Timebase Ground-Loops

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Break the ground loop with a timebase isolation transformer!

The practice of locking the timebase of an instrument to a "house frequency standard" is a good way to improve the frequency accuracy and traceability of your measurements. However, an undesired side-effect may be a ground-loop induced measurement error for certain measurands — especially for low-level audio measurements. (In such instances, the external timebase connection may complete an unwanted ground-loop path.)

The Problem

For example, consider the following scenario: I was using an HP 3325B Synthesized Generator and an HP 3585B Spectrum Analyzer to measure the audio gain of a device-under-test (DUT). I locked the 3325B and 3585B timebases to the "house frequency standard" via a distribution amplifier. I then connected a very low-level audio signal from the 3325B to the DUT's input port. The DUT amplifies the small signal (80 dB gain), which I attempted to measure by connecting the DUT's output port to the 3585B 1M ohm input port. However, I discovered the DUT was self-oscillating (which it isn't supposed to do). When I disconnected the 3325B external timebase connection, I broke the gound-loop and the problem "went away."

Many times external timebase ground-loop effects are more subtle than the above scenario. This can be even worse because moderate measurement errors may go undetected for some time. Therefore, to be safe, you may wish to isolate most (or all) of your external timebase connections. (The problem tends to be worse when an instrument's external timebase input and main signal output are both "floating" relative to the chassis, but not relative to each other; however, many ground-loop scenarios are possible.)

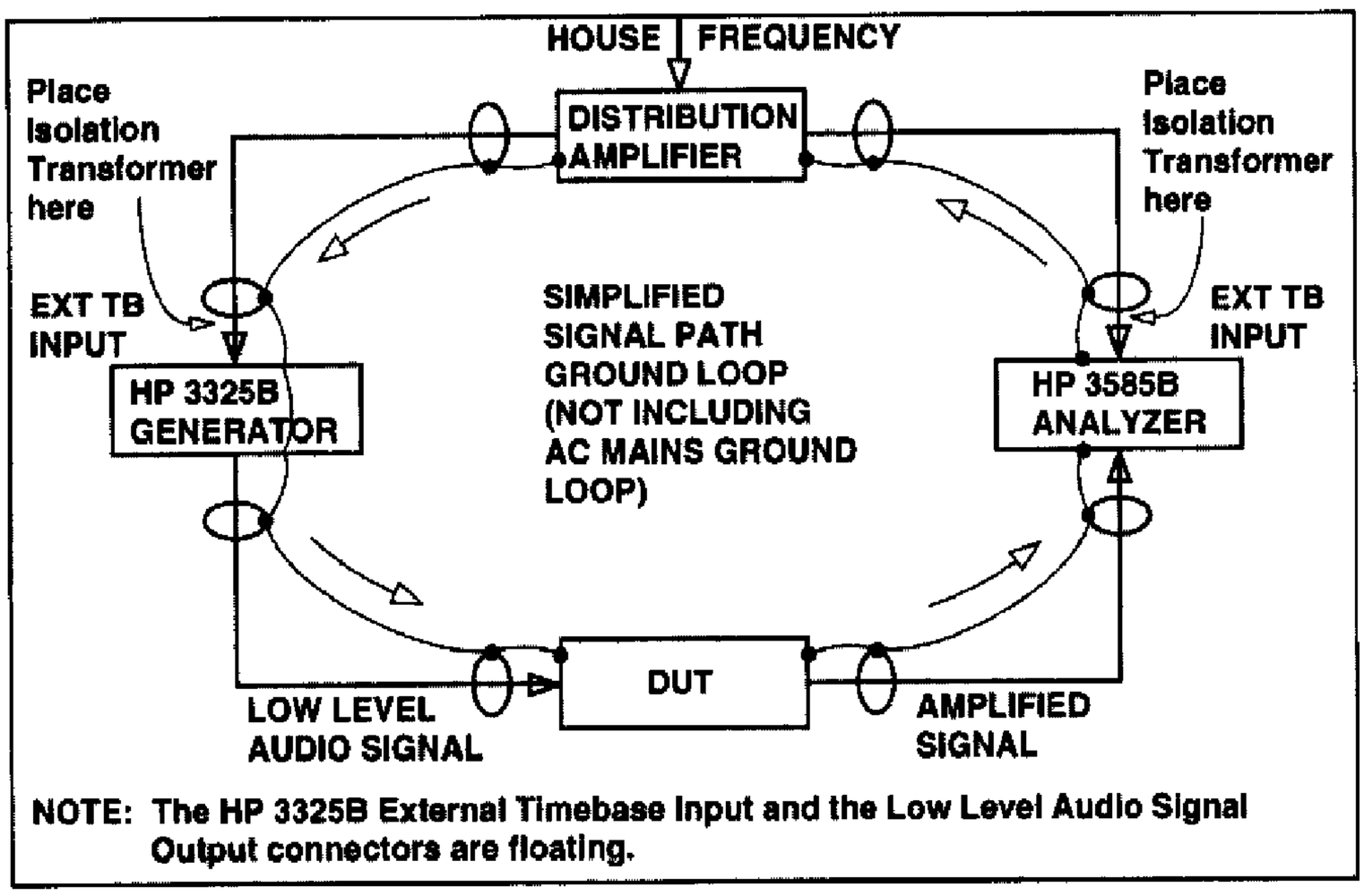

Figure 1. Block diagram showing simplified ground-loop problem

The Solution

Break the timebase ground-loop by inserting isolation transformers between the frequency distribution amplifier and the external timebase input of each instrument. (Place each isolation transformer as near the external timebase input as possible.)

The isolation transformer should preferably:

1. Have 1:1 ohms ratio, with bandwidth to at least 20 MHz.

2. Be mounted in a small, shielded case with BNC connectors.

3. Break the ground-loop, but not alter the timebase signal.

The transformer may be "home-built" from suitable parts. However, as of this writing, I have used a low-cost, commercially available isolation transformer to successfully break timebase ground-loops. It is:

Mini-Circuits, P/N FTB-1-1-75 *C15
$36.95 (U.S. Dollars)

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