



KRONE

# Specification For Class E & E<sub>A</sub> Applications Using ADC KRONE Category 6 and 6<sub>A</sub> Copper And ADC KRONE Optical Fibre Cable

Major changes are highlighted in **Yellow** and should be un-highlighted before use in any tender specifications;

1	IDC to accept 2 x 0.5 mm dia wires per slot if needed	CL 2.1.2 & 2.3.3
2	LSZH cable to IEC 60332-3 is acceptable alternative for cables	CL 2.2.1
3	OS2 fibre cable added	CL 2.4.2
4	AXT Testing is not required for C6 or C6 <sub>A</sub> , there's no AXT sampling plan	CL5.1 & Appn 1&3
5	OF testing to AS/NZS ISO/IEC 14763-3 added	CL 5.2.1 & 5.2.6
6	1-Test Cord Method of Reference Setting is preferred optical test method	CL 5.2.2
7	Install cabling in accordance with HB29	CL 9.1
8	OF cables can share a tray with data or LV electrical cables if separated	CL 9.2
9	25mm Min Bend Radius of OF pig-tails& patch cords, and 10x for cables	CL 9.3
10	Min Bend OF cables 10 x for no-load, 20 x installation & long-term load	CL9.3
11	OF loose-tube vertical cables should have at least 3 coils every 20m	CL 9.3
12	Cable stacking height is 150mm for flat pathways, or height of tray sides	CL 9.4
13	Floor boxes in concrete shall have at least 2 x 32 dia conduits	CL 9.4
14	Duct compartment capacity increased. Use 'Side Entry' termination.	CL 9.4
15	Conduits shall be filled to 40% max. Conduit capacity table added	CL 9.4
16	Conduits/ducts must protrude 50-75mm AFF	CL 9.4
17	Cable stacking height is 90mm for mesh pathways, or height of tray sides	CL 9.4
18	Cables shall not be attached to ceiling hangers/supports	CL 9.5
19	Support 1 or 2 cables with 6 or 8mm cable clamps, not conduit clamps	CL 9.5
20	New Appendix 2 added; Requirements for Warranty Testing	Appn 2
21	Previous Appendix 2 renamed to Appendix 3	Appn 3
22	Min length of Patch Cord, System Tail, Equipment Cord is 2m for C6 <sub>A</sub>	Appn 3, CL2.3.7

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# Class E Copper And Optical Fibre Cabling Specification

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*For 10 GBE performance installations the clauses in Appendix 3 shall be an additional part of this specification.*

## 1. GENERAL REQUIREMENT

Tenderers shall propose and submit a comprehensive Structured Cabling Solution to define the telecommunications infrastructure (patch panels, frames, patch cords, cables, faceplates and outlets) necessary to build a uniform premises distribution system, which will function for a multi-media communications solution to support up to 1000Mbps (1GBE) and to provide a 20 year warranted system.

A Structured Cabling Solution that uses Category 6 UTP components and Optical Fibre backbone shall be capable of providing 1 Gigabit Ethernet operation using full duplex transmission. An acceptable alternative would be to provide a Cat 6 shielded F/UTP cabling solution if requested by the designer or end user.

The solution should define the method(s) of flexible patching for the telecommunications services to enable simple Moves, Adds & Changes, (MAC's) without frequent rewiring of locations.

### 1.1 Conformity to Standard

The latest versions of the following standards are to be complied with unless otherwise specified:

1. **AS/ACIF S008**  
Requirements for Authorised Cabling Products
2. **AS/ACIF S009**  
Installation Requirements for Customer Cabling (Wiring Rules)
3. **AS/NZS 3000**  
SAA Electrical Wiring Rules
4. **AS/NZS 3084**  
Commercial Building Standard for Telecommunications Pathways and Spaces
5. **AS/NZS 3085.1**  
Administration of Communications Cabling Systems – Basic Requirements
6. **AS/NZS 4117**  
Surge Protective Devices for Telecommunication Applications
7. **AS/NZS ISO/IEC 14763-3**  
Implementation and Operation of Customer Premises Cabling – Part 3: Acceptance for Optical Fibre Cabling
8. **AS/NZS IEC 61935.1** (Replaced AS/NZS 3087 in 2006)  
Testing of Balanced Communications Cabling In Accordance with ISO/IEC 11801 – Part 1
9. **ISO/IEC 11801 Ed 2**  
Information Technology – Generic Cabling for Customer Premises – Class A to F
10. **ISO/IEC 11801 Ed 2 Amendment 1**  
Information Technology – Generic Cabling for Customer Premises – Class E<sub>A</sub> and F<sub>A</sub> Channels
11. **ANSI/TIA 568-B.2-10**  
Transmission Performance Specification for 4 Pair 100 Ohm Category 6<sub>A</sub> Cabling PL & Channels

This specification uses the International Standard (e.g. ISO/IEC 11801) wherever possible to reflect the global nature of this specification and the expected global performance requirements.

## 2. STRUCTURED CABLING SYSTEM (SCS)

All ADC KRONE products supplied under this tender shall be genuine ADC or ADC KRONE products. There shall be no unapproved or falsely claimed "Krone Compatible" or "Krone Alternative" products.

The communications channel shall be capable of supporting 1GBE (1000BASE-T) Ethernet.

All copper products in the communications channel shall be capable of supporting the provision of power to the Data Terminal Equipment via the electrically conductive Media Dependant Interfaces as specified in the latest IEEE 802.3af "Power over Ethernet" standard.

All IDC connectors shall be ADC KRONE IDC technology for all systems and subsystems.

### 2.1 Work Area System

Tenderers shall supply and install the wiring or interconnections that connect active terminal devices to the telecommunication outlets. This includes patch cords, connectors, faceplates, as well as the work area patch cords (terminal fly leads) needed to make connections.

The number of outlets required for this tender is approximately < Quantity >

#### 2.1.1 Faceplate

For Cat 6, the faceplates offered shall have the following;

- A choice of 1, 2, 3, 4, or 12 outlets.
- Options for vertical style or horizontal mounting style.
- 3 or 4 port angled faceplates on perimeter trunking or surface skirting ducts.
- A clear label for application of circuit identification
- RotoLoc faceplates are also acceptable

#### 2.1.2 Telecommunication Outlets (TO)

All copper telecommunication outlets supplied by the tenderer shall be ADC KRONE modular 8-position / 8-contact outlets, accepting standard modular RJ45 plugs.

The TO shall be;

- Capable of receiving 0.4 to 0.64mm diameter solid wires into insulation displacement contacts
- Surface or flush mounted, single, dual, triple or quad sockets as specified in the drawings
- Should have the ability to accept a dust cap to prevent dust and dirt getting into the socket
- Underwriter Laboratories (UL) listed, and comply with CFR47 Part 68.500
- Made from high-impact, flame-retardant, UL94 -V0 rated thermoplastic material
- Meet or exceed ISO/IEC 11801 Category 6 component requirements
- RotoLoc Cat 6 sockets are also acceptable
- If shielded sockets are required, they shall be shield Cat 6 KM8 RJ45 style modular sockets (product number 6830 2 711-01 for a bag of 8)

Shielded cable screens shall be connected to the socket at the FD or source end and to the socket at the TO far end. Use a UTP work area patch cord to prevent earth loops.

The TO shall provide Near End Crosstalk (NEXT) performance of;  
≥54dB @ 100MHz, and ≥46dB @ 250MHz for Cat 6.

The Insulation Displacement Connector (IDC) wiring termination shall have a minimum of 2 mechanical forces applied to the wire to provide a reliable and stress-free resistant connection. The IDC termination must be have a 45° angled configuration when connecting with the cable conductor to reduce the effect of metal fatigue.

The IDC contact element shall be special spring brass with silver plating to increase conductivity, angularly arranged across the axis of conducting wire to maximise the gas tight connection. The contact range shall be 5µm silver-plated to ensure minimum oxidation impact.

The IDC contacts shall be capable of accepting two nominal 0.5 mm diameter copper wires per slot.

The socket offered shall be marked to conform to the T568A wiring scheme in ISO/IEC 11801, as a minimum.

The telecommunication outlet shall meet the following electrical performances;

- RJ Interface resistance:  $\leq 20 \text{ m}\Omega$
- Insulation resistance  $\geq 100 \text{ M}\Omega$  at 500 Vdc.
- Contact resistance of  $20 \text{ m}\Omega$  maximum. ( $\leq 1 \text{ m}\Omega$  typical)
- Current rating of  $\leq 2\text{A}$  at  $20^\circ\text{C}$

The telecommunication outlet shall meet the following mechanical performance:

- Insertion life of Level B reliability to IEC 60603-7
- Plug/Jack contact force:  $> 100\text{g}$  minimum per contact using a FCC-approved plug.
- Plug retention force:  $133 \text{ N}$  minimum.
- Temperature range:  $-20^\circ\text{C}$  to  $+75^\circ\text{C}$

### 2.1.3 Work Area Patch Cord

The Cat 6 work area patch cords shall be factory terminated with colour options and with nominal length options of 1, 2, 3, 4.5, 7.5, and 15 metres.

## 2.2 Horizontal Cable System

### 2.2.1 Category 6 Cabling for 1 Gigabit Ethernet

Tenderer shall supply ADC KRONE Category 6 horizontal 4 pair solid cable to connect each telecommunication outlet (TO) or consolidation point (CP) to the floor distributor (FD).

Unless otherwise specified, the type of horizontal cables used shall be 4-pair  $100\Omega$  high performance unshielded twisted pair (UTP) cable for Cat 6 applications.

Although a 4-pair UTP solution is proposed in this specification. A Cat 6 shielded solution may be an alternative if so selected by the system designer or end-user.

Installations requiring a reduction in PVC materials should use the low smoke zero halogen (LSZH) non-PVC Cat 6 solid 4-pair cable colour grey (product number 6462 1 082-00).

The UTP cable shall be of nominal 0.5 mm diameter bare solid copper conductors insulated with high-density insulation and a PVC sheath. The insulated conductors shall be twisted into pairs, with pairs balanced for maximum performance and noise reduction.

The 4-pair UTP cable shall be run using a star topology format from the crossconnect at the floor distributor (FD) on each floor to every individual telecommunication outlet on that floor.

The 4-pair UTP cable must exceed ISO/IEC 11801 Category 6 requirements. It must be tested to Class E to ensure performance for any application up to and including 1000 Mbps from the floor distributor (FD) to the telecommunications outlet (TO) at the work area.

All horizontal UTP cable must meet requirement specified for current applications such as IEEE 802.3, 10/100/1000 BASE T; IEEE 802.5, 4/16/100Mbps; ATM Forum 52/155/622/1200 Mbps, 1 Gigabit Networking.

Each run of cable from the crossconnect at the floor distributor (FD) to the telecommunication

outlet (TO) shall be continuous without any joints or splices. Consolidation points (CP) are permitted provided Class E channel performance is maintained.

The length of each individual run of fixed horizontal cable from the floor distributor (FD) to the telecommunication outlet (TO) shall be based on the distance set out in the tables and formulas in ISO/IEC 11801 plus the appropriate length de-rating for maximum ambient temperatures above 20°C. Installed lengths may differ from the designed lengths as long as they pass testing.

The 4-pair UTP cable should be Underwriter Laboratories (UL) listed as type CM or CMR; or be nominated as LSZH to IEC 603332-3

The 4-pair UTP cable shall meet or exceed the following ISO/IEC 11801 requirements for cable;	
Conductor DC Resistance (Max):	9.38 $\Omega$ /100m @ 20°C
DC Resistance Unbalance (Max)	5%
Insulation Resistance (Min):	5000 M $\Omega$ /1km @ 20°C
Mutual Capacitance (Typical):	5.6 nF/100m
Characteristics impedance:	100 $\Omega$
Worst Case Cable Skew:	45 nsec/100 Meters

### 2.3 Data Centre, Equipment Room and Telecommunications Room Cable Terminations

The size, location and provisioning of services and facilities in the Equipment and Telecommunications Rooms (ER and TR) should be in accordance with AS/NZS 3084.

For copper voice circuits, the tenderer shall supply ADC KRONE HighBand 10-pair disconnect modules to terminate the incoming Service Provider cables, the outgoing Service Provider cables to the PABX, and the PABX Extension lines/cables. The mounting system shall be earthed as described later. These modules shall have the ability to accept overvoltage or surge protection devices, if required.

The Equipment Room (ER) and Telecommunications Room (TR) shall contain black ADC 19" Lab Rack units 44 RU in height, fitted with ADC glide cable management bays for vertical cable and patch cord management. All internal horizontal and/or backbone copper cables shall be terminated on rack mounted patch panels, or wall mounted Profil rods or back mount frames to suit either 8 or 25 pair ADC KRONE modules. The ER or TR must also house the rack mounted or wall mounted fibre termination units for termination of optical fibre cable as defined in the drawings.

Patch cords shall be provided when patching of voice and/or data circuits is required at the cross-connections to facilitate Moves, Adds and Changes (MAC's). The patch cords supplied shall be able to support the designed application, like 1GBE applications.

Lighting intensity on the front and back of installed terminations, patch panels and equipment should be 500 lux at 1m above floor to meet AS/NZS 3084 requirements. The lights should be situated to minimise shadows on the patching and termination areas.

#### 2.3.1 Racks and Cable Management

Tenderer shall utilise glide 19" racks, 44 RU high (product number 6460 1 141-00) for cable termination panels and for equipment mounting as appropriate. Locked cabinets may be used if additional security is warranted. All cabinets and racks shall be mechanically fixed to the floor and/or wall to prevent movement to themselves and the cables.

**Vertical cable and patch cord management** on the 19" rack shall be by attaching either a glide 150mm front only cable manager (product number ADCCMVIBS06F-2), or a 200mm (product number ADCCMS-08) or 250mm (product number ADCCMS-10) front & rear cable manager. Hinged covers matching the vertical cable management shall be fitted to hide and protect the cables and patch cords.

**Horizontal cable and patch cord management** between patch panels or equipment on the 19" glide cable management racks shall be 2 RU glide horizontal cable managers with front hinged-down cover (product number ADCCMHIB-2U). Horizontal cable and patch cord management at

the top, middle or bottom of the 19" rack shall be either 2 RU or 4 RU horizontal crossover troughs.

Fibre cable and fibre patch cord management shall be the ADC FibreGuide tray and channel system that utilises yellow plastic extrusions in 50mm, 75mm or 100mm wide troughs and moulded interconnection fittings. Trough exits shall utilise downspout fittings to maintain the minimum bending radius of the cables and cords.

### **2.3.2 Cross-Connect System**

Tenderer shall utilise Patch By Exception for copper cross-connection of termination modules at the backbone and/or horizontal crossconnect.

The crossconnect system inside Telecommunications Rooms (TR) shall consist of 2 modules per horizontal cable run.

On Module 1, 4-pair positions shall be connected from the top of the module to the network equipment by a System Tail with the RJ45 plug at the equipment end.

On Module 2, 4-pair positions shall be connected at the top of the module to the horizontal cabling from the TO.

The hard-wired jumper cable shall consist of 4-pair solid cable with sheath (the same cable as the horizontal 4-pair cable), and this will connect from the 4-pair positions on the bottom of Module 1 to the 4-pair positions on the bottom of Module 2.

On 8-pair Profil-mounted modules, where possible, the jumpering shall all be laid to the left of the Profil modules to facilitate future hinging of the module on that side.

The crossconnect terminations on Category 6 components shall be either;

- ADC KRONE Cat 6<sub>A</sub> modules, fire-retardant, moulded plastic UL94 V0 rated, mounted horizontally for ease of termination, with 8-pair or 25-pair disconnection contacts for incoming voice and/or data services up to 1GBE, or
- ADC KRONE RJ45 Cat 6 patch panels for incoming voice and/or data services up to 1GBE.
- Cross-connect jumper cable shall be Cat 6 of any suitable length, with sheath, terminated on the bottom of the module on the A-side to the bottom of the module on the B-side.
- For Patch By Exception installations and for patch cord cross-connect installations on HighBand25 modules, the length of the Cat 6 patch cord between modules shall be 1 metres or longer to maintain warranted performance. If a Consolidation Point is contained within the horizontal cable run, the minimum length patch cord shall be 2 metres.

Tenderer shall supply appropriate patch cords with factory-assembled plug-ends for mating with the termination modules. These patch cords are to be used as the "Exception" patching facility during temporary Moves, Adds and Changes.

Restoration of the original hard-wired jumper arrangement shall be by the removal of the "Exception" patch cords.

When the temporary "Exception" patching arrangements are to be made permanent, the appropriate modules shall be hard-wired using solid 4-pair fully sheathed cable, and the "Exception" patch cords shall be removed and stored for future use.

### **2.3.3 Termination Module**

The termination module shall be able to accommodate over 200 repeated wire insertions without incurring permanent deformation.

For up to Class E performance, the termination module shall be an ADC KRONE Cat 6 RJ45 modular outlet or a HighBand 8-pair or 25-pair disconnection module to allow test cords to isolate the cabling system for testing purposes.

The IDC contacts shall be capable of accepting two nominal 0.5 mm diameter copper wires per slot.

For all modules, the termination shall be able to accommodate 0.4 – 0.64 mm diameter solid copper conductors and 7/0.2 – 7/0.32 multi-wire stranded conductors.

The IDC contact element shall be set at 45° and made from special spring brass with silver plating. The wire contact area shall have 5 µm of silver-plating to ensure maximum reliability.

All components that are to be connected to a carrier's network must comply with the A-Tick requirements in accordance with the Telecommunications Labelling Notice.

#### **2.3.4 Copper Patch Panels, Rack And Cabinet-Mounted**

The modular outlet patch panel shall be a ADC KRONE Cat 6 panel with 8 pin modular sockets having a worst pair NEXT loss values for the outlet of >54dB at 100MHz and >46dB at 250MHz.

The patch panel shall be available in 16 or 24 port configurations in one rack unit height or 48 ports in two-rack unit height and shall fit into a 19" rack. Rear cable management shall be an ADC KRONE cable manager either steel or plastic (MasterMinder) to occupy the same height as the 1 RU patch panel.

The contact plating of the modular jacks shall have a minimum thickness of 1.3µm of hard gold in accordance with FCC CFR47 Part 68.5, over a minimum thickness of 2.0µm of nickel. The modular patch panel will have a plug insertion life of Level B reliability to IEC 60603-7.

ADC KRONE Patch Cord Minders shall be fitted so that there is one patch cord minder for every 2 x flat patch panels. The front and/or rear vertical rails of the cabinet shall be set back sufficiently to accommodate the patch cord minders.

When angled patch panels are used, the installation of patch cord minders is not mandated. However, the rack and/or cabinet must have sufficient space on the sides at the front to provide adequate room and support to contain the patch cords and their minimum bending radius.

#### **2.3.5 Optical Fibre Termination Unit, Rack And Cabinet-Mount**

The ADC KRONE 19" rack mount fibre termination unit shall provide crossconnect, interconnect or splicing capabilities.

The 19" rack mount fibre termination unit shall consist of a frame mountable housing for terminating and/or splicing fibre optic cables and allow for organisation of the fibre optic interconnects. The assembly shall have rear openings for cable entry, with posts to accept strain relief terminations and with fibre storage guide facilities for maintaining bend radius.

The 19" rack-mounting unit should be either 12 or 24 ports for one rack unit (1RU) and can be either a fixed position unit or have a slide or swing tray to improve access.

The adaptor plates shall be suitable for LC duplex SC simplex, SC duplex or ST couplings, and the adaptor plates should be installed to angle the through adaptors to the left or to the right of the panel to improve the patch cord management and provide eye safety due to accidental exposure to active fibres.

Connectors on all singlemode fibres (SMF) shall be fusion spliced on site. Connectors on all multimode fibres (MMF) should be fusion spliced on site for optimum performance.

#### **2.3.6 Patch Cords and System Leads**

Tenderer shall supply ADC KRONE Cat 6 patch cords and copper System Leads for cross-connection and/or inter-connection of termination modules, patch panels and network equipment.

The type of patch cords and system leads shall match the termination module used, ie 8-pair or 25-pair Cat 6 modules or Cat 6 RJ45 patch panel and the Cat 6 TOs.

All Cat 6 patch cords shall be factory terminated 4-pair UTP cable with lengths of 1.2, 2.1, 3, 4.5, 7.5, and 15 metres.

System Leads shall be supplied and installed to connect the network equipment to the cross-connect or interconnect modules. The system leads shall have 4-pair conductors with length and construction (stranded or solid) suited to the installation.

System Leads shall have an RJ45 plug on each end and shall be "cut in half" on site to achieve the desired lengths from network equipment to cross-connect module. Each System Lead will produce two (2) System Tails (RJ45 plug one end to IDC termination other end).

Tenderer shall supply ADC KRONE optical fibre patch cords to match the core size of the fibre used on the patch panels and network equipment.

The ADC KRONE Fibre Patch Cords shall;

- Consist of one or two single, tight buffered, multimode graded-index fibres with a 62.5 or 50 micron core or singlemode 9 micron core with 125 micron cladding to suit the installed OM1, OM3, or OS1 fibre optic cabling.
- Be used for optical fibre crossconnects and interconnects.
- Have the fibre cladding covered by Kevlar fibres and a protective outer jacket.
- Be factory terminated with LC, SC or ST ceramic connectors at each end.
- Meet the following specifications:-
  - a) Minimum bend radius: 25 mm
  - b) Operating temperature: -40 to +75° C
  - c) Loss: 0.75 dB per mated pair of connectors
  - d) Return Loss Maximum: -45dB
  - e) Cable OD: 3 mm
  - f) Tip material: Ceramic

### 2.3.7 Data Centre Cabling

Data Centres should be installed in accordance with ISO/IEC 24764 (draft). The minimum cabling requirements are:

- Class E<sub>A</sub> UTP is the minimum for copper cabling.
- Class OF-300 using OM3 is the minimum for optical fibre cabling.
- Requires LC connectivity for up to 2 multimode fibres at Equipment Outlets.
- Requires MPO connectivity for > 2 multimode fibres at Equipment Outlets.
- Requires LC/APC (angled) for singlemode fibres at Equipment Outlets.

## 2.4 Optical Fibre System

### 2.4.1 The Optical Fibre Cables

The multi-core optical fibre cable shall consist of multimode or singlemode fibre, with colour-coded fibres for identification.

Consideration should be given to the use of Pre-Terminated Optical Fibre cable for faster and easier installation.

The fibre cables shall meet the following transmission specification: -  
where, OFL = Overfilled Launch Bandwidth, **EMB = Effective Modal Bandwidth**

#### OM1 Specification

#### 62.5/125 µm Fibre

- |                           |   |
|---------------------------|---|
| a) Sheath colour (indoor) | Orange (if available), or black               |
| b) Maximum fibre loss:    | 3.5 dB/km at 850 nm<br>1.5 dB/km at 1300 nm   |
| c) Minimum bandwidth:     | 200 MHz.km at 850 nm<br>500 MHz.km at 1300 nm |

- d) Numerical aperture: 0.275
- e) Max length for GBE 300 m at 850 nm
- f) Max length for GBE 550 m at 1300 nm

**OM2 Specification**                      **50/125 µm Fibre**  
 This cable is not to be used as part of this specification.

- OM3 Specification**                      **50/125 µm Fibre**
- a) Sheath colour (indoor) Aqua (preferred), or black
  - b) Maximum fibre attenuation: 3.5 dB/km at 850 nm  
1.5 dB/km at 1300 nm
  - c) Minimum bandwidth: 1,500 MHz.km at 850 nm (OFL)  
2,000 MHz.km at 850 nm (EMB)  
500 MHz.km at 1300 nm
  - d) Numerical aperture: 0.2
  - e) Supported length for 1GBE 550 m at 1300 nm
  - f) Supported length for 10GBE 300 m at 850 nm

- OS1 Specification**                      **9/125 µm Fibre**
- a) Sheath colour (indoor) Yellow (preferred)
  - a) Maximum fibre attenuation: 1.0 dB/km at 1310 nm  
1.0 dB/km at 1550 nm
  - b) Cabled cut-off wavelength: <1260 nm
  - c) Supported length for 1GBE 5,000 m typical, depending on design & application
  - e) Supported length for 10GBE 5,000 m typical, depending on design & application

- OS2 Specification**                      **9/125 µm Fibre**
- a) Sheath colour (indoor) Yellow (preferred)
  - a) Maximum fibre attenuation: 0.4 dB/km at 1310 nm  
0.4 dB/km at 1383  
0.3 dB/km at 1550 nm
  - b) Cabled cut-off wavelength: <1260 nm
  - c) Supported length for 1GBE 5,000 m at least, depending on design & application
  - e) Supported length for 10GBE 10,000 m at least, depending on design & application

**2.4.2 Optical Fibre Cable Types**

Optical Fibre Cable types and installation shall comply with the following;

**Underground Installations**

Use ADC KRONE Underground Loose Tube moisture blocked OF cable with gel-filled tubes for all direct buried or conduit buried underground applications. Moisture blocked Outdoor/Underground OF cable must pass the “Water Penetration Test” as referenced in AS/ACIF S008. A sacrificial sheath over the nylon jacket is the preferred option for underground loose-tube OF cable.

Underground Loose Tube cable should be terminated as soon as practical after it enters a building and changed to an Indoor cable to minimise possible combustion risk.

**Outdoor Above Ground Installations**

Use ADC KRONE Outdoor Tight Buffered OF cable for all outdoors above ground applications. This cable has an UV-resistant sheath that can accept exposure to sunlight; however, this cable must be installed in weather-proof, UV-resistant conduit for protection against accidental mechanical damage, where necessary.

All outdoor conduits above ground shall be self-draining so that the indoor/outdoor OF cable does not lie in trapped or ponded water/fluid

Outdoor Tight Buffered cable may be used for Indoor Riser applications.

### **Indoor Installations**

Use ADC KRONE Indoor Tight Buffered OF cable for all internal Horizontal and Riser applications, except as noted above or in wet internal locations.

Indoor Tight Buffered cable may be used for Outdoor applications when the cable is installed in dry above-ground situations only, and it is contained in weather-proof, UV-resistant conduit to prevent accidental mechanical damage. ADC KRONE Indoor/Outdoor OF cable meets this requirement.

All indoor conduits shall be installed in such a way that the indoor/outdoor OF cable does not lie in trapped or ponded water/fluid.

### **2.4.3 Pre-Terminated Optical Fibre**

Where optical fibre cabling is specified on the drawings, consideration should be to the use of Pre-Terminated Optical Fibre (PTOF) cable to minimize installation time. The cable shall be pre-terminated with the appropriate style of connector to suit the requirements (like LC or SC style).

The length of the PTOF shall be measured from FOBOT to FOBOT (Fibre Optic Break Out Tray) and there shall be an additional 650 mm minimum breakout length of fibres, located in each FOBOT, for direct connection into adaptors.

### **2.4.4 Colours For Optical Fibre Adaptors, Connectors and Cables**

Where possible, optical fibre adaptor colours and connector colours for 3 mm patch cords should be;

OM1 62.5µm	Beige
OM3 50 µm	Beige, or Aqua
OS1 9 µm	Blue (UPC – Ultra-polished Physical Contact – flat) or Green (APC – Angled Physical Contact at 8 degrees)

The preferred sheath colours for optical fibre patch cords should be;

OM1 62.5µm	Orange
OM3 50 µm	Aqua
OS1 9 µm	Yellow

## **2.5 Building Distributor and Equipment Room**

The size, location and provisioning of services and facilities in the Building Distributor (BD) and/or the Equipment Rooms (ER) should be in accordance with AS/NZS 3084.

For copper voice circuits, the tenderer shall supply ADC KRONE 10 pair disconnect modules to terminate the incoming Service Provider cables, the outgoing Service Provider cables to the PABX, and the PABX Extension lines/cables.

The Equipment Room may contain telecommunications equipment and other communications equipment such as CATV, Public Address, CCTV, Security, Fire Alarm, and Audio. The ER may also contain computers, small UPS equipment, and other Building Automation Service (BAS) equipment. UPS equipment greater than 100 kVA needs to be located at least 3 m away from the Distribution/Equipment Room to reduce electrical noise.

All cabinets and racks shall be mechanically fixed/bolted to the floor and/or wall to prevent movement to themselves and the cables.

Lighting intensity on the front and back of installed terminations, patch panels and equipment should be 500 lux at 1m above floor to meet AS/NZS 3084 requirements. The lights should be situated to minimise shadows on the patching and termination fields.

## 2.6 Overvoltage Protection

The tenderer shall make provision to supply ADC KRONE overvoltage protection to all incoming lines from the Service Provider and to all above ground and underground lines between buildings in a campus wiring design. The provision for overvoltage protection includes installation of correct earthing at least 6 mm<sup>2</sup> to the mounting frames and racks.

The installation of the arrestor magazines shall be as agreed with the system designer and in any installation in the region of and above the Tropic of Capricorn and in Western Australia this is considered a requirement.

### 2.6.1 Overvoltage Protection up to 16Mbps

Tenderer shall supply ADC KRONE overvoltage magazines complete with 230 volts fail-safe overvoltage arrestors for all incoming copper pairs to protect the incoming Service Provider lines and any outside plant multi-pair copper cables against any overvoltage surge and minimise the damage that may be caused by lightning.

For lightning and overvoltage protection tenderer shall supply ADC KRONE ComProtect maintenance-free 5-point solid state surge protection devices for voice applications and data applications up to and including 16Mbps.

### 2.6.2 Overvoltage Protection above 16Mbps

For of data applications above 16Mbps, install ADC KRONE gas discharge arrestor 3-point surge protection devices for overvoltage protection.

The electrical protection devices supplied by the tenderer shall be in either 10 pair form or a single-pair protection unit.

The gas-tube protector units shall meet the following standards:

DC Sparkover Voltage (at 100V/sec):	230V +/-20%
Impulse Sparkover Voltage (at 100V/microsec):	500V (max)
Impulse Sparkover Voltage (at 1KV/microsec):	650V (max)
Insulation Resistance at 100Vdc:	10,000 MΩ (min)
DC Holdover Voltage:	135V (max)
Capacitance (1 MHz):	3.0pF (max)

## 2.7 Earthing and Bonding

At each and every ER, TR, BD and FD location the tenderer shall supply a Communications Earthing System (CES) as a dual-purpose telecommunications earthing system used for both functional earthing and protective earthing purposes.

Earthing conductors used for a CES system have green/yellow insulation. The size of the earthing conductor shall be a minimum of 6 mm<sup>2</sup> to allow for the installation and operation of overvoltage protection equipment.

All CES conductors from each frame and cabinet shall be connected to a Communications Earthing Terminal (CET) Block located not more than 10m away. The CET shall be in the vicinity of an electrical switchboard and shall be bonded to the electrical protective earth by a Communications Bonding Conductor 6 mm<sup>2</sup> minimum with green/yellow insulation. The tenderer shall supply and install the communications bonding conductor from the CET to the electrical protective earth system. The resistance of the communications bonding conductor shall not exceed 0.5 ohms.

Metallic pathways shall be earthed with 2.5mm<sup>2</sup> green/yellow earthing conductor connected to the building and/or the electrical protective earth system.

All terminations at the electrical protective earth at an electrical switchboard shall be done by a licensed electrical contractor.

The tenderer shall supply and install the CES conductors, the CET blocks and all earthing conductors up to the protective earthing point.

## **2.8 System Performance**

Channel performance is the preferred acceptance criteria for all installations if possible. All Permanent Links are to be installed and all end-user patch cords, equipment cords and work area cords should be in place, and left in the position where they were tested.

Where this is not practical, the Permanent Link performance will be the acceptance criteria for the installation.

### **2.8.1 Channel Performance**

Channels shall meet the appropriate minimum requirements of; ISO 11801 for Class E (using Cat 6 components).

### **2.8.2 Permanent Link Performance**

Permanent Links shall meet the appropriate minimum requirements of; ISO/IEC 11801 for Class E (using Cat 6 components).

Alien Crosstalk (AXT) testing is not required; therefore no AXT sampling plan is necessary for this project.

## **3. INSTALLATION STAFF AND EXPERIENCE**

The successful tenderer shall supply a list of names of installation staff and their ADC KRONE Master Installers certificate number. All certificate numbers must start with the letter 'C' signifying Competency to be a valid certificate. This requirement does not apply to apprentices or trainees under the full-time supervision of an ADC KRONE Master Installer. Certificate numbers starting with the letter 'A' signifying Attendance are not valid as ADC KRONE Master Installers.

Tenderer shall state when each staff was last trained by formal ADC KRONE Master Installer training.

Tenderer shall provide a list of their technical support staff listing their working experience in the relevant field.

Tenderer shall state the nearest location of their principal support centre. This centre shall have permanently stationed support staff that is capable of providing technical support effectively and efficiently.

## **4. APPLICATION ASSURANCE AND WARRANTY**

Tenderer shall provide at least a 20 year Warranty for Class E Channel performance of the Cat 6 Channel Solutions backed by ADC KRONE's 20 years warranty from the date of successful completion of testing and commissioning of the Structured Cabling System.

The 20 year application assurance shall cover the failure of the offered cabling system to operate the applications that the system was initially designed to support, ie those identified in the current (at the time of tendering) versions of the Cabling Performance Specifications (that is the ISO/IEC 11801 or ANSI/TIA 568-B.2-1).

## **5. COMPLIANCE TESTS**

The installer must individually test 100% of the UTP cables and fibre optic cables after installation of the cables to determine compliance to ISO/IEC 11801 performance requirements. Where ever possible, progressive testing of both fibre and copper Permanent Links or Channels is recommended to ensure errors or unacceptable installation practices are minimised on the site.

All test results, including Passes, 'Star-Passes' and Failures, shall be kept by the installer prior to customer acceptance of the site. At customer acceptance, the final test results shall be given to the end user for retention during the period of the warranty.

ADC KRONE accepts PASS and \*PASS results after consultation, but does not accept cable runs with FAIL as part of the normal Warranted installation.

Prior to acceptance by the customer, all compliance test results shall be made available to ADC KRONE to verify PASS and \*PASS results. Any rectification work and re-testing of cable runs containing a FAIL shall be at the installer's expense.

## 5.1 Class E Performance Testing on Cat 6 Installations

The Structured Cabling System shall be tested by the installer for compliance to the requirements specified in the latest ISO/IEC 11801 standard for Class E performance using Level 3 testers or better in accordance with AS/NZS IEC 61935.1 – Testing.

A certain percentage of the outlets may be chosen at random for the final acceptance testing by the end-user or in their absence, by ADC KRONE. The design data and the full results of all compliance tests performed by the installer are to be fully documented and submitted to end-user to hold for the period of the warranty.

The results must include 100% of total installation and provide full electronic data files for each cable run indicating the name of the person doing the testing, date, building, cable identification, cable length, Insertion Loss, NEXT, PSNEXT, ACR, PSACR, Propagation Delay, Delay Skew, ELFEXT, PSELFEXT, and Return Loss. Length alone is not considered to be a pass/fail criterion.

Alien Crosstalk (AXT) testing is not required; therefore no AXT sampling plan is necessary for this project.

The compliance criteria shall be in accordance with the compliance requirements set out in ISO/IEC 11801 for the Class E copper Permanent Link or Channel.

## 5.2 Optical Fibre Link Testing

### 5.2.1 Test Requirements

All multimode and singlemode optical fibre links must be tested for;

1. Continuity and Maintenance of Polarity
2. Length
3. Propagation Delay
4. Optical Attenuation of Link, 2 x wavelengths, 2 x direction

Conduct the tests in accordance with ISO/IEC 14763-3 and ADC KRONE's Performance Testing of Optical Fibre Links For Compliance To ISO/IEC 11801, using Light Source and Power Meter (LSPM). An OTDR is not acceptable for Link loss measurements.

Where LSPM results exceed the Power Loss Budget, the link shall be investigated with an OTDR to determine the location of the faulty component.

### 5.2.2 Reference Setting (Zeroing) Methods for LSPM Testers on MMF and SMF

The 1- Test Cord, Method B, of Reference Setting as per CI 9.1.1.2 of ISO/IEC 14763-3 alternative method is the Warranty Provider's preferred method of testing if the connectors are the same on the LSPM tester and the Link to be tested (E.g. LC on tester Receive port and both ends of the installed optical fibre cable Link).

Where the connectors on the LSPM tester are different from the connectors on the Link to be tested (E.g. SC on tester Receive port and MTRJ on Link), the 3-Test Cord Method of Reference Setting as per CI 9.1.1.2 of ISO/IEC 14763-3 Ed2 shall be used.

### **5.2.3 Use of Mandrels or Coils (for both 1 & 3-Test Cord Methods)**

For MMF, the LSPM Tester shall have the correct Coupling Power Ratio for the cable under test. This can also be achieved by using a Mandrel Wrap on the Launch Cord for mode stripping during Reference Setting and Testing.

For a 3 mm Launch Cord, 5 turns on 17 mm Ø for 62.5 µm  
5 turns on 22 mm Ø for 50 µm

For SMF, the LSPM test launch cord shall have at least 2 x turns of 40±5 mm diameter, air-coiled or on a mandrel, for stripping light out of the cladding and more consistent readings.

### **5.2.4 Reference Cords and Field Calibration Cords (for both 1 & 3-Test Cord Methods)**

All Reference Cords & Field Calibration cords shall be Qualified.

Launch and Tail Reference Cords for MMF & SMF LSPM testing shall be 1m to 5m each and have a Reference Connector at the non-tester end.

Field Calibration Cord shall not exceed 2m and shall have Reference Connectors at both ends.

Reference Connectors shall be the same type of connectors as the cabling to be tested.

Reference Connectors shall have an attenuation of ≤ 0.10 dB for MMF, and ≤ 0.20 dB for SMF

### **5.2.5 Compliance Criteria**

The compliance criteria shall be a PASS for all of the tests listed under Test Requirements. The Optical Attenuation of the Link shall not exceed the Power Loss Budget calculated in accordance with the losses set out in **ISO/IEC 14763-3 for the test cords** and ISO/IEC 11801 for the optical fibre components that make up the Link. For an ADC KRONE warranty, the optical fibre installation must pass the requirements and test methods set out in the ADC KRONE document Performance Testing of Optical Fibre Links **Using ISO/IEC 14763-3**.

## **5.3 Test Result Documentation**

A copy of the full "Plot Data Enabled" test results for each copper cable run and each core of each optical fibre cable run shall be supplied to the end user in a recognised test vendor's application format like Fluke LinkWare or Agilent DataScope Pro or LANTEK Reporter. In addition, a CD in a 'Microsoft Windows' Office application format may be submitted.

## **6. CUSTOMER ACCEPTANCE**

At the conclusion of the installation a preliminary walkthrough with the installation contractor will be performed to check for installation quality, accurate performance of the work, and to verify engineering diagrams. Any modifications to the documentation or the installation that may be required shall be accomplished within a 2 week period.

"Customer Acceptance" shall consist of a final walkthrough with the installation contractor. The walk through shall be scheduled within 3 weeks of the completion of the installation in order to turn the project and documentation over to the end-user. "Customer Acceptance" does not release the installation contractor from repairing any cabling errors or improperly labelled circuits, caused by the installation contractors that may be discovered at a later date.

## **7. EQUIPMENT AND MATERIALS SHALL BE NEW**

All cabling and connection equipment and materials supplied shall be new ADC KRONE approved products.

The Contractor shall check the surface finishes and paintwork around his area of installation and touch-up or repair/replace all damaged parts after the installation of cabling and equipment.

The Contractor shall provide ADC KRONE literature including data on maintenance and operation of all

equipment installed. Relevant catalogues of all materials, instruments, equipment, and components, to be supplied shall be included in this Tender.

All ADC KRONE equipment and materials shall be permanently and legibly marked to indicate clearly the ADC or KRONE name as the manufacturer or the ADC and/or ADC KRONE registered trademark.

## 8. LABELLING AND NUMBERING

Each piece of equipment, patch panel and outgoing cable from the patch panels shall be labelled. Corresponding labelling and numbering shall also be provided on the telecommunication outlets.

Equipment racks/cabinets should be labelled from bottom to top, left to right, omitting the letters “I” and “O”.

All cable labels should be of clear wrap around self-adhesive type or slip-on plastic ring type or a long plastic strip type fixed onto each cable. Each cable is to be labelled at each end 100 - 150mm from the termination point. Lettering on the label is to be machine typed.

Telecommunication Outlets are to be labelled with an approved label secured to the outlet faceplate/cover in a prominent position, firmly affixed.

Cable and TO numbering shall be the same and should be in the format of; “BUILDING-FLOOR-ROOM-NUMBER”. The designations can be letters or numbers. Room is optional. NUMBERS must be in sequential numbers. Use a dash between each designation with no spaces.

Consolidation Points are to be additionally labelled with the distance back to the FD, in metres.

MUTOs are to be additionally labelled with the maximum allowable patch cord length in metres, as per the MUTO cabling design.

### 8.1 Colour Codes For Module Labels or Patch Panel Labels for Communications Cabling

The following colours be used as the background paper/cardboard for labels attached to modules or patch panels. The printing on the label shall be Black.

<b>Communications Module Function for the terminating cables</b>		<b>Recommended Label Colour</b>
CD to BD	Campus Backbone	Brown
BD to FD	Backbone Riser	White
FD to FD	Backbone Tie Cables	Grey
FD to TO	Horizontal Cable	Blue
System Tails	Equipment Ties	Purple
Network Boundary	Carrier Side	Orange
Network Boundary	Customer Side	Green
PABX Ties	Key Telephones	Red
Wireless Access Point	Cabling	Yellow

### 8.2 Colour Codes For Module Labels or Patch Panel Labels for BMS Cabling

BMS colour codes are currently non-standards colours; however, these are the requirements for this specification for labels attached to Modules at BMS Application Service Connection Points: (on specific BMS cabling)

The printing on the BMS label shall be Red to distinguish it from telecommunications module label colours.

<b>BMS Module Function for the terminating BMS cables</b>	<b>Recommended Label Colour</b>
Climate control	Blue
Intercom services	Grey
Lighting control	Aqua
Nurse Call services	Pink
Public Address	Orange
Security/Alarms/Access control/CCTV	Yellow
Video services	Violet

## 9. CABLING INSTALLATION REQUIREMENTS

### 9.1 General

All cables shall be run and installed in a workmanlike manner in accordance with AS/ACIF S009 Wiring Rules for safety and network integrity, and ISO/IEC 11801 for performance, and the following ADC KRONE requirements.

The Installer shall plan the cabling system and routing ensuring adequate segregation from electrical and hazardous services, ensuring system integrity and performance, ensuring that it does not present problems of maintenance or access, and ensuring there is no conflict with the operation and maintenance of other systems.

The Tender shall give full details of the type of cables to be used including the type of termination, identification method, method of installation and limitations (if any).

Termination of cables in the CD/BD/FD/ER or Data Centre shall be on racks, frames or wall-mount assemblies to suit the selected modules and/or patch panels. All cabinets and racks shall be mechanically fixed/bolted to the floor and/or wall to prevent movement to themselves and the cables.

Cable installed underground either direct buried or buried in conduit shall be of gel-filled Loose Tube construction that meets the requirements of the 'Water Penetration' test specified in IEC 60794-1-2 Clause 25, Method -F5B. In addition, such cable shall not allow fluids to penetrate through the sheath.

To comply with the identification requirements of AS/ACIF S009, cable shall not be painted. Occasional overspray from Acrylic water-based painting can be acceptable provided the overspray coverage does not exceed 1m length on the cables.

All metal pathways should be bonded to the building earth system thereby providing a bonding conductor facility to minimise the effects of noise coupling.

No cables in any tray or duct shall be higher than the sides of the pathway unless the cables are exiting the pathway.

### 9.2 Copper Cable

Do not arrange any Cat 6 or Cat 6<sub>A</sub> cables within bundles or in a tray in straight lines. Leave them in a random lay to help minimise external alien crosstalk between the cables. This is the ADC KRONE 'Random Lay In Bundle And Tray for Cat 6 cable and Cat 6<sub>A</sub>' principle.

Where cables are grouped into a bundle;

Cat 6<sub>A</sub> cables shall be grouped together in bundles not exceeding 24 cables per bundle.

Cat 6 cables shall be grouped together in bundles not exceeding 24 cables per bundle.

Cat 5 cables shall be grouped together in bundles not exceeding 32 cables per bundle.

Do not mix Cat 6 and Cat 6<sub>A</sub> cables in the same bundle.

The untwist in a pair at the IDC termination shall be less than, 13 mm for C5e and 5 mm for C6 and C6<sub>A</sub>.

**ISO/IEC 11801 requires** Cat 6<sub>A</sub> permanent links to be at least 15 m long to minimise NEXT or RL issues like \*PASS. For runs less than 15 m obtain the manufacturer's approval before installation.

Cat 6 and Cat 6<sub>A</sub> cables shall be secured with Velcro™ at least 6 mm wide or approved elastic ties. Use Velcro™ or approved elastic ties applied at random spacings up to 300mm apart on catenary wires.

Provide adequate support for all cabling that is vertically installed, ensuring that the weight of the cables is sufficiently supported. Use Velcro™ or approved elastic ties at approx 300mm vertical spacing.

Bend Control accessories (e.g. 'water-falls') shall be used at any change of vertical direction by more than 45 degrees to restrict cable bending during and after installation so that all cables are supported and the minimum bend radius is not exceeded

Cables shall be installed such that all coils and any bends follow the natural spiral lay of the cable.

Cables shall be installed so as not to exceed the minimum bending radius. For UTP, use a bending radius not less than 50 mm radius (100 mm dia) during cable pulling, and not less than 25 mm radius (50 mm dia) for hand placement on horizontal runs e.g. at the TO or in skirting ducts. For tighter bend radius applications, obtain the manufacturer's approval before installation. For shielded cables use a bending radius of not less than 65 mm.

For Cat 6 and Cat 6<sub>A</sub> cable installations, the provision of spare cable should be avoided by good design and careful selection of termination locations. However, if specified on the drawings, allow for approx 2 – 3 metres of spare in the cable runs at the FD (by J-bends or U-bends in the cabinet/rack) and possibly at the entry to the service pole or skirting duct containing the TO. Place this spare cable in such a manner that it is fully supported and that the minimum bending radius is maintained. Spare cable shall not be stored inside service poles or skirting ducts. If spare cable is contained in loops, there shall be no more than 4 loops in a coil at any one location and each loop shall be of different diameter with minimum diameter of 300 mm.

Cables shall be installed so as not to exceed the maximum hauling tension of 11kg for Cat 6 and Cat 6<sub>A</sub> cables and CopperTen Cat 6<sub>A</sub> cables.

Consolidation Points, if installed, shall be at least 15 m away from the FD. The minimum cable distance between FD and TO is 15 m (where no CP is present). The minimum cable distance between CP and TO is 5 m.

A single Multi-User Telecommunications Outlets (MUTO) shall service a maximum of 12 work areas. The MUTO shall be located in areas accessible to the end -user without the need for tools or ladders. . A MUTO shall not be installed in a ceiling or under a floor unless it is accessible by lifting the lid of a factory-built MUTO box at ceiling or floor level.

Red sheathed horizontal fixed copper cabling shall be reserved for fire detection/alarm services.

Cables that penetrate fire barriers shall have the penetrations suitably fire-stopped by qualified operators as required by local building code regulations/laws.

The amount of un-twist in a pair at any termination shall be no more than 13mm for Cat 5, 10mm for Cat 6 and 5 mm for Cat 6<sub>A</sub>.

The amount of cable sheath stripped back at any termination shall such that the sheath terminates approximately 10 mm or less from module or socket housing for C5, C6 and C6<sub>A</sub> cables.

### **9.3 Optical Fibre Cable**

Bend Control accessories shall be used to restrict cable bending during installation and operation so that minimum bend radius is not exceeded as specified in the relevant cable technical data sheet. **If no data sheet is available, the minimum bending radius shall be 25 mm for all pig-tails and patch cords up to 3 mm diameter, and at least 10 times the diameter for all other multi-core fibre cables under no-load and**

20 times the cable diameter during installation or long-term under load.

Cables shall not be installed at a pulling tension that exceeds their specified limited as per in the relevant cable technical data sheet.

Cables used in a building shall be of Tight-Buffered LSZH (low smoke zero halogen) construction and shall be resistant to UV radiation where the cable is exposed to direct sunlight.

Multi-core optical fibre cable shall be fixed to the vertical pathway at approximately 500 mm spacing using firm or elastic ties or Velcro™. Loose-tube and loose-buffered cables installed vertically should have at least 3 coils of at least 0.5 metre diameter located at approx 20 m intervals to limit vertical loads on the fibres in the cable. The coils shall be fully supported to carry the weight of the cable to the next supporting coils.

Cable enclosures (e.g. pits or pull boxes) shall be capable of accommodating the specified minimum bend radius of all installed cable as a bundle.

Optical fibre cables may be installed on the same tray as copper data & voice cables or LV electrical cables provided the optical fibre cables are kept separate from all other cables on the tray by either a physical barrier or a separation distance of at least 25 mm for the entire length. Use a sub-duct for optical cables in LV conduits. These separations are for future maintenance reasons during the life of the warranty period.

Optical fibre cables occupying the same conduits as LV power cables shall be installed in sub-ducts to maintain the integrity of the optical fibre cable during installation and future maintenance.

Cables shall not be installed in areas of elevated temperatures above the warranted temperature, or housed in hydrogen atmospheres such as corroded metallic ducts.

Cable direct buried shall be in suitably prepared ground such as well-tamped surrounding sand or soft soil.

Consideration must be given to minimising the risk of damage to underground cable through vehicle and structural loading or soil movement or severe bending radius or above-ground impact. Underground cable must be suitably protected where it enters and exits the ground against UV radiation and mechanical impact.

#### 9.4 Pathways - Continuous

Continuous pathways are Tray (flat or slotted), Ducts (in-floor, perimeter, skirting), Conduits, Power Poles or Blades or similar.

The recommendations in AS/NZS 3084 Pathways and Spaces should be followed.

For continuous pathway systems, the stacking height of cables shall not exceed 150 mm or the height of sides of the pathway.

Use flat or slotted tray with high sides to provide the best protection against electrical noise.

All cable trays, catenaries and ductwork required to complete the installation will be the responsibility of the Tenderer to supply and install. The installer is to liaise with end-user, and/or main contractor when strip-out of existing floors commences to evaluate if any existing cable tray or ducts can be re-used.

The recommended width of surface/skirting ducts is 50mm to accommodate the minimum bending radius of Cat 5, Cat 6 and Cat 6<sub>A</sub> cables.

For 3-compartment communications ducts and 'Side Termination' method on outlets:

- 50H x 50D mm compartment shall contain no more than 18 x C6<sub>A</sub>, or 24 x C6 or 32 x C5 cables.
- 40H x 50D mm compartment shall contain no more than 15 x C6<sub>A</sub>, or 24 x C6 or 32 x C5 cables.
- 35H x 40D mm compartment shall contain no more than 10 x C6<sub>A</sub>, or 18 x C6 or 24 x C5 cables

All necessary pathway penetrations and access between floors is the responsibility of the Tenderer to provide, and to ensure all penetrations and access holes at the completion of the installation are fully sealed to local authority requirements and fire regulations by qualified personnel.

Conduits shall be designed to have a maximum cross-sectional area Spare Capacity of 50% for the occupying cables. Examples of approx number of cables in a pathway with a Spare Capacity of 50% are;

50 mm Height Tray / Trough				Circular Conduit			
Width	Cat 6 <sub>A</sub>	Cat 6	Cat 5e	Conduit Dia	Cat 6 <sub>A</sub>	Cat 6	Cat 5e
50	18	24	32	20 mm	2	4	6
100	30	55	80	25 mm	4	7	10
200	60	110	150	32 mm	7	12	17
300	90	160	230	50 mm	18	30	40

Floor box in concrete floors for telecommunications cabling shall be supplied/serviced by at least two 32 mm diameter conduits.

Support all cabling within the false ceiling space or under indoor raised flooring by steel cable tray, trunking, ducting, or catenary wires, fixed by manufacturer approved hangers and methods onto structural building or flooring elements. All conductive pathways should be earthed to protective earth from the electrical distribution board on the floor where such cable tray is installed. A licensed electrical contractor must make the connection to the electrical distribution board protective earth.

Before cable is installed and after installation, ensure that conduit, trunking and tray is thoroughly clean of any extraneous material such as cable scraps, dust, dirt, construction debris and moisture. Any cable that has been subjected to immersion in fluid shall have the pathway dried and cleaned and the cable shall be completely replaced with new clean dry cable.

Co-ordinate all trunking, ducting, conduit and tray work with other services on site as necessary.

Conduits and ducting protruding through a floor shall extend between 50 mm and 75 mm above estimated finished floor level.

Where cables exit a tray, provide protection from sharp edges and cable support at the minimum bend radius during the installation process and after completion.

Where cables are installed in partitions or false walls through sharp-edged metal studs, ensure bushings are secured in these penetrations to protect cables.

Restrict conduit runs to no more than 30m of continuous run inside a building between hauling points.

Restrict any single pull to no more than two (2) x 90-degree bends, in conduits or ducts.

The pathway system shall otherwise be installed in accordance with the manufacturer's instructions.

## 9.5 Pathways - Non-continuous

Non-continuous pathways are Wireways (mesh, ribs), Catenaries, Hooks or Bags. Where non-continuous pathways are used to support cable systems, the following minimum requirements shall be followed.

The recommendations in AS/NZS 3084 Pathways and Spaces should be followed.

Cables and cable supports shall not be attached to ceiling hangers/supports.

Catenary wires shall be anchored to structural elements of the building and not to any service or support accessory.

The maximum number of cables on one catenary shall be 2 x bundles of 32 for Cat 5e or 2 x bundles of 24 for Cat 6.

The maximum sag of a pathway when fully-loaded with cables shall not exceed 150 mm between any two supports.

Mesh trays and cantilever bar systems (e.g. Whalebone type) for general use shall have metallic or non-metallic crossbars at 100 mm spacing or less.

Around external corners, the maximum unsupported cable span shall be 150mm. Otherwise use a flat durable sheet in the bottom of the pathway to support the cables.

Curved bend control accessories that support the cables shall be used to fully support the cables over the bend surface and maintain a minimum bend radius of 50 mm in all situations where the cable or the tray/mesh drops down at an angle of 45 degrees or greater.

For non-continuous pathway systems, the stacking height of cables shall not exceed 90 mm or the height of sides of the pathway. The height is reduced to 75mm if the cross bar spacing is up to 120mm in special use trays. This ensures there is not too much weight on the bottom cables that rest on the crossbars.

The clearance above the sides of the tray/mesh shall be at least 1/2 the width of the tray with 100mm as the minimum clearance.

Supports for non-metallic mesh shall be at 1 m spacing or less and the maximum sag between supports should be less than 200 mm when fully loaded.

J-Hooks shall be positioned at 800 mm spacing or less.

The surface of the hook that supports the cable shall be smooth and at least 34 mm wide with rounded-off edges under the cables.

When supporting a single cable on plastic cable clamps use at least 6mm wide clamps for C5e and C6 and 8mm wide for C6<sub>A</sub> cables. When supporting 2 x C5e or C6 cables use a 6mm TPS cable clamp. The spacing between cable clamps shall be 500 mm for vertical runs and 300mm for horizontal and any angled runs. Metal or plastic conduit saddles shall not be used for supporting communications cables.

The fixings of any cable support system shall be onto the building structure by solid mechanical means, not adhesive means.

Non-continuous support pathways should be run in straight lines following the building lines, not a diagonal or zig-zag fashion.

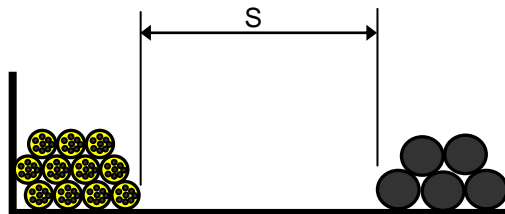
The pathway system shall otherwise be installed in accordance with the manufacturer's instructions.

## **9.6 Separation**

The minimum separation between the fixed telecommunications cabling and parallel runs greater than 3 m in length of LV fixed electrical cabling for performance and noise reduction reasons shall be at least those shown in Table 1, for Separation of UTP IT/Comms Cable from Unscreened Power Circuits

**Table 1**

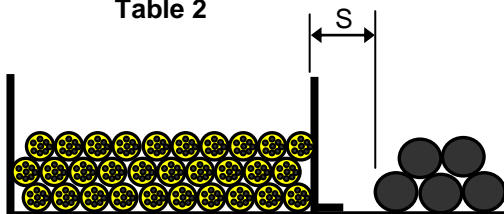
Metallic Tray or Mesh –  
With No Divider or with a  
Non-metallic Divider



No. Power Circuits @ 240 Vac		Separation Distance S in mm		
		0-15	16-30	31+
Environment	Current per circuit, up to			
E <sub>1, 2 &amp; 3</sub>	16 A	50	100	300
	20 A	200	300	600
	30 A	200	300	600
	60 A	300	600	600
	100 A 3Ø	600	600	600

**Table 2**

Metallic Tray [Not Mesh] –  
With Bonded, Solid or Slotted  
Metallic Divider, or  
Separate Metallic Trays,  
Bonded & Earthed



No. Power Circuits @ 240 Vac		Separation Distance S in mm		
		0-15	16-30	31+
Environment	Current per circuit, up to			
E <sub>1, 2 &amp; 3</sub>	16 A	25	50	75
	20 A	50	75	150
	30 A	50	100	150
	60 A	150	300	300
	100 A 3Ø	300	300	450

The minimum separation between the fixed telecommunications cabling and electrical devices for performance and noise reduction reasons shall be at least those shown in Table 3, Separation of UTP IT/Comms Cable from Electrical Devices.

**Table 3**

Electrical Noise Generating Device	Minimum Separation Distance
Copiers	500mm
Electrical Contactors	500mm
Lamps, Fluorescent, MV, Hi Discharge, Neon	150mm
Large hp Motors and Controllers	More than 3m
Radio, TV, Mobile	More than 300m
Thermostat Switches	500mm
Transmitters	
< 1 watt	More than 3m
1 – 3 watts	More than 3m
UPS	
1 – 10 kVA e.g. 1 or 2RU By-pass type UPS	75mm
10 – 100 kVA e.g. large By-pass type UPS	Approx 100 mm per 10 kVA
>100 kVA e.g. larger on-line type UPS	More than 3m preferred

For non-warranted sites where performance is not the primary requirement, the following safety requirements shall be maintained. A minimum of 50 mm separation between the fixed telecommunications cabling and parallel runs of LV electrical cabling. If the run parallel to LV electrical cables is less than 50mm, separate the two with a solid durable barrier (if metallic it should be protectively earthed) for the entire length of run less than 50 mm separation. Where fixed telecommunications cables cross electrical cables, the crossing shall be at right angles with 50mm separation (or a protective conduit/barrier extending 50 mm both sides of the crossing) with both sets of cabling securely fixed in position to prevent any relative movement or change in the separation. These safety separation/segregation are set down in AS/ACIF S009 – Wiring Rules.

Where fixed cabling is installed inside modular furniture partitions and similar enclosures or in service poles, maintain the 50 mm safety separation or have a solid durable separation barrier as per AS/ACIF S009. Wherever possible, maintain a performance separation of up to 300 mm from LV power cables to minimise noise induction. Install cables in partition ducts/trays, free from protrusion of screws and similar sharp fasteners that may damage the cabling. Remove or cover all sharp edges on the cabling pathway.

Where patch cords are installed behind removable panels in modular furniture or in under-desk pathways, maintain a separation from LV power of 10 mm if possible. The preferred length of patch cords running continuously in parallel with LV power under desks plus in 'umbilicals' is 5 m maximum.

In 'umbilical' pathways associated with modular office partition systems, the LV power and the telecommunications cables shall use separate compartments. No additional separation or barriers are required within the separate channels of an umbilical pathway. The end fittings for umbilical pathways shall be such that the minimum bending radius of the communications cables is not exceeded at either end.

## **10. DOCUMENTATION**

The contractor shall provide complete documentation covering the installation and maintenance of the Structured Cabling System. This includes "as built" drawings showing the location of all installed equipment and racks in all Telecommunications Rooms, all main cable runs, cable trays and catenaries, CPs, MUTOs and TOs, complete with outlet numbering.

### **10.1 Quantity**

The Tenderer shall provide three complete sets of documentation. As built drawings shall be provided within 14 days of sectional or partial completion of any part of the project to the project manager and/or the client showing all main cable runs, locations, identifications and destinations.

### **10.2 Printing And Binding of Documentation**

The Tenderer shall provide installation/system manuals, product datasheets and all other documentation in suitably labelled, A4 sized binders. All binding shall be of a high quality to provide for a long and durable service.

### **10.3 Document and Drawing Sizes**

All documentation shall be typed on either single or double-sided A4 pages. Drawings shall where practicable, be on A4 size however, A3 or A1 sizes may be used for larger drawings.

### **10.4 Installation/Systems Manuals**

The Installation/Systems Manual shall cover the following areas:

1. A detailed overview of the building cabling system,
2. Full description of the specific installation,

3. Full schematics showing the overall layout of the installation, and
4. Floor layout drawings showing the location and designation of each outlet, location of cable trays and ducts and location of all connection frames.

#### **10.5 Test Result Documentation**

A copy of the full "Plot Data Enabled" test results in tester format for each copper cable run and each core of each optical fibre cable run shall be supplied to the end user on CD in a recognised test vendor's application format like Fluke LinkWare or Agilent DataScope Pro or LANTEK Reporter. PDF files are not acceptable.

**–END –**

# Appendix 1 General TrueNet™ System Warranty Checklist

Refer to ADC KRONE Specifications for detailed and further requirements for a TrueNet System Warranty

Installation Feature	TrueNet Installation - Sample Requirements	Checked By Initials / Date
Standards Compliance	All installations are in accordance with the latest version of ISO/IEC 11801 for Cabling Performance and AS/ACIF S009 Wiring Rules.	
Horizontal Run Distance	<90 m at 20°C and <82m at 40°C, with cable labels both ends. 'Random Lay in Bundle and Tray for Cat 6 cable and Cat 6A'. Min cable lengths preferred are FD-CP 15m, CP-TO 5m, FD-TO 15m (if no CP). Connect shielded cable to shielded sockets both ends. Earth at FD end only. Use unearthed UTP work area cords.	
Patch Cord Length	<10 metres total work area, patch & equipment cords, or else reduce horizontal Permanent Link length to compensate. Use only ADC KRONE approved lengths for C6 or C6 <sub>A</sub> Warranty.	
Pair Un-twist	<13 mm for C5, <5 mm for C6 & C6 <sub>A</sub> .	
Sheath Stripping	<10 mm from termination housing for C5 & C6 and C6 <sub>A</sub> .	
Minimum Bend Radius	>50 mm (100 mm dia) during installation & conduit pulls for UTP. >65 mm (130 mm dia) for all F/UTP >25 mm (50 mm dia) for unstressed horizontal cable for UTP. >25 mm (50 mm dia) for patch/equipment cords C5, C6 and C6 <sub>A</sub> UTP. >25 mm (50 mm dia) for optical fibre pig-tails, patch/equipment cords to 3mm dia then 10 x dia for no-load and 20 x dia for installs and long-term loads.	
Cable Bundles	32 max for C5. 24 max for C6 and C6 <sub>A</sub> . >25 mm separation preferred between C6 <sub>A</sub> and (C6 or C5). 'Random Lay in Bundle and Tray for Cat6 cable and Cat 6A'. 2 x bundles on 1 catenary for C5 or C6. 1 x bundle on 1 catenary for C6 <sub>A</sub> . No deliberate painting of cables. Overspray by acrylic paint <1m.	
Cable Ties	Use only Velcro™ at least 6 mm wide or other ADC KRONE approved elastic ties for C6 and C6 <sub>A</sub> . Security ties, if needed, shall be firmly applied over Velcro only. Loose plastic ties are permitted for C5. Velcro™ is recommended for C5.	
Conduit Pathway	<40% conduit fill rate. ≤2 x 90° bends and ≤30m continuous sections between pulling points. Conduit bend radius > x 8 copper cable dia. Conduit bend radius > x 20 dia preferred for OF cable. ≥2 x 32 min dia conduits to floor boxes in concrete.	
Tray Pathway	>75mm clearance between ceiling tile and underside of cable or pathway. Clearance above sides of tray = ½ tray width (100 mm minimum). Pathway and cable supports are independent from ceiling supports. <90 mm max height of mass of cables in non-continuous pathway. No cable allowed above tray/mesh sides, except cable exiting pathway. Bend control devices (50 mm min radius) where pathway drops >45°.	
Cable Supports	<300mm between fixings onto catenary wire. <300mm between 10 mm wide flat bar supports (eg whalebone). <100mm between crossbars on mesh tray. <150 mm on external bends. <800mm between ADC approved saddles or J-Hooks. Plastic cable clamps, 6mm for C6 & C5e, 8mm for C6 <sub>A</sub> . No metal cable clamps.	
Separations for Copper Cables (Unless calculated minimums are used)	HV (>1000Vac) = 900mm for performance. 450mm for safety. LV (≤240Vac) = 300mm for performance. 50mm or barrier for safety. EMI Separation = 300mm from fluorescent lights and electrical noise. Lightning Down Conductors = 9m (S009), 2m min for multiple earths.	
Pulling Cable	<11kg for 4-pair copper cable C5, C6 and C6 <sub>A</sub> . <20 kg for multicore OF cable.	
Rack / Cabinet	Shielded cables earthed at FD or source end only; Not at the TOs. >0.9 m clearance in front and behind. >500 lux lighting intensity 1m above floor to minimise shadows on panels.	
Test Results	No FAIL results permitted for Warranty. STAR-PASS results permitted for Warranty only after prior consultation. AXT Testing is not required; therefore no AXT sampling plan is required for this project. OF Testing, use LSPM tester and 1-Test Cord, Method B for Ref Setting if connectors match. OTDR results are not accepted for Warranty. OF 'GAIN' results are NOT permitted for Warranty without prior consultation. All test results for Warranty shall be full "Plot Data Enabled" in tester format (pdf files are not acceptable).	



## Appendix 2 Requirements For Warranty Testing

### 1 GENERAL REQUIREMENT

The following are typical testing requirements for an ADC KRONE Warranty on Copper and/or Fibre cabling.

Test Requirement	Description	Contractor to Complete or Acknowledge
AS/NZS IEC 61935.1	Copper testing shall be done in accordance with this standard	
Tester Unit	Tester manufacturer and model number/name	
Calibration Dates	Last calibration date on tester Main unit	
	Last calibration date on tester Remote unit	
Test Leads	Test lead model number/name	
Tester Software	Version number	
Limit Software	Version number	
Tester Set-Up	ISO/IEC 11801 or AS/NZS 3080 PL or Ch (TIA 568 settings are not acceptable, unless authorised)	
Saved Results	Must be in .flw or in .mdb format (.pdf and .csv files are not acceptable)	
	Full plot data enabled on tester	
Cable Runs	100% of cable runs shall be tested	
	All cable runs shall be correctly identified	
	Explanations shall be provided for missing or out of sequence or duplicated cable identification numbers	
Final Test Results	One complete set of results shall be submitted (several or various portions of results are not acceptable)	
AS/NZS ISO/IEC 14763-3	Optical fibre testing shall be done in accordance with this standard using Light Source & Power Meter on all fibre cable runs (OTDR tests are not acceptable substitutes for LSPM)	
LSPM Tester Unit	Tester manufacturer and model number/name	
LSPM Test Leads	Test lead manufacturer and model number/name	
OTDR Test Unit	OTDR Manufacturer and model number/name (Required for cable runs >300m as a Signature Trace)	

## Appendix 3 Requirements For 10GBE Performance

For Cat 6<sub>A</sub> and 10 GBE performance installations, the clauses in Appendix 2 shall be an additional part of this specification.

### 1 GENERAL REQUIREMENT

Where nominated on the drawings, the tenderer shall provide a UTP cabling solution that can meet the current IEEE802.3an 10,000Mbps (10GBE) channel transmission performance requirements

A Structured Cabling Solution that uses Category 6<sub>A</sub> CopperTen UTP components and Optical Fibre backbone shall be capable of providing 10 Gigabit Ethernet operation using full duplex transmission. An acceptable alternative would be to provide a Cat 6<sub>A</sub> shielded S/FTP cabling solution if requested by the designer or end user.

### 2 STRUCTURED CABLING SYSTEM (SCS)

#### 2.1 Work Area System

##### 2.1.1 Faceplate

For Cat 6<sub>A</sub> the faceplates shall be:

- ADC KRONE 2-port, 3-port or 4-port faceplates with staggered or sufficiently separated socket positions to provide the necessary ANEXT performance separation.
- ADC KRONE 3-port or 4-port faceplates with staggered or sufficiently separated socket positions on perimeter trunking or surface skirting ducts.

##### 2.1.2 Telecommunications Outlets (TO)

The TO shall be;

Category 6<sub>A</sub> CopperTen RJ45 unshielded white outlets for UTP solutions.

Category 6<sub>A</sub> CopperTen RJ45 shielded white KM8 outlets for S/FTP solutions (product number 6830 1 811-01 for bag of 1).

##### 2.1.3 Work Area Patch Cord

Work area patch cords shall consist of ADC KRONE 4-pair CopperTen Cat 6<sub>A</sub> patch cords coloured blue, terminated with RJ45 plugs at both ends. They shall be factory terminated with length options of 2, 3, 4.5, 7.5, and 15 metres. The minimum length of patch cord shall be 2m, for best performance.

### 2.2 Horizontal Cable System

#### 2.2.1 Category 6<sub>A</sub> Cabling for 10 Gigabit Ethernet

For UTP applications intended to run 10 Gigabit Ethernet, the Tenderer shall supply ADC KRONE CopperTen Cat 6<sub>A</sub> 4-pair 100Ω solid cable colour grey (product number 10G-A6TR-GYM2) to connect each telecommunication outlet (TO) or consolidation point (CP) to the floor distributor (FD). The UTP cable shall contain elliptical offset fillers to improve alien crosstalk within cable bundles.

Installations requiring a reduction in PVC should use the low smoke zero halogen (LSZH) non-PVC Cat 6<sub>A</sub> 4-pair solid cable colour blue (product number 10G-A6TZI-BLM2).

For installations requiring the use of a Cat 6<sub>A</sub> shielded solution, the shielded cable shall be 4-pair 100 Ω, 600 MHz screen over foil twisted pairs (S/FTP) cable colour orange (product number 7053 3 762-55).

The minimum Permanent Link length of a horizontal cable should be 15m as per ISO/IEC 11801 Amdt 1. Other minimum lengths are listed in the previous clause 9.2. Horizontal runs of about 16m or less are expected to show low (\*PASS) Return Loss due to the short lengths.

The Tenderer shall supply CopperTen Cat 6<sub>A</sub> 20-pair or 8-pair modules and/or CopperTen Cat 6<sub>A</sub> RJ45 modular sockets together with suitable mounting systems.

## **2.3 Data Centre, Equipment Room and Telecommunications Room Cable Terminations**

### **2.3.2 Cross-Connect and Interconnect System**

The cross-connect or inter-connect terminations on Category 6<sub>A</sub> components shall be;

- ADC KRONE CopperTen modules with 8-pair or 20-pair disconnection contacts mounted to provide separation for minimising alien crosstalk on data services up to 10GBE, and/or
- ADC KRONE RJ45 Category 6<sub>A</sub> patch panels with ADC KRONE Modular 8-way outlets on data services up to 10GBE.
- Cross-connect jumper cable shall be Cat 6<sub>A</sub> of any suitable length, with sheath, terminated on the bottom of the module on the A-side to the bottom of the module on the B-side.
- For Patch By Exception installations and for patch cord cross-connect installations on 8-pair or 20-pair modules, the length of the Cat 6<sub>A</sub> patch cord between modules shall be 2 metres minimum to maintain warranted performance.

### **2.3.3 Termination Module**

The termination module shall be a ADC KRONE CopperTen Cat 6<sub>A</sub> module with sufficient spacing between 4-pair positions to minimise alien crosstalk to an acceptable level. The CopperTen Cat 6<sub>A</sub> module shall be capable of terminating 5 x 4-pair Cat 6<sub>A</sub> CopperTen cables.

### **2.3.6 Patch Cords and System Leads**

The type of patch cords and system leads shall match the termination module used, eg Cat 6<sub>A</sub> patch cords with 20-pair CopperTen modules, Cat 6<sub>A</sub> patch panels and Cat 6<sub>A</sub> TOs.

CopperTen Cat 6<sub>A</sub> RJ45 patch cords shall be factory terminated 4-pair cords with lengths of 2, 3, 4.5, 7.5, and 15 metres. Use UTP, LSZH or S/FTP patch cords and System Leads to suit the installation.

The minimum length of System Tail or Equipment Cord shall be 2m.  
The minimum length of Patch Cord at the cross-connect shall be 2m.

## **2.8 System Performance**

### **2.8.1 Channel Performance**

Channels shall meet the appropriate minimum requirements of;

- ISO/IEC 11801 Amdt 1 Class E<sub>A</sub> Channel.

### **2.8.2 Permanent Link Performance**

Permanent Links shall meet the appropriate minimum requirements of;

- ISO/IEC 11801 Amdt 2 Class E<sub>A</sub> Permanent Link.

A \*PASS may be acceptable, but only after prior consultation with ADC KRONE technical staff.

- Runs of about 16m or less are expected to show low (\*PASS) Return Loss due to the short length.

## **5 ACCEPTANCE TESTS**

### **5.1 For 10 GBE Performance on Cat 6<sub>A</sub> Installations**

The 10GBE Structured Cabling System must be tested by the installer to conform to the requirements specified in the Channel performance of clause 2.8 in this appendix, using Level 3e testers.

A certain percentage of the outlets may be chosen at random for the final acceptance testing by the end-user or

in their absence, by ADC KRONE. The design data and the full results of all acceptance tests performed by the installer are to be fully documented and submitted to end-user to hold for the period of the warranty.

The results must include 100% of cable runs in the installation and provide full electronic data files in tester format for each cable run indicating the name of the person doing the testing, date, building, cable identification, cable length, insertion loss, NEXT, PSNEXT, ACR, PSACR, propagation delay, delay skew, ELFEXT, PSELFEXT, and Return Loss. Alien Crosstalk (AXT) testing is not required; therefore no AXT sampling plan is necessary for this project.

**The ADC KRONE acceptance criteria** using a Level 3e or better tester shall be the requirements set out in ISO/IEC 11801 Amdt 2 Class E<sub>A</sub> for the 10 GBE Permanent Link or, ISO/IEC 11801 Amdt 1 Class E<sub>A</sub> Channel, for the 10 GBE Channel. Always ensure that the latest software specification limits are downloaded from tester manufacturer and stored in the testers.

## **9. CABLING INSTALLATION REQUIREMENTS**

### **9.1 General**

Module termination of CopperTen Cat 6<sub>A</sub> cables in the FD shall be on CopperTen Cat 6<sub>A</sub> Modules accommodating 5 x 4-pair cables. The modules shall be mounted on backmount frames capable of accepting 12 modules per frame. The maximum number of 12-way frames in one vertical wall-mount stack shall be three (3) for mounting directly onto a wall or when mounting onto a false wall with rear cable access.

RJ45 termination of CopperTen Cat 6<sub>A</sub> cables in the FD and at the TO shall be on Cat 6<sub>A</sub> capable sockets wired in the T568A colour scheme, with less than 5 mm of untwist in the pairs.

### **9.2 Copper Cable**

CopperTen Cat 6<sub>A</sub> cables shall be grouped together in bundles not exceeding 24 cables per bundle. Do not mix Cat 6<sub>A</sub> and Cat 6 cables in the same bundle. Do not arrange any cables within the bundles in straight lines but leave them in a “random lay in the bundle and tray” to help minimise alien crosstalk between the cables.

CopperTen Cat 6<sub>A</sub> cables should have 25mm separation from Cat 6 cables wherever possible to facilitate future maintenance. Use the ADC KRONE ‘Random Lay In The Bundle And Tray’ principle within each Cat 6<sub>A</sub> bundle.

Cables shall be installed so as not to exceed the maximum hauling tension of 11kg for CopperTen Cat 6<sub>A</sub> cables.

### **9.3 Pathways - Continuous**

The preferred depth of surface/skirting ducts is 50mm to accommodate the minimum bending radius of Cat 6<sub>A</sub> cables. For 3-compartment communications ducts the same conditions apply to Cat 6<sub>A</sub> cables as apply to Cat 6 cables.

The maximum number of cables on one catenary shall be 1 x bundle of 24 for Cat 6<sub>A</sub> with the cables in a random lay within the bundle.

– END –