AMP

100BASE-T
Impedance Matching Adapters

Premises Systems

AMP Incorporated

A publication of AMP Incorporated, Harrisburg, PA 17105

AMP

100BASE-T
Impedance Matching Adapters

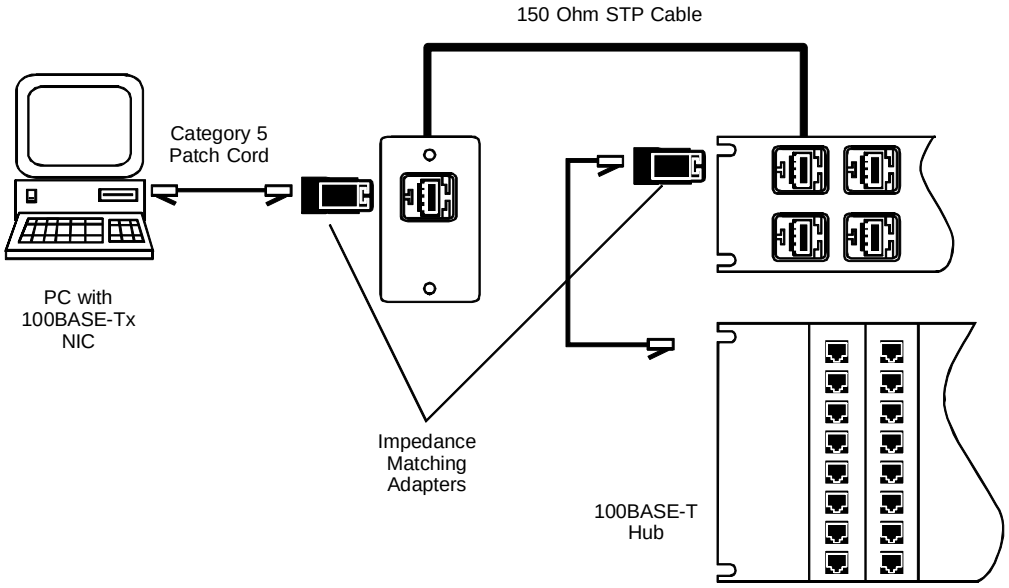
by

Jerry Solomon, RCDD/LAN Specialist
Systems Marketing Manager
Premises Systems

Introduction

Premises cabling systems represent a significant investment to any business, particularly when those systems are comprised of 150 ohm STP[1] cables and connectors. With the growing industry acceptance of Category 5 UTP (unshielded twisted pair) cabling over the last six years, it has become increasingly difficult to find networking hubs and interface cards design to operate on 150 ohm systems. This is unfortunate for the owner of the 150 ohm cabling system because these systems, even though much older than current high-performance UTP systems, can typically out-perform them. Most existing 150 ohm systems are quite capable of migration to 100 Mbps and even 155 Mbps operation – with a little help.

AMP provides that help in the form of *impedance matching adapters*[2]. These are passive devices that adapt the 150 ohm cable to 100 ohm electronic equipment. The impedance matching device performs two functions. The first is to adapt the standard 150 ohm connector interface (the Four-Position Data Connector) to the standard 100 ohm connector interface (the 8-position "RJ45" modular jack). The second function is to match, through a transformer, the 150 impedance of the cabling system to the 100 ohm impedance of the network equipment. When impedance matching adapters are installed at the work area outlet and the telecommunications closet patch panel (as shown in the illustration below), the 150 ohm cabling system appears to the equipment as if it were a 100 ohm system.



Using 100BASE-T Impedance Matching Adapters

[1] STP stands for Shielded Twisted Pair. This is the 2-pair, shielded cable (also known as type 1, type 2, type 9, etc.) that typically has been used in the IBM Cabling System.

[2] Impedance is a measure of the opposition of the cabling system to the signal flow. The optimum transmission occurs when the electronics and the cabling system have the same impedance.

But Does It Work?

That's all well and good, but what assurance do you have that this thing will work in your system? There are three responses to that question —

Product History

First, let's look at the part's history. AMP 100BASE-T Impedance Matching Adapters (part numbers 558420-1 and 558421-1) have been in production for two years at the time of this writing. Thousands have been sold during this time and, to date, none have been returned due to quality or functional problems. None have ever been returned because they wouldn't do what they were designed to do.

Product Performance

Second, let's talk about performance. There are no performance standards in place for impedance matching adapters. Category 5 performance requirements (which are necessary for 100BASE-T systems) apply only to cables and connectors. The performance of impedance matching adapters is beyond the scope of the standard. This can place discussions about adapter performance right up there next to rocket science but, for the sake of thoroughness, we will proceed anyway.

The two primary performance characteristics that essentially define component and cabling system performance are attenuation and near end crosstalk. Attenuation quantifies the amount of signal that is lost as it travels through the system. Near end crosstalk quantifies the amount of noise that is coupled by the system from the device's transmit circuit into its receive circuit. The attenuation of AMP 100BASE-T Impedance Matching Adapters is specified as less than 0.5 dB from 100 kHz to 100 MHz. What does this mean to your network? The attenuation of Category 5 cable is 22 dB/100 m at 100 MHz. This means that the adapter is equivalent to about 2.2 meters of Cat 5 cable. Or about 5 meters for the pair. Does this mean that cabling distances will be limited by the adapters? Far from it! The attenuation of 150 ohm STP cable is 12.3 dB/100 m at 100 MHz. This means that a 100 meter 150 ohm channel is roughly equivalent to only 55 meters of Cat 5 cable. That leaves plenty of room to spare for the attenuation added by the adapters. In fact, the adapters may even be used on closet-to-closet runs approaching 200 meters! For a discussion of the crosstalk characteristics of the adapters, let's proceed to the third response – third-party testing.

Third-party Testing

We realize that it's difficult to look at a stack of numbers and feel the kind of assurance you want to feel when it comes to your LAN. So we enlisted the help of the Fast Ethernet Consortium at the Interop Lab of the University of New Hampshire to test the performance of AMP 100BASE-T Impedance Matching Adapters in real live network operation. The main goal of the Fast Ethernet Consortium is to test interoperability between networking devices from various manufacturers. They provided the perfect environment in which to test the adapters across a wide range of 100BASE-T devices.

Test Configuration

In order to simulate both horizontal and backbone applications, the adapters were tested on two 150 ohm STP links: one of 90 meters and one of 190 meters. 5-Meter Category 5 patch cords were used on each end of the links to create 100-meter and 200-meter channels. Both channels were tested from each end with various adapters. The test results are summarized in the table below.

	Attenuation, dB	NEXT, dB		
Channel length	Margin from Cat 5 spec @ 100 MHz	Worst-case margin above Cat 5 spec	Best-case margin above Cat 5 spec	Average margin above Cat 5 spec
100 Meters	10	6.2	15.2	11.2
200 Meters	3	15.6	24.7	20.1

In each case, channel performance easily exceeded Category 5 requirements.

A Note on Field-testing

Field testers are generally designed to test simple cables and connectors and are usually not capable of "looking through" baluns and impedance adapters containing transformers. Due to the design of the 100BASE-T adapters, *some* field test equipment will actually test the entire channel with the adapters in place. However, not *all* test equipment can do this.

The vast majority of installed 150 ohm channels should be easily able to accommodate 100BASE-T and, therefore, AMP does not recommend that the customer go to the expense of re-qualifying the cabling system. If desired, one or two "worst-case" channels could be tested with 100BASE-T LAN equipment to get a feel for the overall "health" of the cabling system. If more extensive testing is required, and the available testers will not "look through" the adapters, the following is recommended:

Test the cabling without the adapters in place. Check the attenuation margin above Cat 5 requirements. If the margin is greater than 1 dB, there should be enough performance headroom in the system to accommodate the adapters.

Each networking device was tested on the 100-meter channel. Devices that were capable of full duplex operation were also tested on the 200-meter channel. The networking devices that were tested include:

- Network interface cards from:
  3Com
  Compaq
  Digital
  Intel
  Sun
- Repeaters from:
  3Com
  Compaq
  Digital
  Intel
  SMC
- Switches from:
  3Com
  Bay Networks
  Cabletron
  Cisco
  Digital
  Hewlett Packard
  Intel
- Routers from Cisco

Each piece of equipment was tested using the standard interop testing procedure used at the lab –

> The Interop Lab has a custom program which allows one station to repeatedly "ping" another while the program counts dropped data packets. A ping is basically a data packet that asks the receiving station, "Are you there?" to which the receiving station responds, "Yes, I am." The program first pings with 65000 64-byte packets (the shortest allowed by 802.3) and then with 65000 1518-byte packets (the longest allowed by 802.3). The total transmission in each test adds up to over 1.6 billion bits of data. If a dropped packet is considered to equal one bit error, each dropped packet would increase the bit error rate by roughly 6×10^{-10}. A device may drop up to sixteen packets (eight in either direction) and still pass the interoperability test. Although there is no specified bit error rate for 100BASE-Tx, the above limits equate to a BER of 1×10^{-8} or better.

The AMP 100BASE-T Impedance Matching Adapters passed all tests in both the 100-meter and 200-meter channels.

Summary

We have shown that AMP 100BASE-T Impedance Matching Adapters offer:

- A means of extending the life of 150 ohm cabling systems by accommodating 100BASE-T operation
- A 2-year product history of fault-free performance
- Performance in excess of Category 5 (and 100BASE-T) requirements
- Third-party verification of interoperability across a wide range of 100BASE-T equipment

There are many manufacturers (AMP included) who can sell you a new Category 5 cabling system. But the truth of the matter is that your 150 ohm system is more than adequate to support your migration to 100BASE-T. Why not use AMP Impedance Matching Adapters today and save your cabling system dollars until you're ready for something *really* fast, like Gigabit Ethernet (1000BASE-T) – then let's talk again!