



# SMART Installation Standards

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# Introduction

This document provides guidance for installing SMART products. It describes best practices and the standard tasks and equipment needed for a successful equipment installation. This document also provides guidance for those who wish to deviate from a standard installation by including third-party equipment. SMART describes an installation that deviates from a standard equipment installation as a “non-standard installation.”

Because SMART has no control over products manufactured by a third party, SMART cannot make recommendations regarding the use of specific third-party equipment with SMART products. However, SMART has compiled a list of companies that are likely to be able to provide assistance in these areas. These referrals are found in [Appendix A: Third-Party Referrals](#) on page 62.

Contact your installer, reseller or equipment manufacturer for support with equipment you use as part of a non-standard installation. SMART cannot provide support beyond that which is presented in this document.

## **IMPORTANT:**

- Modifications to any SMART product, accessories, components or included cables voids the product’s warranty.
- The use of any third-party product in combination with a SMART product is at your own risk.
- SMART strongly recommends that you test third-party components or adapters before installation. Consult your certified reseller for assistance.

# Plan the installation: selecting the location

Selecting the proper location for your SMART interactive product is crucial for ensuring the best possible experience with the product. You need to consider a variety of factors (such as the location of light sources, a room's ventilation, the product's intended users and so on) as you choose the product's ideal location.

A SMART interactive display is typically installed at a room's focal point, such as at the front of a classroom or meeting room. This section describes important considerations for choosing the best place for the product.

## Environmental factors to consider

Factor	Guidance
<b>Power and other connections</b>	<p>Determine the location and number of power sources in the room.</p> <p><b>NOTE:</b> If there are no power sources at the room's focal point, you might need to consult an electrician to get the power setup you need.</p> <p>You should also locate the other connections in the room. These connections can include:</p> <ul style="list-style-type: none"><li>• The network outlet (unless you'll use a wireless connection)</li><li>• The room computer, which you might connect to the SMART product</li><li>• Speakers or sound system</li><li>• Any other components that the customer wants to connect to the SMART product</li></ul> <p>By documenting this information as you plan the installation, you'll be able to determine whether you'll need additional equipment, such as power bars, additional cables or cable extenders.</p> <p><b>IMPORTANT:</b> Do not install the product near where the power line (mains power) enters the building. Doing so may cause audio noise (such as static) in the system.</p>

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### **Doors and furniture**

Do not install the product near a door, gate or any other object that might damage the product.

Make sure the product is not near shelving units, desks or other furniture that has drawers or doors that could hit the product.

Be mindful of furniture, wall décor and other room features (such as light switches and thermostats) that are already mounted to the wall. Some items can be moved to accommodate the product while others may not.

### **Windows and lighting**

In general, choose a mounting location that's far from bright light sources, such as windows and strong overhead lighting.

To reduce light interference with the product:

- Install blinds or shades on windows or skylights to help prevent light interference.

**NOTE:** Light can come through windows at different angles at different times of the year.

- If possible, install a light switch that turns off or dims lights that shine light directly on the product's screen.

Risks of light Interference include:

- **Reduced visibility:** Light sources can cause glare on the product's screen, reducing its visibility.
- **Touch system interference:** Many SMART interactive displays use infrared (IR) light as a key component of the touch system. Strong light that hits the product's display directly can cause interference with the touch system and prevent the product from working properly.

### **Ventilation**

If the SMART product isn't ventilated properly, it may require additional maintenance, or in extreme cases, fail entirely.

Be aware that ventilation systems that blow air directly on the product can cause issues with the product's heating and cooling. The excessive air movement can also lead to substantial dust build up.

**IMPORTANT:** Do not install the product in an area where it will be subjected to strong vibrations or dust.

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Leave adequate space around the mounted product to ensure proper ventilation: air should circulate freely, and heat should be able to flow away from the product and its mounting equipment. SMART recommends at least 2" (5 cm) of clearance on all sides of the product to allow for proper airflow. If you mount the product in a recessed area, leave at least 4" (10 cm) between the product and the recessed walls to enable ventilation and cooling.

### Room acoustics

The importance of room acoustics varies depending on the room's size and intended use. If you plan to enable voice conferencing in a large room, such as a board room or a lecture space, acoustics will be more important than they would be in a small classroom or meeting space where voice conferencing is not likely to be used often. Sound absorption can be required in large, open areas in which sound can echo freely.

Use this simple test to check the room's acoustics: Stand in different parts of the room and count to ten loudly. If you hear anything other than your own voice (such as a rattle, buzzing from elsewhere in the room or echoes), the room may require some modifications to improve the acoustics.

A number of features in a room can affect its acoustics:

- **Hard surfaces:** Hard surfaces in a room (such as brick, cement, or glass) can cause sound to echo and distort, which can cause muffled or echoing audio during a voice conference.
- **Flooring:** Tile, hardwood or laminate flooring are hard surfaces that can cause echoes and distortion. Carpeted floors offer more absorption of unwanted sounds.
- **Ceiling:** A dropped ceiling with regular ceiling tiles can greatly change the acoustics of a room. Alternatively, a high, open or cavernous ceiling can also affect audio quality. Consult a sound reinforcement specialist before making changes to a room's acoustics.

There are a number of things you can do to improve a room's acoustics:

- **Install acoustic tiles or foam:** Acoustic tiles or foam absorb and diffract sound waves, helping to minimize sound distortion (especially in rooms that have long parallel walls and hard surfaces).



- **Install ceiling tiles with better acoustic absorption:** Although all types of ceiling tile offer a degree of sound absorption, some provide more sound absorption than others. Look for ceiling tiles that have a higher sound attenuation rating. This sound absorption ability is rated on a scale of 0 to 1 or as a Noise Reduction Class on the same type of scale. Higher numbers are better.

### Wall structure

Wall structure is an important component in the successful installation of a SMART product, particularly if you're installing more than one. The wall's flatness and construction will determine its structural ability to support that product and its general suitability as an installation location. In some cases, additional mounting equipment, such as a wall stand, may be required to support a product. See [Wall Mounts](#) on page 15 for more information about wall stands.

**IMPORTANT:** SMART does not recommend installing more than three interactive displays together on a wall. Such an installation involves considerations not described in this document. Contact SMART support for more guidance.

### Wall flatness

Although a wall might appear to be completely flat, it might have a degree of variation, depending on how it is constructed. Installing on a wall with a large variance can lead to issues with the product's touch system, and in extreme cases can damage the product. The area of the wall where you will mount the display is no more than 3/16" (5 mm) off plumb horizontally and vertically.

To evaluate the wall's flatness:

1. Place an object that has a long flat edge of at least 3' (1 m) (such as a meter stick or level) across the wall where the product will be mounted.
2. Look along the object to find places where there is a gap between the object's edge and the wall's surface.
3. Measure any gaps to see if they exceed 5 mm. If a gap is wider than 5 mm, this indicates the wall is not flat enough to mount a display on.

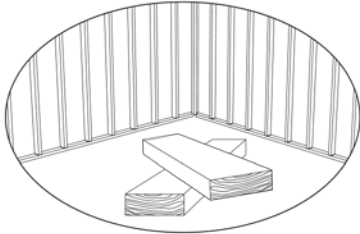
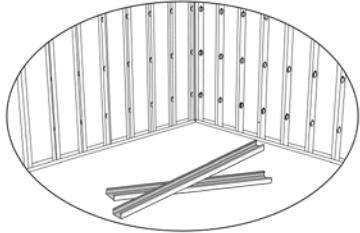
## SMART INSTALLATION STANDARDS

- Repeat steps 1-3, this time placing the object's flat edge diagonally across the wall in the other direction (if you previously placed the object diagonally from the top-left to the bottom-right, place the object from the top-right to the bottom-left).

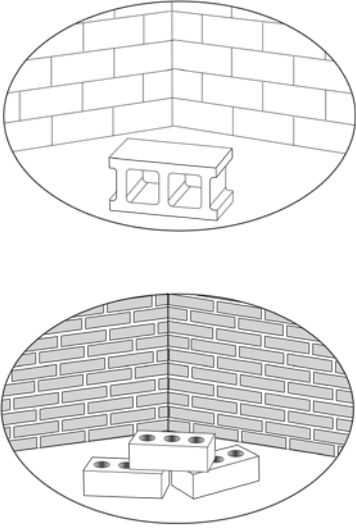
**TIP:** Gaps located at the center of the object indicate a concave wall, while gaps located on both ends of the object indicate a convex wall (consequently, the object may make a “rocking” motion). Walls with a significant degree of convexity or concavity may make it necessary to use shims with the mounting hardware.

### Wall type

The type of wall affects how you can mount the product. The following table identifies wall types and provides guidance for mounting.

Wall type	Description
Drywall over wood studs 	<ul style="list-style-type: none"><li>• Can be load or non-load bearing</li><li>• Can carry weight when constructed as a load-bearing wall</li><li>• Mounting must attach to three wood studs</li><li>• Pilot holes should be drilled into the wood studs. These holes should be no larger than the diameter of the screw's body to ensure the screw's thread gains as much traction in the wood studs as possible</li></ul>
Drywall over steel studs 	<ul style="list-style-type: none"><li>• Commonly non-load bearing</li><li>• Can not support the wall-mounted system without additional support (for example, a wall stand that helps support the product's weight)</li><li>• Mounting must attach to the steel studs</li></ul>
Solid concrete	<ul style="list-style-type: none"><li>• Can be load or non-load bearing</li></ul>

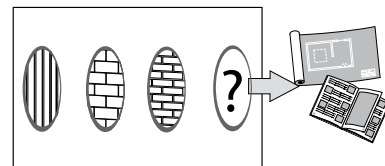
## SMART INSTALLATION STANDARDS

	<ul style="list-style-type: none"><li>• Can carry weight when constructed as a load-bearing wall</li><li>• Must have at least 3" (7.6 cm) between adjacent fasteners</li></ul>
<p>Concrete masonry unit or brick</p> 	<ul style="list-style-type: none"><li>• Can be load or non-load bearing</li><li>• Can carry weight when constructed as a load-bearing wall</li><li>• Use only one masonry or brick fastener per block</li><li>• Do not anchor mounting hardware in mortar or grout</li></ul>
<p>Modular panels</p>	<ul style="list-style-type: none"><li>• Can be load or non-load bearing</li><li>• Can carry weight when constructed as a load-bearing wall</li><li>• If non-load-bearing, might not support the wall-mounted system without additional support (for example, a wall stand that helps support the product's weight)</li></ul>

### Engineering analysis

An engineering (structural) analysis may be necessary for determining if a wall can support the product. Get an engineering analysis if:

- You cannot find the wall's studs using appropriate tools, such as a stud finder
- You are unsure of the wall's construction and the person in charge of the building cannot answer your questions
- The wall is not connected at both the floor and ceiling
- The wall is a modular panel system
- The wall is also bearing the weight of additional hardware or furniture (such as cabinets or bookshelves)

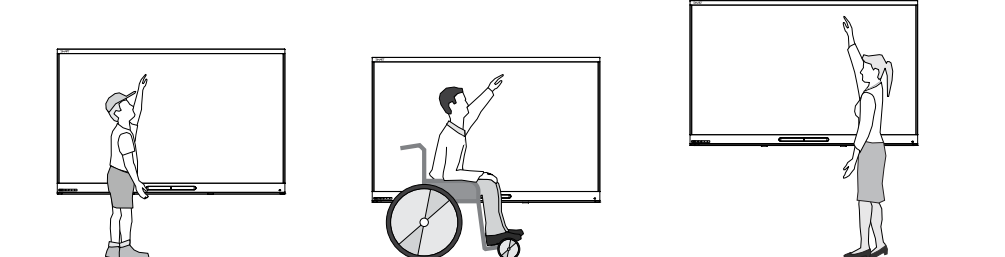


## SMART INSTALLATION STANDARDS

- There are special zoning requirements (for example, earthquakes)
- The wall exceeds typical construction practices (for example, taller than 8' or 2.4 m)

## User factors

Because SMART interactive displays are not just tools for displaying and sharing content but also for collaborating and learning, it's important that you consider the product's users. Make sure the location allows for multiple people to access the product at once and that there are no tripping hazards.

Factor	Guidance
<b>Height</b>	<p>The mounting height should reflect the average height of the users. For example, an interactive display mounted in an elementary school classroom should be mounted lower than one in a business' meeting room.</p>  The illustration consists of three separate line drawings of people interacting with a rectangular display mounted on a wall. From left to right: 1. A young child stands on the ground, reaching up with their right hand to touch the lower edge of the display. 2. A person is seated in a wheelchair, reaching up with their right hand to touch the lower edge of the display. 3. An adult woman stands on the ground, reaching up with her right hand to touch the top edge of the display. The drawings are positioned below a horizontal line representing the ground level.

**Accessibility** Choose a location that is accessible to all users (adults, children, people in wheelchairs and so on). Also take into account room traffic patterns and the space provided around the intended mounting location.

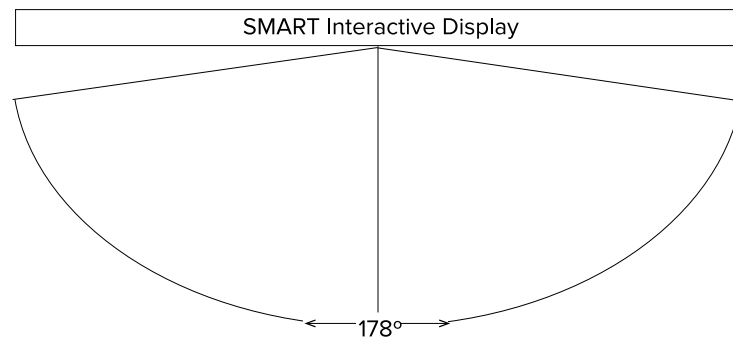
Refer to local regulations regarding accessibility and for any additional requirements.

### Viewing angle and area

Consider the seating around the mounted product. If participants will be sitting at a steep angle (such as in a lecture hall) relative to the display, you may have to adjust the installation height or angle. SMART's interactive displays are designed for vertical mounting only: 90° relative to the floor, plus or minus 5–15° for tolerance, depending on the product (consult the product's documentation). SMART doesn't support mounting these products at other angles or in a horizontal orientation.

**NOTE:** The only product that supports a horizontal orientation is the SMART Table.

The recommended viewing angle and area also depend on the display's [resolution](#) and a variety of other factors that can affect the display's visibility, such as ambient lighting. SMART recommends user's sit within the 178° viewing area, shown in the diagram below.



See SMART's knowledge base article, [Recommended viewing distances and viewing angles for SMART Board interactive displays](#) for more information about viewing angles.

## Room control system and power management

A room control system enables users to control a room's lighting, sound system, and possibly the SMART product you're installing. Some installations may require you to integrate the product with a room control system. Refer to the product's installation or administrator's guide to see if it works with an external room control system.

### Presence detection sensor

Many of SMART's interactive displays include some form of presence detection sensor (also called the proximity sensor) that detects movement in the room and turns on the display. If the sensors detect no movement for a particular interval, the SMART product goes into Standby. The product's use of the proximity sensor can be adjusted or disabled in the product's settings. For more information about power states and power-management settings, refer to the product's installation or administrator's guide or to the [support page](#).

**NOTE:** When you install a SMART interactive product, remember that the product might be able to detect movement through large windows or glass walls. Also, make sure that no obstructions prevent the proximity sensor from functioning correctly.

SMART Board interactive displays feature advanced power-management capabilities. See the knowledge base article, [Understanding the SMART Board 6000 series and 8000i-G5 series interactive flat panels power modes](#) for more information.

### RS-232 control

You can also manage a SMART display's power use by using the RS-232 serial port to connect an external control system to the display. The RS-232 port is a standard connection, featured on nearly all SMART interactive displays. The RS-232 port allows for easy communication between an external control system and the display. To learn about a specific display's capabilities, command hierarchy, and setup, refer to the installation or administrator's guide for that SMART interactive display. PDF versions of documents are available at <http://support.smarttech.com>.

**IMPORTANT:** SMART's interactive displays are not compatible with centralized remote control systems, such as a universal remote control.

# Technical information: preparing to mount hardware

There are a number of factors to bear in mind as you prepare to mount a SMART interactive display:

- Safe transportation of the product
- Required hardware and tools
- Mounting style (wall-mounted or mobile)
- Product's supported mounting orientation
- Product mounted by itself or in combination with another display

## Product transportation

Be careful when transporting the product: these products can be heavy and bulky, and transporting them can be complicated.

**IMPORTANT:** Transport the product at your own risk. SMART cannot accept liability for any damages or injury that occur during the product's transportation.

When transporting the product:

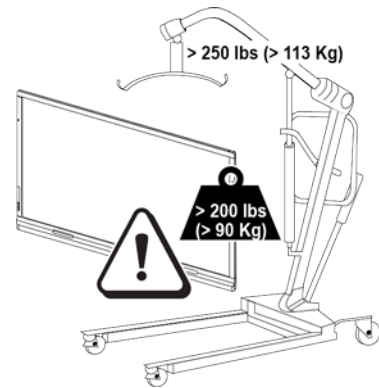
- Follow local safety regulations and standards
- Keep it in its original packaging
- Transport the product in an upright, landscape orientation, with the top of the product facing up.

**NOTE:** Product packaging may be labelled to indicate which side is the front. Look for the word "FRONT" on the packaging to help orient the box during transportation.

- Have at least two or three people available to help move the product. The larger the product, the more people will be required for safely moving it.

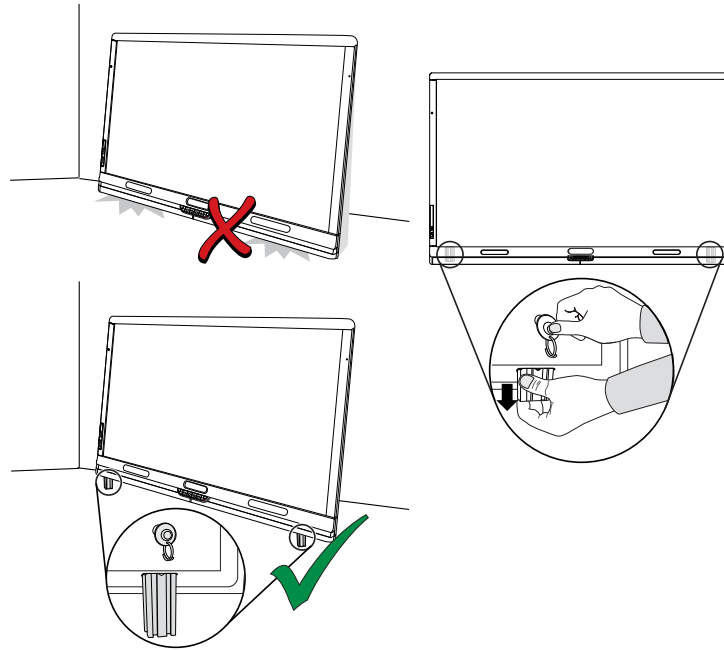
The following questions and guidance will help you plan the best and safest method for moving the product.

Ask...	Description
<p><b>How heavy is the product?</b></p>	<p>Transporting the product from the loading dock to the installation location may be possible using a cart or simply by carrying it. However, larger, heavier products may require more than a basic cart. Furniture dollies are an option in such instances.</p>
<p><b>Is a mechanical lift needed?</b></p>	<p>Use a mechanical lift to safely move a large, heavy product, such as a 75" SMART Board interactive display.</p> <p>Some of the larger interactive displays feature eyebolt mounting holes for use with mechanical lifts during installation. The product's specifications tell you whether a product includes such eyebolt holes.</p> <p>Refer to the product's in-box installation guide for instructions on using a mechanical lift.</p>
<p><b>Can hallways, doors, or elevators accommodate the unboxed product?</b></p>	<p>Some situations may require that the product be removed from its packaging before it is moved. In this situation, SMART recommends that you keep the foam pieces on the bottom corners of the product attached. These foam pieces protect the product if you need to set it down during transport.</p> <p><b>CAUTION:</b> Never rest a SMART Board 8070i-G4 or 8084i-G4 interactive display directly on its bottom edge. This can damage the display's speakers or touch system. Feet attached to the bottom of the display must be extended past the bottom frame before the product is set down (see image to the right).</p>





Ask...	Description
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**Will you need to rotate the product to fit it through openings such as doors and elevators?**

Some openings may not be large enough for the product to fit through easily. In this situation, you may need to rotate the product from its recommended landscape orientation to a portrait orientation in addition to removing the packaging. SMART strongly recommends keeping the foam pieces protecting the product’s corners on.

**IMPORTANT:** Products such as SMART Board interactive displays are designed to be mounted in a landscape orientation, and it is best practice to transport them in landscape orientation as well. Failure to mount the product in its intended landscape orientation will void the warranty.

## Mounting hardware and tools

### Screws, bolts and anchors

The tools and hardware required for installation vary according to the type of wall onto which the product is being mounted. This table describes different types of hardware and the types of wall on which it’s appropriate for use.

Wall type	Mounting hardware
<b>Drywall over wood studs</b>	Wood and lag screws: Threads on these screws are widely spaced. These screws have wider threads.
<b>Drywall over steel studs</b>	Toggle Bolts/Butterfly Anchors: These bolts/anchors have “wings” that open inside a hollow wall, bracing against the wall to secure the fastener.  <b>IMPORTANT:</b> SMART does not recommend using metal screws.
<b>Solid concrete/ concrete masonry unit or brick</b>	Concrete screws and anchors: These screws typically have alternating high and low threads and can be designed for use with a sleeved insert.

### Other hardware

Additional hardware may be required for the installation of the SMART interactive display. This hardware can include:

- Fasteners
- Washers
- Wall anchors

If possible, use the hardware that comes with the product. Consult the installation guide or the manufacturer of third-party mounting hardware for guidance on the type of hardware to use with the wall type.

**NOTE:** Some SMART products do not include mounting hardware. Consult the product’s illustrated installation guide for a complete list of included hardware.

### Tools

Tools commonly used in the installation of a SMART interactive display include:

- Drill and drill bits
- Level
- Stud Finder
- Screw drivers
- Tape measure
- Hole saw

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Although SMART products typically don't include the tools used for installation, the installation guides list the tools you'll need.

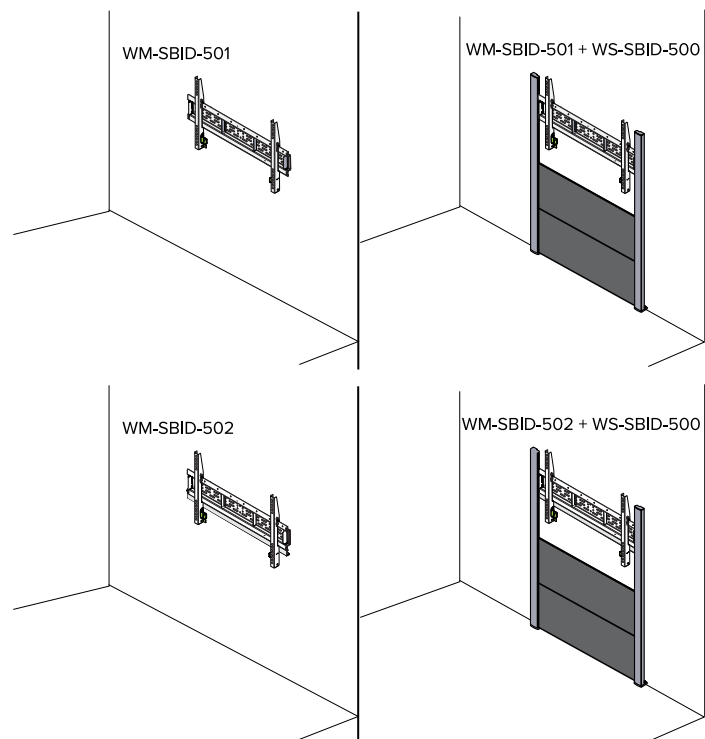
# Wall mounts

The selection of mounting hardware is critical, as is the correct assessment of the wall's load-carrying capability. If either of these are incorrect, equipment can fall off the wall, potentially causing serious injury.

It is always best to mount the interactive display on a wall. If the wall can't support the product's weight, additional hardware can be used to help transfer some of the product's weight to the floor. SMART's wall stand kits are designed for use with SMART Board interactive displays.

SMART offers two wall mounts: [WM-SBID-501](#) and [WM-SBID-502](#). Most displays can use the WM-SBID-501 while the WM-SBID-502 is for larger and heavier displays, such as the SMART Board 8084i-G4. These mounts can be purchased separately or as part of a SMART Wall Stand Kit (WSK-Single or WSK-Dual).

These wall-stand kits are not free-standing mounts; they still require a wall that can support the interactive product's weight. See [Wall structure](#) on page 5 for more information.



## SMART INSTALLATION STANDARDS

SMART offers a number of other mounting options for interactive whiteboards, including:

- [SMART Height Adjustable Wall Mount UX/UF](#)
- [SMART Height Adjustable Wall Mount 600i3](#)
- [Fixed Unit Wall Mount](#)

If you choose a third-party option rather than one of SMART's mounting options, use the information in this section to help choose a compatible option.

### Minimum requirements

The wall mount must support the product's weight and accommodate its dimensions.

**IMPORTANT:** It is crucial to correctly assess the load (weight) requirements of a system correctly. SMART is not responsible for incorrect load assessments.

Choose a mount designed to accommodate the product you're installing and can support the weight of the entire system, *including* its attached accessories or components.

Although mounts for consumer-grade, non-interactive displays are often rated based on the display's size, the mounts might not be sufficient for SMART's interactive displays of equal dimensions. SMART's interactive displays include additional internal components and may also include accessories (for example, speakers and cameras) that add to the system's total size and weight.

### Guidance

Use the following guidance as you select a wall mount:

**Assess the wall** Determine the types of fasteners and mounting materials that are needed based on the wall's structure and the system's combined weight (the display and its accessories and additional components). See [Environmental Factors to Consider](#) on page 2 for guidance on assessing the wall's structure.

SMART makes the following recommendations to help you properly assess the wall:

1. Have a qualified technician assess the installation wall.
2. Talk to the building facilities' group about the wall's construction.
3. If you're still not sure of the wall's suitability, consult a construction contractor or the walls' manufacturer.

If you still can't get suitable answers, have an engineering assessment performed for the wall.

**Look for approval from a regulatory body** Use only mounts that have an Underwriter Laboratories (UL) or similar approval marking. This approval indicates that an independent body has tested the mount for proper adherence to safety considerations. If the mount is not approved by a regulatory body, it may fail to support the product.

**Check that the mount will allow for adequate ventilation:** Consider air flow and ventilation when choosing mounting hardware. The display should have at least 2" (5 cm) of clearance behind it and 4" (10 cm) on all other sides.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Mobile stands

Use a mobile stand if you want to move the interactive display from place to place or if mounting on a wall isn't an option. SMART offers a mobile stand ([FSSBID-100V](#)) designed for use with a number of its displays. Visit the [SMART](#) website for specific information about the available stands and the products with which they're compatible.

If you choose a third-party option rather than one of SMART's mobile stands, use the information in this section to help choose a compatible mobile stand.

SMART does not recommend the use of a mobile stand with systems that include multiple components and cables (such as an entire room system). Cables and table equipment (such as microphones or speakerphones) can be damaged easily and are difficult to manage. Contact SMART support for advice if you choose to use a mobile cart with components in addition to the interactive display. Any damage to components that results from being mounted on a mobile stand will likely not be covered by the warranty.

### Safely using a mobile stand with a SMART product

To protect yourself and the SMART interactive display, follow these guidelines when using a mobile stand:

**Do not overload the stand** Putting too much weight on a stand, possibly by including speakers or other equipment, can make the unit unstable. Consider the system's *total* weight and not just the weight of the display.

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- Be aware of the system's center of gravity** When moving a product mounted on a mobile stand, tipping can be a concern. The addition of other components can increase this risk by affecting the system's center of gravity.
- Use the stand's handles to move the display** SMART recommends using mobile stands that have handles. An interactive display can become misaligned if it's moved using the display rather than the cart's handles. To avoid this, always use one hand to hold the display and the other hand to hold the mobile stand when moving the system. This prevents putting too much pressure on the product itself during transport.
- IMPORTANT:** Products damaged during transport on a mobile stand are outside of SMART's warranty terms and conditions.
- Do not attach speaker brackets directly to the display** Attaching brackets directly to the display can twist the display's frame, causing issues with touch and potentially voiding the warranty. You can make custom brackets that attach to the stand or use an industrial adhesive (for example, industrial strength tape or heavy-duty hook-and-loop fasteners) to attach speakers to the stand. Work closely with the stand's manufacturer when mounting speakers in a non-standard way, as it can potentially change the stand's safety features or affect the unit's center of gravity and create a tipping hazard.
- Be careful of the placement of speakers and microphones** When mounting speakers on a mobile stand, consider their location relative to microphones to avoid issues with echo-cancellation. Make sure speakers are not too close to the microphone, and test the setup with a few outside callers.
- Watch out for equipment and cable placement when using mobile stands that have motorized lifts** Equipment and cables beneath the display can be damaged if a stand that includes a motorized lift lowers the display onto the equipment. Movement of the display can also damage cables if the cables are pinched or bent.
- Use best practices for cable management** Power and extension cables must be manageable during transport to prevent damage. Cables should be easy to wrap and store before moving the stand and product. Letting cables dangle or drag as you move the product can increase the risk of injury, product damage and damage to the cables.

## Minimum requirements

Make sure a mobile stand meets the following requirements:

<b>Supports the display's weight and size</b>	The mobile stand must support the combined weight of the interactive display and all its accessories and components. Ensure that the dimensions of the stand are also properly accommodated.
<b>Provides adequate ventilation</b>	If the mobile stand has an equipment enclosure, the enclosure must provide adequate ventilation for the display and its components. (See <a href="#">Ventilation</a> on page 3 for more information.) Damage that results from overheating caused by improper installation is not covered by warranty and may also void the warranty.

## Guidance

When selecting a mobile stand, look for one that has the following characteristics:

<b>Regulatory body approval</b>	Mobile stands must be approved by Underwriters Laboratories or a similar independent body. This approval indicates that the mounts have been tested for proper adherence to safety regulations. These regulatory tests go beyond the equipment's loading restrictions, helping to guarantee that the stand will be safe when used properly. If the stand is not approved by a regulatory body, it may fail to support the weight of the interactive display.
<b>Low center of gravity or adjustable height</b>	<p>A low center of gravity helps make the system more stable. The ability to reduce the height is useful during transport.</p> <p><b>NOTE:</b> Take care that equipment beneath the mounted interactive display is not damaged when the display is lowered. Movement of the display can also damage cables if the cables are pinched or bent.</p>
<b>Option to mount speakers</b>	Mount speakers directly on the stand itself rather than on the interactive display.
<b>Large wheels</b>	Large wheels make it easier to cross door thresholds and move the stand over a variety of surfaces.

<b>Handles</b>	Using a stand with handles will help prevent the application of pressure directly to the interactive display during transport. Applying pressure to the display's frame directly can twist the frame during transport.
<b>Safety locking mechanism</b>	Using a stand with locking wheels will ensure the interactive display stays in place while it's in use.
<b>Built-in equipment and cable management</b>	Built-in equipment and cable management will help prevent damage to components and connections during transport. Shelving and mounting points are also useful for cable management.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Mounting orientation

The electrical and mechanical components of SMART interactive products are designed to work properly when the product is mounted in the orientation described in the product's installation guide. Mounting the product in a different orientation can cause malfunctions and will void the product's warranty.

There are a number of potential hazards of mounting SMART interactive displays in a non-standard orientation:

- Mounting an interactive display horizontally (like a table top) can cause the glass to sag, damaging the display or interfering with the display's touch system.
- Non-standard orientation can affect ventilation, creating hotspots in equipment, premature failures, and in products that use projectors, exploding projector bulbs.

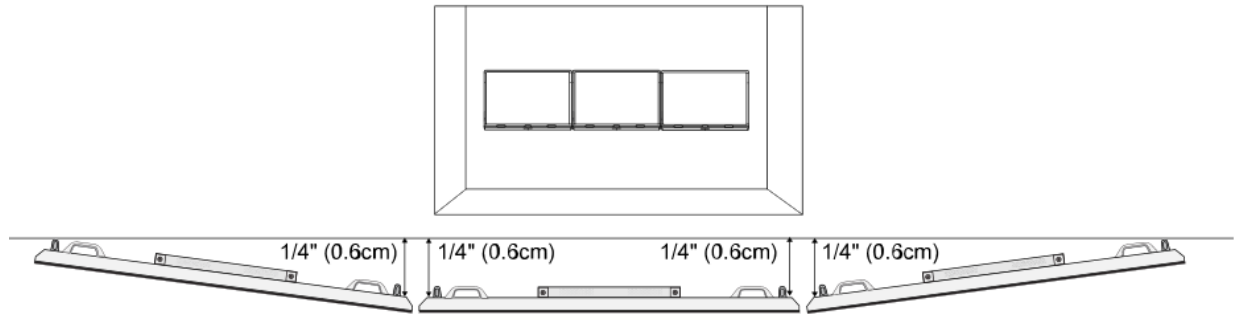
## Mounting multiple displays

A multiple-display configuration can include two or more displays in a variety of arrangements. SMART recommends that you mount no more than three interactive displays side by side.

If you mount multiple interactive displays side by side, install them as shown in the following diagram. This setup helps to ensure the interactive displays' cameras and touch systems don't interfere with each other.



## SMART INSTALLATION STANDARDS



**NOTE:** Different SMART interactive products support multiple display to varying degrees. Consult the product's documentation before including a particular product in a multiple-display configuration.

Although a computer can support up to 16 touch-sensitive displays, the demands on the computer and graphics card increase as you add more displays. If you want to use more than three displays, SMART recommends that you work closely with an experienced installer.

# SMART systems: electrical components

Use components that meet the SMART interactive displays' requirements to ensure that the product works as expected. This section describes the components' requirements and provides guidelines for selecting components for use with a SMART interactive product.

It is best practice to use components manufactured by established, reputable companies.

## Open Pluggable Slot computers

SMART currently offers two types of open pluggable socket (OPS) computers:

- AM30 (-ENT or -EDU)
- AM40 (-ENT or -EDU)
- AM70-L

The AM30/40 and the AM70-L are self-contained systems and include the software that makes them work with SMART hardware. The AM30/40 are also referred to as the iQ appliance. An iQ appliance is included with the SMART kapp iQ board or as part of the 6000i/8000i-G5 series interactive display upgrade kit. The AM70-L (also known as the room system appliance) is included only as part of the SMART Room System for Skype for Business.

Several issues can accompany the use of a non-standard computer:

- Touch, video, or audio might not work correctly
- Additional drivers might not be supported
- OPS overheating or other thermal issues can result
- OPS might not receive full power

**IMPORTANT:** SMART interactive displays do not support “hot plugging” of OPS computers through the OPS slot. “Hot Plugging” describes the removal of the OPS while power is applied.

### Minimum requirements

Use only an OPS that has the following characteristics:

**Active cooling not required**

Although older interactive displays (Generation 4) can support OPS computers that require active cooling from fans within the display.

For more information, see the Knowledge base article, [Open Pluggable Slot computer \(OPS\) disclaimer](#) for more information.

**Can be adequately powered by product's power supply**

If an OPS requires more power than the SMART Board interactive display was designed to dedicate to an OPS, it may restrain your ability to power specific units. Ensure the power supply requirements of the OPS are met by the supply capabilities of the display. Otherwise the OPS will not function fully, and may not even turn on. See the knowledge base article, [Open Pluggable Slot computer \(OPS\) disclaimer](#) for more information.

**Meets the product's requirements for video output and connections types**

Make sure the OPS computer is compatible with the SMART Board interactive display's video resolution and connection types. See the knowledge base article, [Open Pluggable Slot computer \(OPS\) disclaimer](#) for a list of these requirements.

**Complies with regulatory requirements**

Non-SMART OPS computers must comply with your area's regulatory requirements and must also meet IEC 60950-1 certifications for Fire Enclosures.

## Guidance

There is no additional guidance for selecting OPS computers.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Room cameras

SMART's products support USB cameras, both with or without an integrated microphone to enable both video and sound recording with the same component.

**NOTE:** Cameras with integrated microphones are not recommended for recording audio in larger-sized rooms. Separate microphones are better suited to such settings. See [Microphones](#) on page 27 for more information.

Both the SMART Room System for Skype for Business and the SMART Room System for Meeting Pro come with a USB camera (CAM301). Third-party USB cameras can also be used with the SMART room systems. SMART does not offer separate cameras other than those used in its room systems. You can use a third-party camera if you want to use a SMART interactive display for videoconferencing.

**NOTE:** A computer typically supports only one USB camera connection, even with the use of a USB hub.

## Minimum requirements

Use only a camera that has the following characteristics:

<b>Complies with the USB Video Class (UVC) specification</b>	Cameras that do not comply with the UVC specification may introduce reduced image quality or incompatibility with other devices or might not work at all.
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## Guidance

When selecting a camera, look for one that has the following characteristics:

<b>Compensates for the room's lighting</b>	Image quality depends largely on optics and image compression. SMART has worked to achieve a balance between these with the CAM301.
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When choosing a different room camera, consider the room lighting. If the room has only dim fluorescent lighting, consider a camera with higher-quality optics to allow better light sensitivity. Optics cannot compensate for everything. Remember that bright, natural light can make a significant difference in image quality.

<b>Certified for use in a Skype for Business room system</b>	If you're installing a SMART Room System for Skype for Business, use a camera that has been certified for that use.
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<b>Uses high compression encoding (if network bandwidth is a concern)</b>	A high compression encoding scheme helps maintain higher network speeds by sending less data. Different degrees and types of compression will affect the image quality. SMART recommends a camera with built-in H.264 SVC compression.
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## SMART INSTALLATION STANDARDS

<b>Large enough to allow adequate range of focus or zoom</b>	Smaller cameras can impose limitations of focus and zoom.
<b>Good optics</b>	A camera with fine-polished glass lenses and a large aperture can provide better image quality than one with plastic lenses and a smaller aperture.
<b>High-resolution image sensor</b>	Cameras with high-resolution image sensors can produce better images, particularly if digital-zoom features are used.
<b>Optical zoom</b>	If you want to zoom the camera to narrow the field of view optical (mechanical) zoom is recommended over a camera with only a digital zoom function. Digital zoom can reduce image quality, especially on cameras with lower resolution image sensors.
<b>Appropriate focal range for the room's size</b>	Use a camera with a defined focal range that is appropriate for the size of the room in which it will be used. Generally, the larger the room, the longer the focal range of the camera needs to be. For example, a camera with a focal range of 1-5' (0.3-1.5 m) will not provide a good image of the room beyond 10' (3 m), and a camera with a focal range of 10-40' (3-12 m) will not provide good image of objects in close range to the camera.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Speakers

Some of SMART's products, such as its SMART Board interactive displays, include internal speakers, but you might want to use external speakers in particular applications.

The speakers included with SMART's interactive products are designed to provide sound at the front of the room, not for projecting sound in larger spaces. If you want to use the SMART interactive display in a larger space, you'll need external speakers.

In most cases, external speakers should be connected to the audio output on the interactive display, but there are other setups that can provide additional options for connecting external speakers. For example, a room computer connected to the display might also provide an

## SMART INSTALLATION STANDARDS

audio connection. See [Acoustics](#) on page 57 for more information about connecting external speakers and producing the best possible audio experience.

SMART offers speakers for use in the classroom (such as the [SBA series](#)) and the meeting room (such as [CSR500](#)). These speakers are self-powered: they only require a [Line Level](#) input signal and have an internal amplifier.

Both series of speaker include mounting brackets for mounting to the wall on either side of the wall-mounted interactive display. For mounting speakers on mobile carts, refer to [Mobile stands](#) on page 17.

### Minimum requirements

There are no minimum requirements for selecting speakers.

### Guidance

When selecting speakers, look for speakers that have the following characteristics:

**Meet the suggested specifications as close as possible**

In small to medium sized rooms (rooms up to a size of 20'×30'), using speakers that meet the following suggested specifications as close as possible should help to ensure good quality audio:

- **Frequency response:** 80 Hz to 10 kHz ± 3 dB
- **Total Harmonic Distortion (THD) at Peak Power:** 100Hz – 10kHz 1% Avg. 3% Max.
- **Signal to Noise Ratio:** Better than 60dB
- **Sensitivity (1W@1m):** 86dBA Sound Pressure Level (SPL)

This information should be available in the speaker's specifications.

For rooms larger than 20'×30', such as auditoriums, SMART recommends that you consult with an audio specialist to help determine the best option for the space.

**IMPORTANT:** If the speakers are used in conjunction with microphones (for example, as part of a meeting room conferencing system or complete audio system), it's important to place speakers correctly in relation to the microphones, especially if you're using wireless microphones. For more information about speaker and microphone placement, see [Acoustics](#) on page 57.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## NOTES

- When substituting audio components, it is important to substitute the speakers, microphones and mixer. Substituting only part of the audio system can lead to echo and noise.
- For SMART Room Systems for Skype for Business, SMART does not recommend using speakers other than those sold by SMART. The speakers that are part of the SMART Room System are acoustically tuned to work with the included microphones and audio processor. SMART can not assist with any audio issues that arise from the use of non-SMART products.

## Microphones

Microphones can provide audio recording for a classroom or lecture hall or function as part of a voice conferencing solution in a meeting room. SMART offers microphones as part of a complete audio system and does not offer them separately. SMART offers a classroom audio system and a conferencing meeting room audio system. Classroom audio systems are available separately, but the conferencing audio system is available only as part of SMART's Room System for Skype for Business or SMART's Room System with Meeting Pro.

### Minimum requirements

There are no minimum requirements for selecting microphones.

### Guidance

When selecting microphones, look for microphones that have the following characteristics:

<b>Appropriate for the room's intended use</b>	The type of microphone (wireless or wired) that will best suit the system depends on how the room will be used. A wireless microphone might be better suited for a room used primarily for lectures or presentations, with one person speaking at a time and moving around the space. Wired table-top microphones might be better suited for a room used for video conferencing, in which a number of stationary people speak throughout a meeting.
<b>Suitable polar (pickup) pattern</b>	Select a microphone that has a suitable <a href="#">polar (pickup) pattern</a> . An omnidirectional pattern is good for rooms set up for a single speaker, such as a lecture hall or presentation space. A unidirectional microphone is good for rooms set up for voice conferencing.

<b>Designed for normal speech</b>	Microphones can be designed for different uses (musical recordings, lectures, speeches, and so on). Ensure you choose a microphone that has a frequency response and polar pattern suited for a speaking application.
<b>Provides channel diversity (wireless)</b>	If you use wireless microphones, be sure to choose a wireless microphone that provides enough channel diversity to support multiple wireless devices in one location, particularly if you plan to use wireless audio equipment in more than one location within a building.
<b>USB microphone (if used with a SMART Room System)</b>	If you decide to use a third-party audio system to replace the SMART conferencing audio system included with a SMART Room System for Skype for Business or a SMART Room System with Meeting Pro, the audio system must be a USB audio system. For more details on this, see the knowledge base article, <a href="#">Using hardware not provided by SMART with your SMART Room System with Skype for Business</a> .

**IMPORTANT:** If the microphones are used in conjunction with speakers (perhaps as part of a meeting room conferencing system or complete audio system), it's important to place the speakers correctly in relation to the microphones. For guidance on speaker and microphone placement, see [Acoustics](#) on page 57.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

**NOTE:** If you're substituting audio components with third-party components, it is important to substitute the speakers, microphones and mixer. Substituting only part of the audio system can lead to echo and noise.

## Room controls

Although SMART does not offer room control equipment, SMART's interactive displays and projectors support RS-232 communication through their control ports. Each product has its own communication commands and protocols, which are described in the product's user's or administrator's guides.

SMART does not have minimum requirements or additional guidance for selecting a third-party room control systems.



## SMART INSTALLATION STANDARDS

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

# SMART system: cables

To ensure the proper functioning of a SMART product, it is important to use cables that meet the system's requirements as closely as possible and are tested for compliance with connection standards. The system's requirements vary according to the signal type and the distance the signal needs to be transmitted.

## General cable best practices

Cables can vary widely in terms of quality and cost, and higher cost doesn't always indicate better quality. The cable's quality can greatly affect the quality of signals they carry. This becomes increasingly important as cable runs get longer.

Always use the cables provided with the SMART product. SMART tests these cables against industry standards and for regulatory compliance. Refer to [Appendix B: SMART Reliability Testing](#) on page 64 for more information. If you need a cable that is not included, or you need to replace a cable, follow these general guidelines to help ensure the third-party cables function correctly within the system:

- Use cables tested for compliance to connection standards. For example, use HDMI cables that provide proof of being tested against the HDMI standard.
- Test cables for continuity. Connect the cable and confirm that the signal is sent and received correctly.
- Choose good quality cables from reputable manufacturers.
- If possible, use cables from a single manufacturer. This is especially important if you're performing multiple installations. It provides greater consistency across the entire installation, and if you encounter any issues, you deal with only one manufacturer.
- Keep cables as short as possible. Shorter cables are less prone to signal degradation. If cables are too long, noise, rolling lines, video drop-out or other adverse effects can result, especially with analog video signals at higher display resolutions.

**NOTE:** For guidance on adapting and extending connections, see [SMART Systems: Cable Accessories](#) on page 47.

- Use cables that feature end-to-end shielding. Shielding reduces the risk of external electromagnetic interference (EMI).
- Use cables that are designed for flexibility and durability. Such cables are:
  - Coated with rubber, silicone or similar flexible materials rather than plastic or similar, less-flexible materials
  - Made with stranded wire and a high per-wire strand count rather than a solid-core wire

## SMART INSTALLATION STANDARDS

- When possible, use connection cables with larger internal wires (a larger diameter) to reduce signal reduction or loss over longer distances. This diameter for video and audio cables is typically 22-24 AWG, and 12-16 for speaker cables. Network and USB cables are typically in the range of 22-26AWG.

**TIP:** Use the [American Wire Gauge \(AWG\)](#) reference numbers to determine the size of the cable's internal wires.

- Avoid cables with very large [ferrite beads](#). A ferrite bead that seems conspicuously large in proportion to the diameter of the cable can indicate the ferrite bead is compensating for excessive interference that results from poor cable construction or excessive length.
- If you install terminators on a cable yourself, test the cable for correct connections and continuity. Such installations are more common for analog audio, RS-232 and Ethernet cables.
- Avoid using poor-quality passive (unpowered) digital cables. These types of cables can also result in noise, video drop-out and other adverse effects, especially with higher display resolutions.

## Cable maintenance and management best practices

Use the following guidance to help manage the system's cables and maintain them in good working order:

- Keep the cables in good condition: secure them out of the way of high-traffic areas, don't bend them beyond their [critical bend](#) radius, and avoid excessively disconnecting and reconnecting the cable. If frequent connections and disconnections of the cable are unavoidable, make sure the cable's connector is rated to withstand them.
- Use cable ties to secure cables or groups of cables that will not need to be frequently connected and disconnected. This provides the cables with some strain relief and reduces the risk of damage. If cables will need to be connected and disconnected frequently, leave additional length on the cable to allow for easy connecting/disconnecting of the cable.

**CAUTION:** Securing the zip ties too tightly can damage the cables.

- Reduce the risk of ground loops by using the same power source (such as a power bar) for all devices in the system. Ground loops can cause noise, humming and interference with audio or video systems.
- If possible, run extra, known-working cords through a conduit during installation. It's less expensive to include spare cables than to install a replacement later. Otherwise, make sure you have an extra set of cables that have been tested and are known to work properly. These will be helpful if you need to troubleshoot the installation.

# Power

Power cables can be grounded (three-pronged) or ungrounded (two-pronged). Grounded power cables limit the buildup of static electricity, reducing the chances of electric shock and damage to audio systems and other sensitive equipment.

SMART's hardware features a standard International Electrical Commission (IEC) interface and provides certified, country-specific power cables. SMART recommends that you always use the power cable provided with the product as the cable has been appropriately sized for that product. However, if you ever need to replace a power cable, use the following minimum requirements and guidance.

## Minimum requirements

Power cables must:

**Meet country-specific power requirements**

Power standards vary among regions, and you'll need to use a power cable that supports your region's voltages and frequencies. Although you can use adapters to make power cables compatible with local power sources, first verify that the adapter can handle the necessary voltage conversion.

**Be appropriate for the load current**

Device power cables can be rated for use with different load currents. Make sure the power cable is rated to safely handle more current than a connected device will draw. See the specifications for the SMART product for power consumption information.

If only a power rating is provided, the current can be calculated using the following formula:

$$\text{Power (watts)} \div \text{Voltage} = \text{Current (amps)}$$

## Guidelines

See [General Cable Best Practices](#) on page 30. There is no additional guidance for selecting power cables.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

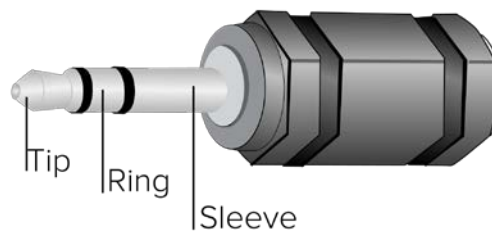
## Analog audio

Analog audio falls into a few categories:

### Unbalanced

An unbalanced cable features two or more conductors, one for ground and at least one for signal.

The 3.5 mm stereo cable is a commonly used unbalanced connection. It has a ground connection (sleeve), a connection for the right stereo channel (ring), and another for the left (tip).



*Connector on a 3.5 mm Stereo Unbalanced Cable*

Unbalanced connections are affordable and ideal for shorter connections. An unbalanced cable of good quality can provide a connection of up to 20' (6 m). The main disadvantage of an unbalanced cable is its susceptibility to electrical interference when using line levels.

### Balanced

Balanced cables use two conductors for the signal, one positive and one negative, in addition to the ground. This means a stereo application requires two cables.

Balanced connections are far more resistant to electrical interference and support runs of 98' (30 m). Longer runs have special considerations and an engineer should be consulted. Although SMART interactive displays do not feature balanced audio connections, you can use a [Balun](#) device to convert unbalanced connections to balanced ones if you need to use a balanced cable. SMART does not sell or support Balun devices, but they can be used if implemented properly. Consult your reseller if you think the use of a balanced cable with a Balun device is required for your installation.

## SMART INSTALLATION STANDARDS

### Powered

Powered connections can be balanced or unbalanced, and are only used to connect an amplifier to a speaker. Powered connections use a much heavier gauge of wire than standard connections, and the connectors will be larger than a standard connector as well. In addition, powered connections typically have a thicker, more durable jacket, enabling easier runs across floors, under stages, and so on.

## SMART products with an analog audio connection

Refer to the product's specifications to determine if the product supports this type of connection.

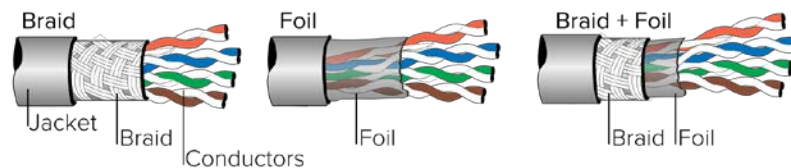
SMART's speaker products come with the necessary speaker cables, and extensions are also available.

## Minimum requirements

Make sure an analog audio cable meets the following requirements:

### Proper shielding

An audio cable's shielding is critical for ensuring the cable's proper functioning. Make sure the cable has at least a 95% overall braided or foil shield. A hybrid shield of braid and foil is even better, and a double braided and foiled shield (not illustrated) is better still.



### A gauge size appropriate for the cable's required length

The thinner a cable's gauge, the shorter its reach can be before signal quality is at risk. For example, if you need to run a 16' (5 m) 3.5 mm stereo cable, you should use a cable with a heavier gauge. The [American Wire Gauge \(AWG\)](#) standard indicates heavier gauges with a low number and lighter/thinner gauges with a higher number.

### Not longer than 20' (6 m)

If a connection is longer than 20' (6 m), you may need to use a balanced connection.

## Guidelines

When selecting analog audio cables, look for cables that have the right gauge of wire. If possible, use analog audio cables with a larger wire gauge for powered connections, such as connecting to speakers. The gauge should be at least a 16 [AWG](#), or a 12-14 AWG for longer distances.

For unpowered balanced or unbalanced cables, the gauge should be at least 20 AWG or higher.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Digital audio

There are two common types of digital audio cables: a digital coaxial cable and an optical digital cable.

### **Digital coaxial cable**

A digital coaxial audio cable has RCA connectors at both ends. The RCA connectors are plugged into the orange digital coaxial receptacles on both the source and receiving device. A digital coaxial audio cable's signal is subject to weakening when it passes over long distances.

### **Optical digital cable**

Optical digital cables use plastic filaments, similar to fiber optics, that use light to transmit the signal. Although audio signals delivered by light don't weaken as they do with copper-wired cables, optical digital cables can be damaged by excessive twisting or curling. This risk increases when these cables run over longer distances. If possible, use a different type of connection if the cable run must be longer than 4'-6' (1.2-1.8 m).

The connector on an optical digital cable looks like a small square plug. This connector can come in a standard or mini size.

## SMART products with a digital audio connection

Refer to the product's specifications to see if it supports this type of connection.

## Minimum requirements

There are no minimum requirements for selecting digital audio cables.

## Guidelines

There is no additional guidance for selecting digital audio cables. However, because digital optical cables are less durable, a best practice is to use shorter cables to reduce the risk of damage.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## RS-232 cables

RS-232 is a standard for the serial communication of data between data terminal equipment (DTE), such as a computer, and data communication equipment (DCE), such as a computer modem, a room control system or a control port on electronic equipment. When using a RS-232 connection, be sure to test it with a terminal program on a computer first.



The RS-232 standard defines the electrical characteristics, timing, and meaning of signals. The standard also defines the physical size and pinout of connectors. Although RS-232 connections (RS-232 serial ports) were once common in personal computers and peripheral devices (such as printers and modems), they have been phased out in most modern devices in favor of USB connections.

RS-232 serial cables are used to connect an RS-232 port on the DTE device to an RS-232 port jack on the DCE device.

Most modern computers don't include an RS-232 port, so if you need use the RS-232 port to connect a computer and a device (such as an interactive display), you'll need an external USB to RS-232 converter.

## SMART products with an RS-232 connection

Refer to the product's specifications to see if it supports this type of connection.

## Minimum Requirements

There are no minimum requirements for selecting RS-232 cables.

See [General Cable Best Practices](#) on page 30.



## Guidelines

When selecting RS-232 cables, make sure the cable is not a “null” modem cable. Unless they are specifically required, null modem cables should not be used except as a testing cable when troubleshooting connections.

Null modem cables can be identified by the word “null” stamped on them. Null modem cables are also characterized with a crossover of the transmitter and receiver pins.

## Third-party options

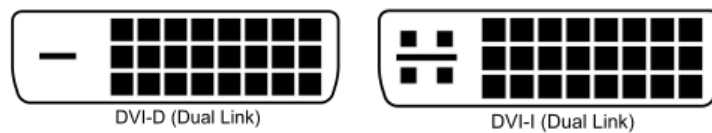
Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Digital Visual Interface (DVI)

Digital Visual Interface (DVI) is a video display interface used to connect a video source (such as a computer) and a display device (such as a monitor). DVI was designed as a digital replacement for the analog VGA connection.

If only one end of a connection uses DVI, you can use an adapter or converter to make the connections compatible. See [Cable Adapters and Converters](#) for more information.

The two most common versions of DVI connections are shown below.



## SMART products with a DVI connection

Refer to the product’s specifications to see if it supports this type of connection.

**IMPORTANT:** Although DVI is typically a video-only connection, some audio source devices can use DVI to send audio. In this case, you must convert the DVI cable to an HDMI connection to connect it to the interactive display. Refer to the source device’s documentation to see if it supports DVI audio. Otherwise, if you need to include audio and other data (such as touch), you will need to use a connection other than DVI.

## Minimum requirements

There are no minimum requirements for selecting DVI cables.

See [General Cable Best Practices](#) on page 30.

## Guidelines

When selecting DVI cables, look for cables that have the following characteristics:

**Match the device's connector type (digital versus analog)** Some connectors, such as the DVI-D, work with digital equipment only. Other types of connector, such as the DVI-I, can work with both analog and digital connections. Make sure you choose the correct type for the device.

**Not longer than 23' (7 m)** To maintain signal quality, DVI cables must not be longer than 23' (7 m). If you need to extend a DVI connection, see [Video Cable Extenders](#).

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## VGA

Video Graphics Array (VGA) is an analog interface designed for use with high-resolution monitors and computers. VGA connections are commonly found on older computers, though the connection is still widely used.

**NOTE:** Although a VGA connection can support up to 1080p with the right source device, this is not recommended. This use pushes the VGA standard to its upper limit. Unless both the cable and source device are of the highest quality, degradation in video quality is likely.

Using low-quality, passive (no powered components) VGA cables can result in an unfocused image, ghosting, noise, rolling lines and other adverse effects.

## SMART products with a VGA connection

Refer to the product's specifications to see if it supports this type of connection.

**IMPORTANT:** VGA is a video-only connection. If you need a setup to include audio and other data (such as touch), you'll need to use other connection types that support those types of data.

## Minimum requirements

Use only a VGA cable that has the following characteristics:

## SMART INSTALLATION STANDARDS

- All pins in the connectors fully populated and wired** The VGA cable connectors have multiple pins. Lower-cost cables might not include them all, and this can cause operational issues.
- Not longer than 23' (7 m)** Running a VGA cable longer than 23' (7 m) is not recommended as it may start to degrade the video signal quality. To extend the video signal properly, use a powered solution. See [Video Cable Extenders](#) on page 51 for more information.

### Guidelines

When selecting VGA cables, look for cables that have the following characteristics:

- Appropriate gauge for the run distance** When running a VGA cable less than 10' (3 m), a thinner cable (about 12-15 mm) will work. However, use a thicker cable if you need to run the cable 10-26' (3-8 m). Consider using a cable that also has smaller [ferrite beads](#) on the ends.
- Minimum of 95% overall braid shielding** The cable's shielding should be, at minimum, a 95% overall braid or even better, use a double braid with good bonding on the shell. The braid should be either soldered or mechanically attached to maintain constant contact. In the absence of a specification from the manufacturer, you can only determine the degree of shielding through a destructive test of a cable sample.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## HDMI

The High Definition Multimedia Interface (HDMI) is a type of cable and connection used for transferring digital data from an HDMI source device, such as a computer, to a display device, such as a monitor, projector or television. HDMI combines video, Consumer Electronics Control (CEC) and multi-channel audio in a single cable, which reduces the cost and complexity of setup.

## HDMI cable characteristics

- Two-way communication supported
- High-definition ready
- Three sizes available:
  - Standard (Type-A)
  - Mini (Type C)
  - Micro (Type D)

**NOTE:** Most SMART interactive displays use the Standard (Type-A) size.
- Different types of HDMI cable, each designed to meet a specific version of the HDMI standard. HDMI types you're likely to use with a SMART product include:
  - Standard
  - High speed
  - Premium high speed
- Backwards compatible with DVI and VGA connections when used with converters

## HDMI cable types and supported versions

The following table provides more detailed information about the types of HDMI cables and the HDMI versions, resolutions and refresh rates they support. Use this to determine the type of HDMI cable that will provide the best experience with your system.

Cable type	Max. supported HDMI version	Maximum supported resolution	Designed and certified for
Standard	HDMI 1.4	1920 × 1080 @ 60Hz, (Interlaced)	HD resolutions (720p and 1080i) used by most consumer electronics
High speed	HDMI 1.4	3840 × 2160 @ 30Hz	Ultra-high definition/advanced displays, such as: <ul style="list-style-type: none"> <li>• 4K UHD</li> <li>• 3D displays</li> <li>• Deep Color</li> </ul>
Premium high speed	HDMI 2.0b	3840 × 2160 @ 60Hz	Ultra-high definition displays (for example, 4K UHD) with advanced features such as higher refresh rates)

## SMART INSTALLATION STANDARDS

Refer to the SMART product's specifications for information on what HDMI standards and resolutions its HDMI ports support.

### SMART products with an HDMI connection

Refer to the product's specifications to determine if it supports an HDMI connection.

### Minimum requirements

Make sure an HDMI cable is no longer than 23' (7 m). Using a longer HDMI cable could degrade signal quality. See [Video Cable Extenders](#) on page 51 for information about extending an HDMI connection beyond this length.

### Guidelines

See [General Cable Best Practices](#) on page 30. There is no additional guidance for selecting HDMI cables.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## DisplayPort

A DisplayPort is a high-bandwidth digital display interface mainly used for connecting a video source to a display device. Found mostly on computers and monitors, DisplayPort, like HDMI, also supports audio. DisplayPort was designed for modern displays, whereas HDMI was designed for consumer electronic connections, such as HDTVs, game consoles, and so on.

### DisplayPort characteristics

- Supports up to 3840 × 2160 @ 60Hz  
**NOTE:** SBID-8084i-G4 interactive displays only support 30Hz.
- Standard and mini formats available
- Different versions available (current version is 1.4)
- Features a captive/locking connector, which is useful for permanent installations

### SMART products with a DisplayPort connection

Refer to the product's specifications to determine if it supports this type of connection.

## Minimum requirements

Make sure a DisplayPort cable is no longer than 23' (7 m). If you need a longer DisplayPort cable, use a powered extension. See [Video Cable Extenders](#) on page 51 for more information.

## Guidelines

See [General Cable Best Practices](#) on page 30. There is no additional guidance for selecting DisplayPort cables.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

# USB

A Universal Serial Bus (USB) is used for data communication and supplying a small amount of power between devices. USB cables come in three sizes:

- Standard
- Mini
- Micro

Each of those sizes can connect to two types of USB connectors: Type-A and Type-B. Type-A USB is the most common for computers, while mini and micro Type-A USBs are mostly used for mobile devices. USB Type-B connectors are commonly found on endpoint devices, such as interactive displays or printers.

A third type of USB, USB C, is newer and comes in only one size. USB Type-C connections are commonly found on small personal electronics, such as mobile devices and newer Apple laptops.

SMART interactive displays have a standard USB Type-A and Type-B connection. The source device's USB connection type determines the type of USB cable you will need. Type-A is currently more common on computers, but newer laptops and computers may come with only a USB Type-C connection.

In addition to different types and sizes, there are also different varieties of USB cables:

- USB 1.x
- USB 2.0
- USB 3.x
- USB 3.1

## SMART INSTALLATION STANDARDS

The main differences among varieties of USB cable are the power delivery and data transfer speeds. Newer varieties (USB 3.0 and 3.1) carry more power and have faster data-transfer speeds. USB 3.0 and 3.1 are backwards compatible with USB 2.0, but not with USB 1.1. Although SMART interactive displays support all varieties, USB 2.0 or newer is recommended.

**NOTE:** Although USB 3.0 and 3.1 are designed to be backwards compatible, the compatibility can be less than 100%, and you might experience issues when using USB 3.0/3.1 with USB 2.0. If you experience issues while using a USB 3.0 connection, try connecting a USB 2.0 hub between the SMART interactive display and the computer. If the issues persist, use USB 2.0 instead of 3.0/3.1 or contact the computer's manufacturer. To guarantee the best USB performance, make sure the latest USB 3.0 and chipset drivers are installed on the computer.

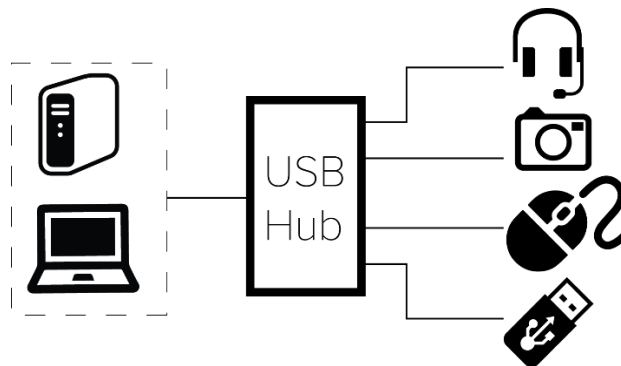
SMART products use the USB connection to enable the touch features. Poor quality USB cables that do not meet industry standards can cause issues with a SMART product's touch functions. Poor quality cables can also cause unexpected behavior with SMART's software products (such as SMART Notebook software) when the software is used with a SMART hardware product or other touch-enabled display.

## SMART products with a USB connection

Most SMART products feature a USB connection. Refer to the product's specifications to determine if it supports this type of connection.

## USB hubs

USB cables connect to the USB ports on devices. For SMART hardware products, use the USB cable to connect from the display's connector panel to a room computer. If you need more than one USB connection, use a USB hub as shown below:



A common scenario in which you might need a USB hub is when you have only one USB port available on the computer but need to connect a mouse, keyboard and microphone. Hubs also let you consolidate USB-connected devices into one port, making it possible to disable all the devices by unplugging a single cable.

There are three types of USB hubs:

## SMART INSTALLATION STANDARDS

- Bus-powered** A bus-powered hub draws its power from the USB source device, such as a computer. A bus-powered hub doesn't need a separate power connection. It's limited to four downstream ports and can't provide more power to the downstream devices than that provided by the USB source device. If you use a bus-powered hub with an extension cable, you can quickly run out of power. You should purchase a USB cable hub with a separate power adapter.
- Self-powered** A self-powered hub draws power from external power supply and provides up to 500 mA for USB 2.0 and 900mA for USB 3.0 to power each of the connected USB devices. The amount of power depends on the specifications of the hub and the version of USB ports available on the hub.
- Dynamic-powered** A dynamic powered hub is a combination of bus- and self-powered hub. it automatically switches between modes if a separate power supply is available.



## Minimum requirements

Use only USB cables that have the following characteristics:

**Not longer than 16' 5" (5 m) (USB 1.1 and 2.0)** USB 1.1 and 2.0 cables cannot be longer than 16' 5" (5 m) without using special extension methods. See [USB Cable Extenders](#) on page 51.

**Not longer than 9' 10" (3 m) (USB 3.0)** A USB 3.0 cable cannot be longer than 9' 10" (3 m) without using special extension methods. See [USB Cable Extenders](#) on page 51.

## Guidelines

When selecting third-party USB cables, look for cables that have the USB certification logo. The logo indicates the cable has passed the USB Implementations Forum (USB-IF) regulatory body's compliance testing for product quality.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

# Ethernet (Network)

Ethernet is a type of Local Area Network (LAN) technology. Ethernet differs from a Wireless Local Area Network (WLAN) in that it requires physical twisted-pair network cables to connect devices, such as a computer and a network router. Different varieties of network cable exist, the most common of which are currently Cat 5e (Category 5 enhanced) or Cat 6 (Category 6). Network cables can be shielded to protect against electromagnetic interference (EMI) which can interfere with communication through the network cable.

## SMART products with a network connection

Refer to the product's specifications to determine if it supports this type of connection.

## Minimum requirements

Use only network cables that are shorter than 300' (100 m). A network cable cannot be longer than 300' (100 m) without the use of special extension methods. The total length includes the "visible" length (from the product to the wall) and the "non-visible" length (the cable behind the wall to the network switch).

## Guidelines

See [General Cable Best Practices](#) on page 30. There is no additional guidance for selecting network cables.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

# SMART systems: cable accessories

## Cable adapters and converters

A variety of cable adapters and converters are available for connecting disparate types of devices. An adapter or converter is usually required when connecting a source device (such as a computer) to a display device (such as an interactive display) that doesn't have a matching connection. For example, a computer that has only a DisplayPort connection would need an adapter to connect to a display that has only an HDMI connection.

Some connection types have multiple versions, such as USB 2.0 and 3.0, HDMI 1.4 and 2.0, Single and Dual mode DisplayPort, and so on. Any adapters you use must take these versions into account: some connections support only adapters of the same version.

### Adapters versus converters

Because adapters do not convert signal types, they work only for connections that have the same signal type. An adapter can't convert a digital signal to an analog signal, for example. If you require such a conversion, a cable converter must be used.

A convertor can adapt the physical connection type *and* the signal type (analog to digital and vice versa). To determine if a converter is needed, you must first understand the signal type of the connection you're trying to use. Some connections are analog-only and others are digital only. See the descriptions for each cable type in [SMART System: Cable Components](#).

Use this list to help select the right option for adapting and converting connections:

<b>Analog to Analog</b>	Use a passive, non-powered adapter or an active amplifier.
<b>Analog to Digital</b>	Use a powered adapter that converts analog signals to digital signals.
<b>Digital to Analog</b>	Use a digital-to-analog converter.
<b>Digital to Digital</b>	Use a passive, non-powered adapter if the digital signals are the same or an active signal converter if the digital input signal is different than the digital output signal.

SMART does not offer adapters or converters other than those for USB to CAT5. You can purchase replacements for these from the [store for SMART parts](#).

## SMART INSTALLATION STANDARDS

Using the wrong cable adapter or converter can lead to a variety of issues, including:

- Signal degradation or drop-out
- Noisy video or audio
- Damaged equipment resulting from improper adapter construction

### Minimum requirements

There are no minimum requirements for cable adapters and converters.

### Guidelines

In general, look for products from established, reputable companies. Using inexpensive, low-end adapters or converters results in lower-quality performance.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Coupling cables

A coupler is a connector with two receptacles (also called a female-to-female connection) used to join two cables of the same type. Couplers can provide an easy way to connect two cables and extend a cable run. However, couplers cause signal degradation and can become easily disconnected. Use of a coupler will usually cause a cable to break industry signal standards due to improper extension. SMART strongly advises against use of couplers because they increase the risk of issues and poor performance of SMART interactive displays.

**NOTE:** Some locations may use wall plates for network and cable connections, and these wall plates may have built-in couplers. If this is the case, test the connection to make sure it functions as expected.

## Extenders

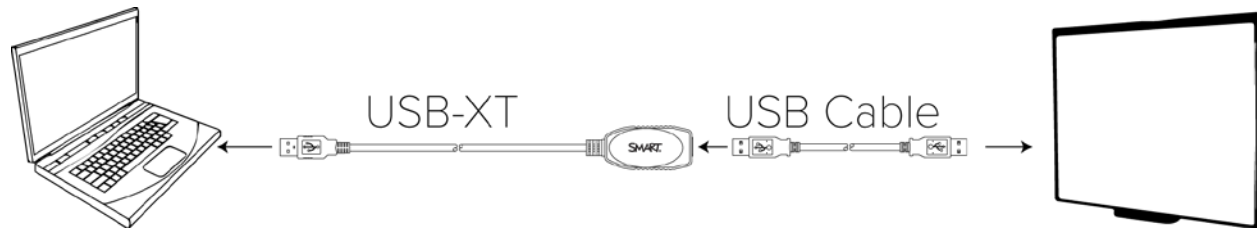
Use only active, externally-powered extenders and not bus-powered extenders (that is, an extender that's powered by the device it's connected to).

**IMPORTANT:** SMART cannot provide support for installations that use bus-powered extenders, (with the exception of extenders manufactured by SMART, such as the USB-XT or Cat5-1100-XT). Before contacting SMART for assistance, replace any bus-powered extenders with a shorter, passive (non-powered) cable and test the system again.

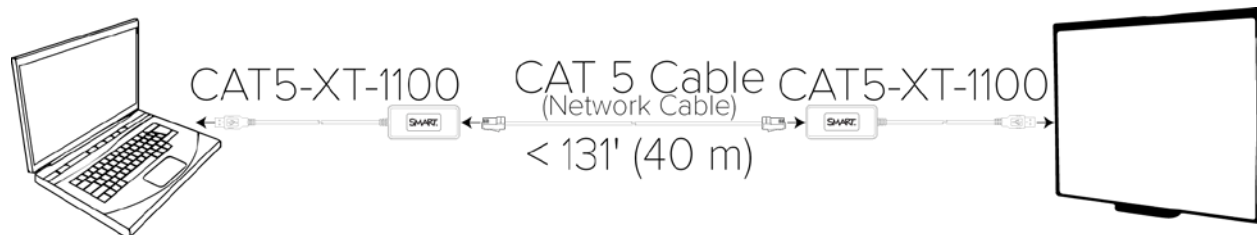
## USB cable extenders

Improperly extended USB connections can cause a SMART hardware or software product's touch features to behave unexpectedly.

A USB extender can be used to extend the USB connection beyond the length of a USB cable that was included with the SMART product, as shown below:

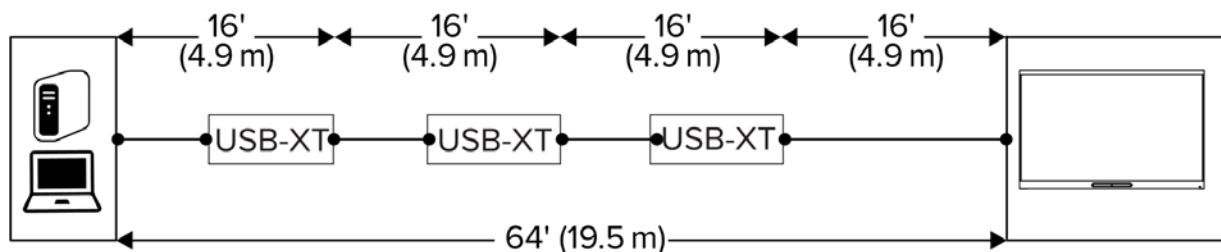


In addition to USB extenders, SMART offers a CAT5-USB extender (CAT5-XT-1100) that enables even greater extension. The CAT5-USB extender uses a Cat 5 or Cat 5e cable in addition to the USB cables:



## USB tier structure

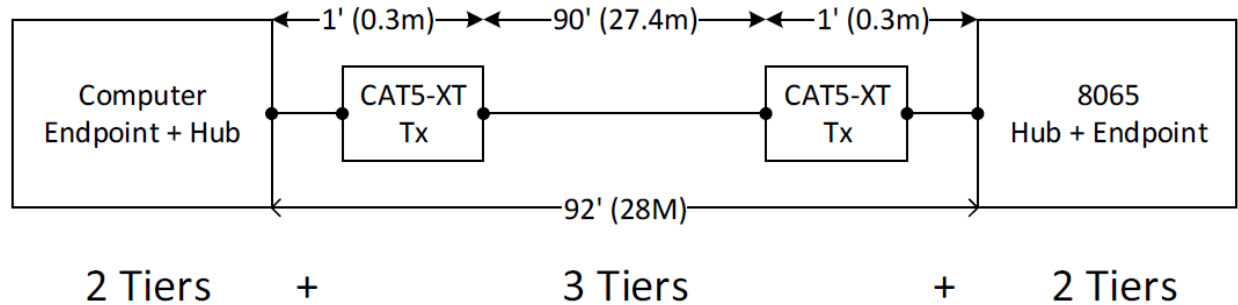
When extending a USB cable, it is helpful to understand how the USB “tier” structure works. USB devices can be extended based on the system's number of USB tiers, up to a maximum of seven. A tier can be a 16'4" (5 m) cable with a built-in hub, a discrete hub, or an endpoint device, such as a computer or SMART interactive product. An endpoint device can contain additional tiers that you won't necessarily see, such as internal hubs. Some SMART interactive products, such as the G5 models, contain one hub and the endpoint, while others, such as the SMART Board 480 interactive whiteboard, do not. (See [Appendix C: Models of SMART interactive products](#) on page 67.) See the example below:



## SMART INSTALLATION STANDARDS

As this example shows, the PC counts for two tiers, the three USB-XTs count as three, and the interactive display counts as two tiers for a total of seven tiers, or about 48' (15 m) of cable extension, plus the additional 16' (4.9 m) from the previous cable.

The next example uses the Cat 5-XT instead. With the Cat 5 cable, one tier of length is approximately 30' (9 m) with a total extension of 92' (28m) and seven USB tiers.



**NOTE:** These are hypothetical examples based on standard calculations. Differences among cables, computers and other hardware can cause actual performance to exceed or fail to achieve these numbers.

An improperly extended USB connection is likely to work only intermittently or not at all. The SMART Board interactive displays have built-in diagnostics to help you understand when this is the case. If the product's Status indicator light is not solid green (or a white moon in the case of SMART Board Generation 5 interactive displays), the issue is likely USB-related or SMART Product Drivers software isn't running correctly.

**NOTE:** Because 7000 series interactive products do not use indicator lights, refer to the SMART diagnostics screen: go to **SMART Settings > Software > Tools > Diagnostics** and verify that SMART Services are running.

## Minimum requirements

Use only active USB extenders. Active extenders help maintain the signal strength as the data is transmitted across longer distances.

**IMPORTANT:** SMART provides support only for its own SMART USB extenders and recommends using the SMART USB-XT or CAT5-XT-1100, as they have been designed and tested to work with SMART's products.

## Guidelines

SMART recommends you use only SMART USB extenders with its products. However, if this isn't possible, use products from well-established, reputable companies. SMART cannot provide support for USB extension beyond the supplied USB cable, or the use of non-SMART USB extenders.

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Video cable extenders

Use an active video extender if you need to extend the length of a digital or analog video connection further than the cables provided with the SMART product, or if you need to extend the connection beyond 23' (7 m). An active extender will help maintain the signal integrity as the audio and video data is transmitted across longer distances.

Although high-quality passive cables can work at longer lengths, an active extender ensures satisfactory signal strength. The extender's supplier should be able to recommend the length of cable that the extender can support.

### Minimum requirements

Use only active, externally-powered video extenders and not bus-powered extenders (that is, an extender that's powered by the device it's connected to).

**IMPORTANT:** SMART cannot provide support for installations that use bus-powered video extenders. Before contacting SMART for assistance, replace any bus-powered extenders with a shorter, passive (non-powered) cable and test the system again.

### Guidelines

When selecting a video expender, look for extenders that have the following characteristics:

**Produced by established, reputable companies**

SMART recommends you use products from well-established, reputable companies. SMART cannot provide support for video extending beyond the supplied video cable.

**Supports EDID and HDCP signals**

If you use a Video Distribution Amplifier (VDA) to extend an analog connection, make sure the VDA extender has an output port that supports Extended Display Identification Data (EDID) and High-Bandwidth Digital Content Protection (HDCP) data to pass through to the input.

For more information about HDCP and SMART's products, see the knowledge base article [SMART Board interactive flat panels and High-bandwidth Digital Content Protection \(HDCP\)](#).

## Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

## Source switching

Source switching is the use of a device to switch between multiple inputs while using only one output. The single output is sent to a SMART interactive display.

SMART does not currently provide external source switching equipment. SMART's display products typically supply at least two video and two USB inputs, enabling a SMART touch interface for two source devices. If you do not have enough available HDMI and USB ports for all the source devices, install SMART's I/O extension module (XTM) or use a source switching device.

To increase the number of available HDMI and USB inputs:

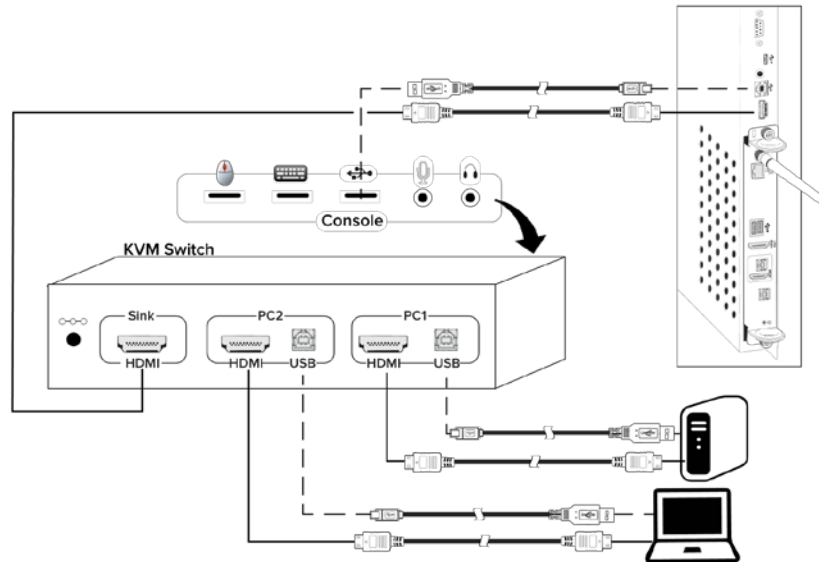
- **Use SMART's I/O extension module:** This module connects to a SMART interactive display's Open Pluggable Slot (OPS) and provides additional HDMI and USB inputs. This module is available through the store for SMART parts.

**IMPORTANT:** You can connect only one of SMART's modules to the display at a time. If the iQ appliance occupies the display's OPS slot, you cannot connect the XTM module without first removing the iQ appliance. If this is the case, use a KVM switch to increase the available HDMI and USB outputs.

- **Use a Keyboard/Video/Mouse (KVM) switch (if connecting a computer):** The switch must support simultaneous HDMI and USB signal switching. Refer to the knowledge base article, [Connecting your laptop to SMART kapp iQ Pro board](#) for information about using KVM switches with SMART's interactive displays.



## SMART INSTALLATION STANDARDS



**IMPORTANT:** To help prevent issues with interactive features, such as gestures or the video display in general, ensure the KVM switching does not buffer or modify (such as scale the image) the USB or HDMI signal in any way.

- **Use an HDMI A/B switch, if connecting a video-only source:** If the source device is video only (such as a DVD or Blu-ray™ player), a simple HDMI A/B switch is sufficient. If the source device does not have an HDMI connection, use a cable adapter.

## Potential Issues

The following issues may result when using a source switching device with SMART interactive displays:

- Problems displaying the correct display resolution
- Sync polarity inversion (analog connections only)
- Signal degradation
- Issues with touch control or writing and drawing
- Errors with HDCP protected content

**NOTE:** SMART does not recommend using a source switching device with a SMART Room System for Skype for Business.

## Minimum requirements

Use only switching devices that have the following characteristics:

## SMART INSTALLATION STANDARDS

**Switches HDMI and USB signals simultaneously** When using a switching device with a computer, the switch must switch both HDMI and USB to enable both video (HDMI) and touch (USB) on the display.

**Supports EDID and HDCP** Ensure that any devices connected in line with a SMART interactive display pass the video handshake signals, such as Extended Display Identification Data (EDID) and High-Bandwidth Digital Content Protection (HDCP). The use of products that do not pass those signals can result in unwanted behavior or no output.

### Guidelines

When selecting a switching device, look for a device produced by an established, reputable company. Using inexpensive, low-end switching devices can result in lower-quality performance.

### Third-party options

Refer to [Appendix A: Third-Party Referrals](#) on page 62 for a list of companies that sell this type of equipment.

# SMART system: configuration

After the hardware is mounted and connected to power and source devices, the system needs to be configured. Configuration includes:

- Calibration/orientation
- Display resolution
- Display changes
- Audio set up
- System settings (language, date, time, etc.)
- Power management set up

## Calibration and orientation

Calibration and orientation are important to the proper functioning of a SMART interactive display's touch features. Calibration and orientation ensure the touch interactions with the display's surface are interpreted and communicated correctly with the SMART software installed on the connected computer. Without calibration and orientation, digital ink could appear at a distance from the pen's contact with the screen, or areas might not respond to touch properly.

Calibration and orientation are required:

- When the interactive display is installed
- After the interactive display is moved

Calibration and orientation are recommended:

- After an upgrade to the interactive display's firmware or the SMART software on the connected computer
- If the room's lighting changes (for example, brighter or dimmer bulbs are installed)
- Touch features aren't working correctly

Refer to the product's installation or administrator's guides on [support.smarttech.com](https://support.smarttech.com) for information about calibration and orientation. Note that the 7000 series interactive displays require only orientation.

## Resolution

Correct configuration of the product's display and resolution settings is important for ensuring the best possible image quality. Methods of configuring the product's display vary with display resolution and the capabilities of the source device.

## SMART INSTALLATION STANDARDS

Most of SMART's interactive displays support full high definition (FHD) 1080p and 4K ultra high definition (4K UHD) resolutions, provided the source device meets the minimum requirements for such resolutions.

SMART advises against the use of an analog video connection for displaying FHD or UHD because analog video connections cannot display high-resolution images with adequate picture quality. If you want to use FHD or UHD resolutions and the source device supports only an analog video connection, you will likely need to upgrade the source device.

Higher refresh rates can result in smoother, flicker-free video. Computers typically display at 60 Hz (that is, 60 frames per second). Setting the refresh rate as high as possible will provide the best experience with image quality and interactivity, provided the connected computer supports the refresh rate. If it doesn't, you may need to set the computer's display settings to a lower refresh rate.

### 1080p FHD resolution

An FHD display has a resolution of 1920 × 1080 pixels for a total of approximately 2.1 megapixels. Most modern video devices (computers, laptops, DVD and Blu-ray players) support 1080p (FHD) resolutions. Check the device's specifications to see which resolutions the source device supports.

SMART recommends a digital HDMI, DVI or DisplayPort connection for best results with FHD. Although an analog VGA connection might support 1080p, the video quality may be degraded, particularly if the VGA cable is longer than 16' (5 m).

### 4K UHD resolution

At 3840 × 2160 pixels (8.3 megapixels), a 4K UHD display has greater pixel density than an FHD display: a 4K UHD resolution display can show up to four times as much visual information as full high definition (FHD) displays.

**IMPORTANT:** Some video hardware described as "4K" or "UHD" may be capable of displaying a 3840 × 2160 image but will not perform well with video at the same resolution. See the Knowledge base article [Minimum requirements for Ultra High Definition or 4K on your interactive flat panel](#) for details.

**IMPORTANT:** Use of SMART software may have additional requirements. See the SMART software's [download page](#) for more information.

Refer to the SMART product's specifications or administrator's guides on [support.smarttech.com](http://support.smarttech.com) for information about supported resolutions and connections.

## Refresh rates: 30 Hz versus 60 Hz

Displays can use a variety of [refresh rates](#), typically 30 Hz or 60 Hz. Higher refresh rates can result in smoother, flicker-free video. This is most evident when using 4K UHD.

Most computers support a refresh rate of 60 Hz. Using the highest frame refresh rate possible will provide a better visual and inking experience when using the SMART interactive display.

**NOTE:** To display 4K UHD at 60 Hz on the SMART interactive display, use the DisplayPort (if available) or HDMI 2.0 input. The standard HDMI 1.4 input supports only 30 Hz at 4K UHD.

## Other resolutions

If the connected computer doesn't support FHD or 4K UHD, refer to the installation or administrator's guide for supported resolutions for your display. Using a resolution other than the display's [native resolution](#) can cause the pixels to be scaled, resulting in slightly blurry images. If the connected computer is using a different [aspect ratio](#) than the display device's, the image can also appear stretched or compressed.

For a list of resolutions other than 1080p or 4K UHD supported by SMART interactive displays, refer to the product's installation or administrator's guide on [support.smarttech.com](http://support.smarttech.com).

## Acoustics

Consider these factors as you configure the system for the best audio performance:

- System gain
- Gain staging
- Ground loops
- Acoustic Echo Cancellation (AEC)
- Equipment placement

Factor	Guidance
<b>System gain</b>	In electronic systems, gain is a measurement of the input signal's strength in relation to the strength of an output signal. Absorption, scattering and other electrical impedance can reduce signal strength as the distance the signal has to travel increases. To account for this reduction and to help prevent the introduction of noise or other signal distortion into the system, systems can include controls for adjusting the gain, typically by increasing or decreasing the signal's strength.

### **Volume Control in Audio Systems**

## SMART INSTALLATION STANDARDS

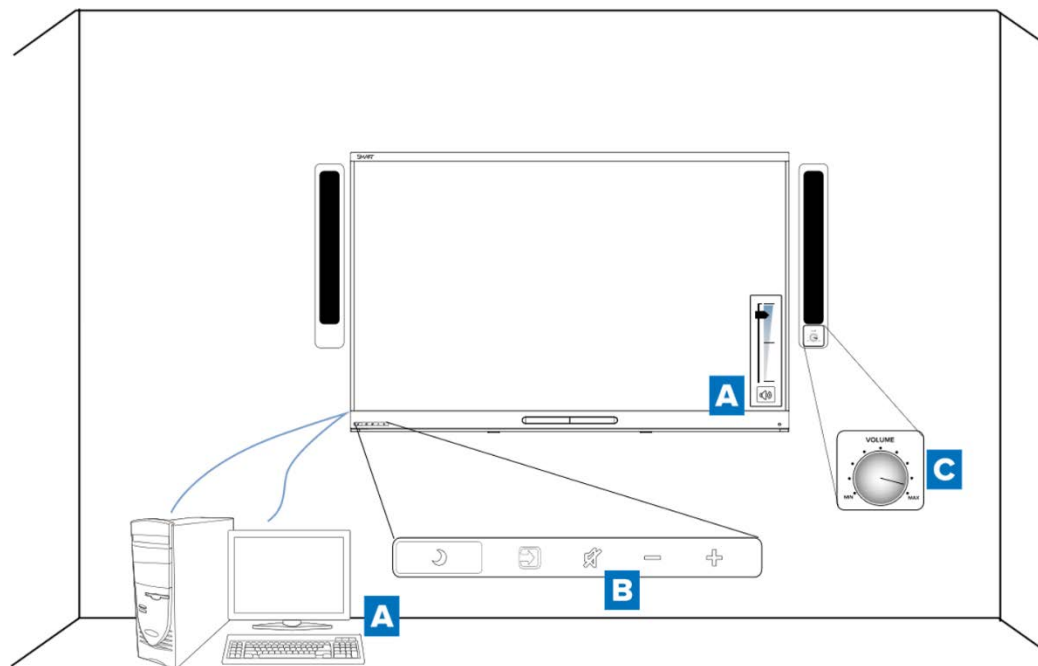
In audio systems, the input signal passes from the source device, such as a computer, through cables to (potentially) multiple devices. Each point within an audio system can introduce distortion or weakening of the audio signal, which in turn affects the system's audio quality. However, any audio system device that has a volume control can be used to adjust the system's gain. Each device with audio controls is considered a "gain stage" and can be used in a process called "gain staging" (described below) to provide the best possible audio.

**Gain staging** Gain staging involves adjusting the signal levels, such as audio, of a series of gain stages to prevent introduction of noise and distortion. Most in-room audio systems will require some sort of adjustment at each gain stage to provide the best audio.

Begin gain staging adjustments at the system's first adjustable volume control (likely at audio signal's source, such as a computer), and end at the system's final volume control (such as a set of speakers).

### To gain stage an audio system with a SMART product

Set the volume on all but the last gain stage to 75-95%. The following example demonstrates this procedure:



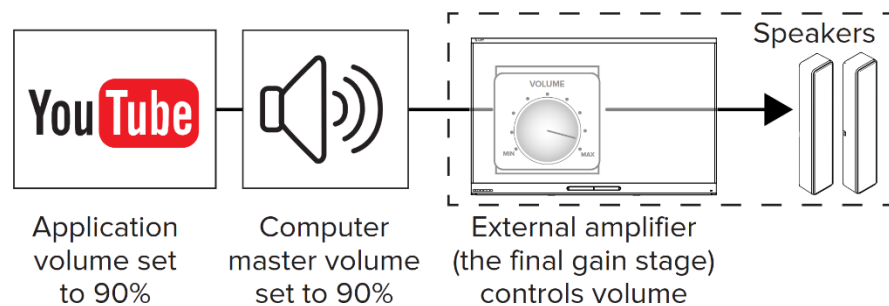
- A. Audio signal source (a media player on the computer connected to the interactive display)
- B. Interactive display
- C. External speakers

**NOTE:** Some models of speaker do not include a volume control.

This example includes four gain stages at which volume can be adjusted:

1. Volume control in the media player software
2. Volume control on the computer
3. Volume control on the interactive display
4. Volume control on the speakers

Starting with the beginning of the audio signal (in this case, the media player), set the first three gain stages' volume controls to 75-90% to push the clearest audio signal from the first gain stage to the last gain stage without overloading the system. Then, at the final gain stage, use the volume controls on the speakers to adjust the sound for the room.



*Gain Staging Example*

**NOTE:** Starting with a lower volume in the first gain stages and increasing the volume elsewhere will amplify any bad qualities (such as noise) of the audio signal.

### Reduce gain stages

If a system includes multiple gain stages or a long path for the audio signal, audio latency and additional signal processing can result in issues with Acoustic Echo Cancellation (AEC). Reducing the number of gain stages in the system to shorten the audio signal's path may be helpful.

A setup that includes a SMART interactive display and a connected computer may include additional options for connecting audio devices. Speakers are commonly connected to the interactive display and act as the final gain stage. If the computer offers an audio connection, the speakers can be connected to the computer, reducing the gain stage count and shortening the audio signal's path.

### **Ground loops**

A ground loop is a low buzzing or hum from the speakers. Ground loops can result when two pieces of equipment are plugged into two different outlets that are on different electrical breaker circuits from one another.

The best way to avoid ground loops is to have all devices powered by the same outlet (see [Environmental factors to consider](#) on page 2). If this isn't an option, use an AC mains isolation transformer on the audio signal's source device (such as the computer). This will match the source's grounding to the SMART interactive display to which the audio source is connected.

**WARNING:** Never remove the earth ground pin from an AC cable, as this can create the potential for electrical shock.

### **Acoustic Echo Cancellation (AEC)**

Issue with Acoustic Echo Cancellation (AEC) are among the most common that can arise in installations that employ both microphones and speakers, especially with installations using components not provided by SMART.

When AEC issues occur, both remote participants and local participants in the meeting room will likely hear an echoing when the other is speaking.

**NOTE:** If you hear an echo of your voice during a conference call with remote participants, the issue is likely with one of the remote participants' devices. Have individual participants mute their microphones one at a time.

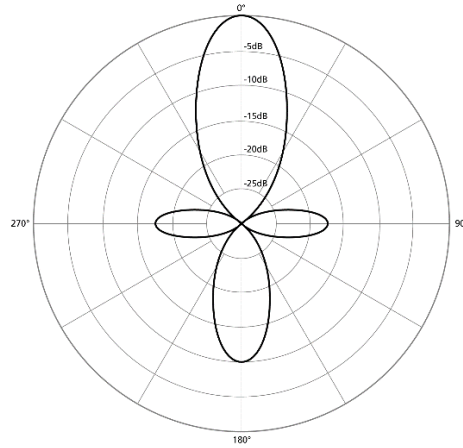
Equipment placement (described below) can help alleviate AEC issues.

### **Equipment placement**

After you've determined that a room is acoustically acceptable, consider the relative placement of sound-recording devices (speakerphones, microphones, webcams, and so on) and playback devices. This helps to avoid AEC issues, such as echoing. (See [Room acoustics](#) on page 4 for more information.)

- If the speakers are above or below the display or whiteboard, maintain a line of sight between the speakers and the microphones.
- Test the setup by making a few calls before you considering the setup acceptable.
- Never place a microphone immediately in front of speakers. Such microphone placement can cause audio issues or loud, unpleasant feedback.
- Look at how the [polar pattern](#) for the microphone captures the sounds around it:





- Although speakers are typically located to either side of the display, the room shape, size, and acoustics might make it necessary to place them elsewhere.

## Other system configuration

For more information about configuring SMART products, refer to the product's installation or administrator's guide on [support.smarttech.com](https://support.smarttech.com).

## Appendix A: Third-party referrals

SMART has identified the companies listed below as potential suppliers of products that may be compatible with SMART products if properly designed, manufactured and correctly incorporated into a SMART system.

**IMPORTANT:** SMART does not assess, inspect, or test products manufactured by others for compatibility with SMART products, and thus provides no guarantee, representation or warranty that the listed products will be compatible with SMART's products, or that they will perform as represented by the supplier.

If you experience any issues, SMART will not troubleshoot third-party equipment added to the system. If troubleshooting is needed, you will very likely be asked to remove the third-party equipment as part of that process. Therefore, SMART highly recommends you set up and test the SMART product as it was shipped *before* you add third-party equipment.

The following list is provided as examples of available peripheral products only. Additional information regarding these products must be obtained directly from the other companies.

**IMPORTANT:** SMART strongly recommends that you test any third-party components, accessories, cables or adapters before installation. Consult your certified reseller for assistance.

Product	Company	Website
Microphones	Yamaha	<a href="https://www.yamaha.com">https://www.yamaha.com</a>
	Shure®	<a href="http://www.shure.com/">http://www.shure.com/</a>
Speakers	Yamaha	<a href="https://www.yamaha.com">https://www.yamaha.com</a>
	JBL®	<a href="http://www.jblpro.com/">http://www.jblpro.com/</a>
Speakerphones	Jabra	<a href="http://www.jabra.com/">http://www.jabra.com/</a>
	Polycom™	<a href="http://www.polycom.com/">http://www.polycom.com/</a>
Cables	Cables 2 Go® (C2G)	<a href="https://www.c2g.com/">https://www.c2g.com/</a>
	Extron®	<a href="http://www.extron.com/">http://www.extron.com/</a>
	Gefen	<a href="http://www.gefen.com/cables/">http://www.gefen.com/cables/</a>

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Product	Company	Website
Adapters	C2G	<a href="https://www.c2g.com/">https://www.c2g.com/</a>
	StarTech	<a href="https://www.startech.com">https://www.startech.com</a>
Video extenders	C2G	<a href="https://www.c2g.com/">https://www.c2g.com/</a>
	Extron	<a href="http://www.extron.com/">http://www.extron.com/</a>
Source switching	StarTech	<a href="https://www.startech.com">https://www.startech.com</a>
	Belkin®	<a href="http://www.belkin.com/">http://www.belkin.com/</a>
OPS computers	NEXCOM	<a href="http://www.nexcom.com/">http://www.nexcom.com/</a>
	Advantech	<a href="http://www.advantech.com/">http://www.advantech.com/</a>
	Axiomtek	<a href="http://www.axiomtek.com/">http://www.axiomtek.com/</a>
Room control systems	Crestron®	<a href="https://www.crestron.com/">https://www.crestron.com/</a>
	Extron	<a href="http://www.extron.com/">http://www.extron.com/</a>
Cameras	Logitech®	<a href="https://www.logitech.com">https://www.logitech.com</a>
	Polycom™	<a href="http://www.polycom.com/">http://www.polycom.com/</a>
Wall mounts and mobile carts	Chief	<a href="https://www.milestone.com/">https://www.milestone.com/</a>
	Peerless-AV®	<a href="https://www.premiermounts.com">https://www.premiermounts.com</a>

## Appendix B: SMART reliability testing

### Cable standards testing

Cables can be tested for compliance to a variety of standards. A quick quality check for a cable is to see what standard it has been tested against.

SMART tests its cables against a variety of standards to ensure the quality of the cables it provides with its products.

SMART tests and certifies its hardware up to the following interface standards:

- HDMI 1.4/2.0
- DisplayPort 1.2/1.3
- HDCP 1.4/2.2
- USB 1.1/2.0/3.0
- VESA Video and Mounting
- Bluetooth 4.0
- IEEE 802.3

### Mechanical, electrical and safety standards testing

The following table identifies the standards SMART uses to validate product reliability:

Type	Standard	Details
Thermal cycling	JESD94 JESD22A-104D IPC9592B	Non-operating Test  Temperature range = from minimum rated storage temperature to maximum rated storage temperature  Temperature rate of change = minimum 15°C/min  Dwell time duration= minimum 5 mins  Number of cycles per hour = minimum 2  Number of cycles = TBD by SMART (dependent on temperature range)

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Type	Standard	Details
		Sample size = TBD by SMART
Random vibration	JESD22B-103B IPC9592B	Non-operating Test Acceleration Level = TBD by SMART Frequency Range = TBD by SMART Axes Stimulated = TBD by SMART Sample size = TBD by SMART
High temperature and humidity with bias	JESD94 JESD22A-101C IPC9592B	Operational Test (non-condensing) Temperature = maximum operating design limit Humidity = maximum operating design limit Input voltage = maximum rated input voltage Output loading = TBD by SMART (dependent on the subsystem) Test time = TBD by SMART (dependent on temp and humidity) Sample size = TBD by SMART
Voltage variation, power and temperature cycling	JESD94 JESD22A-108C IPC9592B	Operational Test (non-condensing) Temperature = stepped from minimum operating design limit to maximum operating design limit Temperature rate of change = 1°C/min Input voltage = varying from minimum rated input voltage to maximum rated Input power = turned on and off Output loading = maximum rated loading Number of cycles = 15 minimum

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Type	Standard	Details
		Sample size = TBD by SMART

# Appendix C: Models of SMART interactive products

	Black finish	White finish	Titanium finish
<b>55" models</b>	SBID8055i-G3	SPNL-4055* SPNL-6055*	SBID8055i-G5*
<b>65" models</b>		SPNL -6065* SPNL-6065-V2* SPNL-4065	SBID8065i-G5* SBID8065i-G5-V2*
<b>70" models</b>	SBID8070i-G3 SBID8070i-G4	SPNL-4070	
<b>75" models</b>		SBD-2075* SPNL-4075 SBID-7075	SBID8075i-G5*
<b>84" models</b>	8084i-G4		

\* Generation 5 (G5) models

# Glossary

**Active cables:** Cables with powered components.

**AEC:** Acoustic Echo Cancellation

**American Wire Gauge (AWG):** American Wire Gauge (AWG) is a standardized system which measures wire diameter. In this system, smaller diameters have higher gauge numbers. AWG is used primarily in North America.

**Aspect Ratio:** Aspect ratio refers to the proportional relationship between an image's height and width. For example, an aspect ratio of 16:9 means that the width of the image is 1.77 times greater than its height ( $16 \div 9 = 1.77$ ).

**AWG:** American Wire Gauge

**Balun:** A transformer that converts an unbalanced signal to a balanced one or vice versa.

**Compression Encoding Scheme:** The type of compression used to reduce file sizes, making them easier to send and store electronically. Some examples of common formats are JPEG, GIF, and MPEG.

**Critical bend radius:** A measurement of the degree to which a cable can be bent to before it is damaged. A cable's bend radius should not be less than ten times the diameter of the cable.

The cable's manufacturer should be able to provide you with the cable's critical bend information.

**DHCP:** Dynamic Host Configuration Protocol

**DVI:** Digital Video Interface

**EDID:** Extended Display Identification Data

**Ferrite bead:** A ferrite bead (also known as a ferrite chokes, blocks, cores, rings or EMI fillers), is a passive electronic component that is used to help suppress Electromagnetic Interference (noise) in electronic circuits. Larger ferrite beads on a cable can indicate the need to compensate for a higher amount of interference in the cable due to poor cable construction or excessive length.

**Frame or Refresh Rate (Hz):** Video is a series of still images shown at very high speed. The speed at which this happens is stated in images shown per second. This number is typically referred to as the frame or refresh rate, and can be stated as Frames Per Second (FPS) or as frame frequency in Hertz (Hz). Both units refer to the same thing.



## SMART INSTALLATION STANDARDS

**Handshake signal:** Refers to the automated exchange of specific signals between a computer and a peripheral device (or another computer) to ensure proper synchronization between the two. This exchange takes place when a connection is first established to set the parameters of communication, and it repeats at intervals during data transmission to ensure continued synchronization.

**HDCP:** High-Bandwidth Digital Content Protection

**HDMI:** High-Definition Multimedia Interface

**Hot plugging:** The addition or removal of components to or from a supporting device while power is still on.

**KVM:** Keyboard/Video/Mouse (switching device)

**Line level:** The strength of an audio signal output by a typical consumer electronic device. It often has a nominal level of -10dBu and a maximum output of +4 to +8dBu. A line level signal requires additional amplification before it can work with an unpowered speaker system.

**Native Resolution:** Every display device has a native resolution (also known as “pixel perfect”) which matches the number of pixels built into the display’s hardware. This means that when using the device’s native resolution, the pixels are displayed at the correct scale, providing the best image quality possible for that device.

**OPS:** Open Pluggable Socket computer

**Passive cables:** Cables with no powered components.

**Polar pattern (Pickup Pattern):** The pattern of a microphone’s sensitivity to sound from various directions.

A polar pattern is either unidirectional (pick up sound from one direction) or omnidirectional (pick up sound from multiple directions). All microphones have a polar pattern.

**Source switching:** Using a device to switch between multiple inputs that go to a single output.

**UL:** Underwriter Laboratories

**USB:** Universal Serial Bus

**VDA:** Video Distribution Amplifier

**VESA:** Video Electronics Standards Association

**VGA:** Video Graphics Array