Application of electromechanical contactors in lighting loads

Eaton's *XT* IEC power control ratings

When determining the appropriate contactor to use for lighting loads, it is important to consider the bulb properties when they are switched on and when they are operating continuously. Depending on the lamp type used, high currents may occur for a relatively long time during the preheating phase or possibly high current peaks, for milliseconds, due to capacitive loading. These currents must be correlated with the continuous current and the making capacity of the contactor used. Particular attention should be paid to the switching capacity for capacitive loads when gas discharge lamps are placed in parallel.

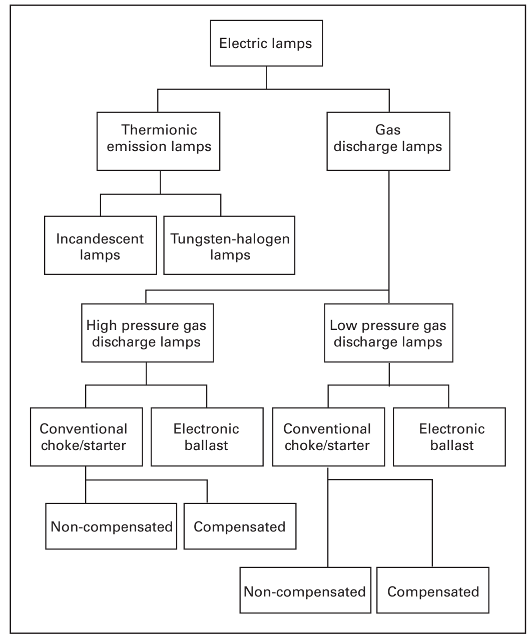

Figure 1. Lamp type flowchart

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Incandescent lamps, tungsten-halogen lamps

Incandescent lamps generate light by thermionic emission on the filament. In the cold state, the filaments of incandescent lamps have an extremely low resistance. Accordingly, peak inrush currents can reach 16 times the normal operating current. Because the operating current is simply disconnected when switched off, the switching on becomes the critical measurement to consider when selecting the appropriate contactor. Thermionic emission, formerly known as the Edison effect, is the flow of charged particles called thermions from a charged metal or a charged metal oxide surface, caused by thermal vibrational energy overcoming the electrostatic forces holding electrons to the surface. The charge of the thermions will be the same as the charge of the metal/metal oxide.

Fluorescent lamps

Fluorescent lamps use a layer of fluorescent material applied to the inner surface of the glass bulb that is excited by UV radiation from a metal vapor discharge. A ballast creates a high voltage pulse that ignites the gas and determines the starting behavior of the lamp. With conventional choke/starter switching, a slightly increased preheating current, typically 1.25 times operating current, flows for a few seconds before it is reduced to operating current after the gas has ignited. Power factor correction capacitors are frequently used for compensation of the reactive current caused by the choke. At the instant they are switched on, these capacitors can cause an extremely high switch-on current, which decreases very quickly. Therefore, the making capacity for a capacitive load must be considered. Particularly when the capacitors are connected in parallel, the number of lamps per switching device may be considerably reduced. In this case, series compensation (e.g., twin-lamp) is more preferred. When electronic ballasts are used to stabilize the lamp current, capacitor charging causes short but high current peaks. Compact fluorescent lamps, well known as energy saving lamps, are also fluorescent lamps that use electronic ballasts.

Sodium-vapor lamps, mercury-vapor lamps

For these gas discharge lamps, special high-reactance transformers are also used, in addition to choke circuitry. The startup phase of these lamps, during which the current can reach 2.2 times the operating current, is longer and can last for as long as 10 minutes. This ballast is frequently compensated and the rating of the contactor used must not exceed the capacitive making capacity limitations.

Metal-halide lamps

These high-pressure gas discharge lamps have halides added to the metal vapors, which increase the luminance yield and also have an effect on the emitted light color. For these lamps, special starters must be used to provide the high-voltage starting pulse. Chokes are commonly used to limit the operating current. During the startup phase, a starting current of up to 2.2 times the operating current will flow for a maximum of 10 minutes in these lamps.

Mercury blended lamps

Mercury blended lamps are metal vapor lamps without integrated ballasts. In these lamps, the filament has a current-limiting effect and emits light. The discharge of metal vapor excites the layer of fluorescent material by emitting UV radiation. The starting behavior of mercury-blended lamps is similar to that of incandescent lamps.

Global standards

UL®/CSA® and IEC requirements differ significantly in the case of lighting load. IEC testing of contactors for lighting loads is designed specifically based on the characteristics of the lighting load. The IEC specifications for the testing requirements and specifications can be found in 60947-4-1 and 60947-6-1 and cover the AC-5, AC-35, and AC-36 groupings. See **Table 1** for ***XT*** contactor ratings.

UL/CSA requirements do not specifically look at discrete loads but the overall safety of the application instead. The UL specification focuses on a temperature rise test and requires that a device shall meet all requirements without failure of the temperature rise sequence testing as outlined in **Table 3**.

Table 1. AC-5, AC-35, and AC-36 IEC ratings for three-pole contactors

XTCE	007B	009B	012B	018C	025C	032C	040D	050D	065D	080F	095F	115G	150G	185L	225L	250L	300M	400M	500M
Incandescent lamps																			
I_e [A]	6	7.5	10	14	21	27	33	42	55	67	79	95	125	153	187	208	249	332	415
Mixed light lamps																			
I_e [A]	5	6.5	8.5	12	16	23	30	38	45	65	67	80	110	123	150	167	200	266	332
Fluorescent lamps, conventional choke/starter switching																			
I_e [A]	9	10	15	20	26	35	41	45	55	95	100	125	145	207	237	263	300	375	525
Fluorescent lamps, twin-lamps (series compensation)																			
I_e [A]	5.5	8	13	15	22.5	29	36	47	59	71	95	100	138	186	213	236	270	338	473
Electronic control gear																			
I_e [A]	5	6.5	8.5	12	17.5	22.5	28	35	45.5	56	66.5	80.5	105	130	158	175	210	280	350
High-pressure sodium lamps, high-pressure mercury-vapor lamps																			
I_e [A]	3.5	6	10	12	17.5	20	25	30	36	55	60	80	95	138	158	175	200	250	350
Low-pressure sodium lamps																			
I_e [A]	3	4	6	7.5	10	12	15	22	25	35	40	50	70	100	111	123	140	175	245

These ratings are IEC ratings covered under AC-5, AC-35, and AC-36. Relevant IEC product standards are 60947-4-1 and 60947-6-1.

Note: Current ratings shown in **Table 1** should be used for system voltages of <500 Vac. When used on power systems >500 Vac, these currents should be derated by the factor 0.6.

Table 2. AC-5, AC-35, and AC-36 IEC ratings for four-pole contactors

XTCF	032C	045C	063D	080D	125G	160G	200G
Incandescent lamps							
I_e [A]	21	27	42	55	79	95	125
Mixed light lamps							
I_e [A]	16	23	38	45	67	80	110
Fluorescent lamps, conventional choke/starter switching							
I_e [A]	26	35	45	55	100	125	145
Fluorescent lamps, twin-lamps (series compensation)							
I_e [A]	22.5	29	47	59	95	100	138
Electronic control gear							
I_e [A]	17.5	22.5	35	45.5	66.5	80.5	105
High-pressure sodium lamps, high-pressure mercury-vapor lamps							
I_e [A]	17.5	20	30	36	60	80	95
Low-pressure sodium lamps							
I_e [A]	10	12	22	25	40	50	70

Table 3. Applicable standards

	Utilization category description	Applicable standard	Pass/fail criteria
AC-5a	Switching of electric discharge lamp controls	IEC:2005 60947-4-1	Device shall make and break currents without failure under the conditions stated in Table 8 of IEC 60947-4-1
AC-5b	Switching of incandescent lamps	IEC:2005 60947-4-1	
AC-35	Electric discharge lamp loads	IEC:2005 60947-6-1	Device shall make and break currents without failure under the conditions stated in Table 2 of IEC 60947-6-1
AC-36	Incandescent lamp loads	IEC:2005 60947-6-1	
UL/CSA	Temperature rise sequence testing	UL 508	Device shall meet all requirements without failure of the temperature rise sequence testing as outlined in Tables 45.1 and 46.1

Discussion of mechanically and electrically held contactors

It is common practice to discuss lighting contactors as either mechanically held or electrically held in order to distinguish how the device operates and how it is applied.

Electrically held contactors are operated using a coil to operate and hold the contactor in position. The benefit of using an electrically held contactor is these devices offer a more simplistic design and will open during a power loss condition, removing the load prior to the power returning. The disadvantage is that an audible electrical hum is often associated with electrically held devices. Eaton's XTCE contactors are electrically held.

Mechanically held contactors, often referred to as mechanically held/ electrically operated contactors, are designed with a mechanical lock to hold the contacts in either an open or closed position. The actuation of the device is typically controlled through an electrical control signal for positioning between the open and closed status. The advantages of a mechanically held contactor are that it requires no power to hold in position and there is no electrical hum associated with the operation. This may also be a disadvantage depending on the needs of the application because the loads will not be removed on loss of power when mechanically held devices are used. Power consumption on power-up versus available supply should be considered in order to determine whether a mechanically held contactor is the right product for a specific application.

Additional lighting contactor products are offered to meet more of the application needs of our customers. These options include the electrically held CN35 product line, the mechanically held C30CN product line, and the magnetically latched A202 product line. Information on these products is available on the web at: www.eaton.com/electrical.

Eaton
1000 Eaton Boulevard
Cleveland, OH 44122
United States
Eaton.com

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