

Cable Certification

General Testing Criteria (Applies to all cable certification testing)

1. RCIT reserves the right to be present during any or all cable testing procedures. The Contractor shall obtain authorization from the RCIT Project Engineer prior to commencing testing. RCIT reserves the right to require retesting of any cables tested prior to the Contractor authorization for test commencement at no additional cost to RCIT.
2. All cabling not tested strictly in accordance with these procedures shall be retested at no additional cost to RCIT.
3. 100 percent of the installed cable shall be tested.
4. Test equipment shall be fully charged prior to each day's testing.
5. All Category 6 UTP Cable, Multimode, and Single Mode Fiber Optic Cable tests shall be performed using the **Fluke DTX 1800 CableAnalyzer** (Tester) and the **Fluke DTX 1800 SmartRemote** (Remote) Model cable tester set, no substitute testers are allowed. The Contractor shall indicate the **Fluke LinkWare** software revision installed on the test equipment is the most current available from the cable tester manufacturer (see Fluke Networks Website; <http://www.flukenetworks.com>) prior to commencing any final cable tests for record.
6. All cables, Horizontal, Intrabuilding Backbone Cable, and Interbuilding Backbone Cable, shall be tested prior to the cutover of voice and data systems to the new cable plant, unless otherwise directed by the RCIT Project Engineer. Complete test results by cable type, including a Summary Report shall be presented to RCIT Project Engineer within five working days after the cutover date.
7. Test results shall be provided in electronic report format using the **Fluke LinkWare Cable Test Management Software** on a data CD. Handwritten test reports are not acceptable. Paper print-outs of complete, individual cable tests are not required unless previously requested in the RCIT Scope of Work. Electronic reports must be accompanied by a Certificate signed and stamped by an authorized RCDD representative of the Contractor warranting the truth and accuracy of the electronic report data. The certificate must reference traceable cable/fiber numbers that match the electronic record.
8. Test reports shall include the following information for each permanent Cat 6 copper cable link or permanent optical fiber link (MM and/or SM) tested:
 - 8.1. Tester manufacture, model, main unit serial number, remote unit serial number, main unit adapter type, remote unit adapter type, software version, operator.
 - 8.2. Cable number and project/job name.
 - 8.3. Auto test specification used.
 - 8.4. Date and time of test.
 - 8.5. Overall pass/fail indication.

- 8.6. Wire map results that indicate the permanent cable link tested has no shorts, opens, miss-wires, split, reversed or crossed pairs, and end-to-end connectivity is achieved.
- 8.7. Two copies of the test results will be provided in electronic format. The Summary Report provided by the **LinkWare Cable Test Management** software program, for both Copper and Fiber tests are the only portion of the test results required in paper format as well. The detailed report of individual copper cables tested is not required in printed copy format.
- 8.8. Any individual test that fails a relevant performance parameter shall be marked as a FAIL and the Contractor shall indicate the action taken to correct the problem.
- 8.9. Overall PASS/FAIL indication for the cable or fiber tested.

Category 6 Data Cable Certification Testing

1. All testing shall be performed in conformance with EIA/TIA 568-B.2 using the permanent link test setup. Cabling shall meet the performance specifications for Category 6 specific to TIA/EIA 568 B.
 - 1.1. The following equipment is required to perform Category 6 Data Cable Testing with the Fluke DTX 1800 CableAnalyzer and Fluke DTX 1800 SmartRemote:
 - 1.1.1. DTX 1800 CableAnalyzer with battery pack and/or AC adapter
 - 1.1.2. DTX 1800 SmartRemote with battery pack and/or AC adapter
 - 1.1.3. (2) Cat6/Class E Permanent Link Adapters
 - 1.2. The DTX 1800 CableAnalyzer (Tester) profile will be configured as follows:
 - 1.2.1. Select SPECIAL FUNCTIONS> SET REFERENCE. Follow the manufacturer's procedures for setting the reference between the DTX 1800 CableAnalyzer and the DTX 1800 SmartRemote.
 - 1.2.2. Select SETUP on the DTX 1800 menu, and set the following testing parameters:**
 - 1.3. SETUP > INSTRUMENT SETTINGS:
 - 1.3.1. Select Tab 2 and set:
 - 1.3.2. Operator (Name),
 - 1.3.3. Site Client Name; set the Project Location (if unclear, contact the RCIT Project Engineer for assistance)
 - 1.3.4. Select Tab 3 and set
 - 1.3.5. Date (if incorrect)
 - 1.3.6. Time (if incorrect)
 - 1.3.7. Numeric Format: 00.0
 - 1.3.8. Length Units: Meters (m)
 - 1.4. SETUP > TWISTED PAIR:
 - 1.4.1. Select Tab 1 and set: Test Limit:
 - 1.4.2. Press F1 and select: TIA; then under the sub-selection options:
 - 1.4.3. Select TIA Cat 6 Perm. Link
 - 1.4.4. Cable Type: Select Manufacturer, Select Berk-Tek; then under the sub-selection options:
 - 1.4.5. Berk-Tek LM 1000 PL (for Plenum CMP cable)
 - 1.4.5.1. Berk-Tek LM 1000 NP (for Riser-Rated, Non Plenum, CMR cable)
 - 1.4.5.2. NVP (Nominal Velocity of Propagation): Select and manually input these settings as appropriate for the cable used:
 - 1.4.5.3. Berk-Tek LANmark 1000 CMR (Riser Rated) NVP = 69.0%

- 1.4.5.4. Berk-Tek LANmark 1000 CMP (Plenum Rated) NVP = 72.0%
- 1.4.6. Outlet Configuration (Wiremap): T568B
- 1.4.7. Select Tab 2 and set:
 - 1.4.7.1. HDTDX/HDTDR (High Definition Time Domain Cross-talk/High Definition Time Domain Reflectometer): PASS*/FAIL Only
- 1.4.8. AC Wire Map (for PoE Midspan Injectors only) Select **Disable**
 - 1.4.8.1.1. NOTE: This test is not commonly required or performed for RCIT. This test option will be noted in the body of the Specifications, if AC Wire Map testing is required.
 - 1.4.8.1.2. **Select AUTO TEST and verify that the Tester screen reads the following:**
- 1.4.9. TIA Cat 6 Perm. Link –
 - 1.4.9.1.1. NOTE:
 - 1.4.9.1.2. The Tester is set for the minimum TIA Standards for each Cat6 Permanent Link test parameter specified by TIA568-B.2. RCIT incorporates Berk-Tek LANmark 1000 Cat 6 cable into their Structured Cabling Standards. LANmark 1000 Cable is an extended performance product which exceeds the minimum standards imposed by TIA for the Cat 6 Permanent Link tests. This extended performance will appear as increased head room or performance margin for these tests, as applicable.
- 1.4.10. Berk-Tek LM-1000 (PL, or NP, as appropriate from SET UP menu)
- 1.4.11. Operator: (Name)
- 1.4.12. Site: County of Riverside Department Name for the Installation Site
- 1.4.13. Folder: (Contractor selected)
- 1.4.14. Store Plot Data: YES
- 1.5. When the Tester is set for AUTO TEST, the Tester will conduct the following tests when the Tester is connected properly and the AUTO TEST button is pressed:
 - 1.5.1. Wire Map
 - 1.5.2. Resistance
 - 1.5.3. Length (in Meters, HDTDR)
 - 1.5.4. Propagation Delay
 - 1.5.5. Delay Skew
 - 1.5.6. Insertion Loss (Attenuation)
 - 1.5.7. NEXT (Near End Crosstalk) and NEXT at the SmartRemote
 - 1.5.8. Return Loss
 - 1.5.9. ACR (Attenuation to Crosstalk Ratio) and ACR at the SmartRemote

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1.5.10. PSACR (power-sum Attenuation to Crosstalk Ratio) and PSACR at the SmartRemote

1.5.11. ELFEXT (Equal Level Far End Cross Talk)

1.5.12. PSELFEXT (Power Sum Equal Level Far End Cross Talk)

1.5.12.1.1. NOTE:

1.5.12.1.2. Cat 6 Permanent Link testing automatically certifies each cable for 100BaseT and 1000BaseT networks. Tests are performed automatically in both directions for applicable tests. When set for Cat 6 Permanent Link testing, the Tester performs cable tests at frequencies up to 250 MHz.

1.5.13. Save all tested cable results.

1.5.14. Tests with PASS* and FAIL* notation are to be identified in the cable summary report.

1.5.15. If the test failed, (One or more test parameters marked with an “X”) press the F1 button: FAULT INFO, on the Tester and review the diagnostic information for the failure. The tester will show likely causes for the failure and the suggest actions for correcting the problem.

1.5.16. All cable tests must pass prior to cable plant acceptance.

1.5.17. Record and save Attenuation, NEXT, PSNEXT, Return Loss, ELFEXT and PSELFEXT data that indicate the worst-case result, the frequency at which it occurs, the limit at that point and the headroom margin in dB. Length (in meters), propagation delay and delay skew relative to the applicable limit. Information shall be provided for all pair combinations included in the T568B Wire Map function of the Tester.

1.1.1. Save all tests (ex. 1A.001A, 1A.001B, 1A.002A, 1A.002B)

TIA Cat 6 Perm. Link

Wire Map	Res.	Length	Prop. Delay	Delay Skew	Freq.	Insertion Loss	NEXT	RL	ACR	ELFEXT	PS NEXT	PS ACR	PS ELFEXT
	Ω	Max.	nS	nS	MHz	dB	dB	dB	dB	dB	dB	dB	dB
12345678 12345678 12345678S 12345678S	i	90 m	498	44	1	3	65.0	19.1	62.0	64.2	62.0	59.0	61.2
					4	3.5	64.1	21.0	60.6	52.1	61.8	58.3	49.1
					8	5	59.4	21.0	54.4	46.1	57.0	52.1	43.1
					10	5.5	57.8	21.0	52.3	44.2	55.5	49.9	41.2
					16	7	54.6	20.0	47.6	40.1	52.2	45.2	37.1
					20	7.9	53.1	19.5	45.2	38.2	50.7	42.8	35.2
					25	8.9	51.5	19.0	42.7	36.2	49.1	40.2	33.2
					31.25	10	50.0	18.5	40.0	34.3	47.5	37.6	31.3
					62.5	14.4	45.1	16.0	30.8	28.3	42.7	28.3	25.3
					100	18.6	41.8	14.0	23.3	24.2	39.3	20.7	21.2
					200	27.4	36.9	11.0	9.6	18.2	34.3	7.0	15.2
					250	31.1	35.3	10.0	4.2	16.2	32.7	1.6	13.2

Copper Feed Certification Testing

1. All copper backbone cables shall be tested for shorts, opens, miswires, split, reversed or crossed pairs, and end-to-end connectivity using the Fluke CableAnalyzer.
 - 1.1. The Tester should be connected to a commercially available test adapter that allows the connection of the RJ-45 modular plug on the Fluke CableAnalyzer to either a 110 termination block, or 66M1-50 termination block as appropriate. Suggested adapter components are:
 - 1.2. Independent Technologies 110 Block Adapter, Independent Technologies Part Number: ITC-3002B, or equal.
 - 1.3. Independent Technologies Universal 66 Block Adapter, Independent Technologies Part Number: ITC-3002C, or equal.
 - 1.4. Testing will verify that all pairs in 4 pair increments for all the pairs in the copper feed cable.
 - 1.5. SETUP > TWISTED PAIR:
 - 1.5.1. Select Tab 1 and set: Test Limit:
 - 1.5.2. Select: TIA; then under the sub-selection options:
 - 1.5.3. Select TIA Cat 3 Perm. Link
 - 1.5.4. Select Cable Type: Select Custom, Select Name; Enter ARMM Riser Cable:
 - 1.5.4.1. NVP (Nominal Velocity of Propagation): Select and manually input these settings as appropriate for the cable used:
 - 1.5.4.2. ARMM Cable (Riser Rated) NVP = 60.0%
 - 1.5.4.3. Outlet Configuration (Wiremap): T568B
 - 1.5.4.4. Select Tab 2 and set:
 - 1.5.4.5. HDTDX/HDTDR (High Definition Time Domain Cross-talk/High Definition Time Domain Reflectometer): PASS*/FAIL Only
 - 1.5.5. AC Wire Map (for PoE Midspan Injectors only) Select **Disable**
 - 1.5.5.1.1. NOTE: This test is not commonly required or performed for RCIT. This test option will be noted in the body of the Specifications, if AC Wire Map testing is required.
 - 1.5.6. Select Single Test and verify that the Tester screen reads the following:
- 1.6. TIA Cat 3 Perm. Link – ARMM Riser Cable
- 1.7. When the Tester is set for Wire Map, the Tester will conduct the Wire Map test when the Tester is connected properly and the Enter button is pressed:

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- 1.7.1. Wire Map
- 1.7.2. Propagation Delay
- 1.7.3. Delay Skew
- 1.7.4. Save all tests (ex. 1A/2A-01 PAIRS 1-4, 1A/2A-01 PAIRS 5-8, 1A/2A-01 PAIRS 9-12, 1A/2A-01 PAIRS 13-16, 1A/2A-01 PAIRS 17-20, 1A/2A-01 PAIRS 21-44, 1A/2A-01 PAIRS 22-25 for a 25 pair cable)

Special Services Patch Panel Certification Testing

1. All copper special services patch panel cables shall be tested for shorts, opens, miswires, split, reversed or crossed pairs, and end-to-end connectivity using the Fluke CableAnalyzer.
 - 1.1. The Tester and Remote Units should be connected to the DTX PLA002 Cat 6 Permanent Link Adapters. The Tester shall be connected to the RJ-45 jacks installed within patch panels. The Remote shall use a modular plug adapter on the Fluke CableAnalyzer to test the far end terminations on either 110 termination blocks, or 66M1-50 termination blocks as appropriate. Suggested adapter components are:
 - 1.2. Independent Technologies 110 Block Adapter, Independent Technologies Part Number: ITC-3002B, or equal.
 - 1.3. Independent Technologies Universal 66 Block Adapter, Independent Technologies Part Number: ITC-3002C, or equal.
 - 1.4. Testing will verify that for RJ11 jacks the “A” outlet jack (white) is on pairs 1&2 and the “B” outlet jack is on pairs 3&4 in the USOC Wire Map configuration.
 - 1.5. Testing will verify that for RJ45 jacks, that all pairs 4 pairs are tested.

1.5.1.1. Select Single Test and verify that the Tester screen reads the following:

- 1.6. SETUP > TWISTED PAIR:
 - 1.6.1. Select Tab 1 and set: Test Limit:
 - 1.6.2. Select: TIA; then under the sub-selection options:
 - 1.6.3. Select TIA Cat 5e Perm. Link
 - 1.6.4. Cable Type: Select Manufacturer, Select Berk-Tek; then under the sub-selection options:
 - 1.6.5. Berk-Tek LM-350 PL (for Plenum CMP cable)
 - 1.6.5.1. Berk-Tek LM-350 NP (for Riser-Rated, Non Plenum, CMR cable)
 - 1.6.5.2. NVP (Nominal Velocity of Propagation): Select and manually input these settings as appropriate for the cable used:
 - 1.6.5.3. Berk-Tek LANmark 350 CMR (Riser Rated) NVP = 70.0%
 - 1.6.5.4. Berk-Tek LANmark 350 CMP (Plenum Rated) NVP = 72.0%
 - 1.6.5.5. Outlet Configuration (Wiremap): T568B
 - 1.6.5.6. Select Tab 2 and set:
 - 1.6.5.7. HDTDX/HDTDR (High Definition Time Domain Cross-talk/High Definition Time Domain Reflectometer): PASS*/FAIL Only
 - 1.6.6. AC Wire Map (for PoE Midspan Injectors only) Select **Disable**

1.6.6.1.1. NOTE: This test is not commonly required or performed for RCIT. This test option will be noted in the body of the Specifications, if AC Wire Map testing is required.

1.6.6.2. Select Single Test and verify that the Tester screen reads the following:

- 1.7. TIA Cat 5e Perm. Link – Berk-Tek LM-350 NP
- 1.8. When the Tester is set for Wire Map, the Tester will conduct the Wire Map test when the Tester is connected properly and the Enter button is pressed:
 - 1.8.1. Wire Map
 - 1.8.2. Length (in Meters, HDTDR)
 - 1.8.3. Propagation Delay
 - 1.8.4. Delay Skew
 - 1.8.5. Save all tested cable results.

Fiber Certification Testing

1. The Contractor shall be responsible for testing every strand of each Intrabuilding and Interbuilding fiber optic backbone cable.
 - 1.1. RCIT typically does not specify installations that leave fibers unterminated, (dark fibers) therefore, all strands in each cable shall be terminated, mounted in a fiber distribution/patch panel, labeled and tested.
 - 1.2. The installed fiber link(s), each consisting of two (2) fibers/strands (Tx and Rx). Multimode fiber will be tested as specified by TIA/EIA-568-B.1.7.1 and ANSI/TIA/EIA 526-14A Method B. Singlemode fiber will be tested as specified by TIA/EIA-568-B.1.7.1 and ANSI/TIA/EIA 526-7 Method A.1.

NOTE:

Method A tests the loss (attenuation) of the fiber one connection at the end of the fiber.

Method B and Method A.1 test the loss the fiber and the connections at both ends of the fiber.

Method C tests only loss of the fiber cable itself without connections.

- 1.3. The following tests apply for both multimode and single mode fiber cables.
- 1.4. The testing procedure for each fiber optic strand is as follows:
- 1.5. Perform end-to-end, bi-directional power loss tests at 850nm and 1300nm wavelengths for multimode, and 1310nm and 1550nm for singlemode fibers.

NOTE:

The Fluke DTX 1800 CableAnalyzer and Fluke DTX 1800 SmartRemote Set is capable of testing fiber links in both directions from one termination location. The CableAnalyzer will prompt the Operator to switch cable connectors (at the panel connector adapter/bulkhead, NOT at the Tester or Remote) when the Near End to Far End Testing is completed, and the Tester is ready for Far End to Near End testing to be accomplished.

- 1.6. The allowable loss budget for each terminated cable run will be calculated by summing the maximum allowable loss for splices, mated connector pairs, and fiber length. Calculating the Loss (Attenuation) for the Fiber Length segment (between connectors) is performed as follows:
 - 1.6.1. Loss (Attenuation) per 1000 meters (1 km) of fiber cables specified by RCIT per the Manufacturer:

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Berk-Tek GigaLite 50um/125um MM (Type LB): 3.0dB/km@850nm/
1.0dB/km@1300nm

Berk-Tek Singlemode (Type AB): 0.7dB/km @1310nm/0.7dB/km@1550nm

Corning 50um/125um MM (Code C): 3.5dB/km@850nm/1.5dB/km@1300nm

Corning Singlemode (Code E): 1.0 dB/km @1310nm/1.0dB/km@1550nm

- 1.6.2. Divide the cable length in Meters by 1000 Meters to determine length in kilometers (km):

Example: The fiber cable segment is 85 meters long, as measured from the cable jacket markings.

$$85 \text{ meters} / 1000 \text{ meters} = 0.085 \text{ km}$$

Multiply the Attenuation (dB) per km times the length in km:

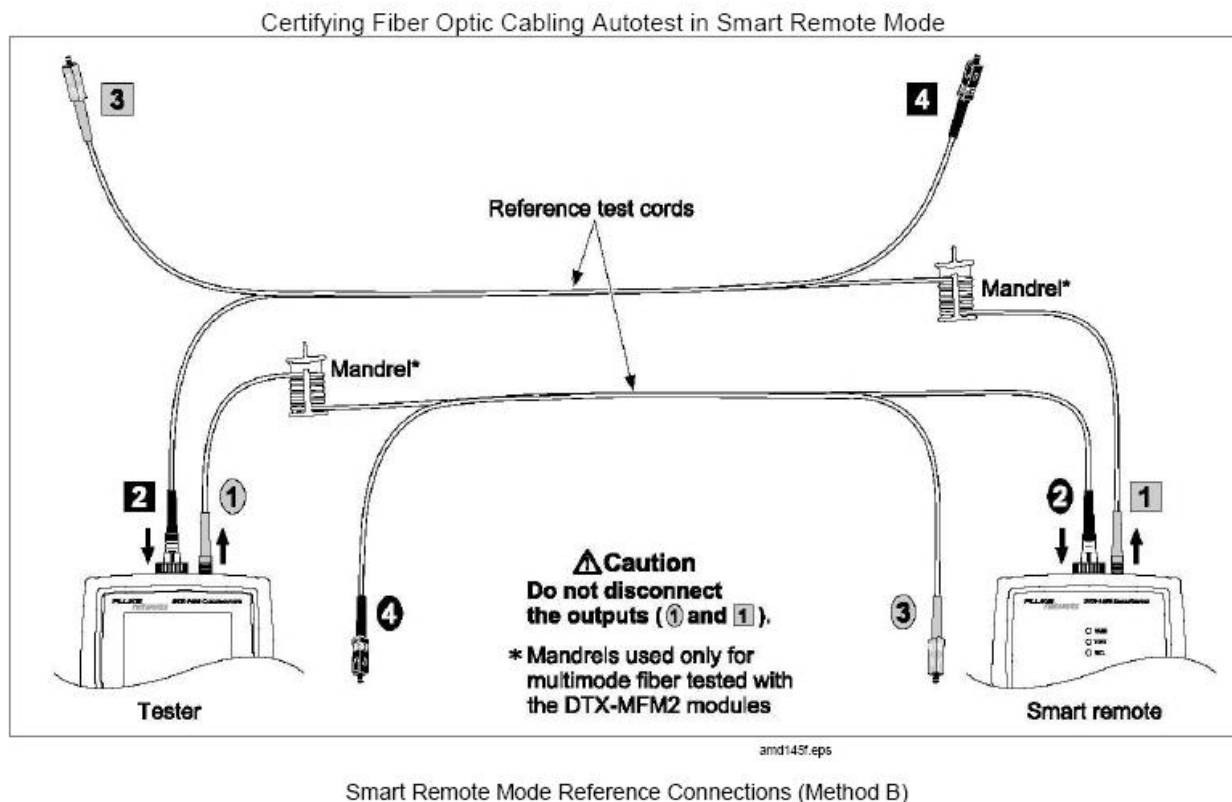
Example: Attenuation of Berk-Tek GigaLite 50um/125um MM (Type LB) Fiber:

$$3.0\text{dB/km} \times 0.085\text{km} = 0.255\text{dB}$$

*(Length from calculation above. This figure will vary with cable length)

- 1.7. The following maximum allowable Loss budgets apply for cable and connectors:
- 1.7.1. Fusion Splices: Maximum allowable Loss (attenuation) per spliced strand: 0.2dB
 - 1.7.2. Connectors: Maximum allowable Loss per mated connector pair: 0.50dB
 - 1.7.3. Fiber: Maximum allowable attenuation for each fiber strand shall not exceed the calculated maximum Loss rating based on performance as stated by manufacturer of the cable under test.
- 1.8. If a fiber strand of a cable run exceeds the calculated maximum power loss, as measured by the Fiber Loss tests, the fiber strand shall then be tested with the Tester configured with the Fluke DTX-OTDR Module to determine whether it is the fiber strand, fusion splice(s) or the connector, that exceeds the power loss margin.
- 1.9. If the connector exceeds the power loss margin, then re-polish and/or re-terminate the connector and repeat the testing procedures above.
- 1.10. If the fusion splice exceeds the power loss margin, break the splice, re-splice and retest.

- 1.11. If a fiber strand in the cable exceeds the specified power loss budget, then the contractor shall notify the RCIT Project Engineer as soon as possible to determine the impact of cable replacement on the Project Schedule. RCIT and the Contractor will devise a plan to procure new materials and replace the faulty cable.
 - 1.12. Record and document the length and power loss readings in relative decibels (dB) for every strand. Indicate as part of the testing documentation those runs that exceeded the power loss margins and the action taken (re-pulling the cable, re-polishing or re-terminating the connector).
2. The following equipment is required to perform Fiber Optic Cable Testing with the Fluke DTX 1800 CableAnalyzer and Fluke DTX 1800 SmartRemote:
 - 2.1. DTX 1800 CableAnalyzer with battery pack and/or AC adapter
 - 2.2. DTX 1800 SmartRemote with battery pack and/or AC adapter
 - 2.3. DTX-MFM2 Fiber Modules (pair) for 50um/125um Multimode fiber cable
 - 2.4. DTX-GFM2 Gigabit Fiber Modules (pair) for 50um/125 Gigabit Multimode fiber cable.
 - 2.5. DTX-SFM2 Fiber Modules (pair) for Singlemode fiber cable
 - 2.6. Fluke DTX SC Fiber Connector Adapter (pair)
 - 2.7. Fluke 50um Fiber Mandrel (red plastic, pair) used ONLY for testing Multimode cables.
 - 2.8. Fluke Reference Test Cords, 50um/125um (pair)
 - 2.9. Fluke Reference Test Cords, Singlemode (pair)
 - 2.10. Fiber cleaning supplies
3. The Tester and Remote profile will be configured as follows:
 - 3.1. Install the DTX-MFM2 Fiber Modules for Multimode tests, DTX-MFM2 Fiber Modules for Gigabit Multimode tests, or the DTX-SFM2 Fiber Modules for Singlemode testing as appropriate.
 - 3.2. Select SPECIAL FUNCTIONS> SET REFERENCE. Follow the manufacturer's procedures for setting the reference between the DTX 1800 CableAnalyzer and the DTX 1800 SmartRemote.



- 3.3. For Multimode Fiber Testing, Select SETUP on the DTX 1800 menu, and set the following testing parameters:
- 3.4. SETUP > FIBER LOSS:
- 3.5. Select Tab 1 and set:
 - 3.5.1. Test Limit> TIA568B Backbone MM
 - 3.5.2. Fiber Type> Select Manufacturer>Nexans>LANmark OF3

NOTE:

Berk-Tek is not an available manufacturer option in this menu, however, according to Berk-Tek, LANmark OF3 contains the same glass as Berk-Tek Gigalite10 Type EB fiber, and , LANmark SM is the same as Berk-Tek Type AB fiber.

- 3.5.3. Remote End Setup> Select Smart Remote
- 3.5.4. Bi-Directional> Select Yes
- 3.6. Select Tab 2 and set:
 - 3.6.1. Number of Adapters (mated pairs)>2
 - 3.6.2. Number of Splices: >(Number of fusion splices as applicable)
 - 3.6.3. Connector Type> SC

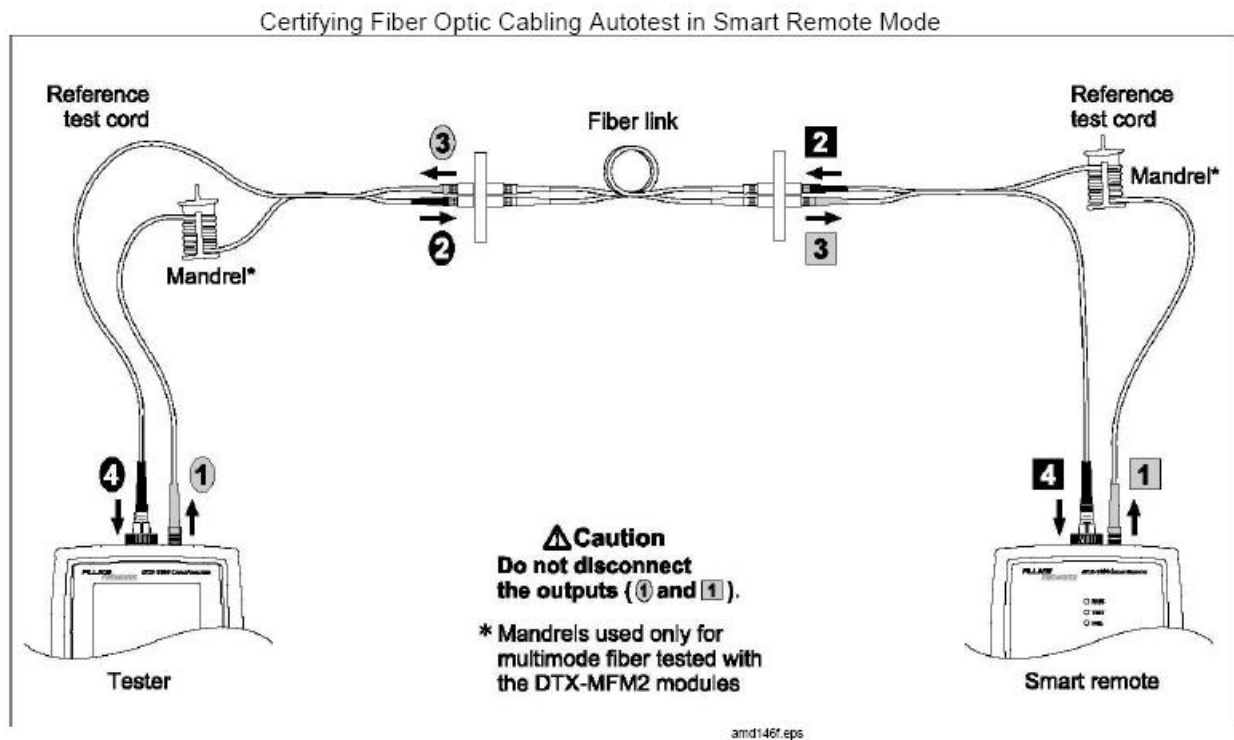
- 3.6.4. Test Method> Method B
- 3.7. Select Tab 3 and set: Index of Refraction>Default
- 3.7.1. Press F1 and select: TIA; then under the sub-selection options:

Select AUTO TEST and verify that the Tester screen reads the following:

TIA568B Backbone MM
LANmark OF3 (50)
Smart Remote

- 3.7.2. Berk-Tek LANmark OF3 (PL, or NP, as appropriate from SET UP menu)
 - 3.7.3. Operator: (Name)
 - 3.7.4. Site: County of Riverside Department Name for the Installation Site
 - 3.7.5. Folder: (Contractor selected)
 - 3.7.6. Store Plot Data: YES
- 3.8. When the Tester is set for AUTO TEST, the Tester will conduct the following tests when the Tester is connected properly and the AUTO TEST button is pressed:
- 3.8.1. Length (in Meters)
 - 3.8.2. Loss (Attenuation)
 - (a) Length (in meters) relative to the applicable limit. Any individual test that fails the relevant performance specification shall be marked as a FAIL and action taken to correct the problem.
 - (b) Overall pass/fail indication.

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Smart Remote Mode Test Connections (Method B)