Using External and Isolated DC Feeding Bridges

Introduction

This application note outlines how to construct a simple DC feeding bridge for use with the AI 150/120 Caller ID Simulators, and the AI 240 CAS Test System. In most cases, the internal feeding bridge in the AI150/120 and AI 240 provides enough flexibility to meet the user's requirements. However, an external and isolated DC feeding bridge can be very useful in at least two situations. The first is in cases where the user would like to test the operation of the CPE outside the normal line voltage and loop current regions. An external feeding bridge can be designed with almost arbitrary limits for line voltage and loop current. The second case occurs where the CPE under test does not fully isolate its telephone interface to the remainder of the CPE circuitry. In these situations, the proper connection of CPU emulators and signal measuring equipment can become tricky due to grounding loops. An isolated feeding bridge can greatly simplify these issues.

Background Information

The telephone interface provided on the AI 150/120 and AI 240 is capable of line voltages up to 52 Volts, with loop currents as high as 40 mA. This is generally sufficient to cover the range of conditions normally seen by the CPE in everyday usage. However, if the CPE is to be subjected to higher voltages or currents, an external feeding bridge must be used.

Also, the telephone interface on the AI 150/120 and AI 240 is ground reference. This means that both the DC and AC voltages present on the tip and ring leads are **not** floating with respect to earth ground. The ground reference telephone interface has certain advantages over a floating system. A floating telephone interface can result in inconsistent CPE performance, since the isolation achieved can vary dramatically depending on the computer used, and the location of the computer. There always exists some capacitive path preventing perfect isolation. A common cause is usually the inter-winding capacitance of power supply transforms. They have relatively large capacitance's and can greatly effect the ability of a telephone interface to truly "float". As such, a large amount of common mode power frequency hum can be generated on the tip and ring leads of a floating telephone interface. Since it is a common practice to receive the Caller ID data from the telephone lines via a differential amplifier, depending on the common mode rejection of the amplifier design, the hum noise can overwhelm the Caller ID signal and prevent consistent data reception. To make matters worse, the amount of hum present on the telephone line will vary greatly depending on the computer used and even its location. Measuring or characterizing the power supply hum voltage can be extremely difficult, due to its high source impedance. In many cases, simply connecting measuring equipment to the tip and ring leads so greatly reduces the power supply hum that measurements are meaningless.

However, sometimes it is necessary to have the telephone interface "floating". A typical example is when an emulator is connected to a CPE that does not have an isolated telephone interface. In this case, the emulator is generally always referenced to earth ground via the computer it is connected to. Since the AI 150/120 and AI 240 also supplies the telephone interface voltages with respect to earth ground, the telephone line may become unbalanced. The CID1500 and CAS2200 programs will report an unbalanced line condition, but to resolve the problem, some sort of isolation will be required. One of the best methods available for achieving near perfect isolation is though the use of a computer UPS. With the computer running from the UPS battery, near perfect isolation can be reached. Unfortunately, the UPS will require frequent recharging for tests that require a long time to finish. An isolated feeding bridge can also be used to resolve the unbalanced condition, and is the focus of this application note.

Feeding Bridge Circuit

The circuit in figure 1 below, shows a simple DC feeding bridge that also provides isolation between the CPE under test and the Telephone interface of the AI150/120 and AI 240. The circuit is not complex and can achieve very good performance depending on the quality of the components used.

The key to the circuit is the transformer X. The transformer provides the isolation between the two telephone lines and, for the most part, determines the performance of the circuit. It should be a high quality 1:1 transformer.

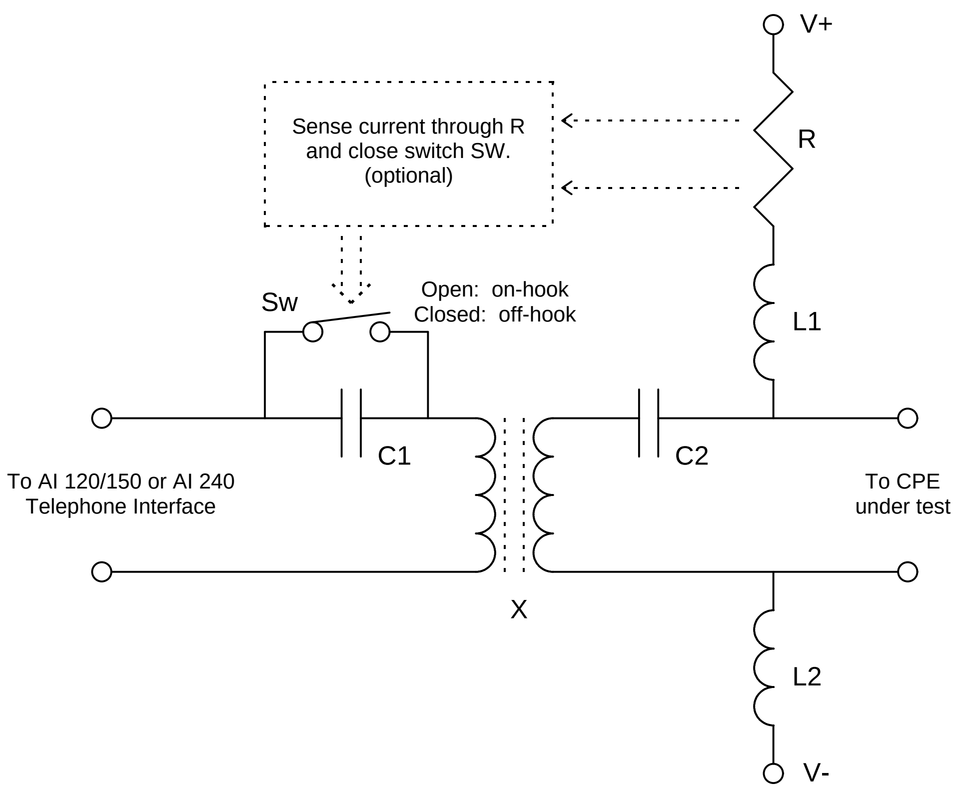


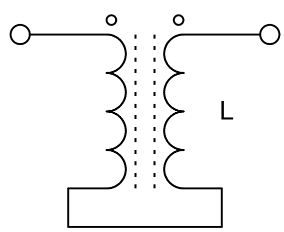
Figure 1. External and Isolated DC Feeding Bridge

Since the ringing signal, along with the audio signals pass through the transformer, it should have a good low frequency response. Otherwise the ringing voltage will be greatly reduced and either a higher ringing voltage must be generated, or a higher ringing frequency used. If the transformer used can not handle very high DC currents, or it will saturate the core, then reduce the loop current setting in the CID1500 and CAS2200 program to their minimum settings. This will reduce the saturation of the magnetic core and reduce the distortion of the audio signals.

The switch SW is used to control the loop current flow on the AI 150/120 side of the telephone interface. When the switch SW is closed, current will flow through the transformer and the CID1500/CAS2200 programs will indicate an “off-hook” state. This is required for sending Type II (CIDCW) Caller ID transmissions in the CID1500 program. With the switch open, no DC current flows, and the programs will assume that the CPE is on-hook. This process can be automated by including a circuit that senses the current drawn through resistor R and closes the switch SW. This way, when the CPE under test goes off-hook, the switch will automatically close. Likewise, when the CPE goes on-hook, the switch will open.

The capacitors C1 and C2 are used as DC blocks. The value of C1 only has an effect when the switch SW is open. This is normally the case when the CPE under test is on-hook. Since the telephone line impedance’s are relatively high, a value of 10 uF should be sufficient to pass the low frequency ringing signals with little loss. The voltage rating for C1 should be at least 52 Volts. Capacitor C2 will have to pass the low frequency ringing signals, as well as the audio signals. Again, using a value of 10 uF should provide a sufficiently low frequency response. The voltage rating of C2 must be at least the supply voltage of the DC feeding bridge, or V+ minus V-.

The inductors L1 and L2 are used to provide a block to the AC signals on the telephone line. Since the inductors are also required to block the ringing signal, a very high inductance is required. Using a 1:1 transformer with a very good low frequency response, connected in manner shown below can provide the large effective inductance required.



The resistor R in the circuit controls and limits the loop current for the CPE under test. Adjusting this value will change the CPE’s loop current when in the off-hook state. Note that when using high line voltages, the power dissipation within the resistor will become quite large. As such the resistor will have to be a high wattage type in order the handle the high powers.

It is important that the grounding of the power supply used in the feeding bridge be carefully considered. If the power supply is isolated, then there should be no concerns. However, if not, pay close attention to how the power supply ground and the CPE ground are connected in order to avoid any unintentional ground loops.

Figure 2 below, shows an alternate configuration for a feeding bridge. This circuit has the advantage that the two inductors L1 and L2 in the previous circuit are no longer required. The transformer used in this circuit is of a special configuration that makes it very simple to construct a DC feeding bridge. These transformers are commonly available, but it is important that the transformer has a good low frequency response in order to pass the ringing signal.

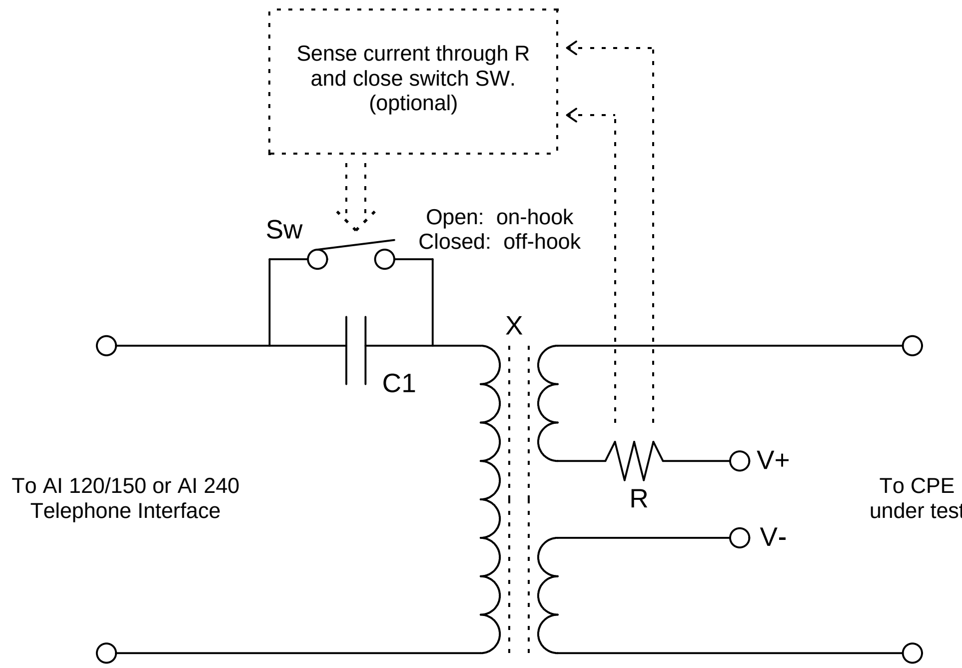


Figure 2, Alternate Feeding Bridge

There are quite a number of additional circuits that can be used to perform the same function as the above circuits. Many of them involve active components to avoid the problems associated with large inductance's. The two circuits shown here should be used as a guide in terms of what basic functionality is required for an external and isolated feeding bridge. The best implementation will always depend on the specific application in mind.

Characterizing Feeding Bridge Performance

Any additional circuitry that is added in the path between of the AI150/120 and the CPE under test has the potential for changing the test signals generated. As such, it is always a good procedure to verify and characterize the performance of any feeding bridge that is being used. Key areas that should be examined include the following.

- Audio signal level loss across the feeding bridge with line unterminated
- Audio frequency response across the feeding bridge with line unterminated
- Audio signal level loss across the feeding bridge with line terminated
- Audio frequency response across the feeding bridge with line terminated
- Source impedance accuracy of the feeding bridge
- Ringing level low across the feeding bridge
- Ringing frequency response across the feeding bridge