Application Notes Ultra-K-UK #11

Tell a Buddy

What is a K-Rated transformer?

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General

A standard transformer is not designed for high harmonic currents produced by non-linear loads and will overheat and fail prematurely when connected to these loads. For this reason a special transformer has been designed. This transformer is a K-rated transformer. K-rated transformers are: able to handle the heat generated by harmonic currents; not effected by harmonics; very efficient when used under their K-factor value; manufactured with heavier gauge copper and a double sized neutral conductor; and have higher magnetic to resistive properties than a standard transformer. All these properties are needed to reduce the heating and distortion effects of non-linear loads

Non Linear Loads

Over the past few decades there has been dramatic growth in the use of equipment that incorporate switching type power supplies; i.e personal computers, fax machines, copiers, electronic high efficiency ballasts, variable speed drives, and various medical equipment. These loads are non-linear in nature; meaning they only demand current during part of the cycle. This type of load creates harmonic currents, which in turn generate heat in the distribution equipment, neutral conductors, and transformers. The temperature rise limit of the insulation in a transformer is usually 150° C or 200° C

When this limit is exceeded, the life expectancy of the transformer will be cut in half for every 10° C to a point where the insulation breaks down destroying the transformer it. In some cases this creates a fire. Because they are designed specifically for non-linear loads, K-rated transformers will not overheat when subjected to harmonic loads. They also stay within the temperature rise limit of the insulation, and should be used wherever harmonic generating loads are present.

K Factor

There are different amounts of harmonic currents produced. The term for the total amount of harmonic current present is called "Total Harmonic Distortion (THD)". Since this value has a wide range, there needs to be an appropriate way to size the K-rated transformer to the load. This is where K-factor comes in. K-rated transformers have an associated
K-factor rating. K-factor ratings range between 1 and 50. The higher the K-factor, the more heat from harmonic currents the transformer is able to handle. A standard transformer that is designed for linear loads is said to have a K-factor of 1, whereas a transformer with a K-factor of 50 is designed for the harshest harmonic current environment possible. Transformers rated with K-factors of 40 and 50 are extremely rare, very expensive and generally are not used.

Making the correct selection of K-factor is extremely important because it affects cost and safety. Calculations of harmonic content produces a precise value of K-factor, but power loads change constantly rendering the calculated value questionable. New construction installations have no data to assist in selecting the appropriate K-factor rating. In these cases, empirical data allows us to use past practices to obtain the correct K-factor rating. Table 1 shows what K-factor rating to use when the electronic equipment represents a certain percentage of non-linear current. This table is based on past practices

Non-Linear Load	K-rating

Sometimes a de-rated K-1 transformer is used to

Incidental electronic equipment representing <5%	K-1
Harmonic producing equipment representing <35%	K-4
Harmonic producing equipment representing <50%	K-7
Harmonic producing equipment representing <75%	K-13
Harmonic producing equipment representing <100%	K-20

Table 1

obtaing a greater K-rating. For example to achieve a K-13 rating, a K-1 rated transformer would have to be oversized 200%.

Other Technologies

As previously stated, a standard transformer can not handle the heat generated by non-linear loads. What some manufacturers will do is specify an oversized standard K-1 rated transformer as a K-13 or K-20 rated transformer at half it's capability. This transformer may be capable of 100 KVA as a K-1 rated transformer, but only capable of 50 KVA as a K-13 rated transformer. This transformer is larger and more costly than a 50 KVA K-13 rated transformer. De-rating a transformer doesn't assure that it will perform correctly when subjected to non-linear loads. The magnetic and resistive properties of a transformer are enhanced when it is designed specifically for non-linear loads. A standard transformer doesn't take these considerations into account and may fail even when subjected to light non-linear loads.

Other manufacturers will use aluminum windings instead of copper because it is less expensive. However, to achieve the same resistive property, it takes 1.6 times as much aluminum as it does copper. Since the terminals to the transformer are copper, there is a need to bond aluminum to copper. Achieving a strong aluminum to copper bond has been proven to be extremely difficult. Even with a tight bond, aluminum expands and contracts easier than copper due to heat variations which will loosen the connection. Even though an aluminum wound transformer is initially less expensive, it is larger and more prone to failure than a copper wound transformer and will cost more in the long run.

Summary

K-rated transformers are designed for the non-linear loads that standard transformers just can't handle. K-rated transformers are manufactured with heavier gauge copper and a double sized neutral conductor and have higher magnetic to resistive properties than a standard transformer which enables them to handle the heat generated by harmonic currents. De-rating of a standard transformer doesn't assure optimal performance under non-linear loads and aluminum wound transformers are prone to premature failure. The *Ultra-K* manufactured by Controlled Power Company is a shielded, copper wound, K-rated isolation transformer which incorporates precise design techniques to handle the heat generated by high harmonic currents. The *Ultra-K* has K-ratings of K-4, K-7, K-13, and K-20, and the options of TVSS and high frequency filters for additional transient protection.

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