HEWLETT PACKARD

Balanced Circuit Measurement with an Impedance Analyzer/ LCR Meter/Network Analyzer

Application Note 346-2

INTRODUCTION

How a Balanced Circuit Differs from an Unbalanced Circuit

A balanced circuit has its electrical midpoint grounded. An unbalanced circuit, however, has one side grounded. A balanced circuit is typically used in communications equipment because a balanced circuit has the advantage of better spurious noise suppression.

Figure 1 shows a balanced cable which is an example of a balanced circuit. The voltages of the cable's two conductors are at every point equal in amplitude and opposite in phase. Figure 2 shows an unbalanced cable which is an example of an unbalanced circuit. Most measurement circuits in HP's impedance analyzers and LCR meters are unbalanced.

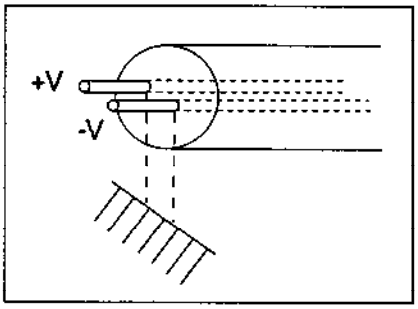


Figure 1. Balanced cable

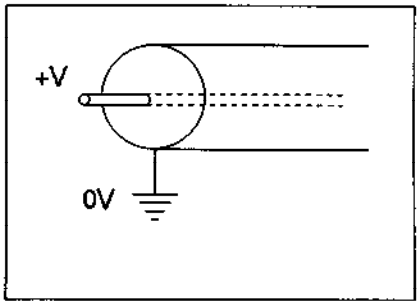
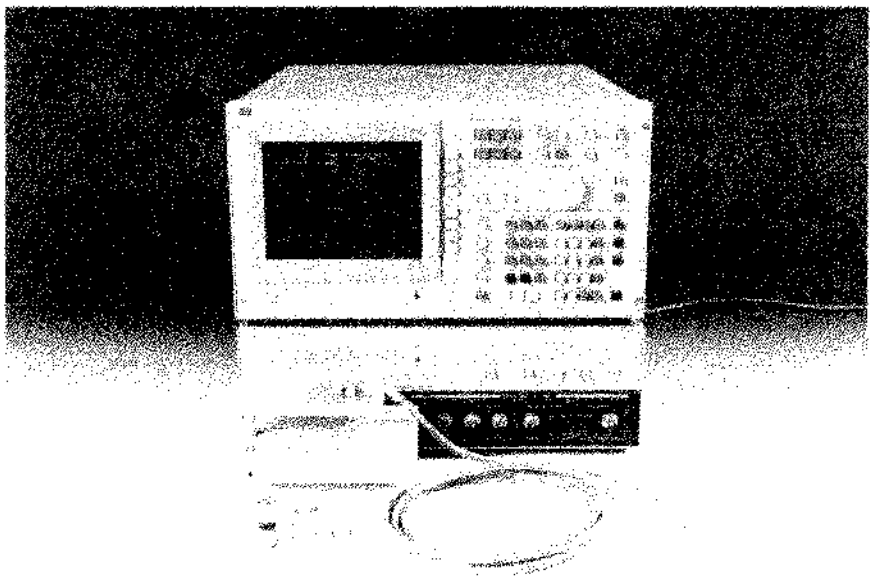


Figure 2. Unbalanced cable



Measuring a Balanced Circuit with an Unbalanced Measurement Instrument

A balanced circuit cannot be directly measured with an unbalanced measurement instrument because of the difference in their configuration.

When measuring balanced circuits, the unbalanced measuring instrument requires a balun (balanced to unbalanced) transformer. A balun is a type of impedance-matching RF transformer.

Figure 3 shows the configuration for measuring a balanced circuit with an unbalanced instrument.

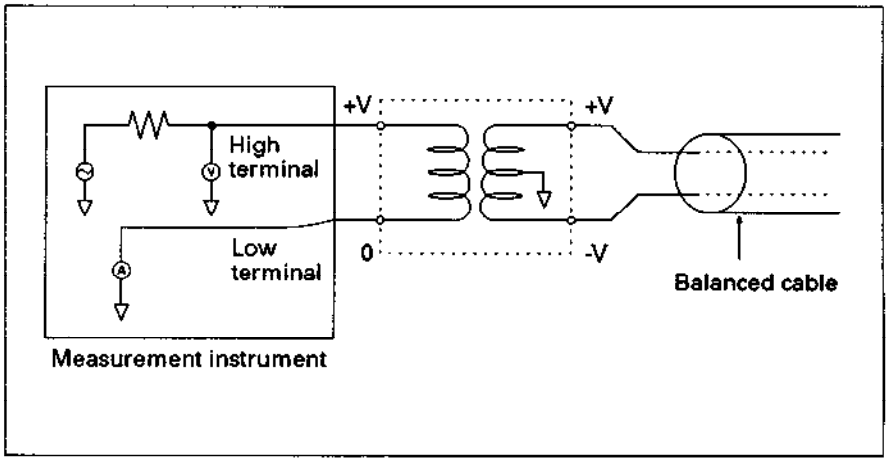


Figure 3. Balanced cable measurement configuration

Note: In balanced cable measurements, residual current in the balun or the measuring instrument can cause measurement errors. To reduce the degree of error, perform open/short and load compensation at the measurement terminals of the balun.

SELECTING A BALUN

There are several types and brands of balun transformers. When selecting a balun, ensure that frequency is compatible with your measurement requirements. When you measure the impedance parameters of a balanced circuit, you don't have to use the balun which has the same impedance with the circuit under test. However, when you measure the transmission or reflection of it, you have to use a balun which has the same impedance with the circuit under test to keep impedance matching. Table 1 shows recommended balun transformers.

Table 1. Recommended balun transformers

Unb/Bal. (Ω)	Bandwidth	Type No.	Suppliers
50:50	0.1 - 125 MHz	0001BB	North Hills Electronics
50:75	0.1 - 125 MHz	0101BB	"
50:100	0.1 - 125 MHz	0300BB	"
50:600	0.1 - 65 MHz	0700BB	"
75:50	0.1 - 100 MHz	1000	"
75:75	0.1 - 100 MHz	1100	"
75:100	0.1 - 100 MHz	1300	"
75:600	0.1 - 60 MHz	1700	"
75:75	20 Hz - 9 MHz	T32-9808-23180	NEC
75:110	300 kHz - 30 MHz	T32-9801-40046	"

MEASUREMENT CONFIGURATION WITH A BALUN AND COMPENSATION

Impedance Measurement Configuration with HP4194A Impedance Analyzer

Figure 4 shows impedance measurement configuration (1) with the HP4194A.

To Calibrate/Compensate for (1):

1. Perform open/short/load calibration at the APC7 connector of the HP16085B which has an internal balun.

   Standards:
   0Ω.....HP PN 04191-85300
   0S.....HP PN 04191-85302
   50Ω.....HP PN 04191-85301

2. Perform 0Ω/0S zero offset at the closest terminal to the DUT.

To Calibrate/Compensate for (2):

1. Assemble a female BNC connector as shown in Figure 5.
2. Perform open/short/load calibration at the BNC connector using the following BNC Calibration standards:

   Short Standard:
   HP PN 1250-0929
   50Ω Load Standard:
   HP PN 11652-60001

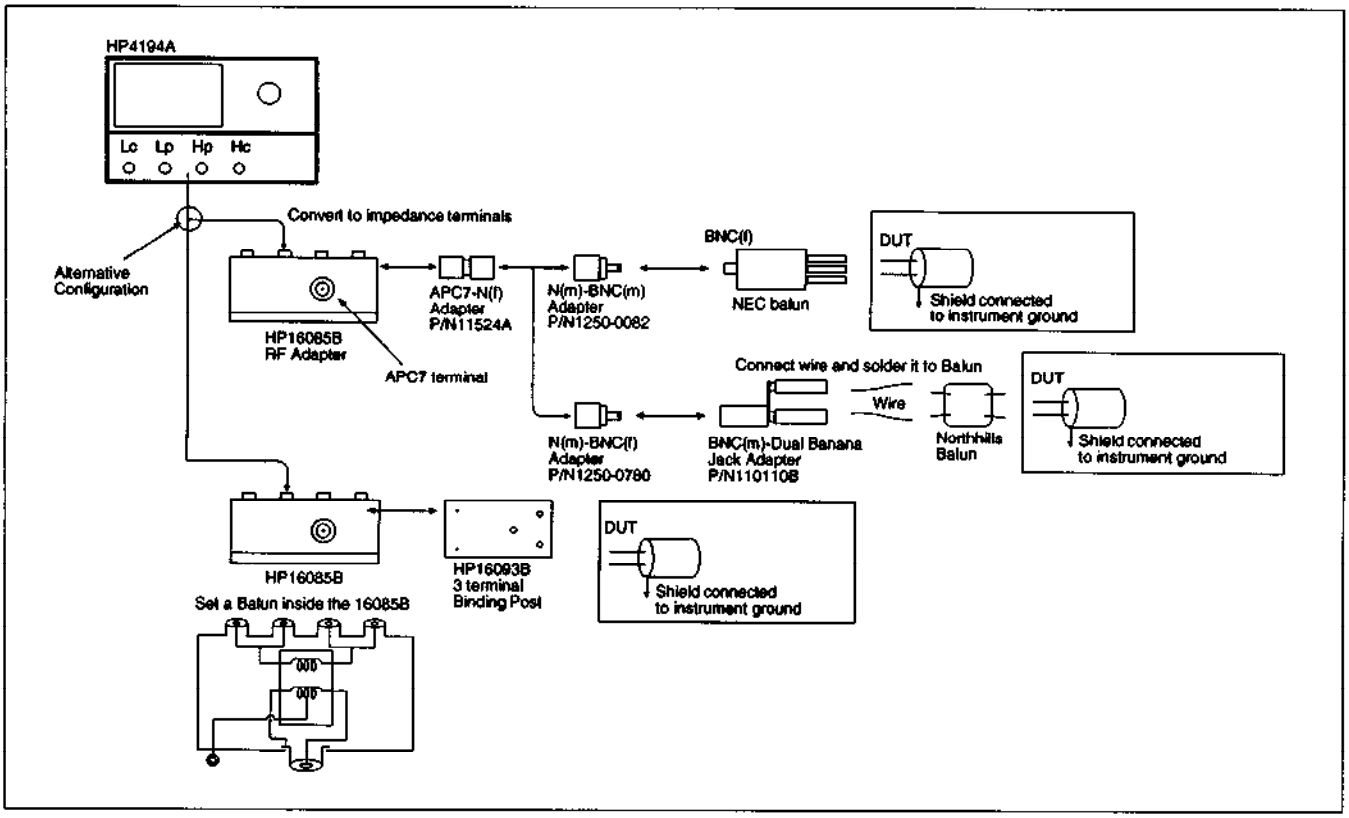


Figure 4. Measurement Configuration (1)

3. Remove the connector and connect the DUT. Measure the DUT.

Impedance Measurement Configuration with the HP4195A

Figure 6 shows impedance measurement configuration (2) with the HP4195A.

To Calibrate/Compensate:

Refer to "To Calibrate/Compensate for (2)" of Impedance Measurement Configuration with HP4194A Impedance Analyzer.

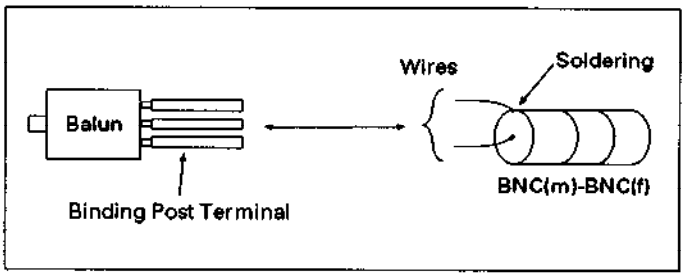


Figure 5. Assembling BNC connector

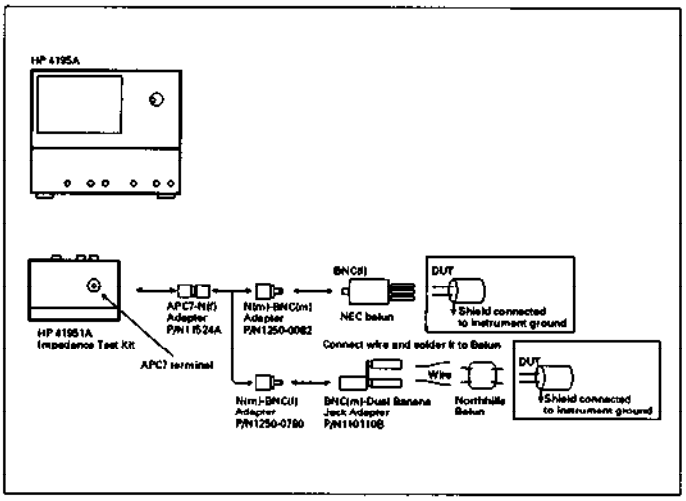


Figure 6. Measurement Configuration (2)

Transmission Measurement Configuration with a Network Analyzer or Gain-Phase Analyzer

Now we change a subject from impedance parameter measurements to network parameter measurements.

Figure 7 shows transmission measurement configuration (3) with a network analyzer or gain-phase analyzer.

To Calibrate/Compensate:

Short the terminals closest to the DUT to the signal out and to the test port, then perform response/thru calibration.

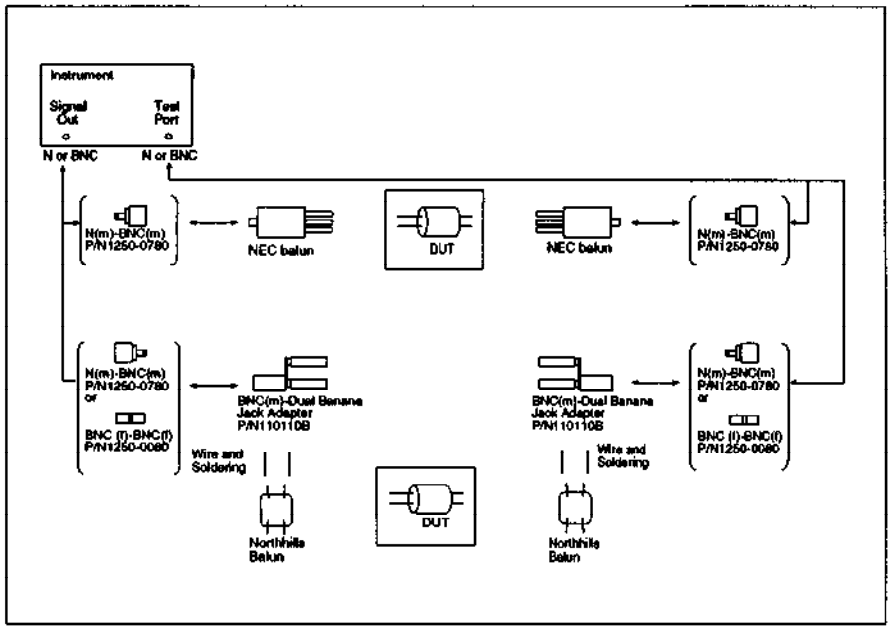


Figure 7. Measurement Configuration (3)

REFERENCES

Application Note 339-4
Measuring The Impedance of Balanced Cables
HP Pub. No.: 5950-2918

Application Note 380-2
Measuring Cable Parameters
HP Pub. No.: 5950-2399

Application Video Tape
Balanced Cable Measurements
HP Part No.: 90468T

For Information on Balun, Contact the Manufacturers:

North Hills Electronics, Inc.
Alexander Place Glen Cove, New York, USA, 11542
Tel: (516) 671-5700
Telex: 46-6886
Fax: (516) 759-3327

NEC Corporation
1-4-28 Mita Minato-ku Tokyo, Japan
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