



# REPORT INTERTEK TESTING SERVICES, INC.

3933 US ROUTE 11, CORTLAND, NEW YORK 13045

ORDER NO.: J20042193-406

DATE: March 19, 2001

REPORT NO.: J20042193-004

## RENDERED TO:

Tyco Electronics  
3700 Reidsville Rd.  
MS# 177-07 (PO Box 55)  
Winston-Salem, NC 27102-0055

**TEST:** Performance testing of the cabling configurations as defined in and to the requirements of ANSI/TIA/EIA-568-B.2-1, Transmission Performance Specification for 4 Pair 100  $\Omega$  Category 6 Cabling.

**STATEMENT OF LIMITATIONS:** At the client's request, the purpose of this report is to provide electrical performance data on the test sample. It is not valid to use this report for any other purpose.

## STANDARDS USED:

ASTM D4566-98, dated December 10, 1998, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable

TIA/EIA-568-B.2-1 Draft 7b, Transmission Performance Specification for 4 Pair 100  $\Omega$  Category 6 Cabling, dated February 2, 2001

TIA/EIA TSB 67 - October 1995, Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems

ISO/IEC 11801-1995 First Edition, Information Technology Generic Cabling for Customer Premises, dated July 15, 1995

**AUTHORIZATION:** The tests were authorized by Mr. Ned  
with Purchase Order No. 33067504.

**DATE OF TEST:** March 5, 2001 through March 13, 2001.

**An independent organization testing for safety, performance, and certification.**

All services undertaken subject to the following general policy: Reports are submitted for exclusive use of the clients to whom they are addressed. Their significance is subject to the adequacy and representative character of the samples and to the comprehensiveness of the tests, examinations or surveys made. No quotations from reports or use of ITS's name is permitted except as expressly authorized by ITS in writing.

**SPECIMEN DESCRIPTION:**



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10 Equipment Cord
2	AMP	1375055	Wall outlet
3	AMP	219599-4 Cat. 6 CMP	Transition Cable
4	AMP	219567 Cat. 6 CMP	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12 Equipment Cord

**EQUIPMENT LIST:**

The following equipment was employed in conducting the tests.

<u>Equipment Used</u>	<u>Model Number</u>	<u>Serial Number</u>	<u>Control Number</u>	<u>Calibration Date</u>
Hewlett Packard Automatic Cable Test System	HP46152A	3903U01003	N/A	03/18/00

**PROCEDURE:****Measurements**DC Resistance

The Resistance of all eight-conductor paths was measured in accordance with ASTM D4566-98, Paragraph 13.

Attenuation (Insertion Loss)

The Attenuation of all four-conductor pairs was measured in accordance with ASTM D4566-98, Paragraph 26. Losses due to reflection, radiation, etc. are assumed to be part of the attenuation.

Near End Cross Talk (NEXT)

NEXT measurements were made between the six combinations of the four conductor pairs in accordance with ASTM D4566-98, Paragraph 24.

Far End Cross Talk (FEXT)

FEXT was measured on twelve permutations of four conductor pairs in accordance with ASTM D 4566-98, Paragraph 25.

Return Loss

Return Loss was measured on all four-conductor pairs in accordance with ASTM D 4566-98, Paragraph 45.3.

Longitudinal Conversion Loss (LCL)

Longitudinal Conversion Loss was measured using the method described in paragraph ASTM D4566-98, Paragraph 46.

Longitudinal Conversion Transfer Loss (LCTL)

Longitudinal Conversion Transfer Loss was measured using the method described in ASTM D4566-98, Paragraph 46.

## Calculations

### Power Sum NEXT

NEXT Power Sum was determined by the method outlined in ASTM D4566-98, Paragraph 24.6, and TIA/EIA 568-B.2-1 Draft 7b, Paragraph 7.2.2.

### Equal Level FEXT (ELFEXT)

ELFEXT was computed by using the Attenuation and Far-End Crosstalk for each pair of the links and the method outlined in ASTM D4566-98, Paragraph 25, and ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.1

### Power Sum ELFEXT

Power Sum ELFEXT was determined by the method outlined in ASTM D4566-98, Paragraph 25, and TIA/EIA 568-B.2-1 Draft 7b, Paragraph 7.3.2.

### Attenuation to Cross Talk Ratio (ACR)

Attenuation to Cross Talk Ratio was determined using the method outlined in ISO/IEC 11801-1995, Paragraph 7.2.5.

### Power Sum ACR

The Power Sum ACR was determined using the same procedure as ACR except that the Power Sum Near-End Cross Talk was used in the computation in lieu of the worst-case NEXT.

### Propagation Delay

Propagation Delay was computed in accordance with ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.2.

### Delay Skew

Propagation Delay Skew is determined in accordance with ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.4.

**REQUIREMENTS:****Measurements**Attenuation

Attenuation was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.1.

Near End Cross Talk (NEXT)

NEXT was tested to the requirements of ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.1.

Return Loss

Return Loss was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.4.

**Calculations**Power Sum NEXT

PS NEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.2.

Equal Level FEXT (ELFEXT)

ELFEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.1.

Power Sum ELFEXT

PS ELFEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.2.

Attenuation to Cross Talk Ratio (ACR)

ACR was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.1 and 7.1.

Power Sum ACR

PS ACR was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.2 and 7.1.

Propagation Delay

Propagation Delay was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.2.

Delay Skew

Propagation Delay Skew was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.4.

**RESULTS:**

See Appendices A through C for Test Results.

**CONCLUSION:**

The cabling configurations, as previously described and supplied by the client, were tested for transmission requirements in accordance with the Procedures contained herein, and did comply with the indicated applicable Requirements.

These Procedures and Requirements were taken from the Standards referred to on Page 1.

Reviewed and Approved By:



Robert Southworth  
Laboratory Supervisor  
Communications Products



Michael Tylanda  
Test Engineer  
Communications Products



# REPORT INTERTEK TESTING SERVICES, INC.

3933 US ROUTE 11, CORTLAND, NEW YORK 13045

ORDER NO.: J20042193-406

DATE: March 19, 2001

REPORT NO.: J20042193-003

## RENDERED TO:

Tyco Electronics  
3700 Reidsville Rd.  
MS# 177-07 (PO Box 55)  
Winston-Salem, NC 27102-0055

**TEST:** Performance testing of the cabling configurations as defined in and to the requirements of ANSI/TIA/EIA-568-B.2-1, Transmission Performance Specification for 4 Pair 100  $\Omega$  Category 6 Cabling.

**STATEMENT OF LIMITATIONS:** At the client's request, the purpose of this report is to provide electrical performance data on the test sample. It is not valid to use this report for any other purpose.

## STANDARDS USED:

ASTM D4566-98, dated December 10, 1998, Standard Test Methods for Electrical Performance Properties of Insulations and Jackets for Telecommunications Wire and Cable

TIA/EIA-568-B.2-1 Draft 7b, Transmission Performance Specification for 4 Pair 100  $\Omega$  Category 6 Cabling, dated February 2, 2001

TIA/EIA TSB 67 - October 1995, Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems

ISO/IEC 11801-1995 First Edition, Information Technology Generic Cabling for Customer Premises, dated July 15, 1995

**AUTHORIZATION:** The tests were authorized by Mr. Ned Sigmon, representing the client, Tyco Electronics, with Purchase Order No. 33067504.

**DATE OF TEST:** March 5, 2001

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**SPECIMEN DESCRIPTION:**



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10 Equipment Cord
2	AMP	1375055	Wall outlet
3	AMP	219597-4 Cat. 6 CMR	Transition Cable
4	AMP	219560 Cat. 6 CMR	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12 Equipment Cord

**EQUIPMENT LIST:**

The following equipment was employed in conducting the tests.

<u>Equipment Used</u>	<u>Model Number</u>	<u>Serial Number</u>	<u>Control Number</u>	<u>Calibration Date</u>
Hewlett Packard Automatic Cable Test System	HP46152A	3903U01003	N/A	03/18/00



**PROCEDURE:****Measurements**DC Resistance

The Resistance of all eight-conductor paths was measured in accordance with ASTM D4566-98, Paragraph 13.

Attenuation (Insertion Loss)

The Attenuation of all four-conductor pairs was measured in accordance with ASTM D4566-98, Paragraph 26. Losses due to reflection, radiation, etc. are assumed to be part of the attenuation.

Near End Cross Talk (NEXT)

NEXT measurements were made between the six combinations of the four conductor pairs in accordance with ASTM D4566-98, Paragraph 24.

Far End Cross Talk (FEXT)

FEXT was measured on twelve permutations of four conductor pairs in accordance with ASTM D 4566-98, Paragraph 25.

Return Loss

Return Loss was measured on all four-conductor pairs in accordance with ASTM D 4566-98, Paragraph 45.3.

Longitudinal Conversion Loss (LCL)

Longitudinal Conversion Loss was measured using the method described in paragraph ASTM D4566-98, Paragraph 46.

Longitudinal Conversion Transfer Loss (LCTL)

Longitudinal Conversion Transfer Loss was measured using the method described in ASTM D4566-98, Paragraph 46.

## Calculations

### Power Sum NEXT

NEXT Power Sum was determined by the method outlined in ASTM D4566-98, Paragraph 24.6, and TIA/EIA 568-B.2-1 Draft 7b, Paragraph 7.2.2.

### Equal Level FEXT (ELFEXT)

ELFEXT was computed by using the Attenuation and Far-End Crosstalk for each pair of the links and the method outlined in ASTM D4566-98, Paragraph 25, and ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.1

### Power Sum ELFEXT

Power Sum ELFEXT was determined by the method outlined in ASTM D4566-98, Paragraph 25, and TIA/EIA 568-B.2-1 Draft 7b, Paragraph 7.3.2.

### Attenuation to Cross Talk Ratio (ACR)

Attenuation to Cross Talk Ratio was determined using the method outlined in ISO/IEC 11801-1995, Paragraph 7.2.5.

### Power Sum ACR

The Power Sum ACR was determined using the same procedure as ACR except that the Power Sum Near-End Cross Talk was used in the computation in lieu of the worst-case NEXT.

### Propagation Delay

Propagation Delay was computed in accordance with ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.2.

### Delay Skew

Propagation Delay Skew is determined in accordance with ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.4.

**REQUIREMENTS:****Measurements**Attenuation

Attenuation was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.1.

Near End Cross Talk (NEXT)

NEXT was tested to the requirements of ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.1.

Return Loss

Return Loss was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.4.

**Calculations**Power Sum NEXT

PS NEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.2.

Equal Level FEXT (ELFEXT)

ELFEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.1.

Power Sum ELFEXT

PS ELFEXT was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.3.2.

Attenuation to Cross Talk Ratio (ACR)

ACR was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.1 and 7.1.

Power Sum ACR

PS ACR was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.2.2 and 7.1.

Propagation Delay

Propagation Delay was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.2.

Delay Skew

Propagation Delay Skew was tested to the requirements of the ANSI/TIA/EIA-568-B.2-1 Draft 7b, Paragraph 7.5.4.

**RESULTS:**

See Appendices A through C for Test Results.

**CONCLUSION:**

The cabling configurations, as previously described and supplied by the client, were tested for transmission requirements in accordance with the Procedures contained herein, and did comply with the indicated applicable Requirements.

These Procedures and Requirements were taken from the Standards referred to on Page 1.

Reviewed and Approved By:



Robert Southworth  
Laboratory Supervisor  
Communications Products



Michael Tylanda  
Test Engineer  
Communications Products



**REPORT  
INTERTEK TESTING SERVICES, INC.**

3933 US ROUTE 11, CORTLAND, NEW YORK 13045

ORDER NO.: J20042193-406

DATE: March 19, 2001

**REPORT NO.:** J20042193-005

**RENDERED TO:**

Tyco Electronics  
3700 Reidsville Rd.  
MS# 177-07 (PO Box 55)  
Winston-Salem, NC 27102-0055

**TEST:** Performance Testing of the cabling configurations as defined in TIA/EIA TSB-67 and TIA/EIA-568-B.2.1 to the requirements of IEEE 802.3ab-1999 for Performance over a 1000 Base T (Gigabit Ethernet) network.

**STATEMENT OF LIMITATIONS:** At the client's request, the purpose of this report is to provide electrical performance data on the test sample. It is not valid to use this report for any other purpose.

**STANDARDS USED:**

TIA/EIA-568-B.2.1 Draft 7b, Transmission Performance Specification for 4 Pair 100  $\Omega$  Category 6 Cabling, dated February 2, 2001

TIA/EIA TSB 67 - October 1995, Transmission Performance Specifications for Field Testing of Unshielded Twisted-Pair Cabling Systems

IEEE 802.3ab-1999 Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4- Pair of Category 5 Balanced Copper Cabling, Type 1000Base-T.

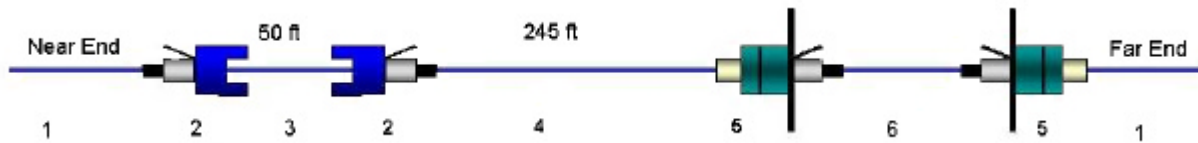
**AUTHORIZATION:** The tests were authorized by, Mr. Ned Sigmon, representing the client, Tyco Electronics, with Purchase Order No. 33067504.

**DATE OF TEST:** March 5, 2001

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**SAMPLE DESCRIPTION:**



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10 Equipment Cord
2	AMP	1375055	Wall outlet
3	AMP	219597-4 Cat. 6 CMR	Transition Cable
4	AMP	219560 Cat. 6 CMR	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12 Equipment Cord

**EQUIPMENT LIST:**

The following equipment was employed in conducting the tests.

<u>Equipment Used</u>	<u>Model Number</u>	<u>Serial Number</u>	<u>Control Number</u>	<u>Calibration Date</u>
Netcom Systems Multiport Port/ Stream/ Analysis System Chassis	Smartbits 2000	7605 Rev. C1	N/A	N/A
Netcom Systems Smartcard	GX- 1420B	N00280060	N/A	N/A
Netcom Systems Smartcard	GX- 1420B	N00280061	N/A	N/A

**PROCEDURE:****Definitions and Measurements**Frames/ Packet

Frames/ packets are units of data sent across the network. For this testing, the packet size was 64 bytes, which includes 4 bytes of error-control information and details of its origin and its final target.

Transmit Frames (TX Frames)

Transmit Frames is the number of data packets sent by the Smartbits card.

Receive Frames (RX Frames)

Receive Frames is the number of data packets received by the Smartbits card.

Received Triggers (RX Triggers)

Received Triggers are packets of information containing a certain set piece of information that causes that packet to be counted by the receiving unit.

Fragmented/ Undersize Packets Errors

Fragmented or Undersize Packets refers to errors in the packets. The receiving port counts Fragmented packets, packets missing pieces of information, after a collision occurs. Undersized packets are packets that had less than 64 bytes of data when received.

Oversize Packets Errors

Oversize Packets refers to packets that arrive at the receiving Smartcard with a size greater than 1518 octets.

Cyclical Redundancy Checksum (CRC) Errors

CRC, or cyclic redundancy check, errors occur when the packets are somehow damaged in transit. When each packet is transmitted, the MAC layer of the transmitting device computes a frame check sequence (FCS) value based on the content of the packet. The receiving station performs the same calculation; if the FCS values differ, the packet is assumed to have been corrupted and is counted as a CRC error. CRC errors can result from MAC layer hardware problem causing an inaccurate computation of the FCS value, or from other transmission problem that has garbled the original data. On most devices, the error priority scheme is set up so that packets which are counted as CRC errors do not have alignment errors as well.

**REQUIREMENTS:****Measurements**CRC Errors

CRC errors are limited to 1 error in  $10^{10}$  packets sent and received in accordance with IEEE 802.3 ab-1999 section 40.4.2.3.

**RESULTS:**

See Appendices A through C for Test Results.

**CONCLUSION:**

The cabling configuration, as previously described and supplied by the client, were tested in accordance with the procedures contained herein, and did comply with the indicated applicable requirements.

These Procedures and Requirements were taken from the Standards referred to on Page 1.

Reviewed and Approved By:

Robert Southworth  
Lab Supervisor  
Communications Products



Michael Tylanda  
Technician  
Communications Products

# Active Environment Testing





# Active Environment Testing

Appendix A  
Test Results  
Repetition 1

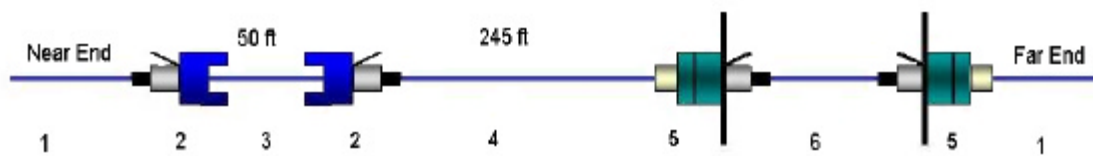
# Intertek Testing Services

## Active Testing

Date of Test: March 5, 2001  
 Test: AE-AA-CMR-1

SmartCounters,23,3,1,0,1,0,15 0,0,0,0,0,0,0,0,0,0,0,0,0,2,0,1	Events	Events	Total
	01 GX-1420B	03 GX-1420B	
Tx Frames	10,133,582,843	10,133,606,684	20,267,189,527
Rx Frames	10,133,575,228	10,133,574,519	20,267,149,747
Rx Bytes	648,548,814,592	648,548,769,216	1,297,097,583,808
Rx Triggers	10,133,575,228	10,133,574,519	20,267,149,747
CRC Errors	0	0	0
OverSize	0	0	0
Frag/UnderSize	0	0	0
Tx From Stack	0	0	0
Rx To Stack	0	0	0
ARP Replies Sent	0	0	0
ARP Requests Sent	0	0	0
ARP Replies Received	0	0	0
ARP Requests Received	0	0	0
PING Replies Sent	0	0	0
PING Requests Sent	0	0	0
PING Replies Received	0	0	0
PING Requests Received	0	0	0
VLAN Frames	0	0	0
IP Frames Received	0	0	0
IP Checksum Errors	0	0	0

### Channel Identification



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10' Equipment Cord
2	AMP	1375055	Wall outlet
3	AMP	219597-4 Cat. 6 CMR	Transition Cable
4	AMP	219560 Cat. 6 CMR	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12 Equipment Cord



# Active Environment Testing

**Appendix B**  
Test Results  
Repetition 2

# Intertek Testing Services

## Active Testing

Date of Test: March 5, 2001  
 Test: AE-AA-CMR-2

SmartCounters,23,3,1,0,1,0,15 0,0,0,0,0,0,0,0,0,0,0,0,0,2,0,1	Events	Events	
	01 GX-1420B	03 GX-1420B	
Tx Frames	10,406,605,956	10,406,455,180	20,813,061,136
Rx Frames	10,406,603,838	10,406,457,302	20,813,061,140
Rx Bytes	666,022,645,568	666,013,267,398	1,332,035,912,966
Rx Triggers	10,406,603,837	10,406,457,303	20,813,061,140
CRC Errors	0	0	0
OverSize	0	0	0
Frag/UnderSize	0	0	0
Tx From Stack	0	0	0
Rx To Stack	0	0	0
ARP Replies Sent	0	0	0
ARP Requests Sent	0	0	0
ARP Replies Received	0	0	0
ARP Requests Received	0	0	0
PING Replies Sent	0	0	0
PING Requests Sent	0	0	0
PING Replies Received	0	0	0
PING Requests Received	0	0	0
VLAN Frames	0	0	0
IP Frames Received	0	0	0
IP Checksum Errors	0	0	0

### Channel Identification



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10' Equipment Cord
2	AMP	1,375,055	Wall outlet
3	AMP	219597-4 Cat. 6 CMR	Transition Cable
4	AMP	219560 Cat. 6 CMR	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12 Equipment Cord



# Active Environment Testing

Appendix C  
Test Results  
Repetition 3

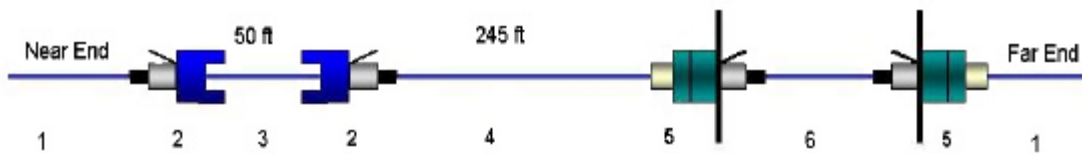
# Intertek Testing Services

## Active Testing

Date of Test: March 5, 2001  
 Test: AE-AA-CMR-3

50,0,0,0,0,0,0,0,0,0,0,0,0,2,0,1	Events	Events	
	01 GX-1420B	03 GX-1420B	
Tx Frames	11,321,776,666	11,320,275,615	22,642,052,281
Rx Frames	11,321,764,394	11,320,263,725	22,642,028,119
Rx Bytes	724,592,937,836	724,496,890,948	1,449,089,828,784
Rx Triggers	11,321,764,594	11,320,263,861	22,642,028,455
CRC Errors	0	0	0
OverSize	0	0	0
Frag/UnderSize	0	0	0
Tx From Stack	0	0	0
Rx To Stack	0	0	0
ARP Replies Sent	0	0	0
ARP Requests Sent	0	0	0
ARP Replies Received	0	0	0
ARP Requests Received	0	0	0
PING Replies Sent	0	0	0
PING Requests Sent	0	0	0
PING Replies Received	0	0	0
PING Requests Received	0	0	0
VLAN Frames	0	0	0
IP Frames Received	0	0	0
IP Checksum Errors	0	0	0

### Channel Identification



<u>Component ID</u>	<u>Manufacturer</u>	<u>Part Number</u>	<u>Description</u>
1	AMP	1-219891-0	10' Equipment Cord
2	AMP	1,375,055	Wall outlet
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4	AMP	219560 Cat. 6 CMR	Horizontal Cable
5	AMP	1365015-1	Patch Panel
6	AMP	1-219891-2	12' Equipment Cord