Audio Visual Systems Standards and Guidelines

Section 1 - Introduction

AV systems cannot be designed or installed without the consideration of other trades. Since typically a limited amount of space in a facility is allocated for infrastructure, the coordination of the AV design with other members of the architect, engineer, and consultant team is important. This includes not only the devices and their functional or physical locations but also power, cable pathways, cable, furniture, lighting, air conditioning, and other infrastructure.

Drawings do not provide enough information or instruction needed to proceed with installation. Since it is not practical to include sufficient notes on construction drawings, a separate set of written instructions, known as specifications, is created to describe in complete detail all of the product quality and installation methods.

The purpose of this document is to ensure all audio visual facilities are designed and constructed to the standard as set out by UITS Learning Space Design.

These guidelines will be used as the standard to which the facilities will be designed or updated over time. Where these standards cannot be met, consultation during the Design Stage, and prior to the commencement of any construction work, with UITS Learning Space Design staff, must be undertaken.

This document details the physical, programming and security requirements for the audio visual equipment to be used in classrooms, meeting rooms, informal learning spaces, computer labs and auditoriums. The UITS Learning Space Design group endorses the INFOCOMM, AV/IT Infrastructure Guidelines for Higher Education as a companion document subject to the specifics of the UITS Learning Space Design Audio Visual Specifications.

Section 2 - Compliance and References

2.1 Industry Standards

Industry standards, guidelines, and best practices:

- INFOCOMM, AV/IT Infrastructure Guidelines for Higher Education
- ANSI/INFOCOMM A102.01:2017 Audio Coverage Uniformity
- ANSI/INFOCOMM 2M-2010, Standards Guide for AudioVisual systems design and coordination process
- ANSI/ASA S12.60-2010, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools

2.2 Quality Management

Quality Management is guided by the Association for Quality in Audio Visual Technology (AQAV and that association's standard)

2.3 Acoustical Guidelines

The topic of acoustics in learning spaces is well documented in ANSI/ASA S12.60-2010, Acoustical Performance Criteria, Design Requirements, and Guidelines for Schools. As the name implies, this standard outlines acoustic design criteria and strategies to achieve proper acoustic conditions in learning environments. Adherence of this standard are a requirement in all learning spaces. Key points within, include:

- Unoccupied classroom levels must not exceed 35 dBA
- The signal-to-noise ratio (the difference between the teacher's voice and the background noise) should be at least +15 dB at the student's ears.
- Unoccupied classroom reverberation must not surpass 0.6 seconds in smaller classrooms or 0.7 seconds in larger rooms

2.4 Intelligibility

Intelligibility of sound systems and public address systems

2.5 Further Reference

2010 Standards for Accessible Design, Americans with Disabilities Act

Section 3 - Physical Requirements for AV Systems

3.1 Equipment Racks
Audio visual equipment is typically mounted in standard 19-inch racks. Racks provided in an AV closet must be provided with a minimum clearance to the front, rear and one side of 36 inches.

All equipment, where possible, will have rack ears for mounting. If equipment is not suitable for rack mounting, a minimum of a 1RU cantilevered shelf will be provided to appropriately support each piece of equipment. Shelves containing equipment which does not require end-user interaction should be installed using either a manufacturer recommended shelf intended to secure the equipment to the shelf (preferred if available) or a Middle Atlantic UFA shelf of appropriate height.

Where racks must be installed in cabinetry, rear access in the form of a lockable door is to be provided where possible or the cabinet must allow for a sliding, rotating rack to be easily mounted for servicing. There must be sufficient width and depth (clear of obstructions such as hinges) for the rack and loop of cables. Adequate ventilation must also be provided in consultation with Learning Space Design.

Rack design must allow for a maximum of 75% fill to accommodate future growth unless otherwise approved by Learning Space Design (i.e. If a 10U rack is provided, only 7U may be used for design fill).

For each permanently installed classroom lectern, a FSR PWB-250 wall box is to be provided. Electrical/Data requirements for this backbox include a minimum of 4 IU Data Jacks, 2 Duplex AC Outlet, and a 1.5” conduit stubbed above the ceiling. Optionally, this backbox may have additional data jacks or an additional 1.5” conduit connected to a secondary wall box for display equipment and connections above the box. Data Jacks and AC Outlets are to be installed in a recessed device box. Supplied AC power should be kept on the same panel/same phase as the rest of the AV system.

3.2 Lecterns

Lecterns will be specified by IU Learning Space Design with either a pre-approved finish or a custom finish to be determined by UAO.
Equipment for the presenter/instructor is to be mounted in integrated 19-inch wide racks, within the lectern assembly and will be determined during the design consultation process. Lecterns containing a rack will minimally include a lockable rear door and will be keyed alike.

Open sections of lectern racks will be typically utilized for user accessible equipment (i.e. PC, Blu-Ray Player, etc) and should include some form of physical security system (i.e. clamping rack shelf, Kensington Lock).

Suitable cable paths throughout the lectern will be provided. Final lectern specification will be determined during the design consultation process. The audio visual integrator is to provide and install a “cable cubby” for user-accessible cables and power. Learning Space Design has a list of preferred cable cubbies that can be supplied upon request.

Lecterns will be specified as height adjustable with an electric lift mechanism for ADA compliance. Modesty panels will be specified if available.

3.3 Electrical

The Contractor shall furnish and install an individual 120 VAC branch circuit, wired to a separate breaker, from the designated panelboard to a minimum quad receptacle mounted inside each equipment rack or cabinet in conduit and according to the NEC 2005.

An AC power outlet shall be provided convenient to each item of equipment inside the equipment rack or cabinet. Extension or “pig tail” non-protected cords from the system cabinet or rack to a system wall outlet is not authorized and shall not be allowed.

AC power wiring shall be run separately from signal cable. Where cable umbilicals are used, AC flexible cords must be run external to any nylon cable wrap and available for inspection.

Each equipment console, cabinet or enclosure shall be labeled to identify which AC panelboard provides power to it.

3.4 Room Layout

3.4.1 Classroom

Sightlines - Sightlines need to be checked in both plan and elevation to ensure all students have an unobstructed view of all areas of the screen. For flat-floor venues with an unobstructed view of the screen, a sensible guideline based on typical ceiling heights and screen sizes is to position the screen so that the bottom edge of the viewable area is no less than 42 in above the floor. If achievable, the preferred height is 48 in or more to provide better clearance over front-of-room furniture. In tiered venues, the distance from the floor may be lowered; however, the decision on the screen position must take into account the potential issue of glare in the presenter’s eyes from the projector. In labs or other spaces where there are obstructions, the screen must be positioned to allow for a clear view over or around the obstructions while at the same time taking into account the maximum allowable viewing angles.

Lectern Position - The lectern is to be positioned in a suitable location in consultation with Learning Space Design. Final lectern position will allow a minimum gap of 48 to 60 inches between the front wall (or other obstruction) and the lectern.

Student Seating

3.4.2 AV Closet

- Reasoning / NVX
- Location in building / Near IDF
- Central AV Closet vs Room-Specific AV Closet
- Rack Layout
- Diagram
- Card Access
- Pathways

3.5 General Display Requirements

3.5.1 Display Sizing

The calculation of the minimum allowable image height or, conversely, the maximum allowable viewing distance for a given screen height depends on the nature of the material displayed and the intent of the viewer. UITS Learning Spaces recommendations specify two types of viewing tasks that are generally applicable in higher education:

- **Detailed Viewing Tasks** (i.e. note taking from text based slides)
  The height of the projection screen or flat panel display shall be no less than the distance to the least favored viewer (LFV) / furthest audience member divided by 6.
• **Inspection Viewing Tasks** i.e. viewing graphic material such as complex mathematical equations, engineering drawings or medical slides containing detailed graphics such as X-Rays.

The height of the projection screen or flat panel display shall be no less than the distance to the least favored viewer (LFV) / furthest audience member divided by 4. This stricter standard is generally not required unless specifically briefed.

The 6:1 ratio for Detailed Viewing Tasks and 4:1 ratio for Inspection Viewing Tasks should be viewed as an absolute minimum and consideration should be given to a more stringent ratio. Rooms where the ratio between screen height to the LFV is lower than 10:1 are not suitable for instructional purposes. Rooms that cannot meet a minimum of a 6:1 ratio require a consultation.

For non-tiered spaces, the bottom of the viewable image should not be lower than 42" as a minimum, with a preferred height of 48" AFF. In labs or other spaces where there are obstructions, the screen must be positioned to allow for a clear view over or around the obstructions while at the same time staying taking into account the maximum viewing angles.

The top of the viewable image should be at least 2" below the lowest device in the ceiling structure (light fixtures, sprinkler heads, or diffusers). Every effort shall be made to have ceiling heights that allow the screen sizes described above.

The table below indicates examples of maximum distances serviced by display sizes shown in 10" variations. Calculations should be performed and confirmed for your specific scenario and display sizes available at that time.

**Quick Reference Chart for 16:9 Screen Sizing**

<table>
<thead>
<tr>
<th>Diagonal (Inches)</th>
<th>Width (viewable area in inches)</th>
<th>Height (viewable area in inches)</th>
<th>Max Viewing Distance (6:1)</th>
<th>Max Viewing Distance (4:1)</th>
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<tr>
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<td>104.6&quot;</td>
<td>48.8&quot;</td>
<td>29' 5&quot;</td>
<td>19' 7&quot;</td>
</tr>
</tbody>
</table>

**3.5.2 Usable Seating Area**

The viewing area within 45º of the displayed images axis (center of the screen) is defined as the **Good Viewing Area** and is preferred for teaching and learning spaces. The angle is measured from a perpendicular line to the screen axis from the edge of the screen.

The viewing area within 45º of the displayed images edge is defined as the **Acceptable Viewing Area**.

Any room seats outside of the usable seating area shall be supported with additional display devices.

**Horizontal Viewing Angle diagram:**
3.5.3 Vertical Viewing Angle

The maximum vertical viewing angle should be no more than 15° to the center of the image, measured from perpendicular at seated eye height (50 in [1270 mm] above finished floor level) from the front row center seat (see figure below). For tight spaces, this rule may be relaxed to a maximum angle of 25° to the top of the screen.

Additionally, the distance to the first row should be no less than the image width, which allows viewers to see the entire screen within a natural field of vision. This will allow the user to view the entire screen without moving his/her head.
Vertical Viewing Angle

3.6 Projection Screens

3.6.1 Screen Material

Projection surfaces themselves also contribute to image quality. The surface should ideally be matte white, a purpose-manufactured projection screen material with a gain of 1.0 (gain is a measure of screen surface reflectivity). Where high-gain or rear-projection screen material is used, the manufacturer’s recommendations regarding optimum viewing angles should be followed.

Matte white vs high contrast

3.6.2 Aspect Ratio

The standard aspect ratio for projection screens is 16:9.

Widescreen and high definition are standard for video and television, and most modern laptops used for display in classrooms have a widescreen display. In light of this, the recommended aspect ratio for classroom displays is widescreen format. Most TVs and computer monitors are available only in 16:9 format, so a 16:9 aspect ratio is recommended for projection screens to avoid distortion of one format or the other.

3.6.3 Single Screen Projection

Projector screens should be placed as close a practical to the center-line of the room.

3.6.4 Dual Screen Projection

Multiple screens may be required for the presentation of different material or to reinforce viewing angles. Where screens are used for the presentation of different material, the angles of view and viewing distances must be considered for each screen. If viewing angles for each screen fail to meet the requirements in the Usable Seating Area section, the screens should display the same content in order to improve the off-axis viewing angle. The presentation of two independent images is a standard requirement for medium to large presentation spaces and every effort should be made to ensure the General Display Requirements for viewing angles are maintained.

3.6.5 Ceiling/Wall Mounted, Powered

Powered Screens are required for spaces which have a mounted height to the projector screen casing which exceeds 9’ AFF, or in any space with two or more projector screens.
Powered, ceiling mounted projector screens are to be recessed, and securely anchored to supporting substrate following the screen manufacturers written instructions. Case must be leveled side-to-side and front-to-back, and must be installed flush to ceiling grid. Location of projector screen should be designed to ensure that the screen exceeds 6” off the wall in order to clear wall mounted whiteboards. Vertical edges of the projector screen should be plumb and viewing surface flat when the screen is lowered.

Powered, wall mounted projector screens are to be securely anchored to the wall following the screen manufacturers written instructions. Case must be leveled side-to-side and front-to-back, and must be installed with 6” stand-off brackets in order to clear wall mounted whiteboards. Vertical edges of the projector screen should be plumb and viewing surface flat when the screen is lowered.

Power screens must be specified to have low voltage control of the screen to ensure they can be controlled by the AV control system.

3.6.6 Ceiling/Wall Mounted Manual

Manual, ceiling mounted projector screens are to be recessed, and securely anchored to supporting substrate following the screen manufacturers written instructions. Case must be leveled side-to-side and front-to-back, and must be installed flush to ceiling grid. Location of projector screen should be designed to ensure that the screen exceeds 6” off the wall in order to clear wall mounted whiteboards. Vertical edges of the projector screen should be plumb and viewing surface flat when the screen is lowered.

Manual, wall mounted projector screens are to be securely anchored to the wall following the screen manufacturers written instructions. Case must be leveled side-to-side and front-to-back, and must be installed with 6” stand-off brackets in order to clear wall mounted whiteboards. Vertical edges of the projector screen should be plumb and viewing surface flat when the screen is lowered.

Manual pull-down screens must be specified with a controlled return.

3.6.7 Walls as Screens

As a general rule, projecting images onto walls or painted surfaces is not acceptable due to the lack of reflectivity of these surfaces. Under certain circumstances, and if image quality may be compromised, walls may be acceptable as projection surfaces as long as they are painted flat (matte) white and are uniformly flat and perpendicular to the projector and the audience. Special paint and construction methods are available for projection walls and may be specified by UITS Learning Spaces. In this case, maintenance is particularly important, since improper painting or partial touch up can hurt image quality.

3.7 Display Devices

3.7.1 Projectors

Multimedia projectors will be supplied and installed as specified by UITS Learning Space Design. The projector is to be installed at the appropriate distance from the screen to allow the projected image to completely fill the nominated screen with the projector’s zoom range at a center setting. UITS Learning Space Design has a preferred list of projector models that can be supplied upon request.

All projectors must have a minimum of RS-232 control capability, with a minimum of (1) HDMI Input. Availability of HDBaseT connection preferred, and may be required in some situations. Crestron Connected Devices preferred.

Laser projectors are typically preferred over lamped projectors due to their reliability, instant-on startup time, and a typically lower total cost of ownership. There may be some scenarios where a lamped projector may be a more appropriate or the only choice, and should be discussed with Learning Space Design.

- Inputs/Outputs
- Size
- Resolution
- Lumens

3.7.2 Ceiling Mounting of Projectors

Projection mounting in a typical 2x2 or 2x4 ceiling grid should utilize the FSR CB-22P when space allows above ceiling. If space does not allow above ceiling for the FSR CB-22P then a Chief CMS440 can be used. Total weight of projectors and mounts exceeding 50 pounds require alternative mounting methods and require approval by UITS Learning Spaces.
FSR CB-22P or Chief CMS 440 must be installed utilizing the manufacturer provided support cables. Tray must be secured to the ceiling grid framework utilizing manufacturer provided hardware. Support cables must have tension adjusted to ensure the FSR CB-22P or CMS440 assembly supported entirely and evenly by all four support cables, but not so tight as to distort ceiling tile framework.

Any equipment suspended by iron pipe (commonly video projectors, monitors, and some loudspeakers) needs some type of hardware in place to keep the pipe or mounds from being unscrewed. Even lighter objects, such as loudspeaker cans or small cameras, can pose a danger if they fall. Best practice is to attach them to the grid deck via a safety chain or wire.

HVAC diffusers and registers should typically be kept 6 ft (1.8m) or more away from video projectors to keep them from affecting their cooling. Exhaust registers should be positioned to avoid blowing air onto any projection screens. Any movement will distort the projected image and be a distraction.

Electrical/Data requirements for ceiling mounted projector locations include 2 data ports and 1 Duplex 120V AC outlets mounted within the same ceiling tile and mount as the projector. Supplied AC power should be kept on the same panel/same phase as the rest of the AV system.

When the weight of the projector exceeds 50lbs a Chief CMA110 or Chief CMA450 Ceiling Plate should be used. The Chief CMA110 should be attached to unistrut and power/data should be mounted to the face of the ceiling tile. The Chief CMA450 should be mounted per the manufacturers instructions.

**FSR CB-22P Mounting Detail**

**CMS440 Mounting Detail**
Chief CMA450 Detail
Chief CMA110 Detail
3.7.3 Flat Panel Displays

All flat panel displays must have a minimum of RS-232C and CEC capability, with Ethernet as additional control options preferred. Manufacturers bi-directional control protocol must be supplied with the specifications prior to installation.

All flat panel displays must be commercial grade.

Flat panel mounts must be installed as per the manufacturers’ specifications and should be of a high quality professional grade product unless alternative is approved by Learning Space Design prior to installation.

3.7.4 Wall Mounting of Flat Panel Displays

Backing for wall mount displays will be minimum 3/4” CDX grade or better plywood in steel stud construction. Backing will often span 3 stud spaces centered on display location. Lag screws into wood studs or lag shield anchors into solid concrete are alternative mounting methods. Use of other mounting hardware (i.e. 1/4” Zip Toggles) may be acceptable, but must be approved by Learning Space Design prior to installation. Drywall or other material placed between backing and flat panel mount may not exceed 5/8” in thickness or mount manufacturer’s recommendation, whichever is lower.

When hanging or suspending any equipment, a safety factor of five times the weight of the object being installed is required (i.e. a 100-lb (45.36-kg) loudspeaker should be installed on a mounting system capable of holding 500 lb (226.8 kg)). The rating applies to all parts of the mounting system that bear the load of the object. Even the nuts and bolts used for mounting applications may require special ratings, often indicated by SAE or ISO grade markings on the hardware.

Mechanical or electronic security may also be required. This will be specified during the design consultation process by Learning Space Design.

For each flat panel display, a FSR PWB-320-TrK with FSR PWB-320-AC3 option wall box is to be provided. Electrical/Data requirements for this backbox include a minimum of 2 IU Data Jacks, 1 Duplex AC Outlet, and a 1.5” conduit stubbed above the ceiling. Optionally, this backbox may have additional data jacks or an additional 1.5” conduit connected to a secondary wall box for equipment and connections below the display. Data Jacks and AC Outlets are to be installed in a recessed device box. Supplied AC power should be kept on the same panel/same phase as the rest of the AV system.
A/V BACK BOX DETAIL

NOT TO SCALE
3.8 AV Control and Switching

3.8.1 AV Control

- AV control equipment is exclusively Crestron unless otherwise specified by UITS Learning Space Design.
- Fusion Monitoring
- Emergency Notifications

3.8.2 AV Switching

- Crestron preference, Extron substitution with LSDG approval
- HDCP compliance with full key management on all inputs and outputs
- EDID management
- Scaling/frame rate conversion
- Audio de-embedding
- Color space management

3.9 Audio

3.9.1 Program Audio

3.9.2 Voice Reinforcement
3.9.3 Assisted Listening

Assistive listening transmitters should receive a dedicated audio feed from the AV system, and should include both program and microphone audio. At a minimum, systems should have a single ceiling microphone near the instructor station. In larger rooms, or rooms where the instructor is likely to move away from the lectern, a wireless lapel should be provided as part of the system for assistive listening purposes.

Audio distributed from a DSP (Digital Signal Processor) to an assistive listening transmitter should be set at a fixed level, and receivers specified should be capable of adjusting the audio level at the receiver. Audio should not be adjusted by the system by at the system level by an end user, only by a Learning Spaces Engineer.

3.9.4 Microphones

3.10 Video Conferencing (27 41 43)

While videoconferencing rooms necessarily have a requirement for video cameras and digital display technology, the great challenge is creating an environment that fosters collaboration for both the local and remote participants. In particular, consider the room, it’s furniture and the equipment as a singular system designed for the conveyance of human speech. The ability of the system to capture, transmit and reproduce audio will determine the intelligibility of the presenter’s voice and, therefore, contributes to the success or failure of the messages conveyed.

3.10.1 Physical Room

Size & Shape of Conference Rooms

- Personal, Office and Focus Booths
- Small Conference Rooms
- Medium Conference Rooms
- Large Conference Rooms
- Multipurpose Spaces
- Classrooms

Ambient Light

Windows and other openings that transmit natural light create challenges for videoconferencing. Some mitigation techniques include:

- Limit the number of windows for dedicated videoconferencing rooms.
- Provide shades, blinds or curtains to block or restrict natural light.
- Avoid pointing cameras towards windows.
- Increase overall lighting levels.

Colors & Wall Finishes – Warm colors and matte finishes are recommended.

- Avoid bright white and glossy surfaces on tables and walls.
- Whiteboards should not produce excessive glare.

HVAC & Other Mechanical Systems

3.10.2 Acoustics

- See 2.3 Acoustical Guidelines. Apply ANSI/ASA S12.60 standards to multipurpose, videoconferencing and collaboration spaces.
- Example - Cisco’s “Guidelines for video conferencing room acoustics”

3.10.3 Lighting

Lighting of people – Persons appearing on camera should be evenly lit with ambient lighting with minimal shadows. Use of standard 4x2 or 2x2 volumetric fixtures can be sufficient with proper spacing and consistent color temperature. A minimum of 35 ft·c (foot candles) is required, though rooms with large windows and extensive natural light will likely require increased ambient lighting. Use of additional light fixtures may be recommended for dedicated presenter locations.

Lighting of walls, whiteboards, etc. – Spot and fill lights may be necessary in some circumstances, though “hot spots” should be avoided. An example to avoid would be a spot light on a glossy whiteboard.

Type of fixture

Pendant and other hanging light fixtures are typically discouraged because:

- Interference with cameras and projectors.
- Uneven light distribution that may create shadows.

LED fixtures – Modern LED lighting fixtures are compatible with current video camera technology.

Example - See Lutron’s brochure for “Linear Recessed and Video Conference Fixture Solutions”
3.10.4 Video Conferencing Hardware

The term “codec” is the shortened form of “coder-decoder.” It is a device that encodes and decodes a data stream utilizing either a hardware or software solution. For video conferencing, the codec can be a hardware appliance that has basically no other function than to deliver a high-quality video conferencing experience, which it does very well. Or, the codec might be based on a more general-purpose computer. Computer based video conferencing is often referred to as PCVC (Personal Computer Video Conferencing) while the term Codec often implies a dedicated hardware appliance.

Hardware Codec

**Standards compliance** – Videoconferencing systems must be fully compatible with both H.323 and SIP standards, including support for dual-stream options such as H.239 and BFCP.

**Manageability** – Videoconferencing systems will be managed centrally to ensure security and privacy compliance. A current list of systems compatible with Cisco’s Telepresence Management Suite (TMS) is available at https://tp-tools-web01.cisco.com/start/d5.

**Integration** – Videoconferencing systems must provide remote control integration capabilities using serial or IP-based methods.

3.11 Lecture Capture

At Indiana University, faculty members and instructors can record their classes using the Kaltura Lecture Capture system. Kaltura Lecture Capture can capture a variety of inputs, including audio, video, computer content, and content from document cameras. Determining the best way to accommodate lecture capture, and whether a software or hardware based approach is appropriate for the space must be determined during the Learning Space Design consultation process.

3.12 Lighting

Section 4 Network and Infrastructure Requirements

Section 5 Audio Visual Systems Cabling Installation Specifications

5.1 Cable Management

All cabling must be neat and secure.

Where cabling is mounted on slides, sufficient cable length must be provided to enable the item to be withdrawn to the limit of the slides and rotation of the rack while remaining fully operational and without stress on cables or connectors. Where cabling is affected by a height adjustable lectern, sufficient cable length must be provided to enable the item to be utilized at it’s full extent while the lectern is in it’s highest position while remaining fully operational and without stress on cables or connectors.

Attention must be given to plenum rated installation to ensure the proper cable type is used (i.e. riser vs plenum rated). Contractor is responsible for verifying the installation requirements.

Lacing bars and Velcro must be used to secure cabling at racks. Zip ties may not be used to secure cabling, with the exception of securing termination points to equipment when following manufacturers recommended instructions.

Any in-ceiling cabling must be suspended above ceiling tiles on J-hooks or Cable Tray. Where J-hooks are used, 3/4” plenum-rated Velcro shall be used to retain and manage cables.

At least one pull string must be run and secured in each conduit

All connections must be to industry standard. Connectors terminated on site are to be of a high quality and professional standard.

Umbilical Length

Tails at equipment length
Specify acceptable J-Hooks and Cable Tray

- Panduit J-Pro Series (Preferred)
- Panduit J-Mod Series
- Cable Tray (Comply with NEMA VE 2 and TIA-569 cable tray or cable basket, 12" or larger as needed)

Lacing bar minimum gap
Panduit for surface mount?

5.2 Cable Labeling

ADD MORE CONTEXT HERE

PRIMARY LABEL

Primary Labels – to identify the type, primary function, and provide the technician with a unique ID in order to trace and/or identify cable runs.

Note that these primary label examples are by no means exhaustive, they are merely there so that someone can extrapolate how to label a cable of a different gauge, classification, etc.

I. Data (category) Cables – 8 conductor twisted pair

<table>
<thead>
<tr>
<th>Label ID /Function Code</th>
<th>Optional Multimedia Modifier</th>
<th>DASH</th>
<th>Category</th>
<th>Shielding Modifier</th>
<th>Plenum-rated modifier</th>
<th>DASH</th>
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For example, a standard CAT6 unshielded data cable would be: D-6U-001
A shielded, plenum rated Crestron DM video cable would be: DM-6SP-001
The optional M modifier is to signify a cable that carries something besides data, i.e. video, audio, control, etc.

II. Fiber Cables

<table>
<thead>
<tr>
<th>Label ID /Function Code</th>
<th>Optional Multimedia Modifier</th>
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<th>Gauge (mm)</th>
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<td></td>
<td>-</td>
<td>4</td>
<td>S</td>
<td>M</td>
<td>S</td>
<td>M</td>
<td>P</td>
</tr>
</tbody>
</table>

For example, a 2mm single mode, single strand, fiber cable would be: F-2SS-001
A 4mm plenum rated, multi mode, single strand fiber cable carrying video would be: FM-4MSP-001
For gauge specifications, leading zeroes will be added to the front of decimals to avoid confusion.

### III. Coaxial Cables

<table>
<thead>
<tr>
<th>Label ID/Function Code</th>
<th>DASH</th>
<th>RG#</th>
<th>Bundled</th>
<th>DASH</th>
<th>Unique Cable ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RF</td>
<td>-</td>
<td>6</td>
<td>S</td>
<td>B</td>
<td>- 001</td>
</tr>
<tr>
<td>RF</td>
<td>-</td>
<td>58</td>
<td>S</td>
<td>B</td>
<td>- 002</td>
</tr>
<tr>
<td>RF</td>
<td>-</td>
<td>59</td>
<td>S</td>
<td>B</td>
<td>- 003</td>
</tr>
</tbody>
</table>

The RG number on coax gives all the information that is needed.

### IV. Speaker Wire

<table>
<thead>
<tr>
<th>Label ID/Function Code</th>
<th>DASH</th>
<th>Gauge</th>
<th>Shielding Modifier</th>
<th>Plenum-rated modifier</th>
<th>DASH</th>
<th>Unique Cable ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shielded</td>
<td>Unshielded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>12</td>
<td>n/a</td>
<td>U</td>
<td>P</td>
<td>- 001</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>14</td>
<td>n/a</td>
<td>U</td>
<td>P</td>
<td>- 002</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>16</td>
<td>n/a</td>
<td>U</td>
<td>P</td>
<td>- 003</td>
</tr>
<tr>
<td>S</td>
<td>-</td>
<td>18</td>
<td>n/a</td>
<td>U</td>
<td>P</td>
<td>- 004</td>
</tr>
</tbody>
</table>

For example, a 14 gauge speaker wire would be: S-14U-001
An 18 gauge plenum rated speaker wire would be: S-18UP-001

### V. Audio Cables

<table>
<thead>
<tr>
<th>Label ID/Function Code</th>
<th>DASH</th>
<th>Gauge</th>
<th>Shielding Modifier</th>
<th>Plenum-rated modifier</th>
<th>DASH</th>
<th>Unique Cable ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Shielded</td>
<td>Unshielded</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>12</td>
<td>S</td>
<td>U</td>
<td>P</td>
<td>- 001</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>14</td>
<td>S</td>
<td>U</td>
<td>P</td>
<td>- 002</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>16</td>
<td>S</td>
<td>U</td>
<td>P</td>
<td>- 003</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>18</td>
<td>S</td>
<td>U</td>
<td>P</td>
<td>- 004</td>
</tr>
<tr>
<td>A</td>
<td>-</td>
<td>20</td>
<td>S</td>
<td>U</td>
<td>P</td>
<td>- 005</td>
</tr>
</tbody>
</table>

For example, a 20 gauge, shielded, plenum rated audio cable would be: A-20SP-001
A 22 gauge unshielded audio cable would be: A-22U-001

### VI. Microphone cables
For example, a 20 gauge, shielded, plenum rated mic cable would be: M-20SP-001

A 22 gauge unshielded mic cable would be: M-22U-001

VII. Control Cables: Cresnet, RS-232, Relays, Digital IO

For example, a 20 gauge, shielded, plenum rated Cresnet cable with drain would be: C-18/4SDP-001

A 22 gauge shielded, plenum rated RS232 cable would be: C-22/03SP-001

VIII. Premade Video Cables

For example, a plenum rated HDMI cable would be: V-HDMI-P-001

A non-plenum rated VGA cable would be: V-VGA-001

IX. Premade Video Adapter Cables

Pre-made adapter cables follow the same naming convention as regular pre-made cables. The order of the connector name should follow the signal flow that is present in the system, i.e. source/transmitter output to switcher/receiver input or switcher/transmitter output to display/receiving device input.
For example, a camera outputs DVI, and is connected to an HDMI input of a switcher. The label would be: V-DVI/HDMI-001

**X. USB Cables:**

USB cables should follow the same conventions as an adapter cable, as many will have a different connector on each end.

For example, a USB2.0 micro-A to micro-B cable would be labeled: U2.0-A-MC/B-MC-001.

A plenum rated USB3.0 A to micro-B would be: U3.0-A/B-MC-001

Notes: Micro designation will be: MC Mini designation will be: MN

**XI. Power Cables**

Power cables will be named from plug end to connector end. A non-exhaustive list of examples and fairly common plugs is listed below.

Consult the charts after these sample entries to label any combination of inlets, outlets, plugs, and connectors.

---

### Table 1: DAS / Function Code

<table>
<thead>
<tr>
<th>Label ID / Function Code</th>
<th>Output Signal</th>
<th>Slasch</th>
<th>Input Signal</th>
<th>Plenum-rated modifier</th>
<th>Unique Cable ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>V</td>
<td>DVI</td>
<td>/</td>
<td>HDMI</td>
<td>-</td>
<td>001</td>
</tr>
<tr>
<td>V</td>
<td>DP</td>
<td>/</td>
<td>HDMI</td>
<td>-</td>
<td>002</td>
</tr>
</tbody>
</table>

### Table 2: Connector Type "SEE NOTES"

<table>
<thead>
<tr>
<th>Label ID / Function Code</th>
<th>Speed</th>
<th>Plug</th>
<th>DASH</th>
<th>MINI / MIC RO SLASH</th>
<th>Plug</th>
<th>DASH</th>
<th>MINI / MIC RO</th>
<th>DASH</th>
<th>Plenum-rated modifier</th>
<th>DASH</th>
<th>Unique Cable ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>U 1.0</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>B</td>
<td>-</td>
<td>P</td>
<td>-</td>
<td>001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 1.1</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>B</td>
<td>-</td>
<td>P</td>
<td>-</td>
<td>002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 2.0</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>MC</td>
<td>B</td>
<td>MC</td>
<td>-</td>
<td>003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 2.0</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>MN</td>
<td>B</td>
<td>MN</td>
<td>-</td>
<td>004</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 3.0</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>MC</td>
<td>B</td>
<td>-</td>
<td>P</td>
<td>005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 3.1</td>
<td>-</td>
<td>A</td>
<td>/</td>
<td>B</td>
<td>-</td>
<td>P</td>
<td>-</td>
<td>006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>U 3.2</td>
<td>-</td>
<td>C</td>
<td>/</td>
<td>C</td>
<td>-</td>
<td>P</td>
<td>-</td>
<td>007</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For example, a USB2.0 micro-A to micro-B cable would be labeled: U2.0-A-MC/B-MC-001.

A plenum rated USB3.0 A to micro-B would be: U3.0-A/B-MC-001

Notes: Micro designation will be: MC Mini designation will be: MN

**REFERENCE CHART 1: NEMA Plugs and Receptacles**
## NEMA Configurations for General-Purpose Nolocking Plugs and Receptacles

<table>
<thead>
<tr>
<th>Wiring/Voltage</th>
<th>15 Ampere</th>
<th>20 Ampere</th>
<th>30 Ampere</th>
<th>50 Ampere</th>
<th>60 Ampere</th>
</tr>
</thead>
<tbody>
<tr>
<td>125V 1 Pole 2 Wire</td>
<td>115R</td>
<td>115P</td>
<td>2-15R</td>
<td>2-20R</td>
<td>2-30R</td>
</tr>
<tr>
<td>250V 2</td>
<td>2-15R</td>
<td>2-20R</td>
<td>2-20P</td>
<td>2-20R</td>
<td>2-30R</td>
</tr>
<tr>
<td>125V 6</td>
<td>5-15R</td>
<td>5-20R</td>
<td>5-20P</td>
<td>5-20R</td>
<td>5-30R</td>
</tr>
<tr>
<td>250V 6</td>
<td>6-15R</td>
<td>6-20R</td>
<td>6-20P</td>
<td>6-20R</td>
<td>6-30R</td>
</tr>
<tr>
<td>277V/AC 7</td>
<td>7-15R</td>
<td>7-20R</td>
<td>7-20P</td>
<td>7-20R</td>
<td>7-30R</td>
</tr>
<tr>
<td>440V/AC 24</td>
<td>24-15R</td>
<td>24-20R</td>
<td>24-20P</td>
<td>24-20R</td>
<td>24-30R</td>
</tr>
<tr>
<td>30/250V 11</td>
<td>11-15R</td>
<td>11-20R</td>
<td>11-20P</td>
<td>11-20R</td>
<td>11-30R</td>
</tr>
<tr>
<td>125/250V 14</td>
<td>14-15R</td>
<td>14-20R</td>
<td>14-20P</td>
<td>14-20R</td>
<td>14-30R</td>
</tr>
</tbody>
</table>

## NEMA Configurations for Locking Type Plugs and Receptacles

<table>
<thead>
<tr>
<th>Wiring/Voltage</th>
<th>15 Ampere</th>
<th>20 Ampere</th>
<th>30 Ampere</th>
</tr>
</thead>
<tbody>
<tr>
<td>125V 1 Pole 2 Wire</td>
<td>L1-15R</td>
<td>L1-20R</td>
<td>L1-30R</td>
</tr>
<tr>
<td>250V 2</td>
<td>L2-20R</td>
<td>L2-20P</td>
<td>L2-30P</td>
</tr>
<tr>
<td>125V 6</td>
<td>L5-15R</td>
<td>L5-20R</td>
<td>L5-30R</td>
</tr>
<tr>
<td>250V 6</td>
<td>L6-15R</td>
<td>L6-20R</td>
<td>L6-30R</td>
</tr>
<tr>
<td>277V/AC 7</td>
<td>L7-15R</td>
<td>L7-20R</td>
<td>L7-30R</td>
</tr>
<tr>
<td>440V/AC 24</td>
<td>L24-20R</td>
<td>L24-20P</td>
<td>L24-30P</td>
</tr>
<tr>
<td>25/250V 10</td>
<td>L10-15R</td>
<td>L10-20R</td>
<td>L10-30R</td>
</tr>
<tr>
<td>30/250V 11</td>
<td>L11-15R</td>
<td>L11-20R</td>
<td>L11-30R</td>
</tr>
<tr>
<td>125/250V 14</td>
<td>L14-15R</td>
<td>L14-20R</td>
<td>L14-30R</td>
</tr>
<tr>
<td>30/250V 15</td>
<td>L15-15R</td>
<td>L15-20R</td>
<td>L15-30R</td>
</tr>
<tr>
<td>120/208V 18</td>
<td>L18-15R</td>
<td>L18-20R</td>
<td>L18-30R</td>
</tr>
<tr>
<td>208V/AC 20</td>
<td>L20-15R</td>
<td>L20-20R</td>
<td>L20-30R</td>
</tr>
</tbody>
</table>

REFERENCE CHART 2: IEC Couplers
Secondary Labels – to identify the input, output, source, and destination of a signal cable. This will aid the technician in trouble shooting and confirming that the proper cables are landed in the correct input/output/source.

I. Inputs

<table>
<thead>
<tr>
<th>Source Name</th>
<th>DASH</th>
<th>Input Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td>-</td>
<td>001</td>
</tr>
<tr>
<td>BluRay</td>
<td>-</td>
<td>002</td>
</tr>
<tr>
<td>Laptop</td>
<td>-</td>
<td>003</td>
</tr>
</tbody>
</table>
### II. Outputs

<table>
<thead>
<tr>
<th>Destination (Display/Projector)</th>
<th>DASH</th>
<th>Output Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display 1</td>
<td>-</td>
<td>003</td>
</tr>
<tr>
<td>Projector 2</td>
<td>-</td>
<td>004</td>
</tr>
<tr>
<td>Prev Monitor</td>
<td>-</td>
<td>001</td>
</tr>
<tr>
<td>Conf Monitor</td>
<td>-</td>
<td>002</td>
</tr>
<tr>
<td>Amp 1</td>
<td>-</td>
<td>005</td>
</tr>
<tr>
<td>Amp 2</td>
<td>-</td>
<td>006</td>
</tr>
<tr>
<td>Echo</td>
<td>-</td>
<td>007</td>
</tr>
</tbody>
</table>

### III. Control

<table>
<thead>
<tr>
<th>Destination (Display/Projector)</th>
<th>DASH</th>
<th>Output Number (from Crestron Processor or control device)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display 1</td>
<td>-</td>
<td>COMA</td>
</tr>
<tr>
<td>DocCam</td>
<td>-</td>
<td>COMB</td>
</tr>
<tr>
<td>Codec</td>
<td>-</td>
<td>COMC</td>
</tr>
<tr>
<td>CNT</td>
<td>-</td>
<td>CRES1</td>
</tr>
<tr>
<td>Lighting Proc</td>
<td>-</td>
<td>CRES2</td>
</tr>
<tr>
<td>Screen L</td>
<td>-</td>
<td>R1</td>
</tr>
<tr>
<td>C2NIO</td>
<td>-</td>
<td>CNT2</td>
</tr>
</tbody>
</table>

### IV. USB & Power

If the signal is coming from a numbered input/output (e.g. a USB switcher,) list the destination followed by the numbered input/output. Otherwise, the destination device name is sufficient, as in the case of a PC. For power cords, simply naming the device being powered is acceptable.

<table>
<thead>
<tr>
<th>Destination (Device the equipment communicates with/powers)</th>
<th>DASH</th>
<th>Output Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW2</td>
<td>-</td>
<td>001</td>
</tr>
</tbody>
</table>

5.3 Audio Visual Cable Specifications
5.4 Cable Termination and Testing

Section 6 Project Documentation

6.1 Close-out Documents
6.2 As-Builts
6.3 Format and Storage
6.4 Test Results
6.5 Build Checklists

Section 7 System Programming

7.1 Manufacturer Specific/Crestron
7.2 LSDG Programming Services
7.3 Branding and UI Layout
7.4 Program Versioning and Storage

Section 8 Commissioning

Section 9 ADA Compliance and Integration

9.1 Hearing Assist

9.1.1 Applicable Standards
2010 Americans with Disabilities Act
http://www.ada.gov/2010ADAstandards_index.htm

IEC 60118-4
Induction-Loop Systems for hearing aid purposes – System performance requirements
https://webstore.iec.ch/publication/798

9.1.2 Guidelines
Assisted listening systems are a requirement in facilities where audio is amplified under the Americans with Disabilities Act. Compliance provisions and the details of what must be provided to meet accessibility requirement vary; therefore, local legislation regarding access must be taken into account when designing audio systems for classrooms, conference rooms and lecture halls. Consultation with UITS Learning Spaces must occur during construction projects to ensure the appropriate system is selected and inputs into the audio system are coordinated.
Infrared Systems - Infrared systems (or IR) operate on the basis of line-of-sight (transmitter and receiver must be able to “see” each other) and confine the signal to the room, which ensures information privacy. Infrared emitter panels are mounted in the room and students can be issued with personal receivers that are equipped with headsets or neck-loops. The wall or ceiling mounted emitter panels can be seen as obtrusive, and may not fit the aesthetic goals of some projects. Best practice is to coordinate the appearance and locations with the architect. **Infrared systems are standard for small to medium sized classrooms and AV systems.** Substitutions to the standardized IR solution must be approved by UITS Learning Spaces.

Inductive Loops - The preferred assistive solution for large classrooms and auditoriums and lecture halls is an inductive-loop system, which allows audio reproduced through the PA to also energize a wire loop, usually installed under floor coverings around the perimeter of the room. People with a hearing disability can switch their own hearing aids, which are fitted with a special telecoil switch, to receive the audio from the loop, providing clearer reproduction of the sound. The advantage of inductive-loop technology is that it does not require issuing a special receiver. The student (or anyone with a hearing aid who uses the space) is able to discreetly use their own listening equipment, which is optimized for their particular hearing abilities. Technically, inductive-loop systems have some inherent disadvantages. Because the loop typically needs to be installed under floor coverings, they are difficult to retrofit. Also, like RF systems, they are prone to interference between rooms — either adjacent rooms or rooms above or below, in the case of multistory buildings. Special loop design utilizing dual transmitters is needed to minimize this problem. **Careful coordination with UITS Learning Spaces is required where inductive loops are installed to ensure a full understanding of responsibilities for providing the various components and how the signal will interface with the AV system.** The shape of the wire loops and their positioning in the room is crucial to the effectiveness of the system. Installation of the loops may require modification to floor slabs or otherwise impact construction, carpet installation, furniture installation, and so on. Best practice is to consult the equipment manufacturer and have them design the layout of the loops, based on the floor plans. This should be done early in the design process.

### 9.1.3 System Specifications

#### Infrared System

When specifying an Infrared Assistive Listening System, the following package shall be specified. Modifications to this package must be approved by IU Learning Space Design.

- **LS-90-01**
  - Listen Technologies ListenIR iDSP Level I System
- **LPT-A117**
  - Listen Technologies Remote Power Supply Kit
- **LA-347-BL**
  - Listen Technologies Single Gang Wall-Box Mounting Plate (Black)

Where necessary for rooms that are too wide to be reasonably covered by one IR Transmitter, an expansion emitter may be necessary. The following items shall be provided when an expansion emitter is deemed necessary.

- **LA-141**
  - Listen Technologies Expansion Radiator (For LT-84 Only)
- **LA-347-BL**
  - Listen Technologies Single Gang Wall-Box Mounting Plate (Black)

Receivers and neck loops shall be specified for each room containing an assistive listening system. The standard LS-90-01 system includes 2 receivers and 2 neck loops. Additional receivers and neck loops shall be specified as necessary in order to meet the minimum number of transmitters and loops required to meet the 2010 ADA Requirements for each space. Approved Transmitters, loops, and additional accessories include:

- **LT-84-01**
  - Listen Technologies Intelligent DSP IR Receiver
- **LA-439**
  - Listen Technologies Intelligent Ear Phone/Neck Loop Lanyard

The following cable types and connectors shall be specified:

- **9451P**
  - Belden 22 AWG, 1 Pair
- **2413**
  - Belden Enhanced Category 6 Nonbonded-Pair Cable, Plenum
- **Z6A-K01**
  - Siemon Z-MAX 6A UTP Module, Keystone, Black
- **A3L890-06IN-BKS**
  - Belkin 6 inch Black Cat6 Snagless Patch Cable UTP
- **37094**
  - C2G Two Port Keystone Single Gang Wall Plate – Stainless Steel

#### RF System
RF Assistive Listening Systems are not considered to be a standard item, and should not be specified for projects without consultation and approval from the IU Learning Space Design Team.

**Induction Loop System**

When specifying an Infrared Assistive Listening System, the following package shall be provided:

**Loop Drivers**

The following loop driver models are approved for specification. An appropriate model should be selected to ensure full coverage of the space. Models outside of these must be approved by IU Learning Space Design.

- **MLD5**
  Listen Technologies MultiLoop Driver (5 Amps x 2), covers up to 3875 sq. ft

**Receivers**

The following receiver models are approved for specification. An appropriate number of receivers should be provided in order to meet the minimum number of transmitters and loops required to meet the 2010 ADA Requirements for each space.

- **LP-IL-1**
  Listen Technologies Hearing Loop Receiver with Lanyard Package

**Cabling**

The following cabling is approved for specification. An appropriate cable type should be selected based on the size of the space and installation method.

- **DBC2.5**
  Listen Technologies Direct Burial Cable
- **LA-396-14-G**
  Listen Technologies 14 AWG Hearing Loop Cable
- **LA-397-16-G**
  Listen Technologies 16 AWG Hearing Loop Cable

**Accessories**

The following accessories are approved for specification. All listed accessories shall be provided to IU Learning Space Design at the completion of the project. The field strength meter shall be used for measuring, setting up, and commissioning the hearing loop system to the requirements of IEC 60118-4 standard.

- **FSM+SCC**
  Listen Technologies Field Strength Meter with Signal Connection Cables
- **R1**
  Listen Technologies Loopworks Measure Receiver

**IP Based**

IP-Based Assistive Listening Systems are being evaluated and are not yet considered to be a standard item. These systems should not be specified for projects without consultation and approval from the IU Learning Space Design Team.

**9.1.4 Integration**

**Certified Individuals**

Hearing Loop system integrators must have completed Listen Technologies Hearing Loop Installation Training and Certification Hands-On Certification.

**Commissioning**

Installed loop systems must comply to IEC60118-4, and the contractor must provide test results and a certificate of conformity to show compliance to IEC60118-4.
9.1.5 Signage Specifications

Signage identifying the availability of Assistive Listening Devices is required to meet ADA Compliance.

Signage shall be provided. UAO shall provide appropriate signage types, locations, and heights.

9.2 Wheelchair Accessibility

9.3 Consultations

Version Revision History

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