

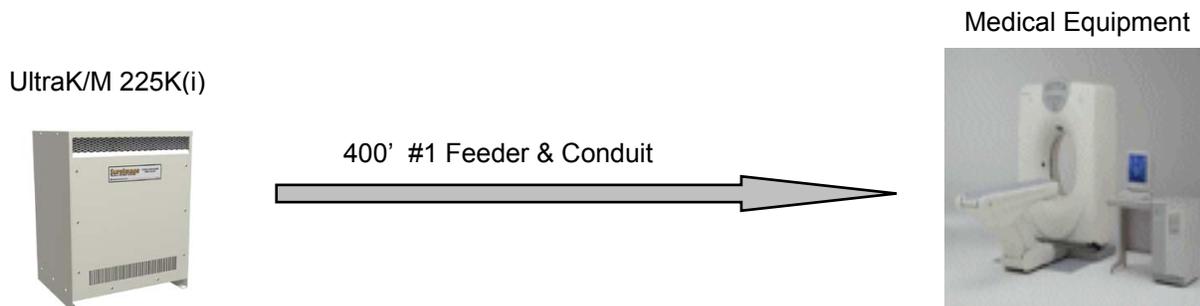
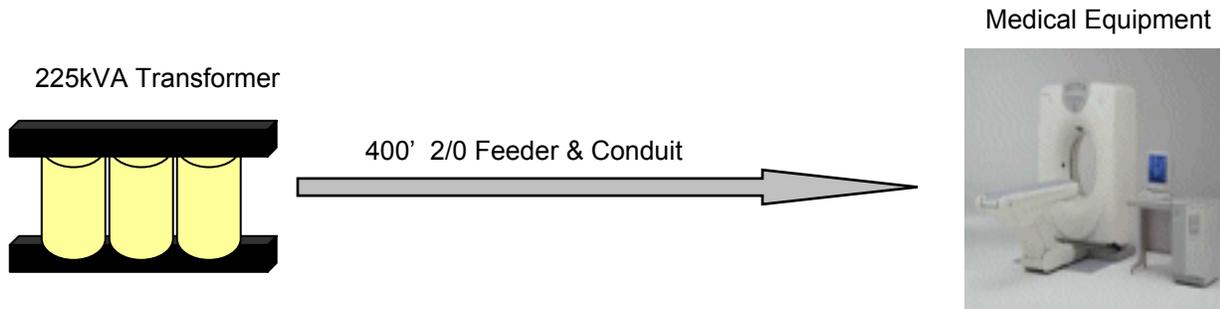
Source Impedance

General

When installing medical imaging or treatment equipment, the source impedance is often specified by the medical equipment manufacturer using a % impedance or a value in ohms. The first question is...why? In fact, the source impedance is critical due to the "total load regulation" that must be met. Total load regulation can be defined as the drop in voltage measured when going from a typical

steady state load to a maximum load condition, realized under normal operating conditions. In the case of medical imaging or treatment equipment, this occurs when the equipment steps from a stand-by mode to a scan or treatment mode of operation. The overall source impedance will determine the source voltage drop as measured at the medical equipment's input terminals.

The source impedance is affected by a number of factors. However, the dedicated distribution transformer installed up-stream from the medical equipment will have a significant impact. Its impedance must be kept to a minimum in an effort to meet the OEM's specified source impedance and total load regulation specification.



Source Impedance: % Output Impedance vs. Milli-ohms

As it is becoming more apparent that medical imaging and treatment equipment specifications are using ohmic values to define the impedance of source power supplies, we need an easy way of converting the traditional % impedance (%Z) to milli-ohms (mΩ). The impedance and regulation of a distribution transformer are closely related and both describe the voltage drop across a transformer under a loaded condition, with the regulation figure slightly less than the impedance figure. Percent impedance describes the percent of nominal voltage (impedance voltage) required to flow rated current through a shorted secondary. Percent regulation will approach this figure under reactive loads.

A higher impedance, or %Z, will result in a higher output voltage variance and therefore, potentially reducing the medical equipment's ability to produce quality images. The ultimate goal is to provide superior power conditioning while adding the least amount of impedance to the system.

This goal can be met by utilizing a dedicated distribution transformer with a low impedance of 2% at its continuous power rating. Keep in mind that 2% impedance provides better than 2% load voltage regulation, whether stepping from no load to 100% continuous load or from 50% load to a 150% intermittent load rating on a K(i) rated transformer.

To calculate the transformer's ohmic value, we must find the impedance voltage and divide it by the rated secondary current.

Example:

For a 100KVA transformer with an output of 480/277V, line current of 120.3 Amps, and an impedance of 2%...the ohmic value of the output impedance would be:

$$V_z = V_n * \%Z$$

$$V_z = 277V * 2\% = 5.54V$$

$$R = V_z / I$$

$$R = 5.54V / 120.3A$$

$$R = \mathbf{46.0m\Omega}$$

Using this equation, a 50kVA transformer with an output of 208/120V and an impedance of 2%...the ohmic value would be **17.3mΩ**.

To put these numbers into perspective, a medical equipment manufacturer requiring a 50kVA minimum power source may specify a source impedance of <100mΩ at 480V or <30mΩ at 208V. Since the total source impedance will be higher than the impedance of the distribution transformer alone, the ohmic value of the transformer's impedance should be something less than the source impedance specified.

NOTE: The 2% impedance transformers described in this application note are meant to be applied in dedicated medical equipment applications. A general distribution transformer feeding larger and varied facility loads would need its impedance at a value compatible with fault clearing devices.

The Controlled Power Company Solution

The Controlled Power Company *SureImage* Model Ultra-K/M Power Conditioning Transformer and Model 700F/M Voltage Regulator with Power Conditioning are K(i) rated systems designed specifically for high surge medical equipment loads.

Each model is carefully and purposefully designed to match the needs of the protected medical imaging or treatment equipment. All models contain a triple-shielded isolation transformer design with an impedance of 2% typical. This design, combined with

power conditioning and voltage regulation features, allow **medical facilities** to meet stringent source impedance requirements and protect their equipment investment.