SUPPORT NOTE

SN-141

Instrumentation Step-Up and Step-Down Transformers

Introduction

Reedholm test systems are used throughout the world with a range of AC power inputs. Instrumentation card cages require single-phase 117V ±10% at 50 or 60Hz. If being installed at a facility that cannot assure delivery of AC power within the 105V to 129V span, a step-up or step-down transformer is needed.

This note was written to guide selection and set-up of step-up or step-down transformers. While the US voltage standard is 117V, it is commonly referred to as 120V, so that convention is used hereafter.

Not all of the test system elements need to be powered from the input transformer. Most probers, computers, and third party instruments can be altered in the field for the range of voltages encountered at industrial sites around the world.

Older Dell test controllers had to be manually switched for the correct input voltage, whereas 120W power supplies in the SBC controllers accept 100 to 240VAC. Even though the test controllers can accept lower and higher input voltages, they are typically plugged into the 120V power strip plugged into the output of a step up or step down transformer.

AC Voltage Delivery

The NEMA outlet below delivers 15A at 120V.

- Hot or live (120V) relative to earth. However, voltage to neutral is what matters.
- Current return, or neutral. This can be several volts relative to earth because of IR drop in the neutral wiring.
- Ground or earth. No current should flow in this line. Ground fault interrupters use the presence of ground current to open circuits.

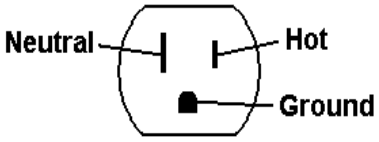

Figure 1 - NEMA 5-15 Outlet

Types of Transformers

Transformers operate by energy transfer between mutually coupled inductors. Multiplying the turns ratio of the transformer secondary winding relative to the input winding results in the nominal output voltage. If the output voltage is higher than the input, it is a step-up type; if lower, it is a step-down type.

For example, if there were twice as many windings on the primary relative to the secondary winding, output voltage would be halved. If the transformer were used for current, the output current would be doubled. However, power input transformers are used in voltage mode, so consideration of current ratios are not germane to this note. Similarly, when there are twice as many secondary winding than on the primary, output voltage would be doubled.

Isolation Transformer

Isolation transformers such as the step-down diagrammed in figure 2 do not provide direct electrical connections between primary and secondary windings. Generally, ground is brought through because it is used for safety. Note that there is no direct connection between neutral and ground on the secondary.

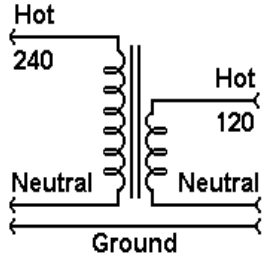

Figure 2 - Isolation

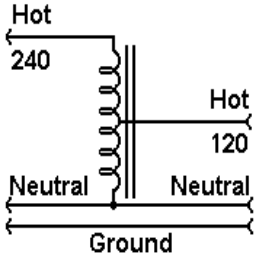

Figure 3 -AutoXformer

Unless neutral is connected to ground, unbalanced capacitance in the equipment hooked to the secondary determines the neutral voltage. With severe imbalance, that voltage could be larger than the hot output. That is a problem for equipment not designed for large neutral voltages. In some power strips, RF filter capacitors between neutral and ground do not have adequate voltage ratings for neutral voltage upwards of 120V.

Autotransformer

At the expense of isolation, the simpler autotransformer diagrammed in figure 3 is much lighter, does not generate as much heat, and is more compact. That is because a single winding is used to couple energy to the output. Care needs to be taken that the neutral connection is found and used for input and output. Ground should never be used to conduct current except for safety protection. Since the same magnetic flux flows through all windings, voltages are related by the ratio of winding turns spanned by the output and input taps.

Multiple Tap Autotransformer

Inputs and outputs of an autotransformer can have multiple taps to provide more than one combination of input and output voltages. In fact, the step-down transformers being delivered with Reedholm systems at the time this note was written have taps for four inputs (240, 220, 200, and 110VAC) and two outputs (220 and 110VAC). The jumper shown selecting 220V in figure 4 should provide output voltage within the 117V±10% span for instrumentation and test controller operation. If the output voltage is not within the span, the jumper needs to be moved.

- If the output was >129V or 110V+10%, the jumper would be moved to the 240V position to reduce output voltage by ~10%.
- Conversely, if the output was <105V, the jumper would be moved to the 200V position to increase output by ~10%.

The step down transformers being delivered are fuse protected at 20A and are ISO plus CE certified.

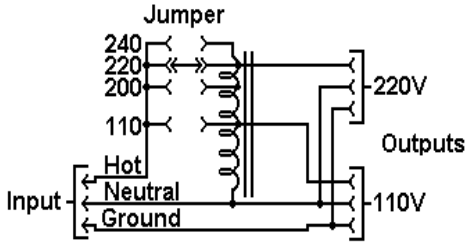

Figure 4 –AutoXformer with Taps

Transformer Ratings

It is important to choose a transformer of adequate current carrying capability. Transformers are rated for specific voltage and current in both the primary and secondary. For example, a transformer with a primary voltage rating of 240V, a secondary rating of 120V, and a 2000VA rating would be safe to operate with these maximum currents:

- Primary: 2000VA/240V = 8.333A
- Secondary: 2000V/120V = 16.666A

System Power Requirements

A Reedholm test system installation requires power for the instrumentation (called Reedholm hardware in an RI-EG configuration), computing elements, and prober. One has to consider that currents flowing in a startup condition such as in-rush current, are typically greater than those needed to sustain operation. For example, at start-up a computer has to get the hard disk spinning, and that takes more current than to keep it spinning.

Third party supplies or measurement units might require considerable power to deliver or measure large currents, but seldom does the current demand alter the recommended outlets.

USA and Other 120V Installations

The system block diagram in figure 5 is for 120V installations at 50 or 60Hz. It shows using separate 117V outlets for the three types of system elements.

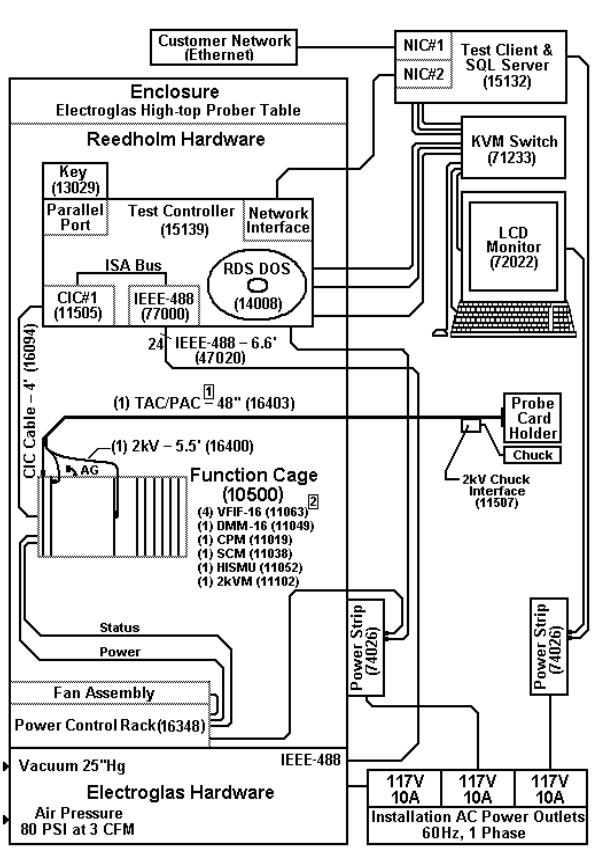

Figure 5 – Configured for 120V 60Hz Operation

International Installations

With the test client computer and prober connected independently of the power strip, a 2000VA autotransformer is more than large enough for most Reedholm test system configurations.

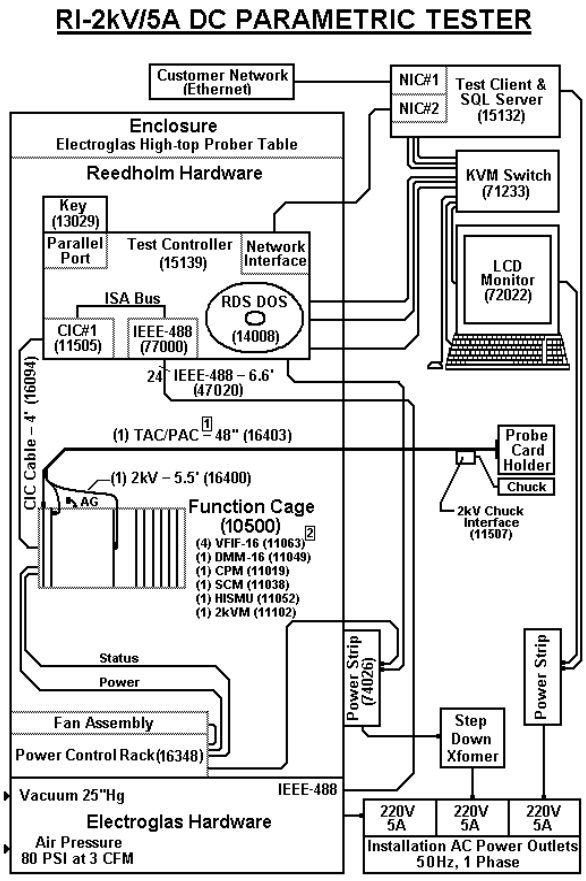

Figure 6 - Configured for 220V 50Hz Operation