Agilent AN 346-2

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

Application Note

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 Agilent Technologies' impedance analyzers and LCR meters are unbalanced.

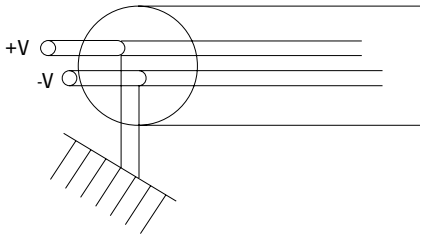

Figure 1. Balanced cable

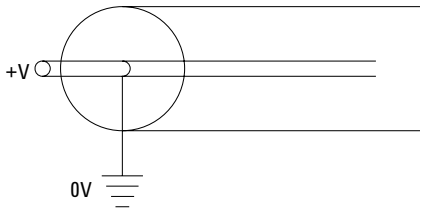

Figure 2. Unbalanced cable

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.

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.

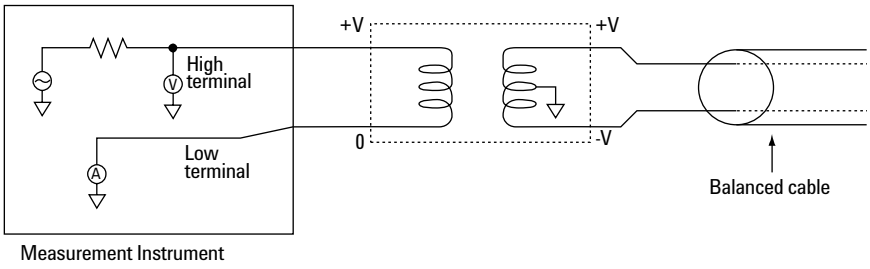

Figure 3. Balanced cable measurement configuration

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.

Agilent Technologies

Innovating the HP Way

Measurement Configuration with a Balun and Compensation

Impedance Measurement Configuration with Agilent 4294A Impedance Analyzer

Figure 4 shows impedance measurement configuration (1)/(2) with the 4294A.

To Calibrate/Compensate for (1):

1. Perform open, short, and load compensation at the balanced terminals of the 16314A. Use the furnished compensation standards of the 16314A.

Standards	0Ω	PN 04191-85300
	0S	PN 04191-85302
	50Ω	PN 04191-85301

To Calibrate/Compensate for (2):

1. Assemble a female BNC connector as shown in Figure 5.

2. Perform open, short, and load calibration at the BNC connector using the following BNC Calibration standards:

Short Standard		PN 1250-0929
50Ω Load Standard		PN 11593A

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

Impedance Measurement Configuration with the Agilent 4395A(#010)

Figure 6 shows impedance measurement configuration (2) with the 4395A.

To Calibrate/Compensate:

Refer to "To Calibrate/Compensate for (2)" of Impedance Measurement Configuration with 4294A impedance analyzer.

Transmission Measurement Configuration with a Network Analyzer

Figure 7 shows transmission measurement configuration (3) with a network 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.

Table 1. Recommended balun transformers

Unb/Bal. (W)	Bandwidth	Type No.	Suppliers
50:50	100 Hz to 10 MHz	16315A	Agilent Technologies
50:100	100 Hz to 10 MHz	16316A	Agilent Technologies
50:600	100 Hz to 3 MHz	16317A	Agilent Technologies
50:50	0.1–125 MHz	0001BB	North Hills Signal Processing
50:75	0.1–125 MHz	0101BB	North Hills Signal Processing
50:100	0.1–125 MHz	0300BB	North Hills Signal Processing
50:600	0.1–65 MHz	0700BB	North Hills Signal Processing
75:50	0.1–100 MHz	1000BB	North Hills Signal Processing
75:75	0.1–100 MHz	1100BB	North Hills Signal Processing
75:100	0.1–100 MHz	1300BB	North Hills Signal Processing
75:600	0.1–60 MHz	1700BB	North Hills Signal Processing

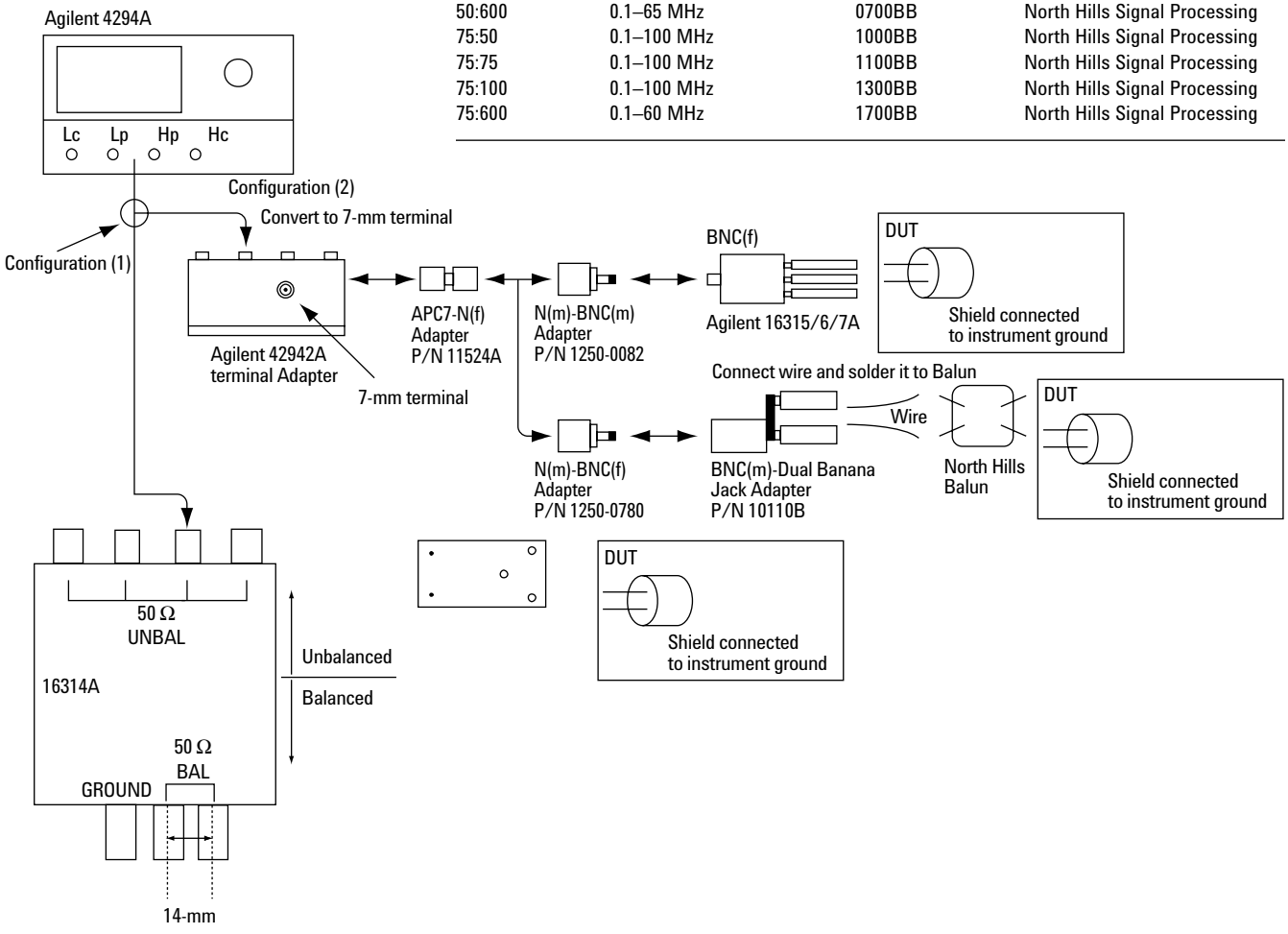

Figure 4. Measurement Configurations with 4294A

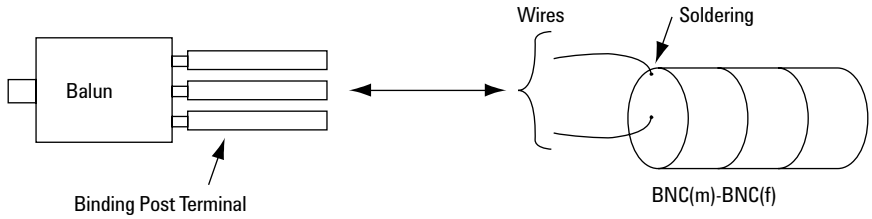

Figure 5. Assembling BNC connector

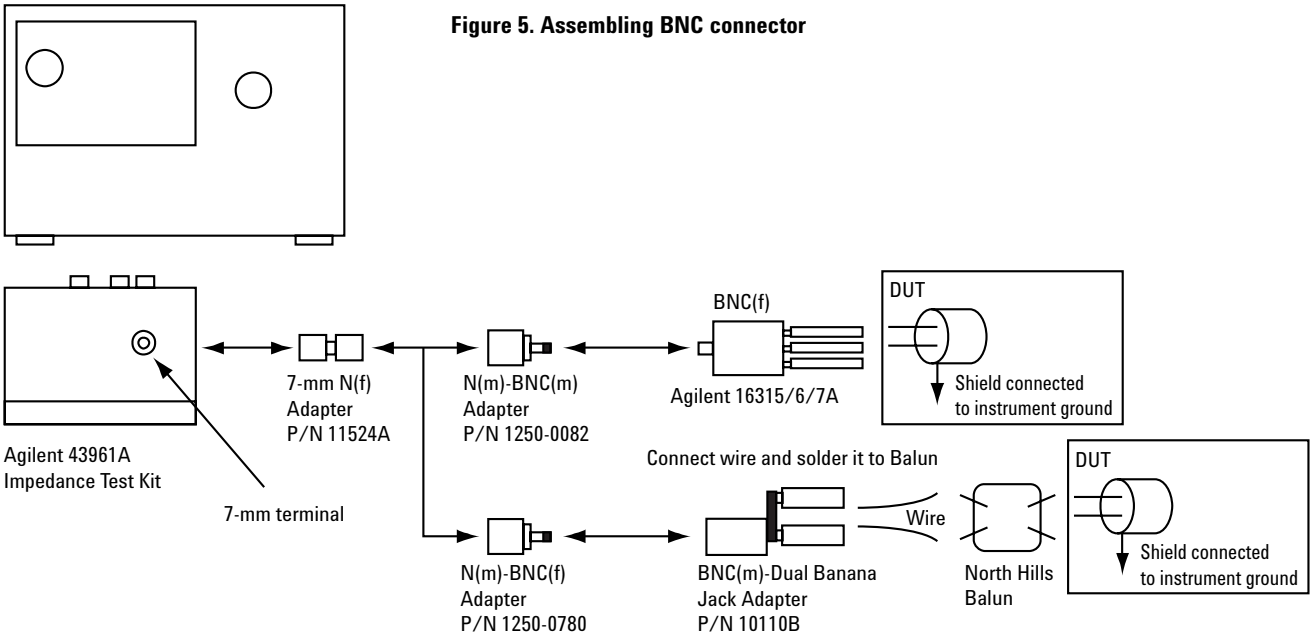

Figure 6. Measurement Configuration (2)

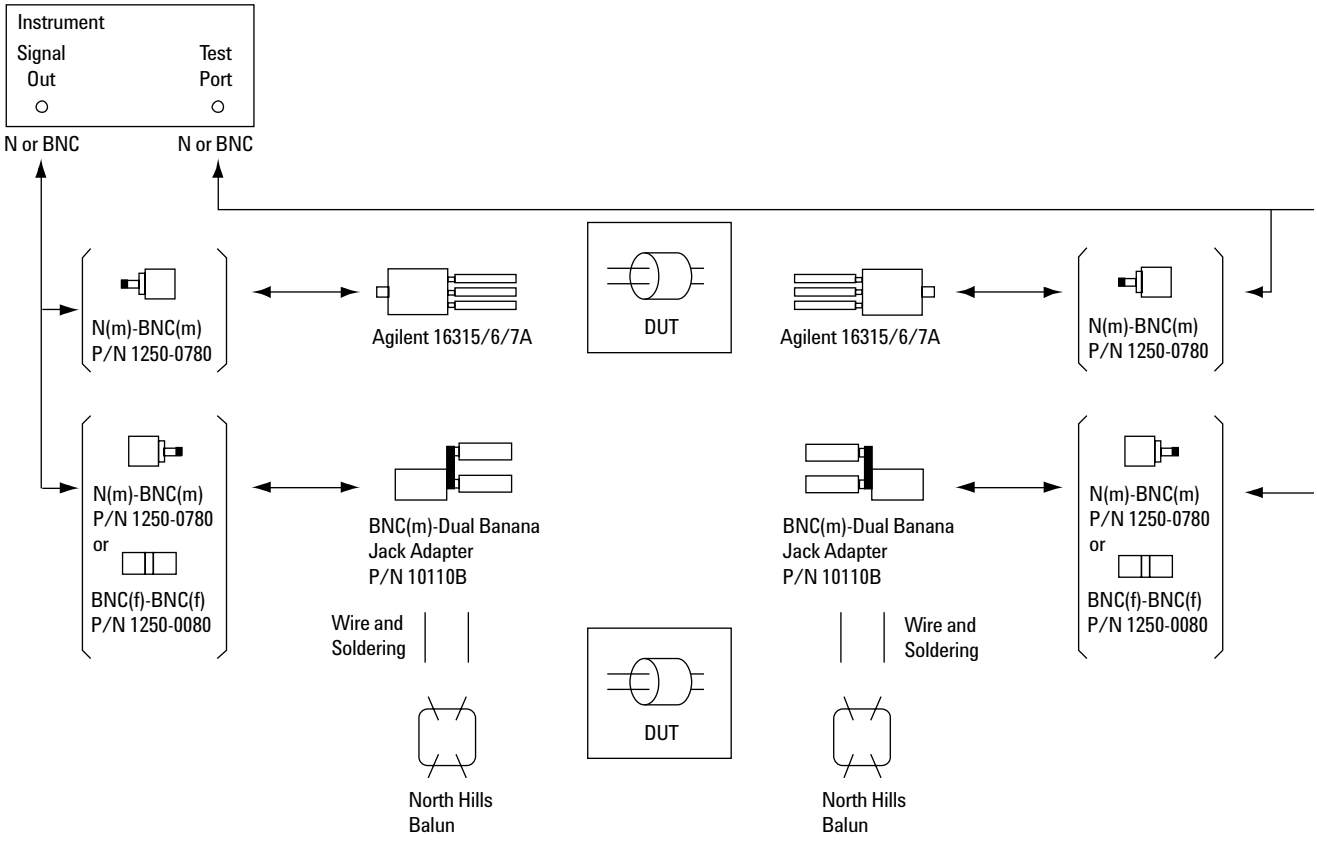

Figure 7. Measurement Configuration (3)

References

Impedance Measurement Handbook, Publication Number 5950-3000

For Information on Balun, Contact the Manufacturers:

North Hills Signal Processing
A Porta Systems Company
575 Underhill Blvd.
Syosset, NY 11791
Tel: (516) 682 7740
Fax: (516) 682 7704
www.northhills-sp.com/contact.html

By internet, phone, or fax, get assistance with all your test and measurement needs.

Online Assistance
www.agilent.com/find/assist

Phone or Fax
United States:
(tel) 1 800 452 4844

Canada:
(tel) 1 877 894 4414
(fax) (905) 206 4120

Europe:
(tel) (31 20) 547 2323
(fax) (31 20) 547 2390

Japan:
(tel) (81) 426 56 7832
(fax) (81) 426 56 7840

Latin America:
(tel) (305) 269 7500
(fax) (305) 269 7599

Australia:
(tel) 1 800 629 485
(fax) (61 3) 9210 5947

New Zealand:
(tel) 0 800 738 378
(fax) (64 4) 495 8950

Asia Pacific:
(tel) (852) 3197 7777
(fax) (852) 2506 9284

Printed in U.S.A. 10/00
5091-4480E

Agilent Technologies
Innovating the HP Way