Application Note-AN0604D

Revision B

Tips for connecting 24-volt power

This application note covers choosing a transformer and connecting 24 volt AC power to a KMC Controls DDC controller.

Multiple factors must be considered before choosing and connecting a transformer to power a KMC controller. This application note provides information to help system designers and installers make decisions about powering controllers with transformers and then installing them correctly.



You can be killed or seriously injured if you contact live, high voltage circuits. Disconnect AC mains and follow all local lock-out and tag-out procedures when connecting or working on transformers.

Choosing a transformer

Most KMC controllers require a 24-volt, AC power source for operation. The recommend source for power is a UL listed, Class 2 transformer. When choosing a transformer, consider the following:

- Mounting
- Primary voltage
- Secondary voltage
- Load capacity

Mounting Transformers supplied by KMC Controls may be either foot or knock-out mounted. Foot mounting is usually used inside of an enclosure. Knock-out mount attaches the transformer directly to a conduit fitting such as a cover plate for a handy-box.



Illustration 1 KMC XEE–6000 series transformer

Primary voltage The primary voltage rating of the transformer must match the voltage of the AC mains to which it will connect. Transformers are manufactured for either a single primary voltage such 120 or 240 volts or multiple voltages. The two XEE–6000 series transformers in Illustration 2 are examples of both types of primaries.



Illustration 2 Transformer schematics

Secondary voltage The secondary voltage for KMC transformers is 24 volts AC. Some transformers include an optional circuit breaker which protects the transformer and wiring from current that exceeds the capacity of the circuit components.

Load capacity The load capacity is a measure of how much power the transformer can deliver to attached devices. This is usually expressed as VA, an abbreviation for Volt-Amperes. See <u>Calculating transformer size</u> on page 1-21 for additional information on transformer load capacity.

Connecting to controllers

KMC Controls recommends supplying power to each controller from a transformer dedicated to the controller. Illustration 3 is a typical connection of a KMC XEE–6000 series transformer connected to a KMC controller. The usual practice is to connect the phase (usually blue) wire of the transformer secondary to the phase or ~ terminal and the common (usually brown) wire connected to the – or ground terminal. Other transformers may use a different color scheme. Unless required by an electrical code requirement, do not ground either lead of the secondary.



Illustration 3 Connecting to a single controller

Connecting several controllers to a single transformer

When more than one controller must be powered from a common transformer, connect as shown in Illustration 3. In addition, observe the following requirements:

- Connect the phase (~) terminals in parallel with other phase terminals and the commons (-) in parallel with the other common terminals. See Illustration 4.
- If the secondary must be grounded, ground it at only one location. See <u>Grounded secondary connections</u> on page 1-18.
- Connect only controllers with the same type of power supply. Controllers with half-wave power supplies and full-wave power supplies cannot be powered directly by the same transformer. See <u>Grounded secondary</u> <u>connections</u> on page 1-18.
- Choose a transformer with the correct VA rating. See <u>*Calculating transformer*</u> <u>*size*</u> on page 1-21.
- Choose a wire size that limits the voltage drop to no more than 5%. See <u>Calculating voltage drop</u> on page 1-22.



Illustration 4 Powering two controllers from one transformer

Grounded secondary connections

KMC recommends that secondaries of transformers powering network devices be floating! Some conditions exist, however, that require that the secondary of a transformer be connected to earth ground. In the United States, for example:

- The National Electrical Code® requires (section 250.20) grounding transformers for AC systems of less than 50 volts if the primary voltage exceeds 150 volts to ground or if the main transformer supplying power to the building is ungrounded.
- Some municipal electrical codes more restrictive than the NEC may require that the secondaries of all transformers that supply 24 VAC be grounded.

IF a grounded secondary is mandated, ground the common (–) wire from the transformer to an equipment grounding screw in the equipment enclosure. If more than one controller is powered from the transformer, ground both at the same ground screw.



Illustration 5 Grounding the secondary of a transformer (when required)

If grounded transformers are used on a network containing both **full-wave** devices and **half-wave** devices, problems may occur because of the circuit differences in the power supplies. The common connection (direct or indirect) on the network and the grounds on the transformers may set up an inadvertent short circuit. In the example shown in Illustration 6 below, the transformer on the full-wave device is shorted across one of the rectifier diodes during half the AC cycle. Likely symptoms of such a situation may include:

- A circuit breaker or fuse opens.
- The power supply and/or transformer becomes overheated or damaged



Illustration 6 Shorting of circuit from connected (grounded) full-wave and half-wave devices

Even with grounded transformers, this should not be a problem:

- If all the devices are full-wave or all the devices are half-wave. (Nearly all currently available KMC devices are half-wave.)
- If the full-wave and half-wave device connections remain truly isolated.

If circumstances require the use of a grounded transformer with a full-wave and a half-wave device on a network, one possible solution may be the use of an isolation transformer. The example shown in Illustration 7 below, shows a single XEE-6000 series transformer and a 24 VAC isolation transformer. (Be sure the transformer is rated to handle the extra load—the total nominal load on a transformer should be no more than 80% of the transformer's rated value.) An isolation transformer could also be used between a transformer and a single device.



Illustration 7 Powering a full-wave and a half-wave device from a grounded transformer

Grounded transformer secondaries may also become a source of a network ground loop. A ground loop occurs in a network when a small voltage potential exists between two or more "ground" connections. This potential introduces an unwanted current in a signal path, adding noise to the network and possibly even damaging equipment. Symptoms of ground loops in KMC controller networks may include one or more of the following network communication problems:

- Misreadings of inputs.
- Panels drop off the network.
- Multiple attempts required to open data screens.
- Unable to pass network points.
- Network bulbs illuminate.

Good network planning and wiring practices will avoid most problems with ground loops and save considerable time and expense. To avoid ground loops, take care to provide only one electrical path to ground and follow good wiring practices.

Calculating transformer size

An inadequately sized transformer may result in erratic network problems or controller failure. The proper method to choose the correct size for a transformer is calculate the total VA load and then choose a transformer with a rating 25% higher than the total load. For example, three controllers, each rated at 10 VA can be powered from a transformer rated for 40 VA loads.

Example:

10 VA + 10 VA + 10 VA = 30 VA 30VA x 1.25 = 40 VA

The VA rating is available from the transformer manufacturer and is usually located on the nameplate.



Illustration 8 Typical nameplate with VA rating

Calculating voltage drop

Inadequate voltage caused by voltage drop may result in erratic network problems or controller failure. Voltage drop occurs when power flows along a length of wire. To minimize the effects of voltage drop, connect transformers as close to their connected controllers as possible. The size of the connected load and the gauge of the connecting wire has a significant effect on an acceptable distance between the transformer and the controller.

Use the following formula to calculate voltage drop based on the length and size of wire and the load presented by a controller. Limit the voltage drop at each controller to no more than 5% or 1.2 volts AC.

Example:

Voltage drop = Amps x (length of circuit in ft) x 2 x (ohms per 1000 ft) / 1000 = I x L x 2^* x R / 1000

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Wire Size-AWG, stranded	Ohms / 1000 ft (at 77°F)
22	16.46
20	10.35
18	6.512
16	4.095
14	2.576
12	1.620

Table 1 Wire resistance