



TECHNOLOGY INFORMATION SHEET

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FLUORESCENT LAMP BALLASTS

1. Purpose of a Ballast

Why is that black rectangular box contained in a fluorescent light fixture called a ballast? Isn't the term ballast the name given to the heavy objects that are at the bottom of a large ship? Actually, a ballast is defined as anything that adds stability or steadiness. In that sense, it is the perfect name for the function that the black box provides to the fluorescent lighting system. As a ship's ballast stabilises the vessel, so does a light's ballast stabilise its operation.

A ballast is a device that is used with fluorescent and other discharge lamps to provide the required current and voltage. The primary function is to provide the lamp with high voltage and/or cathode heating during start-up, and then to stabilise the arc by limiting the electrical current to the lamp. In addition, some ballast's can provide power quality correction and dimming capabilities.

Specifications

Ballast specifications are based on the number of lamps (1 - 4) served by the ballast, the type of lamp it is for, and line voltage. For example: "two lamp F40T12 120V ballast." is designed for two 40 watt, T12, lamps which operates on 120V input.

Ballast's are available in rapid start (lamps in series) or instant start (lamps in parallel) configurations.

Ballast's for tube fluorescent lamps are attached inside the fixture behind the reflector. A ballast in one fixture can be used to drive up to four lamps in up to four fixtures. Ballast's for compact fluorescent and high intensity discharge lamps are usually located in the base of the lamp.

Efficiency

Ballast efficiency is measured by 1) the Ballast Factor which is the ratio of the actual light output of the lamp when operating with the ballast versus the specified lamp light output, and 2) the additional power that the ballast draws over and above the lamps.

Power factor (power used/line volts x line amps) and harmonic distortion are also an important characteristics of ballasts.

2. Electronic vs. Electromagnetic

There are two basic types of ballasts: low-frequency magnetic ballasts and high-frequency electronic ballasts. The functions of the two types of ballasts are essentially the same; that is, they control the starting and operating characteristics of the electricity for the appropriate fluorescent lamp. The primary difference is in the frequency delivered to the lamps and, obviously, the components that generate the frequencies.

Magnetic Ballasts

The magnetic ballast uses a magnetic transformer of copper windings around a steel core to convert the input line voltage and current to the voltage and current required to start and operate the fluorescent lamps. Capacitors are added to assist lamp starting and power factor correction. But the output frequency is the same as the input frequency (60 Hz).

Electronic Ballasts

An electronic ballast uses integrated circuitry to perform all functions of the ballast. It rectifies the

60 Hz AC input to DC and then produces a very high frequency current (20,000 - 50,000 Hz) using an inverter and power conditioning components. In most models, the electronics are also used to provide current limitation, and improve power factor.

Use of controllable integrated circuits in an electronic ballast allows the output to be varied and the fluorescent lamps dimmable in response to manual or automatic (sensor) control.

Some “hybrid” ballasts use some electronic circuitry to produce the high frequency current but use conventional current limiting and power factor correction components.

Reliable integrated circuit electronic ballasts are available in Canada only at 120 volts and 277 volts (US standard). Electromagnetic ballasts are available in 120 and 347 volts.

3. Performance and Advantages of Electronic Ballasts

Energy Savings

The primary advantage of electronic ballasts is that they draw less power and therefore provide energy savings. For example, magnetic ballasts consume 12 or 13 watts internally, whereas the electronic ballasts may consume only 4 watts. The lower power consumption also means that there is less heat generated by the ballast resulting in lower operating temperatures. The lower fixture temperatures and high frequency operation causes the lamps, themselves, to operate up to 10% more efficiently, i.e. the ballast factor is improved.

TYPICAL SAVINGS

Standard electromagnetic ballast driving two lamps draws 82 watts
Electronic ballast operating the same lamps draws 60 watts

Savings 27%

Reduced Flicker, Noise and Weight

Electronic ballasts also provide additional benefits to fluorescent lighting systems. A characteristic flicker can occur from magnetic ballasts that are produced from the low frequency 60 Hz input.

High-frequency ballasts eliminate the flicker. Minimising light flicker improves the overall light quality and can enhance work performance¹. Electronic ballasts also weigh less than magnetic ballasts. Finally, the characteristic hum of magnetic ballasts is also eliminated.

Temperature and Life

Electronic ballasts operate at lower temperatures than magnetic ballasts, increasing lamp life, and reducing air conditioning and maintenance costs.

BENEFITS OF ELECTRONIC BALLAST

- **Noise typically 25% less than magnetic**
- **Weight typically 50% less than magnetic**
- **Operating temperature 30 deg C lower than magnetic**

Lamp Dimmability

One of the most significant features of full integrated circuit electronic ballasts for future lighting system designs, is its “dimmability”. With the addition of light-level sensors, electronic ballasts can provide optimum power to the lamp to maintain a constant level of light as daylight increases and decreases through the day.

In daylit perimeter spaces, daylight dimming can save up to half the lighting energy. In addition, dimming features can automatically increase light levels as the lamps age or reduce light levels when new lamps are installed. The ability to dim fluorescent lighting means that light “management” is now possible. (See the Automated Lighting Controls Technology Information Sheet).

Other Benefits

Low-frequency magnetic ballasts will consume power even after the lamps have failed. Most high-frequency electronic ballast are designed with built-in circuitry to cut out when the lamps are not operating.

Finally electronic ballasts run on AC or DC and can be used to drive several lamp types (e.g. all rapid

¹ An uncommon but serious result of flicker is the triggering of seizures among epileptic or photosensitive people.

start T12s, T10s and T8s), whereas electromagnetic ballasts must be matched with the specific lamp types. This makes retrofitting with electronic ballasts easier.

Other information about ballasts can be obtained through publications listed on Efficient Lighting Reference List.

4. Other Issues

Power Factor

Complex electrical loads (other than simple resistive loads) have elements that change the ratio of the useable power to the supplied power. In other words, more supply power is required than is utilised. This is defined as the power factor. Most utilities penalise companies that have a low power factor. Both magnetic and electronic ballasts have components that reduce the power factor ratio²; in some cases it is less than 85%. Electronic ballasts are now capable of power factor ratings of over 95% (some manufacturers claim greater than 99%). When purchasing ballasts it is important to ensure they have a power factor equal to or greater than 95%.

Total Harmonic Distortion

Many electrical devices, especially electronic devices, can produce a harmonic distortion of the shape (sine wave) of the electrical wave form. This distortion degrades the quality of the electricity and can subsequently decrease the effectiveness and efficiency of the equipment. Total Harmonic Distortion is defined as a ratio of the sum of all the harmonics over the magnitude of the fundamental power. Most magnetic ballasts have a total harmonic distortion between 18% and 35%. Most electronic ballasts have the total harmonic distortion below 20% with some below 10%. It is advised to purchase ballasts that have low distortion specifications.

Environmental Impact

Electromagnetic ballasts used to contain PCB's, but have not done so for many years.

² An ideal Power Factor Ratio is 1.0, which means that volt-amps supplied are equal to the power used.

