APPLICATION NOTE

Measuring the Longitudinal Balance of 2-Wire Equipment

Introduction

This Application Note describes a method of using the Sage Model 930A or 930i Communications Test Set to determine the longitudinal balance of a piece of equipment containing a 2-wire transmission interface. Using precision signal feed resistors equal to or better than the tolerance specified in this document should yield useful longitudinal balance measurements down to at least 70 dB.

Longitudinal balance provides an indication of a circuit's ability to reject induced noise on the Tip-Ring pair of a 2-wire circuit. An example of induced noise is power line noise. Typically, audible circuit "hum" problems are caused by harmonics (whole number multiples) of the fundamental 60-cycle power frequency. The frequencies that make up this audible "hum" are usually 180, 300, 420, 540, 600, 780, or 900 cycles. They can be coupled to the Tip and Ring leads of 2-wire lines if the pairs are run parallel to AC power lines or near electrical equipment.

It's important to note that 2-wire lines are "balanced" lines. That is, it's assumed the Tip and Ring leads have identical resistance, inductance and capacitance to ground. Also, the electronic circuitry these pairs connect to are designed to ONLY look at tip-to-ring signal voltages. Therefore, if the Tip lead has a 5-volt induced hum signal with respect to ground, and the Ring lead has an identical 5-volt induced hum signal with respect to ground, the DIFFERENCE between Tip and Ring is ZERO volts and the circuitry never responds to that hum signal.

So, if you precisely EQUALLY excite each lead (Tip, and Ring) with respect to ground, you should not see any signal BETWEEN Tip and Ring. If you do see a signal, it must be due to unequal resistance, inductance and/or capacitance to ground.

So, as shown in *Figure 1*, you can use 930 #1 as a signal source to EQUALLY excite Tip and Ring (with respect to ground) through precision equal-value resistors. You can then simultaneously use 930 #2 as a transmission measuring set to measure the *Balanced* noise value, then the *Noise-to-Ground* value. You can then compute the Longitudinal Balance by subtracting the "Balanced" noise reading from the "Noise-to-Ground" reading. The result is expressed in dB.

Note that, although the *Figure 1* shows two 930's, 930 #1 (which is serving as a signal source) could conceivably be replaced by a quality audio signal generator.

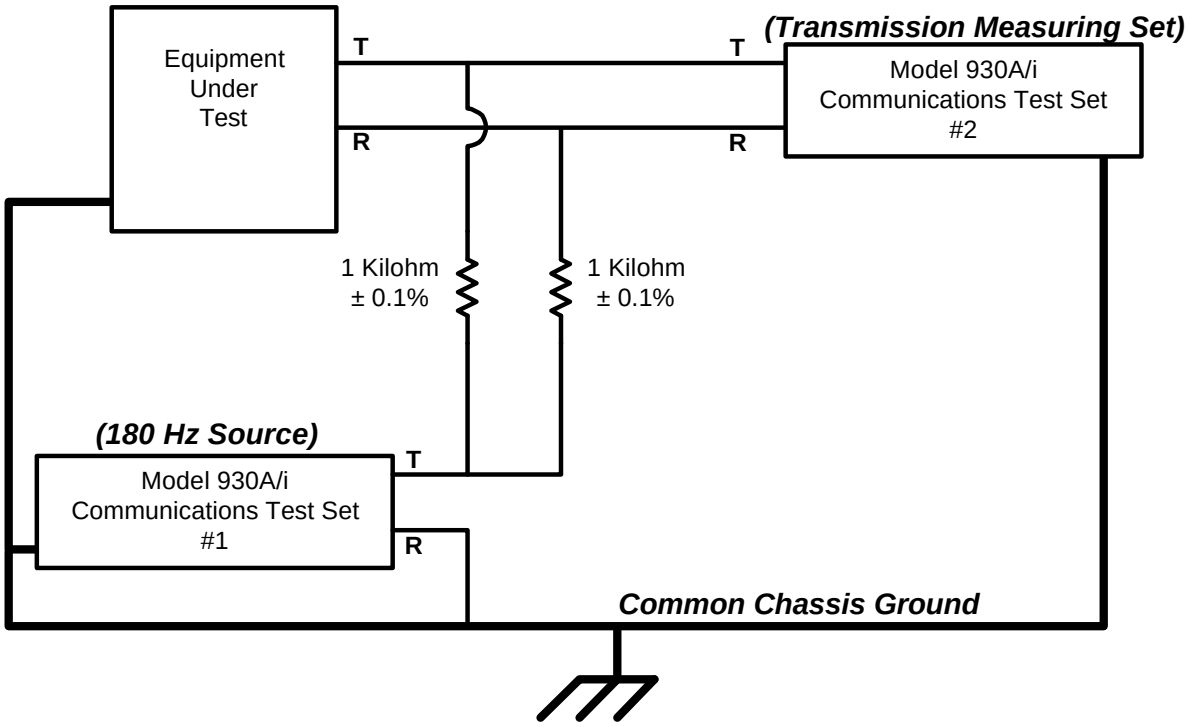

Figure 1 — Suggested Test Configuration for Measuring Longitudinal Balance

Critical Requirements

1. It is critical that high precision resistors be used in the signal feed from 930 #1 to the T and R leads of the Equipment Under Test (EUT). Using lower tolerance resistors can significantly affect the accuracy of measurements.

2. For any given pair of Balanced and Noise-to-Ground measurements, the measured values should fall within the 930's published range specifications. That is, the measured Balanced Noise reading must be greater than 10 dBrn and less than 100 dBrn. Likewise, the Measured Noise-to-Ground value must be greater than 50 dBrn and less than 130 dBrn. Usually, this condition is satisfied (with the resistor values given in Figure 1) by setting 930 #1's Send Tone transmit level between 0 dBm and +10 dBm.

Configuring the 930's

1. For 930 #1,
   a. Press the TRUNK TYPE function key several times, then repeatedly press the Up- or Down-arrow keys until you see a display similar to the one illustrated below:

      `E&M I   BRIDGE  SEND-M  2W 600`

   b. If the display does not show "2W 600", repeatedly press Softkey 4 until it does. [***NOTE:*** If your EUT's 2-wire interface has a different impedance (i.e. 135, 900, or 1200 ohms), You should use Softkey 4 to select a 2-wire Trunk Type of that impedance.]

   c. Press Sofkey 2 (under "BRIDGE") to change it to "TERM". Your 930#1 display should now look like the one below:

      `E&M I    TERM   SEND-M  2W 600`

d. Press the "Send Tone" function key. It's the 4th button from the top, in the vertical row of black buttons at the left of the 930 front panel. Your display should look similar to the one illustrated below:

SENDTONE: 1010 Hz -16.0 dBm OFF

e. If we assume you want a test frequency of 180 Hz, press Softkey 1, then use the numeric keypad to enter "180" and finish by pressing the grey "ENT" key which is located at the bottom right of the numeric keypad.

f. Change the transmit level of the tone: press Softkey 3, press the "0" button twice and finish by pressing the grey "ENT" key.

g. Your display should now look like the illustration below:

SENDTONE: 180 Hz +0.0 dBm OFF

h. If the 930 displays "OFF" at the far right of the display, press Softkey 4 to change it to "TR". Your display should now look like the one below:

SENDTONE: 180 Hz +0.0 dBm TR

i. Although it's not necessary in the 2-Wire E&M Trunk Type to be off-hook in order to transmit the tone, it's good practice to always flip the 930 front panel "hook" switch to the off-hook position when transmitting a signal. So, do so now.

2. For 930 #2,
   a. Press the TRUNK TYPE function key several times, then repeatedly press the Up- or Down-arrow keys until you see a display similar to the one illustrated below:

E&M I BRIDGE SEND-M 2W 600

b. If the display does not show "2W 600", repeatedly press Softkey 4 until it does. [***NOTE:*** If your EUT's 2-wire interface has a different impedance (i.e. 135, 900, or 1200 ohms), You should use Softkey 4 to select a 2-wire Trunk Type of that impedance.]

c. Press Sofkey 2 (under "BRIDGE") to change it to "TERM". Your 930#1 display should now look like the one below:

E&M I TERM SEND-M 2W 600

d. Although it's not necessary in the 2-Wire E&M Trunk Type to be off-hook in order to measure the tone, it's good practice when in the "TERM" mode to always flip the 930 front panel "hook" switch to the off-hook position when measuring a signal. So, do so now.

e. Press the "Measure Noise" function key. It's the 2nd button from the bottom, in the vertical row of black buttons at the left of the 930 front panel. Your display should look similar to the one illustrated below (the measured value may be different):

22 dBrnC C-MSG TR BAL

f. Repeatedly press Softkey 2 until you see "3K FLT". Your display should now look something like the one below (the measured value may be different):

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22 dBrn    3K FLT     TR     BAL
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Connecting the Equipment

Interconnect the 930's and the equipment to be tested, as illustrated in *Figure 1*. Pay particular attention to the need for a common chassis ground. Note that, for this test, it is not necessary to connect the E&M leads.

Performing the Test

1. On 930 #2, verify the display looks like the illustration below (the measured value may be different):

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22 dBrn    3K FLT     TR     BAL
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2. Record the "balanced" noise reading it displays.

3. On 930 #2, press Softkey 4 to toggle from a "balanced" noise reading to a "noise-to-ground" reading. Your display should now look like the one below (the measured value may be different):

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96 dBrn    3K FLT     TR    N TO G
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4. Record the "noise-to-ground" reading it displays.

5. Subtract the "balanced" noise value from the "noise-to-ground" value. The result is the Longitudinal Balance at the frequency you selected in 930 #1's Send Tone function. In this example the Longitudinal Balance would be: 96 - 22 = 74 dB

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