# 27 00 00 Communications

1. **Introduction**

1.1. The purpose of this document is to provide a guideline for the standardization of the telecommunications cabling (copper and fibre) and wireless network installations within the Queen's University campus.

The intention of this document is to provide the comprehensive source of information and guidance for those involved with cabling installations within the Queen's University campus.

These guidelines will be adhered to by Queen's staff and external contractors for telecommunications related work at Queen's University. This applies to all new and renovated space as well as moves, adds and changes in the campus cable plant.

The original guidelines were instituted December 1, 2009 and updated from time to time.

1.2. Applied Codes and Standards

This document embraces the following Telecommunication codes and standards:

- TIA/EIA-568-B.1, B.2, B.3 Cabling Standards
- TIA/EIA-569 (CSA-T530) Pathways and Spaces
- TIA/EIA-606 (CSA-T528) Infrastructure
- TIA/EIA-607 (CSA-T527) Performance Standard
- Ontario Hydro – Electrical Safety Code

1.3. Approved Designers

Division 27 does not have a defined code which must be met and inspected. Communications infrastructure and system designers must take into account many issues that are not mandated by electrical code.

Queen's requires that system designers have BICSI RCDD designation and that design for communications infrastructure & pathways follow BICSI standards and best practices. Where this document diverges from those standards and practices, the provisions of this document will take precedence. Where this document is silent, BICSI standards will be adhered to.

1.4. Approved Installers

The installation of communications cabling is a specialized function which shall only be performed by companies and workgroups who have established credentials.

The minimum training requirement for communication cable installers:

| | |
|---|---|
| Belden IBDN 726 | Copper Installation |
| Belden IBDN 727 | IBDN System Installation & Testing - Copper |
| One of the following for fibre installation | |
| Belden IBDN 746 | Fibre installation |
| Corning CFI | Corning Fibre Installation |

Some projects will require system certification and manufacturer warranty. To meet this requirement, installation companies must be Certified System Vendors (CSV) for the Belden Category 6 solution.

Some projects will require the cable contractor to be a member in good standing with an applicable trade union.

1.5. Scope

These guidelines are intended to provide the cabling specification for:

- Newly constructed buildings
- Buildings undergoing major renovations
- New long-term leased occupancy facilities
- MAC's (moves adds and changes) to existing facilities

1.6. Installation Policy

1.6.1. Queen's ITS is the authority for communications cable plant at Queen's University

1.6.2. Design of communications infrastructure shall be performed by approved designers (1.3)

1.6.3. Designs of communications infrastructure will be approved by Queen's ITS

1.6.4. Installation of communications cable plant will be performed by approved installers (1.4)

1.6.5. Installers will provide the required documentation as a contract deliverable (3.3)

1.6.6. Installers will test cable plant to the required performance level and rectify any failures as a contract deliverable (6)

2. **Spaces**

2.1. Telecommunication Rooms (TR)

*TR* is an enclosed space for housing telecommunications equipment, cable terminations, and cross-connects. The room is the cross-connect between the backbone cable and horizontal cabling. There will be one TR per floor but may be more

depending on the size and layout of a floor. The TRs should be centrally located to accommodate cable routing to each location served by that TR. Cabling from the TR is distributed to each work space served by that TR using a variety of approved pathways and infrastructure. The cable distance between the TR and any workspace must be no more than 90 meters. The equipment in the TR may include cabling cross connects and patch panels, punch down blocks, fiber patching equipment, network devices etc.

- TR's must be dedicated to the exclusive use of telecommunications. TR's will not be shared space with electrical, mechanical, security and access control or janitorial storage of any kind.
- TR's will have a unique key lock system under the control of ITS.
- TR's size will be a minimum of 3.5 X 2.5 m unless otherwise approved.
- Floors in TR's shall be treated concrete or tile. Carpeted floors are unacceptable.
- The TR will have an open ceiling i.e. no suspended or false ceilings
- Each TR will have a minimum of four 100mm sleeved core holes between floors. Core holes will be properly fire-stopped.
- At least one wall of a TR will be covered in ¾" fire rated plywood from floor to ceiling. If fire rated plywood is not available then the plywood will be painted with at least two coats of fire resistant paint.
- TR's shall be equipped with a grounding bus bar that is tied back to the building's grounding system.
- TR's will be equipped with a rack for network, fibre patch panels and UPS. The rack will be secured to the wall or floor and shall have 80 cm of open space on all sides for access.
- The TR door should open out where permitted by code.
- TR's must have adequate ventilation or conditioned air to maintain a room temperature from 21 to 24 C and relative humidity of 45%.
- TR's must have a minimum light level of 50 foot candles
- TR's shall have two separate 15 amp 110 volt electrical outlets and one 20 amp 110 volt emergency power electrical outlet (where available) to provide power to the equipment rack.
- TR's in any new construction shall adhere to specifications in CSA-T530, Standards for Telecommunications Pathways and Spaces.

2.2. Equipment Room (ER)

A centralized space for telecommunications equipment that serves the occupants of a building. Equipment housed therein is considered distinct from a TR because of its nature or complexity. The physical and environmental requirements are the same as specified in section 2.1.1 for TR.

2.3. Entrance Facilities (EF)

The Entrance Facility (EF) is the main telecommunications building service entrance. It is the area where the demarcation between the inter-building and intra-building

cabling systems is effected. This securable room is to be dedicated to this purpose with no other building services sharing the space.

The EF will be connected to the campus communications network with a minimum of 4 100mm PVC ducts to the nearest communications manhole (MH) as specified by ITS. If the EF is not serving as the Main Telecommunications Room (MTR) for the building then an equal number of 4" conduits must be installed to connect the EF and the MTR.

One wall of the EF will be covered in ¾" fire rated plywood (good one side) from floor to ceiling. If fire rated plywood is not available then the plywood will be painted with at least two coats of fire resistant paint as specified by ITS.

3. **Pathways**

3.1. Horizontal

Horizontal pathways are the routes taken for the installation of cable from the TR's to the WA (work area). The pathways may include cable tray, conduit, under floor duct, and J hooks in ceiling spaces.

3.2. Vertical

Vertical pathways consist of conduit runs or risers going between floors, and are used to connect TR's and ER's. There will be a minimum of 4 x 100mm conduits or sleeves between TR's or ER's.

3.3. J-Hooks

J-hooks are used to support telecommunications cabling within ceiling spaces. They should be spaced a maximum of 1 meter apart. Cable pathways should follow a prescribed route going over the top of heating ducts and other conduit if possible. Lines shall not be lain across ceiling tiles. Mechanical ducts and pipes shall not be used as support. J-hooks may be stacked to handle up to 100 lines; trays must be used for over 100 lines.

3.4. Cable Tray

Cable tray used to support cable in ceiling spaces and under access floors will be ventilated or basket type tray. Cable tray hung from a ceiling will have a minimum 4 inches of clearance above from obstructions for installation of cable.

3.5. Conduit

TOs will have a minimum 19mm conduit installed directly to the Telecommunications room (TR) or to cable tray in the ceiling space. Where J hooks will be used to run cable in suspended ceiling the conduit will stub above the ceiling and be finished with a bushing. Where there is a bulkhead, conduit will stub into the ceiling space outside the bulkhead.

When conduit is used, there will be no more than two 90 degree bends between pull boxes. For runs more than 30m, pull boxes must be installed so that no segment between pull boxes exceeds 30m. Pull boxes will not be used as a 90 degree bend. The use of "LB" type conduit fittings is not allowed. Empty conduit must have a pull string with 90.7kg (200 lbs) minimum test rating installed. The conduit fill will not exceed CSA standards for all sizes (see 6.2 Conduit Fill Guidelines).

3.6. Floor Boxes

If a floor box is required to service a space, the type and size used must be approved by Queens ITS.

3.7. Outlet Boxes

The outlet box will be mounted at the same height as the convenience electrical outlet, 45mm AFF unless otherwise specified.

There will be no more than 4 cables installed per single gang box. For 5 or more cables, a double gang box must be used. A 4x4 box may be used with the appropriate single- or double-gang plaster ring.

4. **Cable System Design Intent**

The campus communications cable plant is designed as a "structured cabling system" (SCS). An SCS attempts to wire a building for information needs without knowing specifically what equipment will be utilized. An SCS is geared for long term stability and flexibility and is based on the idea of wiring the building once. The structured cabling system approach allows the wire and outlets to remain unchanged while the connections and services vary.

Queen's current building communications system is built on Belden IBDN Category 6 Copper using 2400 series horizontal cable and GigaBIX & GigaFlex termination hardware. This system has guaranteed bandwidth of 250 MHz and meets or exceeds performance measures for category 6 channel specifications**.**

4.1. Planning Process

ITS is the control entity for campus telecommunication facilities. ITS will review drawings and specifications on construction and renovation projects for compliance with University telecommunications/network infrastructure standards and user specifications.

Queens ITS will review and approve all additions or alterations to the outside plant distribution system.

5. **Horizontal Cabling**

Horizontal cabling is the portion of the telecommunications cabling system that extends from the work area telecommunications outlet (TO) to the horizontal cross-connect in TR.

The horizontal cabling includes the horizontal cable, the TO, and the horizontal cross-connect.

5.1. Copper Cable

Copper horizontal cable shall be plenum-rated FT6 category 6 4-pair UTP as set out in Section 6.1.1. The cables will be terminated in RJ45 jacks with the T568A pinout configuration.

The maximum horizontal cable distance from the TR to the TO shall be 90 metres.

Any special service-specific requirement (e.g. pair crossover) shall be done outside of the telecommunication outlet in the cross-connect or the station patch cord.

5.2. Telecommunications Outlet

The standard TO will consist of two copper cables terminated in RJ45 jacks. The jacks will be mounted in a 4-port faceplate. See 10.3 for specific part numbers.

5.3. Cross-Connect

Connections between copper horizontal and backbone cables and between network equipment and horizontal cables will be done with suitable cross-connect wire.

Voice grade services will be connected with category 3 rated cross-connect cable.

Data services will be connected with category 6 rated cross-connect cable.

5.4. Data Pigtails

For network equipment installed in a TO, data pigtails will be installed to extend the ports to the MDF to allow connection to horizontal cables.

A data pigtail is a category 6 patch cord with factory-terminated RJ45 on one end to plug into equipment and the other end terminated on GigaBIX hardware mounted in the MDF.

Data pigtails are installed in bundles of 24 unless otherwise specified and are of a length suitable for dressing within the rack.

## 6. Backbone Cabling

Backbone cable, regardless of media type, is defined as the cable that connects telecommunications rooms (TR's), entrance facilities (EF), and/or equipment rooms (ER's) within or between buildings. This definition includes cable formally known as riser and outside plant cable. The Backbone cable type and size will be specified by ITS.

Typical backbone cable will consist of:

- Appropriately sized category 3 multipair copper for PBX telephone & other analogue circuits. Minimum size: for in-building distribution, 50 pair; for inter-building distribution, 100 pair
- Appropriately sized singlemode OS2 fibre for data network distribution. Minimum size: for in-building, 12 strand; for inter-building, 24 strand
- Six category 6 cables for in-building distribution

## 7. Testing

### 7.1. Copper Cables

Testing of all cables is to be completed in accordance with the manufacturer's certification requirements and the applicable standards.

Testing of the horizontal 4 pair cables will involve a complete "Channel Test" using a certified Category 6 tester. If any of the cables fail the "Channel Test", then the failure will be assessed and the appropriate action taken to ensure a pass. This may include re-terminating and/or replacing termination hardware or the entire cable run.

Data pigtails must also be tested using the primary "Wire Mapping" to ensure correct end-to-end continuity, opens, shorts, and pair polarity. Any deficiencies found during testing must be corrected immediately and re-tested.

Multipair copper riser and backbone cables must be tested using the primary "Wire Mapping" to ensure correct end-to-end continuity, opens, shorts, and pair polarity. Any deficiencies found during testing must be corrected immediately and re-tested.

A report of test results will be provided by the installer.

### 7.2. Fibre Cables

Design will include a loss budget calculation which will be included in the tender specification.

Primary test of power loss with a light source and power meter will be performed to be sure the maximum loss margin is not exceeded.

Test each strand of fibre with a Power Meter / Light Source combination operating at wavelengths of 850 nm and 1300 nm for multimode fibres and 1310 nm and 1550 nm for single mode fibres. Perform these tests in both directions. The tests are to be completed after cable installation, splicing and connectors are installed.

The total Link loss including fibre, connectors and splices for will not exceed 4dB for SM fibre and 8dB for MM fibre.

Secondary test with OTDR will be performed to document the fibre run including any connector loss and losses due to other issues (macrobend, reflectance). This test will be performed at wavelengths of 850 nm and 1300 nm for multimode fibres and 1310 nm and 1550 nm for single mode fibres. Perform these tests in both directions.

| Device | Maximum |
|---|---|
| OS2 LC UPC connector | -55 dB reflectance |
| OM3/4 LC UPC connector | -30 dB reflectance |

A report of test results will be provided by the installer.

7.3. Labelling Requirements

The labeling scheme will be based on the CAN/CSA-T529-95, T528-93, EIA/TIA-606 and EIA/TIA-568-A standards with modifications to fit Queen's requirement. Queen's ITS will specify the labeling to be used on jacks, Bix connectors and pigtails as well as fibre terminated in patch panels.

If an outlet has multiple jacks, the labeling must be affixed to represent the exact jack without confusion to which jack corresponds to the labels. In the TR the labeling will be reflected as it is at the outlet.

7.4. Records

The communications installer will provide As-Built drawings for the horizontal cabling upon completion of the installation in AutoCAD Version (current version) or equivalent format, and hard copy. The drawings will include the following:

- outlet location with appropriate outlet labeling
- primary cable tray and conduit infrastructure
- wireless access points with MAC address of the device clearly labelled

The communications installer will submit documentation of cross-connects in a spreadsheet showing the following for each connection:

- jack label & room number
- label of data pigtail or backbone cable name and pair

The communications installer will submit a test report in soft copy to document the results of all tests performed. The report should indicate for each cable the values of all measured parameters, when it was tested successfully, the location, cable type, cable number and tester make and model. The test report must be submitted at the conclusion of the project.

8. **Communications Ducts**

All new building construction planning must include a cable path into the existing telecommunications outside plant distribution system. The Queens standard is four (4) 100mm communication ducts installed from the building EF to the nearest manhole MH. There may be a requirement for additional ducts or there may be more than one EF in a building complex, in which case, there will be a minimum of four 100mm ducts installed from each EF to the nearest MH. The telecommunications outside plant distribution system will be used exclusively for data, voice, low voltage control/alarms, and video cables.

9. **Wireless Access Point (WAP)**

Queen's ITS provides a centrally managed wireless network using technology by Aruba Networks.

Design & device layout will take into account client device transmit power levels and programmed occupancy of the space. Designers will refer to Aruba Validated Reference Design documents especially for dense deployment areas like classrooms, and voice services.

The standard WAP is the AP300/310 series with internal dual band antennas supporting IEEE 802.11b/g, a, n, & ac wave 2. Service is to be available in both 2.4 gig and 5 gig bands to a minimum level of -65 dBm throughout useable space. This includes mechanical/electrical, elevator, stairwell, storage, kitchen & washroom facilities. Minimum SNR is to be 25.

Power for the WAP is to be provided by POE+ 802.3at.

Each WAP location will have a single cable terminated in a box. For t-bar ceiling, a doublegang box or 4x4 box with double or single gang ring will be installed flush with the ceiling and supported by box hanger or similar device. In the case of drywall ceiling, the box will be flush mounted and fed by conduit to an access hatch or other accessible ceiling. Installation and termination of the cable is to follow the horizontal cable standards.

9.1. Current Queen's University wireless policy

The wireless airspace at Queens will be solely administered by ITS to ensure the quality, integrity, reliability, and security of the Queens University wireless network. Queens ITS is the authority for approval and installation of all devices using wireless connectivity. The unmanaged use of devices could potentially interfere with Queens

University wireless network and in extreme cases render wireless inoperable. In order to assure the highest level of service to the users of the wireless network, the university requests cooperation from all members of the campus community in minimizing the potential for interference. The university requests that use of all other devices in the 2.54 and 5 GHz bands be discontinued in university-owned buildings. In cases where the device is being used for a specific teaching or research application, support staff will work with faculty to determine whether there are circumstances under which use of the device may still be accommodated without causing interference to wireless network users. ITS will work with departments to accommodate special needs, where technically feasible.

10. **Copper Cable and Termination Hardware**

Queen's current standard for horizontal cable is based on Belden IBDN Category 6 system

10.1. Horizontal Cable

All horizontal cable runs will consist of Category 6 PVC 4 pair UTP, Belden IBDN GigaFlex 2400 series cable

Belden 2413 - Plenum White CMP

Horizontal cable runs are not to exceed 90 metres

10.2. Riser Cable

Riser cables will be 24 gauge, Category 3, twisted solid annealed copper conductors, individually insulated and color-coded in accordance with telephone industry standards.

Belden ARMM/ATMM Category 3 Armored Cable, or equivalent

10.3. Termination Hardware

The termination hardware used at Queens is Belden IBDN products which are category 6 GigaBix and GigaFlex devices. These include but are not limited to:

- Workstation Outlet (jack) PS6+Module (Almond) AX101064
- Modular furniture Outlet (jack) PS6+Module (Black) AX101066
- Wall Plate – 4 Port (Almond) AX101436
- Modular Furniture Adapter 3 Port (Black) A0407074
- Mount AX101472
- Connector AX101447
- Wire Guard AX101486
- Designation Strip AX101483
- Management Ring AX101478
- WAP t-bar support Caddy Bar 512A T-bar box hanger 24”

11. **Conduit Fill Guidelines**

Queen's expects communications infrastructure designers to follow BICSI best practices and the Ontario Electrical Code.

For horizontal cable conduit fill, see also Belden conduit fill guidelines.

The following chart provides guidelines used by ANSI/EIA/TIA 569 on conduit capacities for cat. 6 cable servicing voice and data systems (OD 0.230 in). The minimum size conduit used will be 19mm.

- 19 mm (3/4 inch) 5 cables
- 25 mm (1 inch) 8 cables
- 32 mm 1 ¼ inch) 14 cables
- 38 mm (1 ½ inch) 18 cables
- 51 mm (2 inch) 26 cables

12. **Fibre Cable and Termination Hardware**

12.1. Inside Riser Fibre

OM3 (current) multimode 50/125 um breakout riser cable - Corning xxxT88-31180-29 or equivalent.

OS2 single mode enhanced, breakout riser - Corning xxxE81-33131-24 or equivalent

OM1 (legacy) multimode 62.5/125 um breakout riser cable

12.2. Outside Distribution Fibre

| Cable | Fibre Count | Corning Part # | Description |
|---|---|---|---|
| OM3 | 12 | 012TUF-T4180DA1 | 12 multimode OM3 50/125 loose tube, gel-free, interlocked armor distribution, indoor/outdoor |
| OM3 | 24 | 024TUF-T4180DA1 | 12 multimode OM3 50/125 loose tube, gel-free, interlocked armor distribution, indoor/outdoor |
| OS2 | 24 | 024EUF-T4101DA1 | 24 single mode OS2 loose tube, gel-free, interlocked armor distribution, indoor/outdoor |

| Cable | Fibre Count | Corning Part # | Description |
|---|---|---|---|
| OS2 | 48 | 048EUF-T4101DA1 | 48 single mode OS2 loose tube, gel-free, interlocked armor distribution, indoor/outdoor |
| OM1 (legacy) | | | multimode 62.5/125 loose tube outdoor series, armored |

12.3. Fibre Termination

Patch panels: The fibre cable will terminate in a multiport Corning patch panel in the MTR and at the individual floor TR's.

Connectors: the standard connector is LC duplex UPC, factory terminated, for both OS2 and OM3/4

12.4. Fibre Termination Hardware

The fibre termination hardware used at Queens is Corning devices. Queen's standard is fusion-spliced pigtails with factory terminated LC UPC connectors in a slack management cassette. Mounting bulkhead is LC duplex. Cable polarity for inter- and intra-building cable runs is Type A both ends.

- Standard fibre patch panel CCH-04U
- Fibre patch panel (smaller installations) CCH-01U
- LC termination (**current standard as of summer 2017**)
- 50 micron OM3 12 strand (6 port LC duplex) PC pigtail cassette CCH-CS12-E4-P00TE
- OS2 12 strand (6 port LC duplex) UPC pigtail cassette CCH-CS12-A9-P00RE
- OS2 24 strand (12 port LC duplex) UPC pigtail cassette CCH-CS24-A9-P00RE

13. Other Hardware

- Rack - R.F.Mote 83 inch relay rack RFM-1944-RM
- Floor box - Wiremold have a variety of floor boxes
- Cable tray - Thomas&Betts have a selection of ventilated tray available
- J-Hooks - Erico have Caddy J-Hooks of various sizes

14. Glossary

**ANSI** - American National Standards Institute.

**Backbone Cabling-** The inter-building and intra-building cable connections in a SCS (Structured Cabling System) between EF, ER and TR. Backbone cabling consists of copper and fibre media, main and intermediate cross-connects and terminations at these locations.

**CSA** – Canadian Standards Association

**Cross Connect-** Cabling systems which include index strips (GigaBix connectors) mounted on terminal blockpanels (GigaBix Mounts) which seat individual pairs of wires from cables that connect with BIX style punch-down wire connecting blocks that are subsequently interconnected with either horizontal cables, riser cables or patch cord connectors.

**EIA** - Electronics Industries Alliance.

**EF** (Entrance Facility) - Room where outside circuits/wiring enter a building through communications ducts and are terminated or distributed to TR's throughout the building.

**ER** (Equipment Room)- An area within a building where major components of voice and data systems (PBX's, data switches and communications processors) are housed. ER's are often distinct from TR due to the size and quantity of the equipment they contain.

**Horizontal Cabling-** Category 6, 4 pair cabling system that runs from each WA outlet to the TR's. The maximum horizontal distance from the TR to the communication outlets is 90 meters.

**MDF** (Main Distribution Frame**)** – Old term removed from standards language but left in this document for reference. The MDF is a termination point in either the EF or TR where equipment and terminations of circuits are connected by crossconnect wires or patch cords. All cables including copper pairs and fibre cables supplying services are terminated at the MDF.

**M.H.** (Man Hole)- is an underground vault used to house communications ducts for installing Cables between other M.H. or to a building(s) EF.

**Network Infrastructure** - The components (TR's, EF, cable pathways, grounding, wiring and termination hardware) that together provide the basic support for the distribution of all voice and data information.

**Outside Plant-** all cables, conduits, ducts and other equipment located between a buildings EF and other building(s) EF.

**ITS** - Queens University Information Technology Services, responsible for wired and wireless data and telephone systems.

**PATCH CORD** - A length of wire, or fiber cable, with connectors on each end used to join network circuits.

**PATHWAY** - A raceway, sleeve, or exposed location for the placing of telecommunications cable.

**SCS** (Structured Cabling System)- TIA/EIA-568-B defines a hierarchical cable system architecture, in which a main cross-connect (MCC) is connected via a star topology across backbone cabling to intermediate cross-connects (ICC) and horizontal cross-connects (HCC).

**TR** (Telecommunications Room) - The space in a building designed to provide a secure, suitable environment for the installation of cable, telecommunications equipment, and termination and administration systems. Telecommunications rooms are the points where the backbone and horizontal distribution facilities intersect. They are floor-serving rooms whose function is to terminate and connect the backbone cable system to the horizontal cable system and to house electronics that assist in the distribution of information to that floor.

**TIA** – Telecommunications Industries Association.

**UTP** (Unshielded Twisted Pair) - wiring consisting of two insulated wires twisted around each other to reduce induction, thus interference, from one wire to the other. Twisted pair wire comes in bundles with varying numbers of pairs of wires, from two pair (four wires) to many thousands of pairs. UTP wiring is used to wire voice and data networks within buildings because it is relatively easy to install.

**WA** (Work Area Outlet) - Work area wiring subsystem consists of communication outlets (wallboxes and faceplates), wiring, and connectors needed to connect the work area equipment (computers, printers, and so on) via the horizontal wiring subsystem to the TR. The standard requires that two outlets be provided at each wall plate-one for voice and one for data.

**WAP** (Wireless Access Point)- a device that allows wireless communication devices to connect to a wireless network using Wi-Fi 802.11 standards. The WAP usually connects to a wired network, and can relay data between the wireless devices (such as computers) and wired devices on the network.