high efficiency ratings. High efficiency ballasts are a minimum of 90% efficiency with some ballasts nearly 95% efficient which means the ballast only consumes 5-10% of the total system power. These high efficiency ballasts exceed minimum high efficiency standards as established by almost all energy advocate groups, utility rebate programs and the NEMA Premium® ballast program. The ballasts are marked with the Ultra brand as well as the NEMA Premium® ballast mark. These ballasts have multi-voltage control (MVC), which automatically adjusts to handle voltage from 120V through 277V. That cuts the ballast models you need to stock from 40 down to 13, which can dramatically reduce inventory carrying costs. UltraMax® ballasts have ArcGuard Protection, too, with a UL Type CC Anti-Arc Rating. Plus, they're ultra-lamp-friendly, with a low lamp current crest factor of 1.4 for optimal lamp performance. Both UltraMax® and UltraStart® have anti-striation control for better light quality with no lamp striations (spiraling). And the small, low-profile design of these ballasts makes retrofits effortless at the job site. Also unique to our programmed start UltraStart® ballasts is parallel lamp operation which means that if one lamp fails the others remain on, and quick starting times of less than 700 milliseconds which is necessary in avoiding delays with automatic sensors.

GE Fluorescent Ballast Types

Electronic Instant Start

The most common fluorescent ballast is the instant start and is used typically in long 3 to 10-hour lamp cycle applications. These ballasts are energy efficient and can deliver 20% to 40% energy savings when installed with energy-efficient lamps in building retrofits. These ballasts deliver >550 open circuit volts when starting lamps and operate lamps at high frequencies which offers flicker-free operation and better lamp efficiencies.The ballasts are significantly quieter than conventional magnetic ballasts and are backed by GE's ultra system 5-year ballast limited warranty and extended lamp warranties.

UltraMax® Professional Series

A family of high-efficiency GE T8 instant-start electronic linear fluorescent ballasts designed to optimize GE's T8 Ultra lamps for optimal system energy savings. UltraMax® ballasts have a low lamp current crest factor and virtually "read" and adapt to incoming voltage from 108V to 305V. Other features include UL Type CC Anti-Arc Rating and anti-striation control to eliminate lamp striations and spiraling. These ballasts are offered in ballast factors: low wattage (.77), normal light (.87), normal-high (N+) (1.0) and high (>1.15).

UltraMax® General Series

Offered in dedicated or multi-volt (120-277V), these high-performance T8 instant-start ballasts also meet minimum efficiency requirements as established with the NEMA Premium® ballast program. These ballasts are offered in ballast factors: low wattage (.77), normal light (.87), and high (>1.15).

Programmed Start

Programmed Start electronic ballasts have a lamp starting method that preheats lamp filaments before applying an open circuit voltage (OCV) to start the lamp. Use Programmed Start ballasts to ensure long lamp life when turning lamps on and off more than five times in a day or in conjunction with any automatic light control or sensor. This type of starting circuit keeps lamp-end blackening to a minimum and improves lamp life performance, especially in applications where the lamps are frequently switched on and off.

UltraStart®

UltraStart® is a family of high-efficiency GE Programmed Start electronic linear fluorescent ballasts that also exceed NEMA Premium® ballast efficiency requirements but are designed to optimize GE's T8 Ultra lamps in frequently switched applications. Instant start ballasts provide 7,000-13,000 starts before 50% lamp failure. UltraStart® provides greater than 100,000 starts before 50% lamp failure. UltraStart® ballasts provide the same energy savings and convenience of instant start ballasts but with the longer lamp life offered a programmed start ballast. These ballasts are offered in ballast factors: programmed start x-low wattage (XL) (.60), low wattage (.71), normal light (.87), and high (>1.15).

Ballast Date Codes

Date Codes

GE electronic ballast manufacturing date codes are located on the upper right-hand corner of the label. The code lists the month, year and day of manufacture. A typical code is C16-073, where the month is listed as A (January), B (February), C (March) as in this code followed by the year 16 (2016) and the date of manufacture 073 (the 73rd day of 2016).

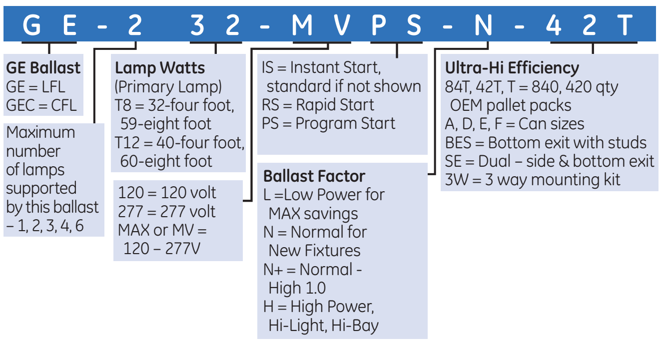
Ballast Life

GE electronic ballasts are designed and manufactured to an average life expectancy of 60,000 hours of operation at maximum rated case temperatures. As a rule of thumb, ballast life is doubled for every 10C reduction in ballast case temperature. However there are other variables such as transients, voltage sags and swells, ambient temperature, etc., which affect ballast life as well.

Instant Start vs. Rapid Start Sockets

When using programmed start or dimming ballasts in fixtures, sockets must be 2-pin rapid start type. Fixtures with T8 instant start ballasts must use jumpered rapid start sockets or shunted lamp holders (internal to the lamp holder) that bridge the lamp bi-pins together into one contact on each side of the lamp. If retrofitting from a instant start ballast fixture with shunted sockets to a dimming or programmed start ballast, rapid start type sockets must be used to properly start lamps and maintain rated lamp life.

GE Ballast Electronic nomenclature



Understanding Fluorescent Systems

GE introduced the first practical fluorescent lamp in 1938. All fluorescent lamps operate on electrical control gear called a ballast. Today, electronic ballasts have continued to replace the magnetic designs that were common previously. The 4-foot T8 lamp on an electronic ballast is the most common system. The generic version of this lamp is called the F32T8 and in recent years, energy saving reduced wattage lamps like the F28T8 and the F32T8/25W have become popular. These lamps typically operate on Instant Start (IS) or Programmed Rapid Start (PRS) ballasts and both types of ballasts are available in a variety of ballast factors ranging from 0.60 to 1.18.

Ballast Factor

The F32T8 lamp has a "nominal" wattage of 32 watts. Nominal means "in name only" because there are no ballasts commercially available that will operate this lamp at 32 watts! The "N" or "Normal" ballast factor ballast operates this at around 26 watts while the "L" operates the lamp around 23 watts; the "N+" operates it around 29 watts and the "H" around 34 watts. Electronic ballasts operate lamps at high frequencies of greater than 20 kHz, which results in more efficient lamp operation than at 60 kHz, like the magnetic ballasts they replace. This results in a lamp that is more efficient than the 32 nominal watts.

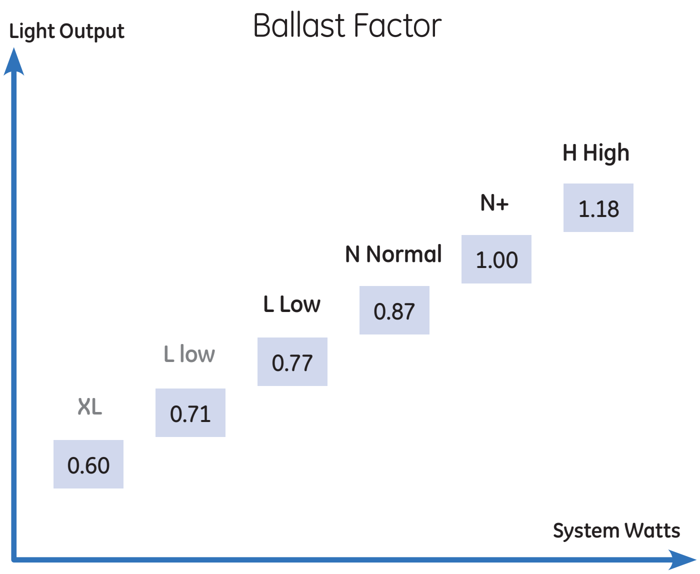
Unlike HID lamps and Incandescent/Halogen lamps which are designed for optimum performance at a specific wattage, linear fluorescent lamps can be operated over a reasonably wide range without sacrificing performance, such as life or efficacy. Therefore, there is no "optimum" wattage for a lamp, only a range. The F32T8 lamp can produce between 60% to 118% of its catalog lumens when operated on a ballast with a ballast factor of 0.60 to 1.18. The higher the operating wattage, the higher the lumen output within this range.

Consumers have a choice among ballasts, depending on how much light they desire from the lamp and how much energy they are trying to save. The ballast specification from the ballast manufacturer provides the "input wattage" of the ballast. A two lamp electronic ballast with input watts of 56 watts (BF of 0.88) is using 56 watts of power to operate 2 lamps--typically 26 watts in each lamp and 4 watts in the ballast. In contrast, a ballast with BF of 1.18 will consume 76 watts but also produce more light.

An engineer or designer will choose a high BF when trying to "squeeze" as much light as possible from the lamp, e.g. in high-bay applications or when they are trying to reduce the number of lamps used in the area. A lower BF reduces the light output and wattage of each lamp, so that more lamps (and more fixtures) are needed to achieve a certain footcandle level in the same area. Of course more fixtures also means closer spacing and more uniform lighting.

It must be noted that ballast factor (and any measure involving BF) requires a measurement of lamp lumens and is, therefore, not a pure electrical measurement. The uncertainty and variation associated with individual lamp performance is present in these measures.

Actual Light Output of Lamp = (Catalog Lumens) x (Ballast Factor)



Instant Start and Programmed Rapid Start Ballasts

There are two major families of ballasts. While the current limiting function is the same, these ballasts differ in how they start the lamp.

Instant Start (IS) Ballasts apply a relatively high voltage (e.g. 550 volts) to get the discharge going and the lamp starts instantaneously. (GE's UltraMax® family)

Programmed Rapid Start (PRS) Ballasts provide a gentler start through cathode heating prior to application of starting voltage, and are particularly useful when lamps are turned on and off frequently (motion sensors, occupancy sensors). However, they are being used even in one-start-a-day applications because they extend lamp life significantly. (GE's UltraStart® family)

Ballast Efficacy Factor (BEF)

BEF is BF (Ballast factor) divided by ballast input watts. For a given BF and a certain number of lamps operated on the ballast, the more efficient ballast will have lower watts and, therefore, a higher BEF.

$$\text{Ballast Efficacy (BEF) Factor} = \frac{\text{Ballast Factor}}{\text{Ballast Input Watts}} \times 100$$

Some industry groups write standards based on BEF in order to identify more efficient ballasts. However, this measure is somewhat obscure and an alternate measure that is simpler to understand is:

System Efficacy (Mean System LPW or MLPW)

This is the mean source lumens provided by the particular system divided by the watts the system is using.

$$\text{Mean Source Lumens} = \left(\text{Lamp Mean Lumen Rating}\right) \times \left(\text{Ballast Factor}\right) \times \left(\text{Number of Lamps}\right)$$

and

$$\text{System Efficacy (MLPW)} = \frac{\text{Mean Source Lumens}}{\text{Ballast Input Watts}}$$

The Consortium on Energy Efficiency (CEE) uses both BEF and MLPW in its documents on high performance T8 specifications and reduced wattage T8 specifications. The rebate programs of many utilities around the country currently use these two measures to determine which systems will qualify for rebates.

Ballast Electrical Efficiency (BE)

A simple electrical measure of how efficiently a ballast performs is:

$$\text{Ballast Efficiency} = \frac{\text{Watts Delivered to Lamps}}{\text{Ballast Input Watts}}$$

NEMA (National Electric Manufacturer's Association) uses Ballast Efficiency (BE) as an alternative method to designate "NEMA PREMIUM" ballasts as those having 90% or greater electrical efficiency. BE is gaining increasing acceptance as an objective and reproducible measure because it excludes the variability present in individual lamp performance and the difficulties associated with accurate determination of lumens.

Fluorescent Ballast Application Notes

Ballast Operating Lifetime

Heat is the enemy of modern electronic ballasts. As ballast case temperature increases, life expectancy decreases. GE ballast designs feature patented high efficiency circuits that have less losses and lower internal heat generation than competitive ballasts. Ballast lifetime is developed from thermal testing conducted per UL specified test conditions at a 40°C still air ambient condition. Some GE ballasts are even UL approved for use at 55°C ambient without exceeding the maximum permissible case temperature. Since GE ballasts typically operate well below the maximum temperature rating, the ballast lifetime will usually extend longer that the design life of 60,000 hours. Reducing the case temperature by 10°C will double the life expectancy, but this depends on the operating environment which includes ambient temperature, fixture thermal performance and input voltage conditions.

EMI and RFI

All electronic ballasts operate at frequencies that generate Electromagnetic Interference or Radio Frequency Interference. GE Ballasts are tested by FCC certified labs to ensure their emissions are well within the established limits for Class A Commercial and Industrial applications. Some GE ballasts are designed for Residential applications and meet a more stringent Class B Consumer FCC rating. The Consumer rating will minimize chances of the ballast interfering with radio and television reception. If interference results, ensure the ballast case is properly grounded to the metal fixture, and the fixture is grounded by a green ground wire that connects directly to the service panel. As the electromagnetic spectrum is increasing occupied, it is recommended to test a sample lamp and ballast system in the intended environment to ensure there are no undesired interactions with other equipment or systems operating in the same environment.

Energy Saving Lamps

Energy saving lamps lower the lamp operating wattage by use of special gas mixtures. These lamp are sometimes harder to strike or break down than full wattage lamps and due to the gas mixture, may be more susceptible to striations during operation. GE Ballasts feature proprietary anti striation circuitry that minimize or completely eliminate striation effect of energy saving lamps. Ballast remote mounting distance is specified for standard full wattage lamps only.

Fixture Wiring Techniques

Electronic ballasts are now much more popular than the old magnetic ballasts, offering superior energy efficiency, greater lamp efficacy, and cooler operation. The first electronic ballasts operated only slightly above the audible frequency range around 22 kHz. As today's ballasts operate at high frequency, typically 40 kHz and higher, some attention is needed to ensure the fixture wiring does not create any starting or operational issues due to wiring capacitance.

As ballasts decrease in size, the operation frequency increases. The increased frequency of operation makes capacitive effects more pronounced. Capacitive effects come from a high frequency lead wire being in proximity to another lead wire or the grounded metal of the fixture. Worse capacitive effects result when the lead wires are closer and the frequency is higher.

When installing ballasts into fixtures, the wiring needs to be routed point to point and if possible, the excess wire trimmed out. Occasionally, some installers tend to be too neat, twisting the wires together or bundling the wires together with wire ties. While this does make for a neat fixture, it may create capacitive effect issues for the lamp and ballast system.

Wire bundling can create unintended current flows from lead to lead and also from lead to ground in the fixture. These current flows are parasitic, and will reduce the available starting voltage, preheating current or discharge current in the lamp. The results can be poor or erratic starting or reduced system efficacy as some of the energy from the ballast is getting "short circuited" away from the intended lamp load. In T5 or CFL applications, excessive stray capacitance can also affect End Of Life circuit operation, causing the ballast to prematurely shut down.

In dual switched systems, or systems that use two or more ballasts within the same fixture, ballasts more subject to cross talk and interference due to capacitive effects. It is important the wiring be placed neatly without bunching up the excess in the wiring channel. Lamp leads can run parallel to each other but should not be bundled or tied together. Lamp leads should also trimmed when possible to eliminate excess lead length. It is also good to keep the output leads from one ballast away from those of the other ballast. Lamp leads should also be kept away from the AC input leads as this can cause undesired interference or EMI, which can affect other devices operating on the same power source.

In summary, the lamp lead wiring should be laid parallel into the fixture with excess length trimmed. Do not twist or otherwise bundle the leads together, and ensure no leads are caught or crimped between the ballast channel cover and the fixture body.

Remote and Tandem Mounting of Ballasts

As today's economics drive lower first costs, many fixture manufacturers increasingly use only one ballast to operate lamps in two or more fixtures. This tandem mounting scheme decreases the total number of ballasts needed for a given installation. The fixtures are typically interconnected with a wiring "whip" of flexible metal conduit with a number of wires inside. The whip brings the high frequency lamp leads from the ballast in one fixture to the lamp or lamps in a satellite fixture. Tandem operation has lamps operating in the fixture that has the ballast and also in the satellite fixture.

Remote mounting is when a ballast is located in a separate enclosure without lamps and wires to all the lamps run through a conduit or flexible whip to a remote fixture which contains the lamps.

In past years, ballasts were magnetic and operated at 60 Hz, and tandem or remote mounting scheme was only occasionally used, so issues with remote or tandem mounting were not so frequent. In today's energy efficient electronic ballasts, the frequency is much higher, usually greater than 40 kHz, and more fixtures are being tandem operated to manage first costs of a system. Tandem operation can lead to system issues such as poor or erratic starting and differences in light level during steady state lamp operation.

These issues develop when the combination of high operating frequency and parasitic capacitance from the wiring create unintended coupling between conductors or to earth ground. Each wire in the fixture and the interconnect whip will have a certain capacitance to other wires running parallel to it, and also a capacitance to earth ground. This unintended capacitive coupling creates a shunt path taking away some energy that was intended for the lamp load. This causes reductions in the available open circuit voltage need to strike the lamp or a loss of preheating energy. Both cases lead to poor or erratic starting in the remote fixture(s).

For some multiple lamp ballasts, certain lamp leads are at higher potential and should be connected to lamps that reside in the same fixture as the ballast. The ballast manufacturer may have specific recommendations as to which of the lamp leads can be utilized for the remote fixture of a tandem set, and restrictions on how long the wiring from ballast to lamp may be. Ballasts may also have different permissible wiring lengths per lamp lead color based on the application. Remote mounting applications may permit a longer wiring length than some tandem applications as the remote situation presents a uniform loss to all lamp leads. The tandem operation scheme may present different capacitances to different lamp leads that could result in poor starting and differences in light level during operation.

In some cases, these issues are compounded because the interconnect whip is carrying wires connected to two different ballasts. Since the ballasts are not likely to be exactly in phase, there can be additional losses due to capacitive phase cancellation between leads of the two different ballasts. There may also be system interactions where either ballast will work fine separately, but will not work together. In these cases, the interconnect whip may need to be shorter, limiting the distance between the fixtures, or two separate whips could be used.

As the ballast operating frequency gets higher, the capacitive shunting effect become more pronounced. Dimming ballasts typically are at the highest frequency when in deep dimming. Due to the effects of capacitive losses, lamps may appear at different intensities or drop out and may flicker due to losses of cathode heating energy. It is recommended that dimming ballasts not be remote mounted or used in tandem operation, all lamp wiring must stay within the fixture containing the dimming ballast.

Energy saving lamps may be more susceptible to starting issues when used in remote or tandem fixture operation. These lamps utilize a gas mixture that does not ionize as easily as full wattage lamps, and are more likely to have starting issues due to the reduced starting voltage resulting from the capacitive losses.

Remote starting distances are specified at room temperature using standard life, full wattage lamps, with one ballast driving all lamps located in the remote fixture through a single conduit at the specified distance. In view of the possible differences related to any specific application, it is advised that any tandem or remote mount application using one or more ballasts be tested in the final configuration to ensure the system will perform as expected in the intended environment.