INDICATING LIGHTS

755 Lamp

LED Lamp

Stacklight LED

Stacklight Incandescent Lamp

Notes on the Application of Industrial Control Indicating Lights

This is a guide to the application of indicating lights used for industrial control. Of primary interest and concern are the factors which influence lamp life and reliability. The topics discussed are culled from application experience and questions from users.

Common Causes of Lamp Failure

There are four common causes of lamp failure:

Notching

Evaporation of the tungsten filament until a thin section breaks. In long, high voltage filaments this usually occurs at a support point located at the middle of the filament. It occurs earlier on DC than AC and less frequently on half-wave AC.

Excessive Voltage

Particularly from voltage spikes or transients. Lamp life increases (or decreases) with the 12th power of voltage reduction (or increase) while light output is affected only by about the 3.6 power of voltage reduction so a substantial life increase can be achieved with a small decrease in brightness.

Vibration and Shock

Long thin filaments are particularly vulnerable to shock and vibration.

In general, the longer filaments in higher voltage lamps are more susceptible to failure due to shock and vibration.

Excessive Heat

Excessive heat contributes to notching for incandescent lights and may melt the plastic sleeve on LED lamps.

Data on life published by lamp manufacturers is based on controlled laboratory testing in AC applications, at rated current, and at a constant rated voltage—with no consideration for the effects of transients and mechanical shock. It is not necessarily the same as service life; environmental influences may result in a shorter life.

AC Applications

Transformer Type

Energizing a low voltage lamp through a specially designed isolating transformer virtually eliminates transient voltage and voltage spike failure. Through careful design, the transformer can be matched to the lamp characteristics in such a way as to extend the life of the lamp to several times its rated life. The lower voltage lamp used in transformer type lights is also more resistant to most industrial shock and vibration. The majority of industrial installations use the transformer type light.

These transformers are designed with a magnetic coupling between the primary and secondary. This design absorbs voltage surges and supplies a constant voltage value to the lamp filament. If the lamp tries to draw more current, the secondary voltage drops to prevent this from happening.

The secondary voltage is usually set at a voltage less than the rated lamp voltage for extended lamp life with little reduction in light output. The secondary voltage must be measured with the lamp connected. Open circuit voltage will be two or three times the correct value; each lamp type will determine it's own voltage. A 10 percent reduction in voltage will almost quadruple the rated lamp life.

The 6-volt lamp (connected to the transformer secondary) has a short, thick filament that has a resonant frequency well above that of most industrial vibration. It is highly resistant to mechanical shock. The shorter filament does not require midpoint support - this reduces the effect of notching discussed earlier.

Direct Connected (Full Voltage) and Resistor Type

These types have a lower initial cost. They can be considered where the light is used infrequently so that lamp life is not an important consideration, where the AC voltage supply is exceptionally well regulated with no spikes or transients and where there is little shock or vibration. This is especially so if lamp failure is only a nuisance and is not critical to the operation. Application experience has shown that an initial low price should usually not be a primary consideration in selecting lamp types because of the high cost of frequent replacements due to voltage spikes on AC lines.

DC Applications

In DC applications the advantages of the transformer cannot be realized. The only types available are the direct connected and resistor type. Fortunately, most DC sources have excellent regulation and spikes and transients are not a factor. If there is a problem, it must be dealt with through corrective action in the power circuit. As noted earlier, notching is a more severe problem in DC so reduction of the voltage applied to the lamp is very important.

By employing the fact that incandescent lamp life increases with the 12th power of voltage reduction and that light output only decreases with the 3.6 power of voltage reduction, the lamp voltage can be reduced to the lowest level that gives sufficient light output. This can be done either through the use of series resistors or by selecting a lamp with a higher voltage rating than the application, however, a limiting factor in using series resistors is heat generation. An examination of the lamp selection for cataloged direct connected indicating lights will reflect these trade-offs.

In using series resistors, a limiting factor is heat generation. The amount of heat which would be generated by a series resistor sized to use a 120 volt lamp on a 240 volt circuit is usually unacceptable.

Mechanical Shock and Vibration

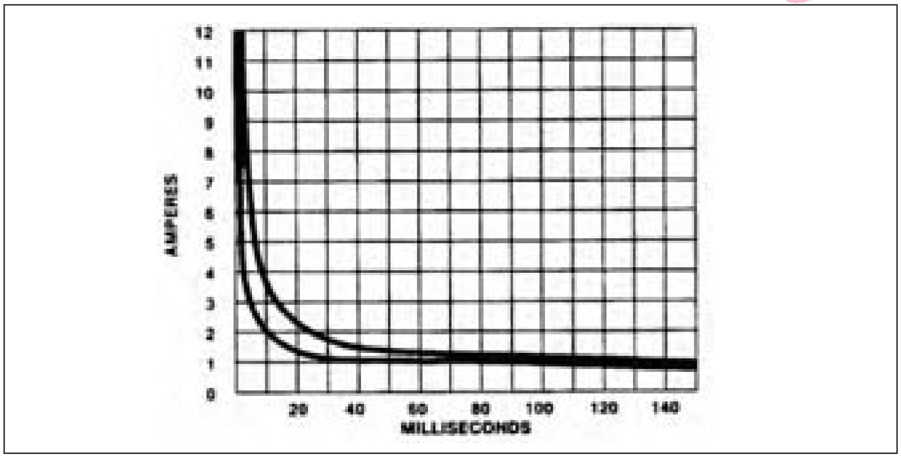
The most effective way of combating shock and vibration is to use a lamp without a filament - an LED or a neon light. LEDs are considerably brighter than neon lights, and offer a greater variety of color. See the discussion of neon and LED lights below for further considerations of these lamps.

If incandescents are used, 120 volt AC transformer units are the most vibration and shock resistant type and are many times more reliable than direct voltage types. Another practical method of overcoming shock and vibration is to keep the filament continuously hot. Tungsten filaments become brittle at room temperature. The transition point from ductile to brittle occurs just below the point of light emission - about 350°C. To take advantage of this characteristic, a bypass resistor continuously energizes the lamp when it is not indicating. The current for no indication is about one percent of the indicating current. A practical means of determining the correct current is to back off the current just below where the lamp filament ceases to glow - at this point the filament resistance is about twice its room temperature value.

Lamps for Restricted Current Draw

Neon lamps draw very little current (2 milliamperes typical) and may be the solution where current is a problem. LED lamps are another excellent choice. The life of an LED is actually increased in an undercurrent situation. See discussion of neon lamps and LEDs below.

INRUSH CURRENT VS. TIME FOR TUNGSTEN FILAMENTS



Inrush Current

Inrush current is not usually a consideration in the application of indicating lights. Indicating lights differ from electromagnetic devices where consideration of inrush is essential, in two important ways:

The inrush current for a lamp is of very short duration.

An electromagnetic device has a very much reduced impedance for the open versus the closed state. If the system is not capable of supplying the high inrush current to immediately close the magnet, it continues to draw excessive current and may burn out; under the same conditions a lamp just takes a little longer (milliseconds) to reach its steady state.

If the inrush current is a problem, some additional transformer capacity could be supplied - usually 20 percent of steady state current is sufficient. Inrush can be a factor in application of lamps operated by electronic circuits.

The above curve is typical of lamp inrush current characteristics and may be used as a guide.

Light Emitting Diodes (LED)

Recent technological developments have made LED bulbs a viable alternative to incandescent lights. In the past, high cost, low intensity and limited color choices rendered LEDs impractical. Today, LED bulbs are as bright as or brighter than incandescent bulbs, available in a variety of colors, and when considered over an extended time period, they can be more cost effective than incandescent lamps.

With the advent of new super bright LED materials, luminous intensities of 10 to 20 times that of older technology are now available. Combined with the previously recognized benefits of long life, resistance to mechanical vibration and shock, and performance in undercurrent situations, the LED becomes a very competitive alternative to traditional incandescent lamps.

Additional benefits include faster switching speed, useful in safety applications and for conveying diagnostic information, and efficient power conversion, for lower operating costs.

As with the neon lamps, false indications can be a problem. Cutler-Hammer provides bridge rectifiers preventing reverse voltage from causing a false indication, however, glowing may be caused by a warming resistor, a blocking diode, or noise on the line as well. Most of these problems can be rectified with the use of a resistive load at the terminator or a parallel resistor inside the LED base or external to the device.

Excessive heat can be a problem for LED lamps, because the resistor is housed in the base. In some designs, this may cause the plastic sleeve to melt separating the terminal from the base. In higher quality units, the terminal may be soldered to the base or the base may be potted internally with epoxy reducing the effects of excessive heat.

Neon Lamps

Neon lamps do not have filaments and, hence, do not have the shock and vibration

INDICATING LIGHTS
CONTINUED

problems encountered with filament lamps. They do, however, have some limitations. They emit a very low level of light. Nearly all of the emission is in the red spectrum - generally they can only be used with a clear or amber lens for adequate indication. Since the light output is much less than for incandescent lights, it should be checked for adequacy under the ambient light conditions to be encountered. As the lamp ages, its output is further diminished.

The lamp draws very little current but it does have a minimum voltage for ignition. Because it requires little energy, it is readily triggered by induced voltages picked up from the circuits it is connected to, causing a false indication. This is neutralized in the Cutler-Hammer lamps by a bleeder resistor of high ohmic value connected in parallel with the filament -this is in addition to the series ballast resistor required in all neon systems (built into the lamp base in Cutler-Hammer devices).

Application Data

10250T

Type of Light	Lamp Used	Approximate Current, mA at Rated Volts	Theoretical Lamp Life, Hours as Applied
10250T/E34 Transformer Type			
24V	#755	130	60,000
120V	#775	26	60,000
240V	#775	13	60,000
380V	#775	8	60,000
480V	#775	7	60,000
600V	#775	5	60,000
10250T/E34 Direct Connected (Full Voltage) and Resistor Type			
120V*	120MB	25	7,500
240V*	120MB	25	7,500
6V	#755	150	20,000
12V	#756	80	15,000
14V	#756	80	15,000
24V	#757	80	7,500
32V	#1828	50	3,000
48V	#1835	50	5,000

*Resistor AC or DC

E22

Type of Light	Lamp Used	Approximate Current, mA at Rated Volts	Theoretical Lamp Life, Hours as Applied
E22 Transformer Type			
120V	#755	16	60,000
240V	#755	7	60,000
480V	#755	4	60,000
110V/50 Hz	#755	13	60,000
240V/50 Hz	#755	7	60,000
415V/50 Hz	#755	3	60,000
440V/50 Hz	#755	4	60,000
E22 Direct Connected (Full Voltage) Type			
6V	#755	150	20,000
12V	#756	80	15,000
24V	#1819	40	2,500
48V	W1225	20	1,000
120V*	W1226	20	1,000

*Resistor Type

E30

Type of Light	Lamp Used	Approximate Current, mA at Rated Volts	Theoretical Lamp Life, Hours as Applied
E30 Transformer Type, Single Indicating Light			
120V	#259	130	5,000
208V	#259	26	5,000
240V	#259	13	5,000
380V	#259	8	5,000
480V	#259	7	5,000
600V	#259	5	5,000
E30 Transformer Type, Dual Indicating Light			
120V	6PSB	130	20,000
208V	6PSB	26	20,000
240V	6PSB	13	20,000
380V	6PSB	8	20,000
480V	6PSB	7	20,000
600V	6PSB	5	20,000
E30 Direct Connected (Full Voltage) Type			
6V	6PSB	140	20,000
12V	12PSB	170	12,000
18/24V	24PSB	73	10,000
28V	28PSB	40	5,000
32V*	28PSB	40	5,000
48V	48PSB	50	10,000
120V	120PSB	25	7,500
E30 Resistor Type			
120V	120PSB	25	7,500

*Resistor Type

NOTE: Published theoretical lamp lifes are based on ideal laboratory conditions and should be used for comparison only. Actual life may be shorter due to various application conditions described in this paper.

For Use with 10250T, E22

Type of Light	Lamp Used	Current Draw from Lamp	Theoretical Lamp Life, Hours as Applied
Neon Type			
120V	NE51H-R-68	1.2	25,000
240V	NE51H-R-22	1.2	25,000

Type of Light	Lamp Used	Approximate Current, mA per Light	Theoretical Lamp Life, Hours as Applied
Stacklight Incandescent Lamps			
12V	BA15D	40	7,000
24V	BA15D	40	7,000
48V	BA15D	40	7,000
110 – 140V	BA15D	40	7,000
220 – 260V	BA15D	40	12,000

Type of Light	Color	Approximate Current, mA at Rated Volts	Turn-on Voltage (V)	Turn-on Current (mA)*	Theoretical Lamp Life, Hours as Applied
LED Lamps					
10V AC/ 6V DC	Red	22	2.5	0.15	100,000
	Yellow	22	2.5	0.15	100,000
	Green	16	3.5	0.06	100,000
	Blue	16	3.5	0.06	100,000
12V AC/DC	Red	22	2.5	0.15	100,000
	Yellow	22	2.5	0.15	100,000
	Green	16	3.5	0.06	100,000
	Blue	16	3.5	0.06	100,000
24V AC/DC	Red	22	2.5	0.15	100,000
	Yellow	22	2.5	0.15	100,000
	Green	16	3.5	0.06	100,000
	Blue	16	3.5	0.06	100,000
48V AC/DC	Red	11	2.5	0.15	100,000
	Yellow	11	2.5	0.15	100,000
	Green	11	3.5	0.06	100,000
	Blue	11	3.5	0.06	100,000
60V AC/DC	Red	9	2.5	0.15	100,000
	Yellow	9	2.5	0.15	100,000
	Green	9	3.5	0.06	100,000
	Blue	9	3.5	0.06	100,000
120V AC/DC	Red	7	2.5	0.15	100,000
	Yellow	7	2.5	0.15	100,000
	Green	7	3.5	0.06	100,000
	Blue	7	3.5	0.06	100,000

Type of Light	Color	Approximate Current, mA at Rated Volts	Turn-on Voltage (V)	Turn-on Current (mA)*	Theoretical Lamp Life, Hours as Applied
Stacklight LED Lamps					
12V AC/DC	Red	92	8	0.6	100,000
	Yellow	92	8.2	0.6	100,000
	Green	60	6.3	0.24	100,000
	Blue	60	7	0.24	100,000
24V AC/DC	Red	47	16	1.2	100,000
	Yellow	47	16	1.2	100,000
	Green	59	12	0.24	100,000
	Blue	59	13	0.24	100,000
48V AC/DC	Red	25	32	0.15	100,000
	Yellow	25	34	0.15	100,000
	Green	18	47	0.12	100,000
	Blue	31	23	0.12	100,000
60V AC/DC	Red	25	32	0.15	100,000
	Yellow	25	33.5	0.15	100,000
	Green	18	47	0.06	100,000
	Blue	17	50	0.06	100,000
120V AC/DC	Red	24	N/A	N/A	100,000
	Yellow	24	N/A	N/A	100,000
	Green	17	N/A	N/A	100,000
	Blue	16	N/A	N/A	100,000

* If noise in line exceeds Turn-on Current and Turn-on Voltage, a parallel resistor on the line is recommended.

Model	Voltage	Current (cont.)	Lamp Life
Xenon Flasher			
12V	DC	460 mA	20,000
	AC	780 mA	20,000
24V Strobe	DC	190 mA	20,000
	AC	320 mA	20,000
48V	DC	100 mA	20,000
	AC	150 mA	20,000
120V	AC	60 mA*	20,000
240V	AC	30 mA*	20,000

* Represents average current draw, 1.6A peak for 120V and .8A peak at 240V.

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