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**Detailed Specification: Fibre Reticulation and Data Cabling**

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**0100 - P&G**

Preliminary & General: Fixed physical setup and practical operating expenditure items.

**0101 - Contractual requirements**

Refer to relevant clause(s) in JBCC, unless otherwise contracted

**0102 - Insurances**

Refer to relevant clause(s) in JBCC or FIDIC, unless otherwise contracted.

**0103 - Temporary Offices and storage**

The contractor shall make allowances for the provision of the following facilities:

- Offices - as a clean working & meeting environment for an appropriate number of site personnel.
- Storage - sufficient as required to store equipment and material safely and conveniently, for access by site personnel.

**0104 - Portable water**

The contractor may make provision for relevant costs for the supply of water to the site, for:

- drinking use
- sanitary use
- construction use

**0105 - Electrical Power**

The contractor shall ensure the provision of Electrical power, sufficient for use in:

- Office environment
- and in-site environment (for purposes of delivering effective works)

**0106 - Compressed air**

The contractor shall ensure the provision of Compressed air, sufficient for use in delivering effective works according to contractual obligations.

**0107 - Cranage**

The contractor shall ensure the provision of Cranage and associated requirements, sufficient for use in delivering effective works according to contractual obligations.

#### **0108 - Sanitary facilities**

The contractor shall make allowances for the provision of toilets (sanitary facilities) sufficient in quantity and quality for regular use by site personnel.

#### **0109 - Telephone facilities**

The contractor shall ensure that necessary communication facilities are in place (on and offsite) to enable regular and efficient communication between all parties in the contract.

#### **0110 - Scaffolding**

The contractor shall ensure the provision of Scaffolding and associated requirements, sufficient for use in delivering effective works according to contractual obligations. This shall include daily inspections of all erected scaffolding in compliance with the latest revision of the Occupational Health and Safety Act.

#### **0111 - Employee Accommodation**

The contractor shall make provisions for employee accommodation and transport near and to the designated construction site.

Such facilities shall be sufficient to ensure:

- A clean and healthy environment.
- Suitable facilities for after-hour / off-site administrative work.
- Safe passage for the employee.

#### **0112 - Equipment and small tools**

Provision shall be made for the purchase and use of relevant equipment and small tools, required to effect contractually successful works.

Such tools and equipment shall be standardised, regularly manufactured (production line) or specialised equipment.

#### **0113 - Head office staff**

The contractor shall make allowance for backend (or head office) support staff.

#### **0114 - Site staff**

The contractor shall make allowance for sufficient allocation of site staff for the project scope and spec as per contract stipulations.

##### **Minimum Specification requirements**

- Sufficient quantity of resources in order to complete the contract effectively.
- Sufficient level of skill set across resources in order to complete the contract effectively.

#### **0115 - Safety Conditions, Site Rules and Regulations**

The contractor shall observe the site rules and regulations as stipulated by the main contractor/consortium. This includes all rules and regulations issued by the Health & Safety officer onsite.

#### **0116 - Medical Examination**

All personnel who conduct works on a designated construction site shall undergo a medical examination before commencing works onsite.

#### **0117 - Security Clearance**

All personnel who conduct works on a designated construction site shall receive security clearance before commencing works onsite.

This will be managed by the relevant discipline heads within the professional and contractual teams.

#### **0118 - Site Meetings**

Regular site meetings shall be held from time to time at the request of project management. The contractor shall attend these meetings when requested.

The contractor may set up site meetings with relevant project management or engineers as and when deemed necessary.

#### **0119 - Programme, Project Planning & Control**

The contractor shall ensure that their works are properly programmed, planned and subject to effective levels of coordination and controls.

#### **0120 - Weather conditions**

The contractor shall take into consideration the prevailing weather conditions during all phases of design, preparation, construction and commissioning of the project.

These conditions are to be considered from the following points of view:

- Daily
- Seasonally
- Regionally prevailing weather patterns (historic and predicted)

#### **0121 - Freight and Duties**

All equipment must be priced to include duties and freight to the site. Any additional charges must be listed in this section and cost for at the time of tender or RFP. The bid price should include the transportation of materials to and from the site.

#### **0122 - Travel**

It is the responsibility of the tenderer to allow for travel to the site with the necessary amount of time allowed to successfully complete the project. The sub-contractor must price for all airline prices from and to site. The client will not book tickets for subcontractors.

#### **0123 - Testing Authority**

Should the contractor be using any equipment, instrumentation or certification process, proof of current certification may be requested, and if so must be offered up to project management for their records.

#### **0401 - Quality Systems**

This item refers to costs associated with ensuring that a recognised and certified process or operational quality system is implemented throughout this project.

- All materials and equipment shall be standardised, regularly manufactured (production line) equipment.
- System manufacturers shall have implemented a recognised quality system or shall be able to indicate a commitment to gaining a relevant ISO accreditation.
- System integrators shall have existing accreditation in place or shall be able to indicate a commitment to gaining relevant ISO accreditation.
- The contractor shall produce a method statement for each discrete system being designed and built.

- A commissioning roll-out plan shall be supplied before commencing construction.
- The contractor shall provide a framework of deliverable Operation & Maintenance documentation, in effect a 'contents page' before commencing with construction. This will include reference to Equipment datasheets, Operation manuals, Maintenance procedures, Configuration settings, as-built drawings.

## **0501 - Testing and Commissioning**

This item refers to the provision and processes associated with quality control and testing carried out during the installation and commissioning phases of the project.

- The Contractor is required to undertake testing and commissioning and shall ensure that all necessary test equipment has been recently calibrated by a relevant test authority.
- All testing/commissioning equipment shall be supplied by the contractor unless stated otherwise.
- If the contractor is not qualified to perform specific tests, it shall be the duty of the contractor to appoint a subcontractor, deemed to be suitably competent to perform relevant tests.
- Before proceeding, the Contractor shall submit his intended Quality Control Procedure (QCP) to the Engineer for approval.
- The Contractor is required to test the functionality of each sub-system to the Engineer's approval and acceptance before proceeding with the overall system functionality.
- The Contractor shall perform all necessary tests to confirm the functionality of the system to the Engineer's approval.
- Where point-to-point cable testing is carried out, the contractor shall produce documentation as evidence thereof. He shall allow further resources to check 10 % of the devices in the presence of the engineer.
- Should the engineer not be satisfied with the level of skill and quantity of resources provided to undertake the work described above, the engineer reserves the right to obtain the expertise of a third party to undertake this work and the cost thereof recovered from the contractor.

## **0600 - 12 Month Guarantee and Maintenance**

The Contractor shall include in his price the checking and maintenance of the entire installation during visits at regular intervals, for a period ending twelve months after practical completion of each phase, and for the replacement of expendable items.

During such visits, the contractor shall as a minimum:

- Inspect the system installation according to the Operator & Maintenance documentation.
- Make good any defects as required in terms of the guarantee given for the system installation in terms of the specifications.
- Attend any complaints made by the client's authorised representative.

## **0700 - Training and Handover Documentation**

### **0701 - Training**

The appointed contractor shall train a number of representatives of the client in the operation of the relevant system installed by the contractor. The training should cover the following aspects of the system:

- Description of the system architecture.
- Configuration of any GUI's and operation of any controls at the displays.
- Configuration of any databases.
- Monitoring and acknowledging any alarms.
- Creating, configuring and generating trend/other reports.
- Creating and configuring any time schedules.
- Manually controlling any field points (if relevant).
- Any first-line maintenance procedures required for the hardware.

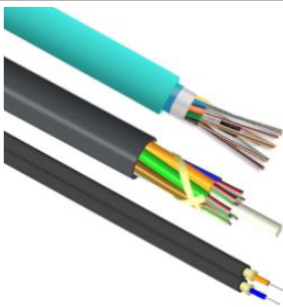
The contractor should provide separate printed and electronic copies of Operator's handbooks and training materials for all attendees.

## 0702 - O&M Manuals

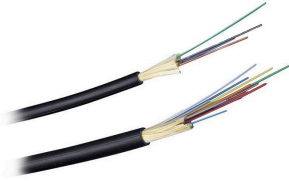
The contractor shall provide a complete set of Operation and Maintenance manuals for this project. The documentation shall include (if applicable to the system installed):

- Updated design specifications including listings and descriptions of any application programs.
- As-builts: site plans and floor plans showing labelled locations of hardware and network equipment, controllers, sensors and routes for cabling and cable containment.
- Schematic diagrams of the system including logical device locations and networking addressing.
- Itemised list of equipment installed indicating make, model, serial number, size and range of operation.
- A datasheet for each item of equipment in the system.
- Configuration data detailing any user-configurable parameters and a definition of what the configuration parameter affects.
- Instructions for installing software.
- Instructions on report generating.
- Instructions on using real-time display.
- Instructions on using alarm and event handlers.
- Instructions on archiving any databases.
- testing and commissioning results.
- maintenance instructions for all software and hardware.
- fault finding guide detailing common issues and steps for rectification.
- documentation should be submitted electronically on a USB flash drive.

## 1700 Fibre Reticulation

1701	Backbone Fibre Cable- OS2 - 24C - SM - unarmoured - HDPE sheath
	
	Power Specification
•	None
	Construction Specification
•	No. of fibres
○	24
•	Loose Tubes (1.3/1.9)
○	Natural
•	Peripheral Strength Member
○	Aramid Yarn
•	Outer Sheath
○	UV Stabilised HPE Sheath, Black Colour
	Communication Specification
•	Optical Characteristics
○	Attenuation @ 1310nm
■	< 0.36 dB/Km
○	Attenuation @ 1550nm
■	< 0.23 dB/Km
	Mechanical Specification
•	Temperature Range
○	[IEC 60794-1-2-F1]
○	10 °C to +70 °C
•	Repeated Bending
○	[IEC 60794-1-2-E6]
○	35 Cycles, R= 20 x D(Diameter)
•	Cable Bending Radius
○	[IEC 60794-1-2]
○	Long Term: 15 x D, D= Cable Diameter
•	Tensile Force
○	[IEC 60794-1-2-E1]
○	Short Term: 250 N
○	Long Term: 100 N
•	Torsion Resistance

<ul style="list-style-type: none"> <li>○ [IEC 60794-1-2-E7]</li> <li>○ 10 Cycl (+/-180°) 1Kg Weight, L=2 Metres</li> </ul>
<ul style="list-style-type: none"> <li>● Crush Resistance <ul style="list-style-type: none"> <li>○ [IEC 60794-1-2-E3]</li> <li>○ 100 N [100 X 100 mm]</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● Water Penetration <ul style="list-style-type: none"> <li>○ [IEC 60794-1-2-F5B]</li> <li>○ 1 Mtr Water Head, 3 Metre Cable Sample, 24 Hours</li> </ul> </li> </ul>
Operational Specification
<ul style="list-style-type: none"> <li>● Optical Characteristics <ul style="list-style-type: none"> <li>○ Attenuation @ 1310nm <ul style="list-style-type: none"> <li>■ &lt; 0.36 dB/Km</li> </ul> </li> <li>○ Attenuation @ 1550nm <ul style="list-style-type: none"> <li>■ &lt; 0.23 dB/Km</li> </ul> </li> </ul> </li> </ul>

1702	Backbone Fibre Cable - OS2 - 12C - SM - unarmoured - HDPE sheath
	
Power Specification	
<ul style="list-style-type: none"> <li>● None</li> </ul>	
Communication Specification	
<ul style="list-style-type: none"> <li>● Manufacturing Standard <ul style="list-style-type: none"> <li>○ ITU G657A</li> <li>○ OS2</li> </ul> </li> </ul>	
Mechanical Specification	
<ul style="list-style-type: none"> <li>● Fibre Count <ul style="list-style-type: none"> <li>○ 12 Core</li> </ul> </li> <li>● Inner Construction <ul style="list-style-type: none"> <li>○ Loose Tube</li> <li>○ Non Metallic Strength Member</li> </ul> </li> <li>● Outer Construction <ul style="list-style-type: none"> <li>○ HDPE (LZSH)</li> <li>○ UV resistant</li> <li>○ Flame retardant material</li> <li>○ Sheath colour: Black</li> </ul> </li> </ul>	
Operational Specification	
<ul style="list-style-type: none"> <li>● Wavelength <ul style="list-style-type: none"> <li>○ 1310nm-1550nm</li> </ul> </li> <li>● Usage Environment <ul style="list-style-type: none"> <li>○ Outdoor</li> <li>○ Riser</li> <li>○ Underground (within sleeve)</li> </ul> </li> <li>● Technical drawings will be issued to indicate: <ul style="list-style-type: none"> <li>○ Installation path</li> <li>○ Splicing diagrams</li> </ul> </li> </ul>	

1703	Splice Closure - 24F - Passthrough splicing capability- water sealed containment
	

#### Product Overview

- The joint enclosure is capable of IP67 rating and can withstand being submerged in water up to a depth of 1m for a 30 minute period.
- Enclosure Shape
  - Horizontal Shape
- Maximum Capacity
  - 24 Splices
- Housing Color
  - Black
- Waterproof Class
  - IP67
- Material
  - PP+GF Body, ABS Tray
- Ports
  - 4 Straight Port (17mm)
- Port type
  - Mechanical Seal
- Enclosure Dimensions
  - 450 mm x 170 mm 100 mm
- Enclosure Weight
  - 1 kg

#### 1704 Backbone 12 -Way HDPE Microduct Bundle



#### Power Specification

- None

#### Communication Specification

- None

#### Mechanical Specification

- Construction
  - 12 Way
- Duct Diameter
  - 65.6x65.6
- Duct Weight - (kg/km)
  - 395
- Maximum Tensile(N)
  - 13800
- Bending Radius Long- Term (mm)
  - 336

#### 1705 Distribution 4 -Way HDPE Microduct Bundle



#### Power Specification

- None

#### Communication Specification

- None

## Mechanical Specification

- Construction
  - 12 Way
- Duct Diameter
  - 41.6x41.6 (mm)
- Duct Weight - (kg/km)
  - 150
- Maximum Tensile(N)
  - 4600
- Bending Radius Long- Term (mm)
  - 209

## 1706 Installation Specifications - Fibre Testing and Certification

### TESTING, IDENTIFICATION AND ADMINISTRATION OF FIBRE 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 backbone and horizontal optical fibre cabling.
- B. This Section includes minimum requirements for:
1. Fibre optic test instruments
  2. Fibre optic testing
  3. Identification
    - a) Labels and labelling
  4. Administration
    - a) Test results documentation
    - b) As-built drawings
- C. Testing shall be carried out in accordance with this document. This includes testing the attenuation and polarity of the installed cable plant with an optical loss test set (OLTS) and the installed condition of the cabling system and its components with an optical time domain reflectometer (OTDR). The condition of the fibre end faces shall also be verified.
- D. Testing shall be performed on each cabling link (connector to connector).
- E. Testing shall be performed on each cabling channel (equipment to equipment) that is identified by the owner.
1. Testing shall not include any active devices or passive devices within the link or channel other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- F. All tests shall be documented including OLTS dual wavelength attenuation measurements for multimode and singlemode links and channels and OTDR traces and event tables for multimode and singlemode links and channels.
1. Optionally documentation shall also include optical length measurements and pictures of the connector end face.

#### 1.3 QUALITY ASSURANCE

- A. All testing procedures and field-test instruments shall comply with applicable requirements of:
1. ISO/IEC 14763-3 Information technology - Implementation and operation of customer premises cabling - Part 3: Testing of optical fibre cabling
  2. IEC 60825-2, Safety of laser products - Part 2: Safety of optical fibre communication systems (OFCS)
  3. IEC 61280-1-4, Fibre optic communication subsystem test procedures - Part 1-4: General communication subsystems - Light source encircled flux measurement method
- B. Trained technicians who have successfully attended an appropriate training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof shall execute the tests. These certificates may have been issued by any of the following organisations or an equivalent organisation:
1. Manufacturer of the fibre optic cable and/or the fibre optic connectors.
  2. Manufacturer of the test equipment used for the field certification.
  3. Training organisations
- 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 (5) business days before testing commences.
  2. The Owner or the Owner's representative will select a random sample of 5% 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 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% testing at no cost to the Owner.

#### 1.4 SUBMITTALS

- A. Manufacturers catalogue sheets and specifications for fibre optic field-test instruments including optical loss test sets (OLTS; power meter and source), optical time domain reflectometer (OTDR) and inspection scope.
- B. A schedule (list) of all optical fibres 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 compliance with the following test limits:

1. Optical loss testing

a) Multimode and Singlemode links

1) The link attenuation shall be calculated by the following formulas as specified in ISO/IEC 14763-3

(i) Link Attenuation (dB) = Cable\_Attn (dB) + Connector\_Attn (dB) + Splice\_Attn (dB)

(ii) Cable\_Attn (dB) = Attenuation\_Coefficient (dB/km) \* Length (Km)

(iii) Connector\_Attn (dB) = number\_of\_connector\_pairs \* connector\_loss (dB)

(iv) Maximum allowable connector\_loss = 0.75 dB for connections embedded into link and 0.50/0.75 dB (MM/SM) for the first and last connector of the link. This budget includes the loss of splice if pigtails are used.

(v) Splice\_Attn (dB) = number\_of\_splices \* splice\_loss (dB)

(vi) Maximum allowable splice\_loss = 0.30 dB

(vii) The values for the Attenuation\_Coefficient (dB/km) are listed in the table below:

Type of Optical Fibre	Wavelength (nm)	Attenuation coefficient (dB/km)	Wavelength (nm)	Attenuation coefficient (dB/km)
Multimode 62.5/125 µm	850	3.5	1300	1.5
Multimode 50/125 µm	850	3.5	1300	1.5
Single-mode (Inside plant)	1310	1.4	1550	1.0
Single-mode (Outside plant)	1310	1.0	1550	0.4

2. OTDR testing

a) Reflective events (connections) shall not exceed 0.75 dB for connections embedded into the link and 0.50/0.65 dB (MM/SM) for the first and last connector of the link

b) Non-reflective events (splices) shall not exceed 0.30 dB.

3. Magnified end face inspection

a) Fibre connections shall be visually inspected for end face quality.

b) Scratched, pitted or dirty connectors shall be diagnosed and corrected.

B. All installed cabling links and channels shall be field-tested and pass the test requirements and analysis as described in Part 3. Any link or channel 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 link or channel meets performance requirements. The final and passing result of the tests for all links and channels 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. Note: High Bandwidth applications such as 1000BASE-SX, 10GBASE-SR, and FC1200 impose stringent channel loss limits. Where practical, certification should consider loss length limits that meet maximum channel (transmitter to receiver) loss.

Fibre Type		Bandwidth	1000BASE-SX	
µm		(MHz.Km)	Length (m)	Loss (dB)
OM1	62.5	200	275	2.38
OM2	50	500	550	3.56
OM3	50	2000	N/A	N/A
OM4	50	4700	N/A	N/A

Fibre Type		10GBASE-SR		FibreChannel 1200-MX-SN-I	
µm		Length (m)	Loss (dB)	Length (m)	Loss (dB)
OM1	62.5	33	2.5	33	2.4
OM2	50	82	2.3	82	2.2
OM3	50	300	2.6	300	2.6
OM4	50	400	2.9	N/A	N/A

PART 2 - PRODUCTS

2.1 OPTICAL FIBRE CABLE TESTERS

A. The field-test instrument shall be within the calibration period recommended by the manufacturer.

B. Optical loss test set (OLTS)

1. Multimode optical fibre light source

a) Provide dual LED light sources with central wave lengths of 850 nm (+30 nm) and 1300 nm (+20 nm)

b) Output power of -20 dBm minimum.

c) The light source shall meet the Encircled Flux launch requirements of IEC 61280-1-4.

d) The test reference cords must demonstrate an insertion loss ≤ 0.15 dB when mated against each other. This performance needs to be verified after setting the reference and then again every time 300 links have been tested. The results from verifying the test reference cords shall be stored alongside link results.

e) Acceptable manufacturers

1) Fluke Networks

2. Single Mode optical fibre light source

a) Provide dual laser light sources with central wavelengths of 1310 nm (+20 nm) and 1550 nm (+20 nm).

b) Output power of -10 dBm minimum.

c) The test reference cords must demonstrate an insertion loss  $\leq 0.25$  dB when mated against each other. This performance needs to be verified after setting the reference and then again every time 300 links have been tested. The results from verifying the test reference cords shall be stored alongside link results.

d) Acceptable manufacturers

1) Fluke Networks

3. Power Meter

a) Provide 850 nm, 1300, 1310 nm and 1550 nm wavelength test capability.

b) Power measurement uncertainty of  $\pm 0.25$  dB.

c) Store reference power measurement.

d) Save at least 10,000 results in internal memory. e) PC interface (USB, RJ45 or cloud connectivity). f) Acceptable manufacturers

1) Fluke Networks

4. Optional length measurement

a) It is preferable to use an OLTS that is capable of measuring the optical length of the fibre using time-of-flight techniques

C. Optical Time Domain Reflectometer (OTDR)

1. Shall have a bright, colour transmissive LCD display with back-light.

2. Shall have rechargeable Li-Ion battery for 8 hours of normal operation.

3. Weight with battery and module of not more than 4.5 lb and volume of not more 200 in<sup>3</sup>.

4. Internal non-volatile memory for results storage.

5. USB ports to transfer data to a PC or internet connectivity to transfer results to a cloud storage

6. Multimode OTDR

a) Wavelengths of 850 nm ( $\pm 20$  nm) and 1300 nm ( $\pm 20$  nm).

b) Event dead zones of 1.0 m maximum at 850 nm and 1300 nm.

c) Attenuation dead zones of 2.5 m maximum at 850 nm and 4.5 m maximum at 1300 nm.

d) Distance range not less than 9,000 m.

e) Dynamic range at least 28 dB at 850 nm and 30 dB at 1300 nm.

7. Singlemode OTDR

a) Wavelengths of 1310 nm ( $\pm 20$  nm) and 1550 nm ( $\pm 20$  nm).

b) Event dead zones of 1 m maximum at 1310 nm and 1550 nm.

c) Attenuation dead zones of 3.6 m maximum at 1310 nm and 3.7 m maximum at 1550 nm.

d) Distance range not less than 130,000 m @ 1550 nm.

e) Dynamic range at least 30 dB at 1310 nm and 1550 nm

8. Acceptable manufacturers:

a) Fluke Networks

D. Fibre Microscope

1. View of field min. 320 x 320  $\mu$ m. Minimum detectable particle size 0.5  $\mu$ m

2. Acceptable manufacturers:

a) Fluke Networks

3. Optional requirements

a) Video camera systems are preferred.

b) Camera probe tips that permit inspection through adapters are preferred.

c) Use test equipment capable of saving and reporting the end face image.

E. Integrated OLTS, OTDR and fibre microscope

1. Test equipment that combines into one instrument an OLTS, an OTDR and a fibre microscope may be used.

2. Acceptable manufacturers:

a) Fluke Networks

F. 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) Panduit

b) Silver Fox

c) W.H. Brady

d) d-Tools

e) Brothers

2.2 ADMINISTRATION

A. Administration of the documentation shall include test results of each fibre link and channel.

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 into a Windows™-based database utility that allows for the maintenance, inspection and archiving of these test records. Alternatively the result records maybe uploaded to a cloud service for intermediate access.

PART 3 - EXECUTION

3.1 GENERAL

A. All tests performed on optical fibre cabling that use a laser or LED in a test set shall be carried out with safety precautions in accordance with ANSI Z136.2.

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

### 3.2 OPTICAL FIBRE CABLE TESTING

- A. Field-test instruments shall have the latest software and firmware installed.
- B. Link and channel test results from the OLTS and OTDR shall be recorded in the test instrument upon completion of each test for subsequent uploading to a PC or Cloud account in which the administrative documentation (reports) may be generated.
- C. Fibre end faces shall be inspected with a minimum view of field of 320 x 320 µm and minimum detectable particle size 0.5 µm. This is suitable for inspecting multimode and single mode fibres. Scratched, pitted or dirty connectors shall be diagnosed and corrected.
  - 1. End faces shall be inspected for compliance with IEC 61300-3-35 Ed.1
  - 2. It is preferable that the end face images be recorded in the memory of the test instrument for subsequent upload to a PC and reporting.
- D. Testing shall be performed on each cabling segment (connector to connector).
- E. Testing shall be performed on each cabling channel (equipment to equipment) that is planned for use per the owner's instructions.
- F. Testing of the cabling shall be performed using high-quality test cords of the same fibre type as the cabling under test. The test cords for OLTS testing shall be between 1 m and 5 m in length. The test cords for OTDR testing shall be approximately 100 m for the launch cable and at least 25 m for the receive cable.
- G. Optical loss testing
  - 1. Horizontal/Backbone link
    - a) Multimode links shall be tested at 850 nm and 1300 nm in accordance with ISO/IEC 14763-3 One Jumper Reference Method
    - b) Singlemode backbone links shall be tested at 1310 nm and 1550 nm in accordance with ISO/IEC 14763-3 One Jumper Reference Method
    - c) Link attenuation does not include any active devices or passive devices other than cable, connectors, and splices, i.e. link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
- H. OTDR Testing
  - 1. Fibre links shall be tested at the appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.
    - a) Multimode: 850 nm and 1300 nm
    - b) Singlemode: 1310 nm and 1550 nm
  - 2. Each fibre link and channel shall be tested in both directions. The calculated bi-directional average for each connector or splice loss shall be used to pass or fail the link.
  - 3. A launch fibre shall be installed between the OTDR and the first link connection.
  - 4. A tail fibre shall be installed after the last link connection
  - 5. When testing from the opposite direction (End2) the fibre which functioned as a tail fibre when testing from (End1) will no function as a launch fibre.
  - 6. It is recommended for improved efficiency and in order to reduce the number of matings between launch/tail-fibres and the link under test that, to use a loop fibre with length similar to launch/fail-fibre to test the A and B fibre of a duplex link at the same time
    - a) Phase 1: Configuration [OTDR] > [L/T-Fibre#1] > [Fibre A] > [Loop-Fibre] > [Fibre B] > [L/T-Fibre#2]
    - b) Phase 2: Configuration [OTDR] > [L/T-Fibre#2] > [Fibre B] > [Loop-Fibre] > [Fibre A] > [L/T-Fibre#1]
    - c) Test Results: The results stored shall include all the details as if the following four individual test were performed 1) From End 1: Fibre A 2) From End 2: Fibre A 3) From End 1: Fibre B 4) From End 2: Fibre B
    - d) From the above four results the bi-directional averages for all connectors in Fibre A and B are calculated. These results are used to pass or fail the link
- I. Magnified End face Inspection
  - 1. Fibre end faces shall be inspected with a minimum view of field of 320 x 320µm and minimum detectable particle size 0.5 µm. This is suitable for inspecting multimode and single mode fibres.
- J. Length Measurement
  - 1. The length of each fibre shall be recorded.
  - 2. It is preferable that the optical length be measured using an OLTS or OTDR.
- K. Polarity Testing
  - 1. Paired duplex fibres in multi-fibre cables shall be tested to verify polarity in accordance with ISO/IEC 14763-3 Part 11.2 The polarity of the paired duplex fibres shall be verified using an OLTS.

### 3.3 IDENTIFICATION

#### A. Labelling

- 1. Labelling shall conform to the requirements specified within ANSI/TIA-606-B or to the requirements specified by the Owner or the Owner's representative.

### 3.4 ADMINISTRATION


#### A. Test results documentation

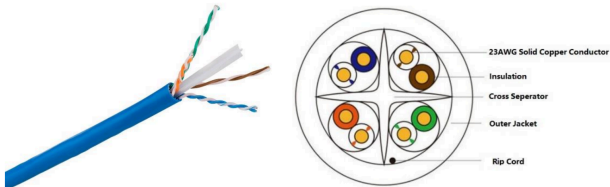
- 1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
- 2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
- 3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on Portable Media Drive prior to Owner acceptance of the building. This Portable Media Drive shall include the software tools required to view, inspect, and print any selection 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. The detailed test results documentation data is to be provided in an electronic database for each tested optical fibre and shall contain the following information
  - a) The identification of the customer site as specified by the end-user
  - b) The name of the test limit selected to execute the stored test results
  - c) The name of the personnel performing the test
  - d) The date and time the test results were saved in the memory of the tester
  - e) The manufacturer, model and serial number of the field-test instrument
  - f) The version of the test software and the version of the test limit database held within the test instrument
  - g) The fibre identification number
  - h) The length for each optical fibre

- 1) The index of refraction used for length calculation when using a length capable OLTS
- i) Test results to include OLTS attenuation link and channel measurements at the appropriate wave length(s) and the margin (difference between the measured attenuation and the test limit value).
- j) Test results to include OTDR link and channel traces and event tables at the appropriate wavelength(s).
- k) The length for each optical fibre as calculated by the OTDR.
- l) The overall Pass/Fail evaluation of the link-under-test for OLTS and OTDR measurements
- m) Optional
  - 1) A picture or image of each fibre end-face
  - 2) A pass/fail status of the end-face based upon IEC 61300-3-35.

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

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on Portable Media Drive. 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. CAD drawings are to incorporate test data imported from the test instruments.
2. 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 builds shall include all field changes made up to construction completion:
  - a) Field directed changes to pull schedule.
  - b) Field directed changes to cross connect and patching schedule.
  - c) Horizontal cable routing changes.
  - d) Backbone cable routing or location changes.
  - e) Associated detail drawings.

1711	24 Port CAT6A fully loaded Patch Panel
	
<b>Power Specification</b>	
<ul style="list-style-type: none"> <li>None</li> </ul>	
<b>Communication Specification</b>	
<ul style="list-style-type: none"> <li>None</li> </ul>	
<b>Mechanical Specification</b>	
<ul style="list-style-type: none"> <li>Body style               <ul style="list-style-type: none"> <li>Symmetrical</li> </ul> </li> <li>Colour               <ul style="list-style-type: none"> <li>Black</li> </ul> </li> <li>Growth Configuration               <ul style="list-style-type: none"> <li>Partially Loaded</li> </ul> </li> <li>Interface, front               <ul style="list-style-type: none"> <li>Standard</li> </ul> </li> <li>Rack Unit               <ul style="list-style-type: none"> <li>1U</li> </ul> </li> <li>Total Ports, Quantity               <ul style="list-style-type: none"> <li>24</li> </ul> </li> <li>Dimensions               <ul style="list-style-type: none"> <li>height 44.45 mm x width 482.6 mm</li> </ul> </li> <li>Material               <ul style="list-style-type: none"> <li>Powder Coating finish, Aluminium material type.</li> </ul> </li> </ul>	
<b>Operational Specification</b>	
<ul style="list-style-type: none"> <li>Fibre Mode               <ul style="list-style-type: none"> <li>Single Model</li> </ul> </li> </ul>	

1712	CAT6A Cable - U/UTP
	
<b>Power Specification</b>	
<ul style="list-style-type: none"> <li>Power               <ul style="list-style-type: none"> <li>PoE+</li> </ul> </li> </ul>	

<ul style="list-style-type: none"> <li>IEEE 802.3at</li> </ul>
<b>Communication Specification</b>
<ul style="list-style-type: none"> <li>Termination Standard <ul style="list-style-type: none"> <li>T568B</li> </ul> </li> </ul>
<b>Mechanical Specification</b>
<ul style="list-style-type: none"> <li>Type <ul style="list-style-type: none"> <li>U/UTP</li> </ul> </li> <li>Cable Colour <ul style="list-style-type: none"> <li>Various</li> <li>For fire services - Red shall be used and the cable type to be amended to Fire rated sheathing</li> <li>All other services shall not make use of red sheathing.</li> <li>Different colour sheathing is to be used to distinguish between services</li> </ul> </li> <li>Wire Gauge <ul style="list-style-type: none"> <li>23AWG</li> <li>Path Leads to have the same wire Gauge</li> </ul> </li> </ul>
<b>Operational Specification</b>
<ul style="list-style-type: none"> <li>N/A</li> </ul>

### 1713 CAT6A 1.5m Patch lead



#### Mechanical Specification

- Category
  - 6A
- Cable Type
  - F/UTP (shielded)
- Conductor Type
  - Solid
- Connector Type
  - RJ45 plug
- Length
  - 1.5 m
- Jacket Material
  - LSHF (Low Smoke Halogen Free)

### 1714 CAT6A Data Outlet



Faceplate



Junction box

#### Power Specification

- PoE+
  - IEEE 802.3at
  - Can be supplied to a low powered device: such as a Camera or IP Phone

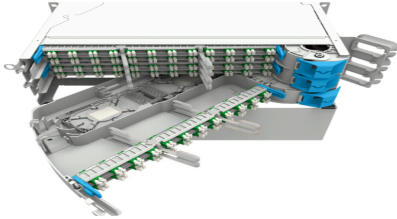
#### Communication Specification


- Termination Standard
  - T568B

#### Mechanical Specification

- Face Plate Dimensions
  - 50(W)x100(H)x15(D) mm

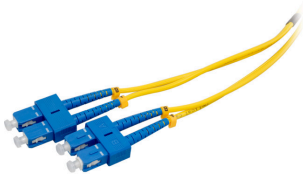
<ul style="list-style-type: none"> <li>○ Assembled on site</li> </ul>
<ul style="list-style-type: none"> <li>● Face Plate Material <ul style="list-style-type: none"> <li>○ Polycarbonate</li> <li>○ Colour finish at architects' discretion</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● Junction Box Dimensions <ul style="list-style-type: none"> <li>○ 50(W)x100(H)x15(D) mm</li> <li>○ Assembled on site</li> </ul> </li> </ul>
<ul style="list-style-type: none"> <li>● Junction Box Material <ul style="list-style-type: none"> <li>○ Galvanised Steel</li> <li>○ Flush mount in wall</li> </ul> </li> </ul>

1715	Fibre splice/patch panel - 144 core - SM - fully loaded - with pigtails
	
Power Specification	
<ul style="list-style-type: none"> <li>● None</li> </ul>	
Mechanical Specification	
<ul style="list-style-type: none"> <li>● Item <ul style="list-style-type: none"> <li>○ Rack unit - 1RU</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Panel Capacity <ul style="list-style-type: none"> <li>○ 144 core single mode fibre cable splice tray</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Construction <ul style="list-style-type: none"> <li>○ Aluminium constructed frame</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Port Type <ul style="list-style-type: none"> <li>○ Single Mode</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● LC/APC Connectors <ul style="list-style-type: none"> <li>○ Prepopulated keys with fibre pigtails</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Prepopulated keys with fibre pigtails <ul style="list-style-type: none"> <li>○ The pigtails shall be to the standard ITU G.657A</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Cable Entry <ul style="list-style-type: none"> <li>○ Multiple cable entry points from both sides</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Cable Gland Entry <ul style="list-style-type: none"> <li>○ 3-20 mm</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Rack Finishings <ul style="list-style-type: none"> <li>○ Colour: Dark black (RAL 9005)</li> <li>○ Final layer: Powder coat finish</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Cable management <ul style="list-style-type: none"> <li>○ All cables to be labelled to engineers drawings using long lasting labels or keystones</li> <li>○ The panel should have cable management solutions to manage incoming and outgoing cables</li> </ul> </li> </ul>	
<ul style="list-style-type: none"> <li>● Technical drawings will be issued to indicate: <ul style="list-style-type: none"> <li>○ Splice map</li> <li>○ Port patching</li> <li>○ and the cables to be terminated at each network rack</li> </ul> </li> </ul>	

1716	Fibre splice/patch panel - 48 core - SM - fully loaded - with pigtails
	
Platform components	
<ul style="list-style-type: none"> <li>● Fiber Optic Panel, 1U, 19 in</li> <li>● Fully loaded with 24 blue LC/UPC Single mode duplex adapters</li> </ul>	
Platform specifications	
<ul style="list-style-type: none"> <li>● Interface, front LC/UPC</li> <li>● Rack Type EIA 19 in</li> <li>● Rack Units 1</li> <li>● Total Ports, quantity 48</li> </ul>	

- Fiber Mode Single mode

## 1717 Fibre patch lead - SM -1.5m - LC/APC



### Product Overview

- Part of the CommScope® Fiber Optic Patch Cords family which provides a variety of solutions for different applications.

### Cable Specifications

- Cable diameter of 2.0 mm and a cable length of 42 m.
- Core/cladding diameter of 50/125 µm which is compatible with most multimode fibre systems.
- LSZH jacket which minimises the emission of toxic and corrosive gases in case of fire.

### Connector Specifications

- LC connectors on both ends which are suitable for small form factor applications.
- Push-pull coupling mechanism which facilitates easy insertion and removal of connectors.
- Ceramic ferrule material which ensures high precision and durability.

### Optical Performance Specifications

- Optical performance that complies with or surpasses TIA/EIA-568-C.3 and ISO/IEC 11801 standards.
- Insertion loss of  $\leq 0.3$  dB for each connector.
- Return loss of  $\geq 20$  dB for each connector.

### Mechanical Performance Specifications

- Mechanical performance that conforms to or exceeds IEC 61754-20, IEC 61300-3-35, IEC 61300-3-34, IEC 61300-2-4, IEC 61300-2-47, IEC 61300-2-52, IEC 61300-2-48 standards.
- Cable retention strength of maximum 11.24 lb @ 0° | 4.40 lb @ 90° for each connector.
- Durability of  $\geq 500$  mating cycles for each connector.
- Tensile strength of  $\geq 66$  lb |  $\geq 300$  N for the cable.
- Bend radius of  $\geq 30$  mm |  $\geq 1.18$  in for the cable.

### Environmental Performance Specifications

- Environmental performance that adheres to or surpasses IEC 61300-2-26, IEC 61300-2-22, IEC 61300-2-15, IEC 61300-2-18, IEC 61300-2-17 standards.
- Operating temperature range of -20°C to +70°C | -4°F to +158°F.
- Storage temperature range of -40°C to +85°C | -40°F to +185°F.

## 1718 Installation Specifications - CAT6A Testing and Certification

### TESTING, IDENTIFICATION AND ADMINISTRATION OF BALANCED TWIST PAIR INFRASTRUCTURE PART 1 - GENERAL

#### 1.1 WORK INCLUDED

- 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.
- 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.
- 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

- This Section includes the minimum requirements for the test certification, identification and administration of horizontal balanced twisted pair cabling.
- This Section includes minimum requirements for:
  - Copper cabling test instruments
  - Copper cabling testing
  - Identification
    - Labels and labelling
  - Administration
    - Test results documentation
    - As-built drawings
- Testing shall be carried out in accordance with this document.
- Testing shall be performed on each cabling link. (100% testing)
- 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, Requirements for Field Test Instruments and Measurements for Balanced Twisted-Pair Cabling
  - 2. ANSI/TIA-568-C.0, Generic Telecommunications Cabling for Customer Premises.
  - 3. ANSI/TIA-568-C.1, 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 organisations or an equivalent organisation:
  - 1. Manufacturer of the connectors or cable.
  - 2. Manufacturer of the test equipment used for the field certification.
  - 3. Training organisations
- 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 (5) business days before testing commences.
  - 2. The Owner or the Owner's representative will select a random sample of 5% 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 2% of the sample results differ in terms of the pass/fail determination, the installation contractor under supervision of the representative shall repeat 100% 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 - recorded for information only
  - 6. DC Resistance Unbalance - recorded for information
  - 7. Insertion Loss
  - 8. NEXT (Near-End Crosstalk)
  - 9. PS NEXT (Power Sum Near-End Crosstalk)
  - 10. ACR-N (Attenuation to Crosstalk Ratio Near-End) - recorded for information only
  - 11. PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End) - recorded for information only
  - 12. ACR-F (Attenuation to Crosstalk Ratio Far-End)
  - 13. PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
  - 14. Return Loss
  - 15. TCL (Transverse Conversion Loss) - recorded for information only
  - 16. ELTCTL (Equal Level Transverse Conversion Transfer Loss) - recorded for information only
- 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 the calibration period recommended by the manufacturer, typically 12 months.
- B. Certification tester
  - 1. Accuracy
    - a) Level III accuracy in accordance with ANSI/TIA-1152
    - b) Independent verification of accuracy
    - c) Acceptable manufacturers
  - 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 > 10,000 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
    - g) Insertion Loss
    - h) NEXT (Near-End Crosstalk)
    - i) PS NEXT (Power Sum Near-End Crosstalk)
    - j) ACR-N (Attenuation to Crosstalk Ratio Near-End)
    - k) PS ACR-N (Power Sum Attenuation to Crosstalk Ratio Near-End)



- l) ACR-F (Attenuation to Crosstalk Ratio Far-End)
- m) PS ACR-F (Power Sum Attenuation to Crosstalk Ratio Far-End)
- n) Return Loss
- o) TCL (Transverse Conversion Loss)
- p) ELTCTL (Equal Level Transverse Conversion Transfer Loss)
- q) Time Domain Reflectometer
- r) Time Domain Xtalk Analyzer

#### C. PC Software

1. Windows® based.
2. Must show when 3 dB and 4 dB rules are applied
3. Re-certification capability, where results must have their Cable IDs suffixed with (RC).
4. Built in PDF export - no additional third party software permitted.
5. Built-in statistical analysis

## 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) Brady Corporation
  - d) Epson
  - b) Silver Fox
  - e) Dymo
  - c) Brother

## 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 into a Windows® -based database utility that allows for the maintenance, inspection and archiving of these test records.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. All outlets, cables, patch panels and associated components shall be fully assembled and labelled 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 software and 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 a PC in which the administrative documentation (reports) may be generated.
- C. Testing shall be performed on each cabling segment (connector to connector). Sampling is not acceptable.
- D. 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.
- E. 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 6 Permanent Link test each day to ensure no degradation of the tester or its Permanent Link adapters.

#### F. 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. For each of the 8 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) Distance to open on shield
  - g) Any other miss-wiring
2. 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:



#### G. 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 325 ft. (99 m) before a failure is reported.

#### H. 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.
3. The propagation delay of each balanced twisted pair shall be recorded.
4. Is not to exceed 498 ns per ANSI/TIA-568-C.2 Section 6.3.18.

#### I. 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 44 ns per ANSI/TIA-568-C.2 Section 6.3.19.

#### J. DC Resistance

1. Often reported as Resistance, is the loop resistance of both conductors in the pair.
2. Is not specified in ANSI/TIA-1152, but shall be recorded for all four pairs.

#### K. DC Resistance Unbalance

1. Often reported as Resistance Unbalance, is the difference in resistance of the two wires within the pair.
2. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all four pairs.

#### L. 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
3. Worst case shall be reported for all four pairs in one direction only.
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 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.7.

#### M. 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
3. Shall be measured in both directions. (12 pair to pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.8.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
7. The Time Domain Xtalk data shall be stored for any marginal or failing NEXT results.

#### N. 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
3. Shall be measured in both directions. (8 pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.9.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
7. The Time Domain Xtalk data shall be stored for any marginal or failing PS NEXT results.

#### O. 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
3. Shall be calculated in both directions.
4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 12 possible combinations.

#### P. 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
3. Shall be calculated in both directions.
4. Is not specified in ANSI/TIA-1152, but shall be recorded for all 8 possible combinations.

#### Q. 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
3. Shall be measured in both directions. (24 pair to pair possible combinations)
4. Both worst case and worst margins shall be reported.
5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.11.
6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).

#### R. PS ACR-F (Power Sum Attenuation 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
  3. Shall be measured in both directions. (8 pair possible combinations)
  4. Both worst case and worst margins shall be reported.
  5. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.13.
  6. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
- S. 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
  3. Shall be measured in both directions. (8 pair possible combinations)
  4. Both worst case and worst margins shall be reported.
  5. Shall be ignored at all frequencies where the Insertion Loss is less than 3 dB for that pair.
  6. Is not to exceed the Category 6 Permanent Link limits found in ANSI/TIA-568-C.2 Section 6.3.6.
  7. Reported margins found to be within the accuracy of the field tester shall be marked with an asterisk (\*).
  8. The Time Domain Reflectometer data shall be stored for any marginal or failing Return Loss results.
- T. 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
  3. Shall be measured in both directions.
  4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.
- U. 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
  3. Shall be measured in both directions.
  4. Is not specified in ANSI/TIA-1152 for a Permanent Link, but shall be recorded for all 8 possible combinations.

### 3.3 ADMINISTRATION

#### A. Test results documentation

1. Test results saved within the field-test instrument shall be transferred into a Windows™-based database utility that allows for the maintenance, inspection and archiving of the test records. These test records shall be uploaded to the PC unaltered, i.e., "as saved in the field-test instrument". The file format, CSV (comma separated value), does not provide adequate protection of these records and shall not be used.
2. The test results documentation shall be available for inspection by the Owner or the Owner's representative during the installation period and shall be passed to the Owner's representative within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling. The installer shall retain a copy to aid preparation of as built information.
3. The database for the complete project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on a Portable Media Drive prior to Owner acceptance of the building and/or electronic system. This Portable Media Drive shall include the software tools required to view, inspect, and print any selection 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. The detailed test results documentation data is to be provided in an electronic database 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 software 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, values for all four pairs
  - o) Insertion Loss, worst case values for all four pairs
  - p) NEXT, worst case margin and worst case values, both directions
  - q) PS NEXT, worst case margin and worst case values, both directions
  - r) ACR-F, worst case margin and worst case values, both directions
  - s) PS ACR-F, worst case margin and worst case values, both directions
  - t) Return Loss, worst case margin and worst case values, both directions
  - u) TCL, worst case values both directions
  - v) ELTCTL, worst case values, both directions.
  - w) Time Domain Crosstalk data if the link is marginal or fails
  - x) Time Domain Reflectometer data if the link is marginal or fails

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

1. Provide record copy drawings periodically throughout the project as requested by the Construction Manager or Owner, and at end of the project on a Portable Media Drive. 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 builds 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.

#### 1721 Fibre Enclosure - LIGHTspeed Indoor Enclosure + cassette F03-2 (2xLC Duplex) - MEGALSPSBFC10



##### Specification

Single fibre count (max)		4
Splices (max)		4
Heat Shrink splice holders (max)		4
Splice protector		40 mm
Mechanical splices holders (max)		2
Cable entry points (max 10 mm)		3
Outlets		2
Adaptor holders		2
Adaptor type		SC Simplex
		LC Duplex
Mounting application (Indoor)		Wall Mount
Dimensions	Height	85 mm
	Width	108.5 mm
	Depth	27 mm
Material type		ABS
Colour		White

#### 1722 Equipment Rack - Type 1



- Rack Height: 42U
- Rack Width: 19 inches
- Rack Depth: 37 inches
- Load Capacity: 3000 lbs (1360.8 kgs) stationary, 2250 lbs (1021 kgs) rolling
- Protection Rating: NEMA 12 (IP54)
- Material: Powder-coated steel
- Colour: Black
- Features: Locking doors and side panels, removable top panel, casters and levellers, cable access openings

**1723 Equipment Rack - Type 2**

**Power Specification**

Item	Specification	Comment
Main supply	To be provided by the electrical engineer	The plug point will be mounted within the rack

**Mechanical Specification**

Item	Specification	Comment
Rack unit	12RU	
Construction	Full rack to be constructed SPCC cold rolled steel	
	Vented front door (solid)	
	Solid removal side panels (solid)	
Fan ventilation	X4 top of rack fans	
	X4 bottom of rack fans	
Rack Finishings	Colour: Dark black	
	Final layer: Powder coat finish	

**Installation Requirements**

Item	Specification	Comment
Installation	Wall mounted	Mounting locations will be provided with technical drawings
Clearance	All rack front and back swing rotations to be checked for obstruction before mounting	
	At least 700mm top and bottom clearance from objects and furniture	
Cable management (Descending cables)	The contractor is to make provision in their costing, for cable management solutions of all cables descending from the existing cable management trays, to the entry points of the rack	
Cable management (In rack)	The contractor is to make provision in their costing for cable management solutions for all patch leads and cable terminations	

**Keyed Notes**

- Technical drawings will be issued to indicate:
- The specific location of each network rack,
- The layout of equipment and devices within,
- and the cables to be terminated at each network rack
- Cable management needs to be implemented for cables descending from cable management trays, to the entry points of the rack, as well as for patch cables within the network rack
- A single mock-up cabinet installation needs to be done before proceeding with the installation and procurement of all other network cabinets, cable management, and cable termination equipment.
- A printed asset register should be placed within each cabinet

**1724 Cat6A Patch Panel 760237032 - NPP-6A-DM-1U-24 24 port Category 6A patch panel**


- Ports: 24 RJ45 female

• Standards: Cat6a, USOC, T568A and T568B
• Data Transfer Speeds: 10 Gbps
• Rack Units: 1U
• Rack Width: 19 inches
• Material: Steel
• Colour: Black
• Features: STP shielded, low-profile, easy installation, cable management bar

1725	Installation Specifications - Passive Equipment Installation
	<b>Server racks or cabinets</b>
•	The server racks or cabinets should be installed in a climate-controlled room or enclosure with adequate power and space for growth.
•	The server racks or cabinets should be securely anchored to the floor and/or wall to prevent tipping or displacement.
•	The server racks or cabinets should be fitted with a grounding cable to prevent electrical interference or damage.
•	The server racks or cabinets should be compatible with the equipment to be installed and should provide easy access for maintenance.
•	The server racks or cabinets should be suitable for the capacity requirements, including the size, weight, and number of servers and other network equipment to be installed.
	<b>Shelves</b>
•	The shelves should be compatible with the server racks or cabinets' mounting standards (e.g., 19-inch rack).
•	The shelves should be capable of supporting the weight and size of the equipment to be installed.
•	The shelves should be installed at appropriate heights, providing space for cabling and maintenance.
•	The shelves should be arranged in a logical manner, providing easy access to network equipment and servers for maintenance.
	<b>Cooling Racks</b>
•	The cooling racks or fans should be installed in or on the server racks or cabinets to maintain an optimum temperature for the equipment.
•	The cooling racks or fans should be compatible with the server racks or cabinets' mounting standards.
•	The cooling racks or fans should be positioned properly, providing good ventilation and space for maintenance.
•	The cooling racks or fans should be tested to ensure compliance with cooling requirements and best practices.
	<b>Cable Management Arms</b>
•	The cable management arms should be installed in or on the server racks or cabinets to organise and manage the cabling infrastructure.
•	The cable management arms should be compatible with the server racks or cabinets' mounting standards.
•	The cable management arms should be adjusted to provide neatly routed cables, reducing the risk of entanglement and disconnection.
•	The cable management arms should be tested to ensure compliance with cabling standards and best practices.
	<b>Rack Mounting Accessories</b>
•	The rack mounting accessories, such as brackets, screws, and nuts should be compatible with the server racks or cabinets' mounting standards.
•	The rack mounting accessories should be installed firmly, providing secure mounting for network equipment and servers.
•	The rack mounting accessories should be labelled with a unique identification number or name for easy identification.
•	The rack mounting accessories should be tested to ensure compliance with relevant standards and best practices.

0800 - PC Sum
An allowance has been made for items for which no design details were available at time of going to tender. More specific details will be available, as the design phase progresses.