Measurement of Longitudinal Balance

BETA TRANSFORMER TECHNOLOGY CORPORATION
A subsidiary of Data Device Corporation

Application Note

AN/156

For reasons of convenience and cost, balanced lines are much preferred in data transmission to single- ended wiring, such as coax cables. Depending on the degree of balance, minimal electromagnetic radiation of the transmitted signal and pick-up of interfering signals are achieved without complex shielding.

Longitudinal and Transverse Voltages

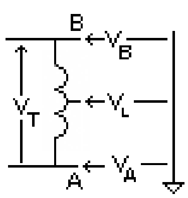
The balanced transmission system, shown in Figure 1, consists of two conductors, A and B, neither of which is grounded. We define two voltages:

The transmitted signal, i.e. the voltage, V_T, between A and B is known as "transverse" or, in old telephone parlance, "metallic."

The algebraic average of V_A and V_B, i.e.

$$V_L = (V_A + V_B)/2,$$

is known as "longitudinal" or "common mode." This is the voltage one would measure from the electrical midpoint between A and B to ground.



Such a midpoint is most easily established by a center-tapped transformer connected between the balanced terminals, as shown in Figure 1.

Presence of common mode is not necessarily harmful. However, a given signal having both transverse and longitudinal components indicates unbalance, i.e. either signal has been partially converted into the other. Common mode converted into a transverse signal will cause interference, and transverse signal converted to longitudinal signal will result in radiation.

ITU-T Recommendation O.9

ITU-T, The Telecommunication Standardization Sector of the International Telecommunications Union Recommendation O.9, entitled "Measuring Arrangements to Assess the Degree of Unbalance about Earth" deals with measurements of balance in communication systems.

Recommended test configurations for two types of balance measurements are shown in Figures. 2a and 2b. A common mode signal, V_{L1}, is applied to Port ab of a DUT via a center-tapped auto-transformer.

In the one-port method of measurement (Fig.2a), the transverse signal, VT1, due to unbalance, is measured at the same Port ab and the ratio,

$$V_{L1} / V_{T1},$$

is defined as "Longitudinal Conversion Loss (LCL)."

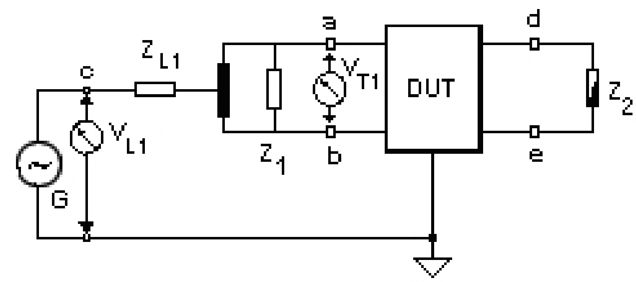


Fig. 2a One-port Balance Test

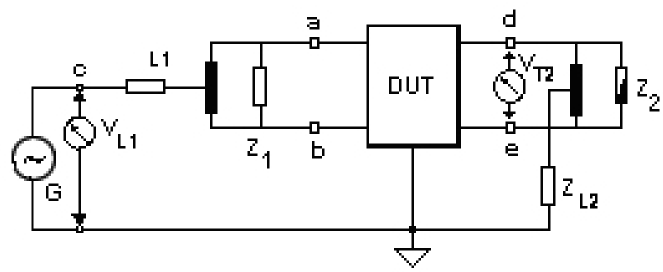


Fig. 2b Two-port Balance Test

In the two-port method (Fig. 2b), the transverse signal, VT2, is measured at Port de and the ratio

$$V_{L1} / V_{T2}$$

Is defined as "Longitudinal Conversion Transfer Loss (LCTL)."

The test circuits clearly show the elements needed for the balance measurement:

1. A common mode signal injection circuit
2. Common mode signal measurement
3. Transverse signal measurement
4. Balanced line termination.

North Hills™

LBB Series Longitudinal Balance Bridges

Recommendation O.9 does not specify how to perform the measurement of the longitudinal and transverse signals. **North Hills Series LBB Longitudinal Balance Measuring Bridges** combine the required elements listed above in a single package to interface directly with a network analyzer. The test circuit of Fig. 3a measures LCL and and that of Fig. 3b LCTL. The two-port measuring method requires a common mode injection circuit in addition to the LBB bridge.

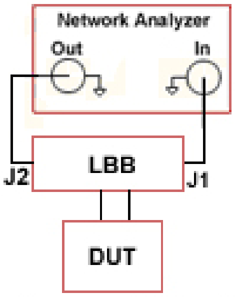


Fig. 3a One-port Balance Test

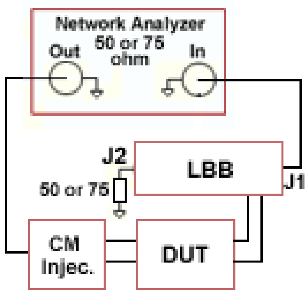


Fig. 3b Two-port Balance Test

After an LBB bridge has been initially calibrated using the test termination provided, the network analyzer will display highly accurate direct readings of longitudinal balance over a wide frequency range.

LBB Series Bridges are available for a variety of balanced impedance levels and frequency ranges. All are designed to interface with 50 ohm and 75 ohm network analyzers. The inherent balance of a unit terminated with a 100 ohm load is shown in Figure 4. A typical test setup is shown in Figure 5.

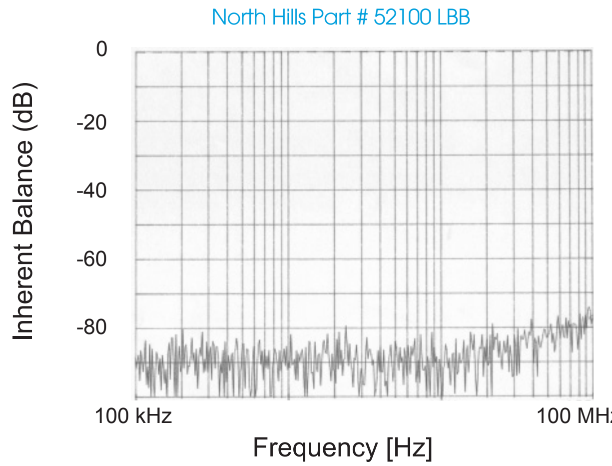


Fig. 4

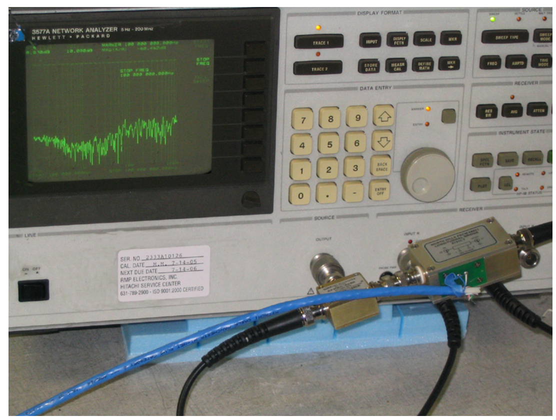


Fig. 5

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