

# Imperial College London

**Information & Communications Technology  
Network Infrastructure Delivery**

**Network Infrastructure Standards**

**April 2020**

**Appendix C – Cabling Specification & Installation**

Version 1.6

# Appendix C

## Cabling Specification and Installation

### Introduction

This Section details the required standards for (SCS) structured cabling systems to be installed as part of the College Network Infrastructure.

### Structured Cabling Standards

All installation works must be undertaken in line with applicable standards and manufacturer's installation instructions:

- BS EN6701:2016+A1:2017 Telecommunications equipment and cabling
- BS 7671:2018 IET Wiring Regulations (18<sup>th</sup> Edition)
- ANSI/TIA/EIA 568-B Commercial building telecommunications cabling standard
- BS 7430 Code of practice for protective earthing of electrical installations
- BS EN 50173 Information technology – Generic cabling systems
- BS EN 50174 Information technology – Cabling installation
- BS EN 50310 Telecommunications bonding networks for buildings and other structures
- BS EN 50346 Information technology – Cabling installation – Testing of installed cabling
- BS EN 60874-1 Fibre optic interconnecting devices and passive components – Connectors for optical fibres and cables
- BS IEC 61000-5-2 Electromagnetic compatibility (EMC) – Part 5: Installation and mitigation guidelines – Section 2: Earthing and cabling
- NJUG National Joint Utilities Group – NJUG Guidelines – Volumes 1 to 6
- All current and relevant ISO/IEC, CENELEC and ANSI/TIA/EIA standards

As a minimum, the CAT6a SCS must support the following transmission requirements:

- IEEE 802.3 Ethernet (10BaseT), Fast Ethernet (100BaseTX) and Gigabit Ethernet (1000BaseT and 10Gbase-T)
- IEEE 802.3 Type 1 / Type2
- EIA RS 232-D (asynchronous)
- 100 Mbit/s services - i.e. TPDDI/CDDI/TP-PMD
- ATM standards (ATM25, ATM52, ATM155 & ATM1200)
- Analogue and Digital Voice Telephony

As a minimum, the CAT5e SCS must support the following transmission requirements:

- IEEE 802.3 Ethernet (10BaseT) Fast Ethernet(100BaseTX) Gigabit Ethernet(1000BaseT)
- IEEE 802.3 Type 1 / Type2
- EIA RS 232-D (asynchronous)
- 100 Mbit/s services - i.e. TPDDI/CDDI/TP-PMD
- ATM standards (ATM25, ATM52, ATM155)
- Analogue and Digital Voice Telephony

All materials shall be new and of types approved by ICT NID Team (see information in “Appendix E – Ordering”), BABT and the BSI for their intended use. Attention is drawn to the selection of the appropriate cables for each type of installation environment.

The colour of the cable will comply to manufacturer's and industry standards.

All installation works must be undertaken in line with applicable standards and manufacturer's installation instructions.

Attention should be paid to cable segregation, cable fixing spacing and defined cable routes in under floor routes.

The above standards should be the minimum acceptable standards.

## **Cable Routes**

All cables with their origin and destination within the same building shall be run internally.

Where there is a requirement to run externally for OSP (Outside Plant) applications i.e. CCTV BMS then a transition point will be permitted to allow for the use of external grade cable. External grade cable not to run more than 2m internally. (Total length not to exceed 90m).

All cable routes should be agreed with NID Team before commencement of their installation.

All routes will follow public spaces for easy access after project completion and hand-over.

All vertical cables shall be secured to installed tray at the intervals recommended by the manufacturer. Contractors should confirm their intended method of securing the cables.

No cables will be left un-supported.

Any installation of cabling in raised floors shall be done in no less than in a space of 300mm of height and within the appropriate containment. Any changes to this specification should be explained to and accepted by NID Team.

All containment will have labels saying "ICT DATA CABLES" every 5 metres and every concealment point.

No other cables are permitted in the containment.

Within a CWC the cables will be installed in such a way that they will allow cabinets to be moved if required.

## Horizontal cabling Installation

To ensure consistency across the College, only the following cabling systems can be used.

Leviton CAT6a U/FTP CCa - Our preferred cabling system. It will be mandatory that all new buildings be installed with this cabling type.

Excel CAT5e U/UTP B2Ca - Only to be installed in circumstances where a compliant CAT6a solution cannot be achieved. (please contact Imperial NID for clarification)

Further information on ordering can be found within Appendix E.

## Installation Requirements

All cables shall be installed in accordance with latest issue of BS EN50174 and the manufacturer's instructions and recommendations. Care should be taken to ensure the minimum bend radius is not exceeded thereby preventing kinks in the cable construction.

Power and data separation must be adhered to, as a guide please use the table below;

		Cable Containment System			
Segregation Classification	Cable Class	None or Non-Metallic	Open metallic containment	Perforated metallic containment	Solid metallic Containment
B	Class D or E or EA U/UTP	100mm	75mm	50mm	0mm
C	Class D or E or EA U/FTP	50mm	38mm	25mm	0mm

All cabling shall be loomed into maximum looms of 24 cables. Looms shall be **Velcro** wrapped to cable basket in accordance with manufacturer's installation instructions, where CAT5e U/UTP is in use nylon cable ties will suffice. Cable looms should be maintained to the equipment cabinet within the CWC. Care should be taken not to crush cables by over tightened fixings. If metal type cable ties are used to comply with fire regulations ensure excess tail is cut flush, to avoid the creation of sharp and dangerous edges.

All rooms will be fed from a single comms room, there will be absolutely no mixing of cabling from two or more comms rooms, into the areas in need of connection.

Any installation requiring replacement of old cabling will imply its removal as an integral part of the work and to be included in the of the project specifications.

Any de-commissioning of cable or user outlet termination requires the complete removal of the cable back to the CWC presentation panel as a part of the work and to be included in the of the project specifications.

Any work within ceilings or under floor must be made good prior to completion.

## Cable Lengths

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All cables shall not exceed 90 metres in length. CWC's should be strategically located to allow for this. All 4 pair cables should be continuous between the Patch Panel in the CWC and the user outlet at the User Connection Point. All cables should be installed within the containment provided or specified.

### Installation of cabling within cabinets

All cables should be neatly installed and secured collectively to the Cabinet or Frame, from the point of entry to the point of distribution across the rear of the patch panel.

All cables installed we have a service loop to increase flexibility in cabinet relocation or movement (emergency or unforeseen events).

It is acceptable for the cables to be dressed as either, 24 cables from one side or split as 12 from each

All patch panels will be grounded for electrical safety.

### Patch Panel Specification

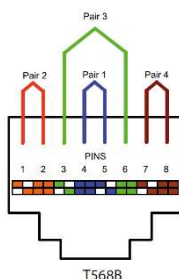
All patch panels should meet or exceed the transmission performance requirements for Twisted-Pair Connecting Hardware defined by the standard or the BS EN 50173 Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568B where this standard exceeds BS EN 50173.

Patch panels, outlets, main link and patch cables should be selected from a single manufacturers system.

### Patch Panel Terminations

All four pairs of the cable shall be terminated onto the rear of the patch panel via Insulation Displacement Connection (IDC) techniques.

The horizontal cables shall be terminated as per the EIA/TIA 568B wiring scheme so that the presentation of the cable pairs on the RJ45 socket are as follows:



To ensure the transmission performance requirements of the cabling system are maintained, the amount of untwisting shall be kept to a minimum last twist should be no further than 13mm from point of termination. In addition, the stripping back of the outer sheath shall also be limited to the minimum amount required to achieve a successful termination.

Where a rear management bar is provided each cable should be individually secured by way of a cable tie, grouping of cables is deemed to be a poor installation practice.

## Patch Panel Capacities

1u 24-way patch panels should be used throughout the installation.

## Patch Panel Cable Management

Due to the design of the patch panels there is no requirement for horizontal cable management bars.

## User Outlet Specification

All user outlets should meet or exceed the transmission performance requirements for Twisted-Pair Connecting Hardware defined by the standard or the BS EN 50173 Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568B where this standard exceeds BS EN 50173.

Patch panels, outlets, main link should be selected from a single manufacturer's system.

Please contact ICT NID Team to confirm data outlet requirements. ***The final numbers will be confirmed by ICT*** based on end user requirements and known usage from the group(s) in other areas.

College data outlet requirements are specified in Network Infrastructure Standards main document.

## Wall Box & Floor Boxes

All wall/dado boxes & floor boxes are to be sized to allow for the minimum bend radius to be achieved as per the manufacture's guidelines.

## Face plates

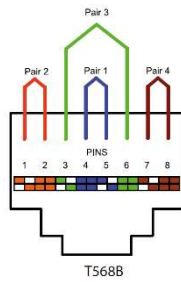
The user outlet faceplate should meet the following requirements:

- All outlets shall be provided with spring loaded shutters that automatically close when patch leads are removed;
- All IDC connector blocks shall be permanently fixed to the faceplate.
- All unused faceplate apertures shall be provided with blanking plates.
- UPVC plastic to be UV resistant.
- Contrasting colour as per Disability Discrimination Act (DDA) requirements.

## User Outlet Terminations

All four pairs of the UTP cable shall be terminated onto the rear of the faceplate via Insulation Displacement Connection (IDC) techniques.

The cables shall be terminated as per the EIA/TIA 568B wiring scheme so that the presentation of the pairs on the RJ45 socket is as follows:



To ensure the transmission performance requirements of the cabling system are maintained, the amount of untwisting shall be kept to a minimum last twist should be no further than 13mm from point of termination. In addition, the stripping back of the outer sheath shall also be limited to the minimum amount required to achieve a successful termination.

Enough slack should remain on the cable to allow the termination to be remade at least twice.

### User Outlet & Patch Panel Labelling Scheme

Cabling will be installed and labelled in a logical fashion, as you enter a room cabling ID's will run from left to right in a sequential order. Where there is more than one entrance to a room or area it will be down to the contractor to come up with a logical system that runs in a sequential order.

All outlets should be labelled in accordance with ICT Network Infrastructure Standards:

All bundles will have labelling on all concealment points (i.e. in risers and through holes). This labelling will be done in the following format:

ICT CAT5e/6a (as applicable)  
 <Installer company name> - <date>  
 <CWC ID>

All UTP outlets should be labelled in accordance with ICT Network Infrastructure Standards:

AAA/BB/CC

Where:

- AAA = The Cabling Wiring Centre (CWC) Number
- BB = The patch panel identifier where the first digit identifies cabinet ID and second the panel ID (i.e. AB would be cabinet A panel B)
- CC = The outlet reference number (01, 02, 03....24)

Each individual 1U x 24-way Patch Panel should have its own Patch Panel identifier. Upon reaching 'Z', the next panel should be labelled 'AA' then 'AB' etc.

For example, the fourth outlet from Patch Panel 'A' within Wiring Centre 127 in the 1<sup>st</sup> cabinet would be labelled 127/AA/04 and the fourth outlet from Patch Panel 'C' would be labelled 127/AC/04 etc.

All labelling is to be done with modified acrylic (trifoliate style) laser engraved labels to withstand the passing of time and duration of the CAT 5e/6a warranty (under normal conditions of office use).

All cables will be labelled at patch panel and outlet side for easier identification. This will be placed in the cable sheath and be done as so it won't fall off or smudge but do not require to be as per above requirement.

### **Patch Cables and Patching**

All patching between active data equipment ports, voice services ports, peripheral services ports and terminated outlets should be accomplished using RJ45 patch cords.

The patch cords should be a part of the proposed cabling system and should be included within the cabling systems application and performance warranty.

User patching to form part of the project specification and cost.

These patch cords will be as defined in the ordering information (Appendix E - Ordering)

All patch cables should meet or exceed the transmission performance requirements for Twisted-Pair Connecting Hardware defined by BS EN 50173 or the Commercial Building Telecommunications Wiring Standard ANSI/EIA/TIA-568B where this standard exceeds BS EN 50173.

Different colour patch cables should be used to differentiate between service types:

Data – Blue

VOIP Phones – Blue

Wireless – Red. Wrap around type label, labelled “WAP”

AV – Red. Wrap around type label, labelled “AV”

BEMS - Red. Wrap around type label, labelled “BEMS”

CCTV - Red. Wrap around type label, labelled “CCTV”

Where flood patching is requested (Lecture theatres, labs and others) the patch leads must be labelled at both ends of the lead (labels to be 2x number of patch leads).

Information needs to be provided to ICT's network infrastructure delivery team and the labels will be provided.

### **Cable Testing**

Following completion of the installation, there are two forms of testing that shall take place:

- *Installation testing* – to be undertaken by the Contractor.
- *Acceptance testing* – to be undertaken by the Contractor but shall be directed and witnessed by NID Team. It should be noted that acceptance testing will involve retesting up to 10% of the entire installation.

### **Installation Testing**

Installation testing should comprise a 100% exhaustive test of the installation by the installation Contractor performed using a calibrated level IIIe tester as a minimum. The testing will be carried out in accordance with the manufacturer's recommended testing procedures & shall prove the link performance characteristics defined within EN50173. These test results will form part of the 25-year performance warranty offered with the installation.



## **Acceptance Testing**

Upon completion of the installation testing, test results are to be sent to ICT. The test results shall be sent in summary format (PDF) or in the native test format i.e. FLW. This should be a 100% test. We will then use this information to perform 10% witness test on the entire installation.

Test results should not be provided in paper format. The results should be provided in electronic format. It is, however, mandatory that the results are formatted in a data-base type structure on the disc/memory stick that a means of searching for individual results is provided. A printed summary of results should be provided with the completion documentation.

## **Warranty**

The horizontal cabling system shall be designed, supplied, installed, tested and commissioned in strict accordance with manufacturers' recommendations to achieve a 25-year performance warranty.

## Backbone Optical Fibre Installation

### Introduction

This Section details the required standards for Fibre Optic cabling. The College has an established policy to install Leviton fibre optic products and has standardised on OS2 fibre type. Due to legacy issues other types may have to be used (only if agreed with ICT). Only the following cable type can be used.

**Leviton 24 core 8/125 SM CDT B2Ca** This is a mandatory requirement. Further information can be found within appendix E.

**Excel 24 core 8/125 SM CST B2Ca** This fibre is to be used for external building links. Further information can be found within appendix E.

**Corning B2Ca Gel-free Loose Tube Dielectric Armour Indoor/Outdoor Cable** This fibre is to be used for external building links where a higher core count is required. Available in 24,48,96 & 144 & 192 core counts. Further information can be found within Appendix E.

### Installation Requirements

All cable routes should be agreed with ICT's representative prior to commencement of the installation.

All cables shall be either:

- Enclosed in trunking;
- Pulled in duct;
- Securely fastened to tray;

All containment shall be clearly marked at 5 metre intervals and at all concealment points with the following label:

"ICT DATA CABLES"

All cables should be complete between termination points; no cable joints or splices will be permitted unless with specific authorisation of the ICT department in writing.

Holes drilled through walls or floor for the routing of cables shall be suitably sleeved to prevent damage to installed cables.

### Labelling

All termination points shall be clearly labelled.

The cable will be labelled with a securely fixed 'traffolyte' type engraved label or with wrapround cable markers, before the fibre panel, showing:

ICT  
<Fibre ID> <CWC1 ID> to <CWC2 ID>  
<Installer company name> - <date>

Where <Fibre ID> is an College internal ID that will be provided to the installer by ICT. For this to occur the following information needs to be provided:

- <CWC1 ID>,
- <CWC2 ID>,
- Number of cores,
- Number of cores terminated,
- Connector type,
- Cable type.
- Any important comments on the installation, if any.

The fibre panel will be labelled with:

<Fibre type> <number of cores> <Fibre ID><CWC ID1><CWC ID2> <X>

Where CWC ID1 and CWC ID2 are the two linked CWCs and CWC ID1 is always the one with the smallest ID value.

X is the panel identifier. Starting with “A” and continuing to “B” and so forth.

Fibre ID. Please contact College ICT NID to obtain the ID number

**e.g.** To connect CWC42 and CWC1 with OS1 24 cores would be – OS1 24 CWC1 CWC42 A. An additional connection would be - OS1 24 CWC1 CWC42 B

As a safety measure a Laser/LED information sticker will be placed on the front (right hand side) of the fibre tray.

All cables shall be clearly labelled at 5 metre intervals and at all points of entry and exit for concealment, indicating:

ICT  
 <Fibre ID> <CWC1 ID> to <CWC2 ID>  
 <Installer company name> - <date>

### **Fibre Optic Termination**

All optical fibre cables should be terminated within fibre panels mounted within a CWC’s Cabinet, in accordance with the proposed cabinet layout.

Panels will be mounted in the cabinet such that the connectors are flush with the mounting rails of the cabinet. The front of the patch panel should not be recessed

LC connectors will be used throughout.

All fibre cores shall be spliced and tested.

After testing the contractor should make sure that all dust caps are in place.

To facilitate re-splicing of fibres, sufficient slack cable should be left to enable at least two re-terminations to be achieved. A minimum of 5m service loop should be coiled neatly within the CWC.

### **Fibre Optic Patch Cords**

LC duplex patch cords should be used.

## **Fibre Optic Testing**

Following completion of the installation, there are two forms of testing that shall take place:

- *Installation testing* – to be undertaken by the Contractor.
- *Acceptance testing* – to be undertaken by the Contractor but shall be directed and witnessed by College ICT. It should be noted that acceptance testing will involve retesting up to 10% of the entire installation.

## **Fibre Optic Installation testing**

Installation testing should comprise a 100% exhaustive test of the installation by the installation Contractor. Tier 1 certification must be completed and submitted for each fibre link. Each fibre core shall be tested bi-directionally at 1310 & 1550nm the results combined will be stored electronically. Tier 1 certification refers to the use of a light source and power meter to perform continuity and loss testing of the installed links. The length of the fibre is also measured. We will not accept OTDR test certification.

The testing will be carried out in accordance with the manufacturer's recommended testing procedures

Test result will be presented electronically in both the manufacturers format & PDF.

The results form will record:

- The unique identifier of the fibre optic cable and fibre number
- The name of the person conducting the test
- The type and manufacture of the cable being tested
- The date of the test
- The results to be recorded on the form shall be:
- All settings of the test equipment so that the test may be exactly recreated if necessary
- The end of the cable from which the test is carried out
- The measured cable length
- The attenuation at 1310nm and 1550nm (dB) or as appropriate

## **Acceptance Testing**

Upon completion of the installation testing, test results are to be sent to ICT. The test results shall be sent in summary format (PDF) or in the native test format i.e. FLW. This should be a 100% test. We will then use this information to perform 10% witness test on the entire installation.

## **Warranty**

The fibre optic cabling system shall be designed, supplied, installed, tested and commissioned in strict accordance with manufacturers' recommendations to achieve a 25-year performance warranty

## **Telecommunication fibre services**

As part of the critical services to the College we may need to have external services installed to enable the connection of a building or campus to the outside world and/or to the rest of the College network.

These links are done, in most cases, via the installation of fibre cables to the campus and/or building.

Considering the risk to College, especially for the Maintenance teams and Projects that may need to change building fabric where these services would traditionally be installed (risers and cable routes throughout the building) the College will be installing “intake rooms” into the buildings. These will be small secure spaces that will have an ODF (Optical Distribution Frame) installed where the Telco will provide their services to and where their delivery point will be.

The link between that ODF or Intake Room to the main comms room for the building or campus will be done with Imperial College own fibre.

For the design of the space and specification of the ODF please check “Appendix E - Ordering”.

## **Voice Installation (Copper Backbone Cabling)**

Currently College runs a VoIP system and therefore the importance of the voice cabling has been reduced. It is still critical for some services (Life Safety) to run over the voice cabling.

As a rule of thumb there will be a BT demarcation point within each campus. From this location there will be 20 pair installed to the main CWC of each building. The cable will be presented in a DP. (501a voice frame) in the buildings (unless there is a specific requirement to have more). Internal voice cabling CW1308 (CPR compliant) will then run directly to the equipment where it will terminate either directly into equipment or on an LJU.

There are legacy connections that run over of horizontal cabling but moving forward we are insisting on the connection type above.

## **Containment**

Cablofil Steel Wire Cable Tray or equal conforming to the material and performance of this specification.

Cable basket shall be manufactured from steel wires, welded together and bent into final shape prior to surface treatment.

Surface Treatments:

- Electro zinc plated to EN 12329
- Hot Dipped Galvanised to EN ISO 1461
- Stainless Steel to EN 10088-2 - AISI 316L and EN10088-2 AISI 304L

Steel Wire Cable Tray Widths & Depths

- Cable Tray dimensions are all internal.
- Depths of 30mm, 54mm, 80mm, 105mm & 150mm.
- Widths of 50mm, 100mm, 150mm, 200mm, 300mm, 400mm 450mm,
  - o 500mm & 600mm for depths of 30mm & 54mm.
- Widths of 100mm, 150mm, 200mm, 300mm 400mm & 500mm for
  - o Depths of 105mm & 150mm
- All trays are of 3000mm Nominal long

## **Specification**

Baskets will be manufactured with a longitudinal 'T-welded' safety edge along the top wire of the sidewall (excluding 30x50)

Baskets will be constructed with a 50mm x 100mm mesh configuration.

All fittings (e.g. changes in direction, level and size) shall be constructed on site, to the manufacturer's instructions, using side action bolt croppers and fastened using 25mm and 30mm counter clamps with M6 bolts and nuts, all surface treated as the tray.

Trays will be coupled together using the recommended fixing methods as stated by the manufacturer.

Basket shall be supported at a maximum span of 2.5m by trapeze, wall, floor or channel mounting methods and will not exceed maximum loads as specified by the manufacturer.

All welds will be manufactured to an average minimum tensile strength of 500Kg per weld.

### **Tests, certification and conformity**

Loading and deflection characteristics of the basket should be tested, and the results published in accordance with the European Standard CEI 61537.

Suitability for the support of Cat6a data cabling should be demonstrated by way of independent test verification.

Fire test certification published in accordance with the DIN4102-12 standard to achieve E30 to E90 for temperatures up to 1000oc

Electrical continuity across a coupling should be demonstrated by means of a published test method and result as specified in IEC61537

<https://www.legrand.co.uk/products/cable-management/cablofil/>

[http://www.cablofil.co.uk/sites/default/files/Cablofil\\_low\\_res\\_0.pdf](http://www.cablofil.co.uk/sites/default/files/Cablofil_low_res_0.pdf)

Cables will be protected in their transition out of the containment by being placed into flexi-duct or cable waterfall.

In areas, for aesthetic/architectural reasons, if there is need for black containment the Cablofil 54 EZ+ cable basket can be used. This is also used in harsh environments

<http://www.cablofil.biz/product/standard-cable-trays/cf-54-ez>

Please see "Appendix E – Ordering" for more information.

### **Mechanical Protection**

Holes drilled through walls or floors for the routing of cables shall be suitably sleeved to prevent damage to installed cables. Where cables pass through floors such protection shall be extended to at least skirting height.

Waterfall systems and others are to be used on exit of the basket into cabinets and appropriate supports used for any flexible ducting used to link any main cable runs to rooms.

### **Electrical Protection**

Notwithstanding the compliance to BS6701 and the issues of cable segregation, additional care should be taken to ensure cables are not routed adjacent to other services where electromagnetic emissions may be generated. Cables should have at least 300mm air gap/separation to any main electrical distribution.

### **Electromagnetic Compatibility**

All cabling components should have been successfully tested for EMC compliance as specified in the European EC Directive 89/336/EEC as amended by Directive 92/31/EEC.

### **Completion Documentation**

The installation Contractor should, on completion of their works and prior to acceptance by ICT, submit two copies of all records and schematics for the installation.

Schematics will detail all cable runs and termination points. The installed cable capacity, cable identification reference, length and type of cable shall be identified.

Records will show clearly all cable terminations and cross connections together with cable capacity and installed length.

The following documentation is required:

- Cabling schematics
- As fitted drawings
- Test results
- Cabinet Layouts
- All relevant operating and maintenance manuals
- All documentation and drawings will be required in electronic format. Full details of CAD formats will be provided. All drawings shall be “as fitted” and shall take account of all changes and variations.

### **Drawings**

All drawings should be provided in accordance with College’s AutoCAD strategy, in digital format.

Please refer to Support Services Engineering Team CAD Strategy (Estates Department).



