



*This document has been prepared to aid consultants or engineers in developing contractual specifications covering the certification of Category 8 Permanent Links. It is offered as a general guide. Suitability for any intended use is the responsibility of the user.*

## SECTION 27 17 00

### TESTING, IDENTIFICATION AND ADMINISTRATION OF BALANCED TWIST PAIR INFRASTRUCTURE

#### PART 1 - GENERAL

##### 1.1 WORK INCLUDED

A. Provide all labour, materials, tools, field-test instruments and equipment required for the complete testing, identification and administration of the work called for in the Contract Documents.

B. In order to conform to the overall project event schedule, the cabling contractor shall survey the work areas and coordinate cabling testing with other applicable trades.

C. In addition to the tests detailed in this document, the contractor shall notify the Owner or the Owner's representative of any additional tests that are deemed necessary to guarantee a fully functional system. The contractor shall carry out and record any additional measurement results at no additional charge.

##### 1.2 SCOPE

A. This Section includes the minimum requirements for the test certification, identification and administration of horizontal balanced twisted pair cabling.

B. This Section includes minimum requirements for:

1. Copper cabling test instruments
2. Copper cabling testing
3. Identification
  - a) *Labels and labeling*
4. Administration
  - a) *Test results documentation*
  - b) *As-built drawings*

C. Testing shall be carried out in accordance with this document.

D. Testing shall be performed on each cabling link. (100% testing)

E. All tests shall be documented.

##### 1.3 QUALITY ASSURANCE

A. All testing procedures and field-test instruments shall comply with applicable requirements of:

1. ANSI/TIA-1152-A, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
2. ANSI/TIA-568-O.D, Generic Telecommunications Cabling for Customer Premises.

3. ANSI/TIA-568-1.D, Commercial Building

Telecommunications Cabling Standard

4. ANSI/TIA 568 C.2, Balanced Twisted-Pair

Telecommunications Cabling and Components Standards.

5. ANSI/TIA-606-B, Administration Standard for Commercial Telecommunications Infrastructure, including the requirements specified by the customer, unless the customer specifies their own labelling requirements.

B. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organizations or an equivalent organization:

1. Manufacturer of the connectors or cable.
2. Manufacturer of the test equipment used for the field certification.
3. Training organizations (e.g., BICSI, A Telecommunications Association headquarters in Tampa, Florida; ACP [Association of Cabling Professionals™] Cabling Business Institute located in Dallas, Texas)

C. The Owner or the Owner's representative shall be invited to witness and/or review field-testing.

1. The Owner or the Owner's representative shall be notified of the start date of the testing phase five business days before testing commences.
2. The Owner or the Owner's representative will select a random sample of five percent of the installed links. The Owner or the Owner's representative shall test these randomly selected links and the results are to be stored in accordance with Part 3 of this document. The results obtained shall be compared to the data provided by the installation contractor. If more than two percent of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat one hundred percent testing at no cost to the Owner.

##### 1.4 SUBMITTALS

A. Manufacturers catalogue sheets and specifications for the test equipment.

B. A schedule (list) of all balanced twisted-pair copper links to be tested.

C. Sample test reports.



## 1.5 ACCEPTANCE OF TEST RESULTS

A. Unless otherwise specified by the Owner or the Owners representative, each cabling link shall be in tested for:

1. Wire Map
2. Length
3. Propagation Delay
4. Delay Skew
5. DC Loop Resistance
6. DC Resistance Unbalance within a pair
7. DC Resistance Unbalance between pairs
8. Insertion Loss
9. NEXT (Near-End Crosstalk)
10. PS NEXT (Power Sum Near-End Crosstalk)
11. ACR-N (Attenuation to Crosstalk Ratio Near-End)
12. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
13. ACR-F (Attenuation to Crosstalk Ratio Far-End)
14. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
15. Return Loss
16. TCL (Transverse Conversion Loss)
17. ELTCTL (Equal Level Transverse Conversion Transfer Loss)
18. PS ANEXT (Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
19. Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk) – sampled per section 3.2
20. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2
21. Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End) – sampled per section 3.2

B. All installed cabling Permanent Links shall be field-tested and pass the test requirements and analysis as described in Part 3. Any Permanent Link that fails these requirements shall be diagnosed and corrected. Any corrective action that must take place shall be documented and followed with a new test to prove that the corrected Permanent Link meets performance requirements. The final and passing result of the tests for all Permanent Links shall be provided in the test results documentation in accordance with Part 3.

C. Acceptance of the test results shall be given in writing after the project is fully completed and tested in accordance with Contract Documents and to the satisfaction of the Owner.

## PART 2 - PRODUCTS

### 2.1 BALANCED TWISTED-PAIR CABLE TESTERS

A. The field-test instrument shall be within a 12 month calibration period.

B. Certification tester

1. Accuracy

- a) Level 2G accuracy in accordance with ANSI/TIA-1152-A
- b) Independent verification of accuracy shall be provided
- c) Acceptable manufacturer

1) Fluke Networks

2. Permanent Link Adapters

- a) RJ45 plug must meet the requirements for NEXT, FEXT and Return Loss in accordance with ANSI/TIA-568-C.2 Annex C
- b) Twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures

3. Results Storage

- a) Must be capable of storing > 5,000 results for all measurements found in 2.1.B.4 below

4. Measurement capabilities

- a) Wire Map
- b) Length
- c) Propagation Delay
- d) Delay Skew
- e) DC Loop Resistance
- f) DC Resistance Unbalance within a pair
- g) DC Resistance Unbalance between pairs
- h) Insertion Loss
- i) NEXT (Near-End Crosstalk)
- j) PS NEXT (Power Sum Near-End Crosstalk)
- k) ACR-N (Attenuation to Crosstalk Ratio Near-End)
- l) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)
- m) ACR-F (Attenuation to Crosstalk Ratio Far-End)
- n) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- o) Return Loss
- p) TCL (Transverse Conversion Loss)
- q) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
- r) Time Domain Reflectometer
- s) Time Domain Xtalk Analyzer
- t) PS ANEXT (Power Sum Alien Near-End Crosstalk)
- u) Average PS ANEXT (Average Power Sum Alien Near-End Crosstalk)
- v) PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)
- w) Average PS AACR-F (Average Power Sum Alien Attenuation to Crosstalk Ratio Far-End)

C. PC Software

1. LinkWare PC – latest version

### 2.2 IDENTIFICATION

A. Labels

1. Shall meet the legibility, defacement, exposure and adhesion requirements of UL 969.
2. Shall be preprinted using a mechanical means of printing (e.g., laser printer).



- 3. Where used for cable marking, provide vinyl substrate with a white printing area and a clear "tail" that self laminates the printed area when wrapped around the cable. If cable jacket is white, provide cable label with printing area that is any other colour than white, preferably orange or yellow – so that the labels are easily distinguishable.
- 4. Where insert type labels are used provide clear plastic cover over label.
- 5. Provide plastic warning tape 6 inches wide continuously printed and bright coloured 18" above all direct buried services, underground conduits and duct-banks.
- 6. Acceptable Manufacturers:
  - a) Brother
  - b) Dymo
  - c) Epson
  - d) Silver Fox
  - e) Brady Corporation

### 2.3 ADMINISTRATION

- A. Administration of the documentation shall include test results of each Permanent Link.
- B. The test result information for each link shall be recorded in the memory of the field-test instrument upon completion of the test.
- C. The test result records saved within the field-test instrument shall be transferred to LinkWare PC via LinkWare Live.
- D. Alien Crosstalk measurements shall be stored to a PC upon completion of the test.

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. All outlets, cables, patch panels and associated components shall be fully assembled and labeled prior to field-testing. Any testing performed on incomplete systems shall be redone on completion of the work.

### 3.2 BALANCED TWISTED PAIR CABLE TESTING

- A. Field-test instruments shall have the latest firmware installed.
- B. Permanent Link test results, including the individual frequency measurements from the tester, shall be recorded in the test instrument upon completion of each test for subsequent uploading to LinkWare PC via LinkWare Live in which the administrative documentation (reports) may be generated.
- C. Permanent Link testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. Alien Crosstalk testing shall be performed using a sampling plan. An acceptance quality level (AQL) of 0,4 %, normal inspection, general inspection level I as defined in ISO 2859-1 for populations

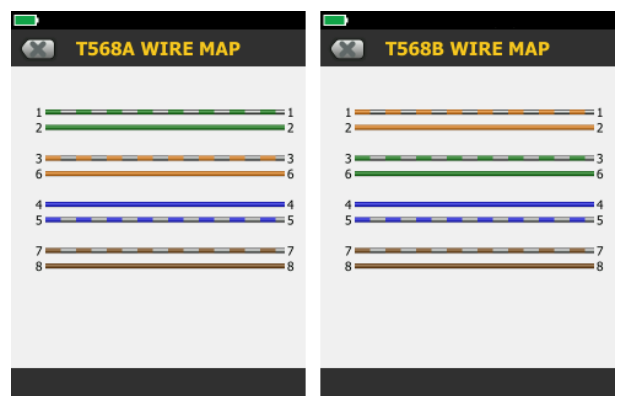
of up to 500,000 links shall be used. The following table represents this sampling level.

Total number of links (N)	Sample size (No. of links to test)
3-33	3 or 0.1 x N (Whichever is greatest)
34-3,200	33
3,201-35,000	126
35,001-150,000	201
150,001-500,00	315

- E. Disturbed (Victim) links chosen for Alien Crosstalk testing shall be an equal combination of short, medium and long links.
- F. Permanent Link adapters made from twisted pair Category 5e, 6, 6A, 7 or 7A cords are not permitted as their performance degrades with use and can cause false Return Loss failures.
- G. The installer shall build a reference link. All components shall be anchored so it is not possible to disturb them. The technician is to conduct a Category 8 Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.

### H. Wire Map Measurement

- 1. The wire map test is intended to verify pin-to-pin termination at each end and check for installation connectivity errors.
- 2. For each of the eight conductors in the cabling, the wire map indicates:
  - a) Continuity to the remote end
  - b) Shorts between any two or more conductors
  - c) Reversed pairs
  - d) Split pairs
  - e) Transposed pairs
  - f) Continuity of Screen to remote end -Screen Continuity is tested along the path of the cabling
  - g) Distance to open on shield
  - h) Any other miss-wiring
- 3. The correct connectivity of telecommunications outlets/connectors is defined in ANSI/TIA-568-C.2. Two colour schemes are permitted. The user shall define which scheme is to be used. The field tester shall document which colour scheme was used. Examples are given below:





**I. Length Measurement**

1. The length of each balanced twisted pair shall be recorded.
2. Since physical length is determined from electrical length, the physical length of the link calculated using the pair with the shortest electrical delay shall be reported and used for making the pass or fail determination.
3. The pass or fail criteria is based on the maximum length allowed for the Permanent Link as specified in ANSI/TIA-568-C.2 plus the nominal velocity of propagation (NVP) uncertainty of 10%. For a Permanent Link, the length measurement can be 87 ft. (26 m) before a fail is reported.

**J. Propagation Delay measurement**

1. Is the time it takes for a signal to reach the end of the link.
2. The measurement shall be made at 10 MHz per ANSI/TIA-1152-A.
3. The propagation delay of each balanced twisted pair shall be recorded.
4. Is not to exceed 179 ns per ANSI/TIA-568-C.2 Section 6.3.19.

**K. Delay Skew measurement**

1. Is the difference in propagation delay @ 10 MHz between the shortest delay and the delays of the other wire pairs.
2. The delay skew of each balanced twisted pair shall be recorded.
3. Is not to exceed 17 ns per ANSI/TIA-568-C.2 Section 6.3.20.

**L. DC Loop Resistance**

1. Often reported as Resistance, is the DC loop resistance of both conductors in the pair.
2. The DC Resistance shall be reported for all four pairs.
3. Is not to exceed 6.4 Ω for all four pairs per ANSI/TIA-568-C.2 Section 6.3.1.

**M. DC Resistance Unbalance within a pair**

1. Is the difference in DC resistance of the two wires within the same pair.
2. The DC Resistance Unbalance within a pair shall be reported for all four pairs.
3. Is not to exceed 200 mΩ or 3%, whichever is the greatest per ANSI/TIA-568-C.2 Section 6.2.2.

**N. DC Resistance Unbalance between pairs**

1. Is the difference in DC parallel resistance of the conductors of a pair compared to the DC parallel resistance of another pair, given in the formula below:

$$Resistance\_Unbalance_{Between\_pairs} = \left( \frac{|R_{P1} - R_{P2}|}{R_{P1} + R_{P2}} \right) 100\%$$

Where:

$R_{P1}$  is the DC parallel resistance of the conductors of a pair.

$R_{P2}$  is the DC parallel resistance of the conductors of another pair.

2. The DC Resistance Unbalance shall be reported for the following pairs

- |            |            |
|------------|------------|
| a) 1,2-3,6 | d) 3,6-4,5 |
| b) 1,2-4,5 | e) 3,6-7,8 |
| c) 1,2-7,8 | f) 4,5-7,8 |

3. Is not to exceed 120 mΩ or 7.5%, whichever is the greatest per ANSI/TIA-568-C.2 Section 6.3.3.

**O. Insertion Loss**

1. Is the loss of signal strength over the cabling (in dB).
2. The frequency resolution shall be:
  - a) 1 - 31.25 MHz: 150 kHz
  - b) 31.25 - 100 MHz: 250 kHz
  - c) 100 - 250 MHz: 500 kHz
  - d) 250 - 600 MHz: 1000 kHz
  - e) 600 - 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in one direction for all four pairs.
4. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
5. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.

**P. NEXT (Near-End Crosstalk)**

1. Is the difference in amplitude (in dB) between a transmitted signal and the crosstalk received on other wire pairs at the same end of the cabling.
2. The frequency resolution shall be:
  - a) 1 - 31.25 MHz: 150 kHz
  - b) 31.25 - 100 MHz: 250 kHz
  - c) 100 - 250 MHz: 500 kHz
  - d) 250 - 600 MHz: 1000 kHz
  - e) 600 - 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pair combinations
 

a) 1,2-3,6	d) 3,6-4,5
b) 1,2-4,5	e) 3,6-7,8
c) 1,2-7,8	f) 4,5-7,8
4. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
6. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

**Q. PS NEXT (Power Sum Near-End Crosstalk)**

1. Is the difference (in dB) between the test signal and the crosstalk from the other pairs received at the same end of the cabling.
2. The frequency resolution shall be:
  - a) 1 - 31.25 MHz: 150 kHz
  - b) 31.25 - 100 MHz: 250 kHz
  - c) 100 - 250 MHz: 500 kHz
  - d) 250 - 600 MHz: 1000 kHz
  - e) 600 - 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.10.



5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
6. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.

R. ACR-N (Attenuation Crosstalk Ratio Near-End)

1. Is a calculation of NEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pairs
  - a) 1,2-3,6                  d) 3,6-4,5
  - b) 1,2-4,5                  e) 3,6-7,8
  - c) 1,2-7,8                  f) 4,5-7,8
4. Although not specified in ANSI/TIA-568-C.2, it shall be recorded for all twelve possible combinations.

S. PS ACR-N (Power Sum Attenuation Crosstalk Ratio Near-End)

1. Is a calculation of PS NEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Although not specified in ANSI/TIA-568-C.2, it shall be recorded for all eight possible combinations.

T. ACR-F (Attenuation Crosstalk Ratio Far-End)

1. Is a calculation of FEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for the following pairs
  - a) 1,2-3,6                  g) 4,5-1,2
  - b) 1,2-4,5                  h) 4,5-3,6
  - c) 1,2-7,8                  i) 4,5-7,8
  - d) 3,6-1,2                  j) 7,8-1,2
  - e) 3,6-4,5                  k) 7,8-3,6
  - f) 3,6-7,8                  l) 7,8-4,5
4. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.12.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).

U. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)

1. Is a calculation of PS FEXT minus Insertion Loss of the disturbed pair in dB.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.14.
5. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).

V. Return Loss

1. Is the difference (in dB) between the power of a transmitted signal and the power of the signals reflected back.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
5. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
7. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.

W. TCL (Transverse Conversion Loss)

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the near-end on the same wire pair.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 8 limits found ANSI/TIA-568-C.2 Section 6.2.15.





**X. ELTCTL (Equal Level Transverse Conversion Transfer Loss)**

1. Is the ratio (in dB) between a differential mode signal inject at the near-end and the common-mode signal measured at the far end on the same wire pair minus the Insertion Loss of that pair.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Both worst case and worst margins shall be reported in both directions for all four pairs.
4. Is not to exceed the Category 8 limits found in ANSI/TIA-568-C.2 section 6.2.17.

**Y. PS ANEXT (Power Sum Alien Near-End Crosstalk)**

1. Takes into account the combined alien crosstalk (statistical) on a receive pair from all external near-end disturbers operating simultaneously.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.
4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links
5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.
6. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.22.

**Z. Average PS ANEXT (Power Sum Alien Near-End Crosstalk)**

1. Is calculated by averaging the individual PSANEXT loss values, in dB, for all four pairs in the disturbed (victim) link.
2. The frequency resolution shall be:
  - a) 1 – 31.25 MHz: 150 kHz
  - b) 31.25 – 100 MHz: 250 kHz
  - c) 100 – 250 MHz: 500 kHz
  - d) 250 – 600 MHz: 1000 kHz
  - e) 600 – 2000 MHz: 2000 kHz
3. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.23.

**AA. PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)**

1. AFEXT loss is the coupling of crosstalk at the far-end from external link pairs into a disturbed (victim) pair of the 4-pair link under test. PS AACR-F is the calculated power sum from all external pairs into the disturbed (victim) pair.

2. The frequency resolution shall be:

- a) 1 – 31.25 MHz: 150 kHz
- b) 31.25 – 100 MHz: 250 kHz
- c) 100 – 250 MHz: 500 kHz
- d) 250 – 600 MHz: 1000 kHz
- e) 600 – 2000 MHz: 2000 kHz

3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.

4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links

5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.

6. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.26.

**BB. Average PS AACR-F (Power Sum Alien Attenuation to Crosstalk Ratio Far-End)**

1. Is calculated by averaging the individual PS AACR-F values, in dB, for all four pairs in the disturbed (victim) link.

2. The frequency resolution shall be:

- a) 1 – 31.25 MHz: 150 kHz
- b) 31.25 – 100 MHz: 250 kHz
- c) 100 – 250 MHz: 500 kHz
- d) 250 – 600 MHz: 1000 kHz
- e) 600 – 2000 MHz: 2000 kHz

3. The disturbed (victim) link shall have disturber links to the left and right of it and if present, links above and below it.

4. Disturber cables shall include all links within the same bundle as the disturbed (victim) link and adjacent links

5. Should be measured in both directions if the link is patch panel to patch panel. If the link is patch panel to telecommunications outlet, then it shall be measured from the patch panel end only.

6. Is not to exceed the Category 8 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.27.

**3.3 ADMINISTRATION**

**A. Test results documentation**

1. The Permanent Link test results (excluding alien xtalk testing) shall be uploaded to LinkWare Live at the end of each working day for inspection by the Owner or the Owner's representative.
2. Test results uploaded to LinkWare Live shall be transferred into LinkWare PC to allow for the maintenance, inspection and archiving of the test records.
3. The database for the complete project, including fibre links, if applicable, shall be stored in LinkWare PC format (\*.flw) and delivered on CD or DVD prior to Owner acceptance of the building. This CD or DVD shall include a copy of LinkWare PC to allow the inspection and printing of the test reports.
4. Circuit IDs reported by the test instrument should match the specified label ID (see 3.3 of this Section).



5. For Permanent Link testing, the detailed test results documentation data is to be provided in LinkWare PC for each tested balance twisted-pair and shall contain the following information

- a) *The overall Pass/Fail evaluation of the link-under-test*
- b) *The date and time the test results were saved in the memory of the tester*
- c) *The identification of the customer site as specified by the end-user*
- d) *The name of the test limit selected to execute the stored test results*
- e) *The name of the personnel performing the test*
- f) *The version of the test firmware and the version of the test limit database held within the test instrument*
- g) *The manufacturer, model and serial number of the field-test instrument*
- h) *The adapters used*
- i) *The factory calibration date*
- j) *Wire Map*
- k) *Propagation Delay values, for all four pairs*
- l) *Delay Skew values, for all four pairs*
- m) *DC Resistance values, for all four pairs*
- n) *DC Resistance Unbalance within a pair, values for all four pairs*
- o) *DC Resistance Unbalance between pairs, values for all four pairs*
- p) *Insertion Loss, worst case values for all four pairs*
- q) *NEXT, worst case margin and worst case values, both directions*
- r) *PS NEXT, worst case margin and worst case values, both directions*
- s) *ACR-N, worst case margin and worst case values, both directions*
- t) *PS ACR-N, worst case margin and worst case values, both directions*
- u) *ACR-F, worst case margin and worst case values, both directions*
- v) *PS ACR-F, worst case margin and worst case values, both directions*

w) *Return Loss, worst case margin and worst case values, both directions*

x) *TCL, worst case margin and worst case values, both directions*

y) *ELTCTL, worst case margin and worst case values, both directions.*

z) *Time Domain Crosstalk data if the link is marginal or fails*

aa) *Time Domain Reflectometer data if the link is marginal or fails*

6. For Alien Crosstalk testing, the detailed test results documentation data is to be provided in AxTalk Analyzer for each tested balance twisted-pair and shall contain the following information

a) *The overall Pass/Fail evaluation of the link-under-test*

b) *The date and time the measurements were made*

c) *The identification of the customer site as specified by the end-user*

d) *The name of the test limit selected to execute the stored test results*

e) *The name of the personnel performing the test*

f) *The version of the test software*

g) *PS ANEXT, worst case margin for all four pairs*

h) *Average PS ANEXT, worst case margin*

i) *PS AACR-F, worst case margin for all four pairs*

j) *Average PS AACR-F, worst case margin*

#### B. Record copy and as-built drawings

1. Provide record copy drawings periodically through out the project as requested by the Construction Manager or Owner, and at end of the project on a CD or DVD. Record copy drawings at the end of the project shall be in CAD format and include notations reflecting the as built conditions of any additions to or variation from the drawings provided such as, but not limited to cable paths and termination point. The as built drawings shall include, but are not limited to block diagrams, frame and cable labelling, cable termination points, equipment room layouts and frame installation details. The as built shall include all field changes made up to construction completion:

a) *Field directed changes to pull schedule.*

b) *Horizontal cable routing changes.*

c) *Associated detail drawings.*