Connectix Cabling Systems™

ISO/IEC 11801 Edition 2.2 Class E_A Field Test Specifications

This document has been prepared to aid in developing contractual specifications covering the testing of Class E_A installations. It is offered as a general guide. Suitability for any intended use is the responsibility of the user.

Class E_A Installation: field test requirements upon completion of the installation

A. General Requirements

1. Every cabling link in the installation shall be tested for:
   - *a. Wire Map*
   - *b. Length*
   - *c. Insertion Loss*
   - *d. NEXT Loss*
   - *e. PS NEXT Loss*
   - *f. ACR-N Loss*
   - *g. ACR-F Loss*
   - *h. PS ACR-F Loss*
   - *i. Return Loss*
   - *j. Propagation Delay*
   - *k. Delay Skew*
   - *l. Direct current (d.c.) loop resistance*
   - *m. Direct current (d.c.) resistance unbalance*
   - *n. Continuity of screen conductors (if present)*
   - *o. Transverse conversion loss (TCL)*
   - *p. Equal Level Transverse conversion transfer loss (ELTCTL) in accordance with the field test specifications defined in*
     - *• ISO/IEC 11801(2002) : Information technology – Generic cabling for customer premises*
     - *• Amendment 1 to ISO/IEC 11801: Information technology – Generic cabling for customer premises*
     - *• Amendment 2 to ISO/IEC 11801: Information technology – Generic cabling for customer premises*
     - *• IEC 61935-1 ed 3.0: TESTING OF BALANCED COMMUNICATION CABLING IN ACCORDANCE WITH ISO/IEC 11801 - Part 1: Installed cabling*

     These standards will be referred to as the "ISO ClassEA Standard"

     This document is also using nomenclature in line with and defined in
     - *• "ISO/IEC 14763-2: Information technology - Implementation and operation of customer premises cabling - Part 2: Planning and installation"*

2. The installed twisted-pair horizontal links shall be tested from the IDF in the telecommunications room to the telecommunication wall outlet in the work area for compliance with the "Permanent Link" performance specification as defined in the ISO ClassEA Standard.
3. One hundred percent of the installed cabling links must pass the requirements of the standards mentioned in A.1 above and as further detailed in Section B. Any failing link must be diagnosed and corrected. The corrective action shall be followed with a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation in accordance with Section C below.
4. Trained technicians who have successfully attended an appropriate training program and have obtained a certificate as proof thereof shall execute the tests. Appropriate training programs include but are not limited to installation certification programs provided by BiCSi, the ACP (Association of Cabling Professionals) or Fluke Networks's CCTT (Certified Cabling Test Technician) training partners.
5. The test equipment (tester) shall comply with the accuracy requirements for level IIIe field testers as de fined in IEC 61935-1: "Specification for the testing of balanced and coaxial information technology cabling – Part 1: Installed balanced cabling as specified in ISO/IEC" Note: A compliance with Level-IV and/or Level-V is of no relevance for testing Class EA installation as stated in the same standard
6. The tester including the appropriate interface adapter must meet the specified accuracy requirements. The accuracy requirements for the permanent link test configuration (baseline accuracy plus adapter contribution) are specified in IEC 61935-1: Table 14 – Level IIIE field tester accuracy performance parameters per IEC guidelines.
7. The RJ45 Permanent Link adapter plug NEXT / FEXT loss shall be between the lower and upper ranges of test plugs as specified for category Cat.6A in IEC 60512-27-100 Ed 1.0: "Connectors for electrical equipment - Tests and measurements - Part 27-100: Signal integrity tests up to 500 MHz on 60603-7 series connectors - Tests 27a to 27g". Such a test plug is often referred to as a "Truly Centered Test Plug". Ideally the test plug is identical to the PCB style version shown in Annex A.4 "PCB based 1 TFC assembly"
8. The tester shall be within the calibration period recommended by the vendor in order to achieve the vendor-specified measurement accuracy.
9. The tester interface adapters must be of high quality and the cable shall not show any twisting or kinking resulting from coiling and storing of the tester interface adapters. In order to deliver optimum accuracy, preference is given to a permanent link interface adapter for the tester that can be calibrated to extend the reference plane of the Return Loss measurement to the permanent link interface. The contractor shall provide proof that the interface has been calibrated within the period recommended by the vendor. To ensure that normal handling on the job does not cause measurable Return Loss change, the adapter cord cable shall not be of twisted-pair construction.

10. The Pass or Fail condition for the link-under-test is determined by the results of the required individual tests (detailed in Group "Internal Transmission"of Table 1 - Installed balanced cabling test parameters). Any Fail or Fail* result yields a Fail for the link-under-test. In order to achieve an overall Pass condition, the results for each individual test parameter must Pass or Pass *.
11. A Pass or Fail result for each parameter is determined by comparing the measured values with the specified test limits for that parameter. The test result of a parameter shall be marked with an asterisk (*) when the result is closer to the test limit than the accuracy of the field tester. If better then Level-IIIe accuracy (ISO/IEC 619351-1: Table 9 - Worst case insertion loss, NEXT, ACR-N, ELFEXT/ACR-F and return loss measurement accuracy for level IIIE test instruments / Link accuracy at permanent link limit) is assumed and used to identify marginal results, the test manufacturer must provide test data from an independent laboratory for the "worst case" to support this assumption. To which extent '*' results shall determine approval or disapproval of the element under test shall be defined in the relevant detail specification, or agreed on as a part of a contractual specification.

B. Performance Test Parameters

1. The test parameters for Class EA are defined in Amendment 2 to ISO/IEC 11801: Information technology – Generic cabling for customer premises. The test of each link shall contain all of the following parameters as detailed below. In order to pass the test, all measurements (at each frequency in the range from 1 MHz through 500 MHz) must meet or exceed the limit value determined in the above-mentioned standard. The frequency step size shall be no greater than 0,5 MHz up to 100 MHz and 5 MHz up to 500 MHz

2. Wire Map

Shall report Pass if the wiring of each wire-pair from end to end is determined to be correct. The Wire Map results shall include the continuity of the shield connection if present.

3. Insertion Loss (Attenuation)

Insertion Loss is a measure of signal loss in the permanent link or channel. The term "Attenuation" has been used to designate "Insertion Loss." Insertion Loss shall be tested from 1 MHz through 500 MHz in maximum step size of 1 MHz. It is preferred to measure insertion loss at the same frequency intervals as NEXT Loss in order to provide a more accurate calculation of the Attenuation-to-Crosstalk ratio (ACR) parameter. Mini mum test results documentation (summary results): Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.

4. NEXT Loss

Pair-to-pair near-end crosstalk loss (abbreviated as NEXT Loss) shall be tested for each wire pair combination from each end of the link (a total of 12 pair combinations). This parameter is to be measured from 1 through 500 MHz. NEXT Loss measures the crosstalk disturbance on a wire pair at the end from which the disturbance signal is transmitted (near-end) on the disturbing pair. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case NEXT margin (2) and the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case should in clude the frequency at which it occurs as well as the test limit value at this frequency.

5. PS NEXT Loss

Power Sum NEXT Loss shall be evaluated and reported for each wire pair from both ends of the link under-test (a total of eight results). PS NEXT Loss captures the combined near-end crosstalk effect (statistical) on a wire pair when all other pairs actively transmit signals. Like NEXT this test parameter must be evaluated from 1 through 500 MHz: Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for PS NEXT. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

6. ACR-N, pair-to-pair

Attenuation Crosstalk Ratio Near-end is calculated from the pair-to-pair NEXT Loss and the insertions loss. It shall be measured for each wire-pair combination from both ends of the link under-test.. ACR-N measures the relative strength of the Near-end crosstalk disturbance relative to the attenuated signal that arrives at the beginning of the link. ACR-N is to be measured from 1 through 500. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-N. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

7. PS ACR-N, pair-to-pair

Power Sum Attenuation Crosstalk Ratio Near-end is a calculated parameter that combines the effect of the NEXT disturbance from three wire pairs on the fourth one. It shall be measured for each wire-pair combination from both ends of the link under-test. PS ACR-N measures the relative strength of the power sum of all Near-end crosstalk disturbances relative to the attenuated signal that arrives at the beginning of the link. PS ACR-N is to be measured from 1 through 500. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst case margin and the wire pair combination that exhibits the worst value for PS ACR-N. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

8. ACR-F, pair-to-pair
Attenuation Crosstalk Ratio Far-end is calculated from the pair-to-pair FEXT Loss. It shall be measured for each wire-pair combination from both ends of the link under-test. FEXT Loss measures the crosstalk disturbance on a wire pair at the opposite end (far-end) from which the transmitter emits the disturbing signal on the disturbing pair. FEXT is measured to compute ACR-F Loss that must be evaluated and reported in the test results. ACR-F measures the relative strength of the far-end crosstalk disturbance relative to the attenuated signal that arrives at the end of the link. This test yields 24 wire pair combinations. ACR-F is to be measured from 1 through 500. Minimum test results documentation (summary results): Identify the wire pair combination that exhibits the worst-case margin and the wire pair combination that exhibits the worst value for ACR-F. These wire pairs must be identified for the tests per formed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

9. PS ACR-F Loss
Power Sum Attenuation Crosstalk Ratio Far-end is a calculated parameter that combines the effect of the FEXT disturbance from three wire pairs on the fourth one. This test yields eight wire-pair combinations. Each wire-pair is evaluated from 1 through 500 MHz. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst pair combinations must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

10. Return Loss
Return Loss (RL) measures the total energy reflected on each wire pair. Return Loss is to be measured from both ends of the link-under-test for each wire pair. This parameter is also to be measured form 1 through 500. Minimum test results documentation (summary results): Identify the wire pair that exhibits the worst-case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case should include the frequency at which it occurs as well as the test limit value at this frequency.

11. Propagation Delay
Propagation delay is the time required for the signal to travel from one of the link to the other. This measurement is to be performed for each of the four wire pairs. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay. The report shall include the propagation delay value measured as well as the test limit value.

12. Delay Skew
This parameter shows the difference in propagation delay between the four wire pairs. The pair with the shortest propagation delay is the reference pair with a delay skew value of zero. Minimum test results documentation (summary results): Identify the wire pair with the worst-case propagation delay (the longest propagation delay). The report shall include the delay skew value measured as well as the test limit value.

13. Direct current (d.c.) loop resistance
This parameter show of the sum total of the d.c. resistance of the wires of a pair

14. Direct current (d.c.) resistance unbalance
This parameter show the difference in the d.c. resistance of each wire of a pair

15. Continuity of screen conductors
This test shall report the shield as open if there is no screen continuity between the cable and the connecting hardware at the TR, CP or TO. Also poor termination practices, which only connect a drain wire and severely affect the TI Surface transfer impedance, shall be reported as an open shield.

16. Transverse conversion loss (TCL)
or Unbalance attenuation, near end is measured by calculating the ratio of differential mode power to common mode power on a pair within a cabling system, which is exited with differential mode power only
Note: Due to the lack of a limit for link the limit for the channel shall be used. This requirement can be considered relaxed if compared with the expected link performance

17. Equal Level Transverse conversion transfer loss (ELTCTL)
Unbalance attenuation, far end or is measured by calculating the ratio of differential mode power to common mode power in a cabling system, which is exited with differential mode power only. This value is the TCTL. The EL TCTL is obtained by subtracting the insertion loss of the channel/link under test from TCTL. The calculation is based on measured ratio between differential and common mode voltage.
Note: Due to the lack of a limit for link the limit for the channel shall be used. This requirement can be considered relaxed if compared with the expected link performance.

C. Test Result Documentation

1. The test results/measurements shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. A guarantee must be made that the measurement results are transferred to the PC unaltered, i.e., “as saved in the tester” at the end of each test and that these results cannot be modified at a later time.

2. The database for the completed job shall be stored and delivered on CD-ROM or DVD including the software tools required to view, inspect, and print any selection of test reports.

3. A paper copy of the test results shall be provided that lists all the links that have been tested with the following summary information

a. The identification of the link in accordance with the naming convention defined in the overall system documentation

b. The overall Pass/Fail evaluation of the link-under-test including the NEXT Headroom (overall worst case) number

c. The date and time the test results were saved in the memory of the tester.

4. General Information to be provided in the electronic data base with the test results information for each link:

a. The identification of the customer site as specified by the end-user
b. The identification of the link in accordance with the naming convention defined in the overall system documentation
c. The overall Pass/Fail evaluation of the link-under-test
d. The name of the standard selected to execute the stored test results
e. The cable type and the value of NVP used for length calculations
f. The date and time the test results were saved in the memory of the tester
g. The brand name, model and serial number of the tester
h. The identification of the tester interface
i. The date of the last calibration of the tester
j. The revision of the tester software and the revision of the test standards database in the tester
k. The test results information must contain information on each of the required test parameters that are listed in Section B and as further detailed below under paragraph C5 & C6.

5. In-link (In-Channel) detailed test results. The detailed test results data to be provided in the electronic database for must contain the following information:
For each of the frequency-dependent test parameters, the value measured at every frequency during the test is stored. The PC-resident database program must be able to process the stored results to display and print a colour graph of the measured parameters. The PC-resident software must also provide a summary numeric format in which some critical information is provided numerically as defined by the summary results (minimum numeric test results documentation) as out lined above for each of the test parameters.
Length: Identify the wire-pair with the shortest electrical length, the value of the length rounded to the nearest 0.1 m (1)
Propagation delay: Identify the pair with the shortest propagation delay, the value measured in nanoseconds (ns) and the test limit value
Delay Skew: Identify the pair with the largest value for delay skew, the value calculated in nanoseconds (ns) and the test limit value
Insertion Loss (Attenuation): Minimum test results docu mentation as explained in Section B for the worst pair
Return Loss: Minimum test results documentation as ex plained in Section B for the worst pair as measured from each end of the link
NEXT, ACR-N, ACR-F. TCL and ELTCTL: Minimum test results documentation as explained in Section B for the worst pair combination as measured from each end of the link
PS NEXT, PS ACRN and PS ACR-F: Minimum test results documentation as explained in Section B for the worst pair as measured from each end of the link

1: Nominal Velocity of Propagation (NVP) expresses the speed of the electrical signals along the cabling link in relation to the speed of light in vacuum (3x108 m/second). Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an 'average' value for NVP is published for all four wire-pairs in a data cable.

2: 'Margin' designates the difference between the measured value and the corresponding test limit value. For passing links, 'worst case margin' identifies the smallest margin over the entire frequency range; the point at which the measured performance is "closest" to the test limit.