

Lens Shift

How One Simple Projection Feature Can Save Everyone Time and Money



A better way to see.

3LCD Group



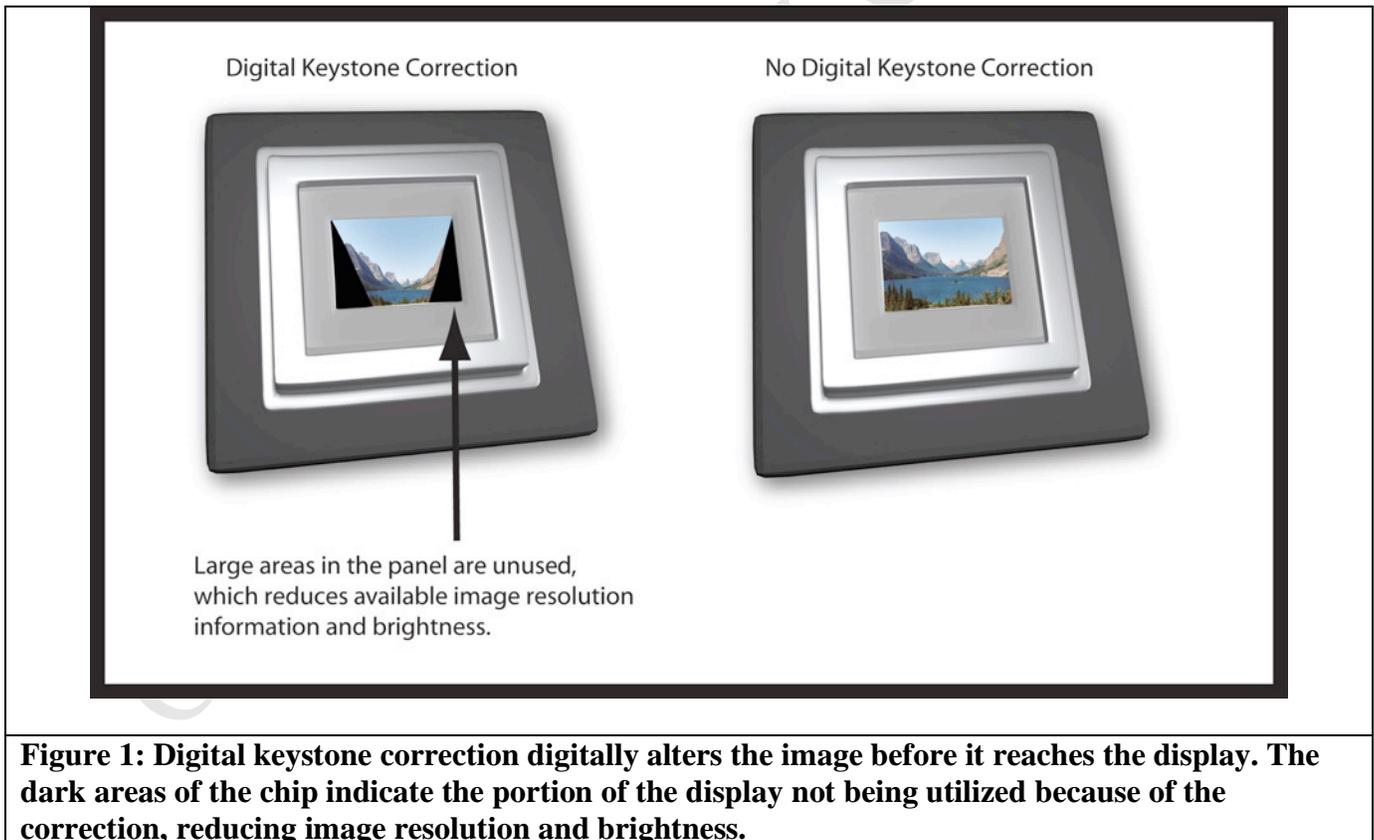
Both residential and commercial installers face challenges when designing spaces using audiovisual equipment. It would be fantastic if rooms could be designed from strictly an audiovisual point-of-view – it wouldn't be so difficult to have great image and sound quality. But of course, architects, interior designers, engineers, and ultimately, the people who will be using the room have many other considerations besides the placement of such equipment. Most rooms have more than one purpose and even if they don't, people usually don't want the technology in the room to be extremely obvious or in the way.

In an ideal display environment, a projector would be perpendicular to and centered to the screen. This of course isn't realistic because most of the time that would place the audience (or something else) between the projector and the screen. Most of the time the projector is mounted to the ceiling, or in some higher location, and projects downward onto the projection screen.

When a projector is not aligned perpendicularly to the screen, the projector must be tilted to reposition the image back onto the screen. This causes an effect called keystone, where the image becomes trapezoidal instead of perfectly rectangular. Vertical keystone occurs when the projector is higher or lower (and must be tilted up or down) than the screen and causes a trapezoidal image that is narrower at the top or the bottom. Horizontal keystone occurs when the projector is tilted right or left and causes the image to be narrower at the left or the right end and occurs when the projector is either further left or further right than the screen. The farther the projector is out of alignment, the worse the keystone becomes.

Keystone has traditionally been corrected digitally. When a source is connected to a digital display, such as an LCD projector, an algorithm can be added to the scaling in the projector that alters the image before it reaches the projection lens, correcting the keystone effect. Basically, the algorithm

adds compression to the fat end of the image trapezoid so it matches the narrow end. If an image is 80% narrower at the bottom, the algorithm will compress the top of the image's pixels so it too will only take up 80% of the space, adjust downward until the image is a perfect rectangle again. However, digital keystone correction has some serious down sides. The correction reduces the apparent resolution of the image and can cause a dimming effect, particularly around the edge that is most compressed. It can also add artifacts and other distortion, most notably a fuzziness (lack of sharpness) around the area of the image being scaled most heavily, since it is now no longer the same size as the native resolution of the display. When the image is scaled, you are in effect giving up a part of the display, which includes not only resolution, but also brightness.





This can cause text and graphics to be difficult to read in a commercial application, and destroy the image quality in home theater video. An extreme keystone correction might be 40°, which could cause you to lose up to a third of the light output and a third of the resolution! A typical projector with digital keystone correction can offer 15° to 30° of vertical keystone correction.

The ultimate solution to keystone is variable lens shift. Variable lens shift is really exactly what it sounds like -- the ability of the lens in a projector to move vertically, horizontally, and sometimes diagonally within the projector housing. Like digital keystone correction, lens shift allows a projector to be off-center from the screen without having to tilt the projector to move the picture onto the screen. Sometimes this is a manual adjustment, and other times it is a mechanical adjustment, controlled using a dial or a joystick. In some projectors, this can be accomplished via the projector's remote control. It doesn't really matter which method a projector with lens shift employs as long as it's available during set-up of the projector. Interestingly, almost all 3LCD projector manufacturers on the market today employ lens shift capabilities as a feature to simplify the installation of their projectors no matter what price range they fall into. Virtually no single-chip DLP projectors offer lens shift. The optical path of a single-chip DLP projector makes it difficult to add lens shift without significantly raising the retail price of the projector. Lens shift is usually available on higher-priced three-chip DLP projectors, but 3LCD is really the only choice for lower and mid-range projector price levels.

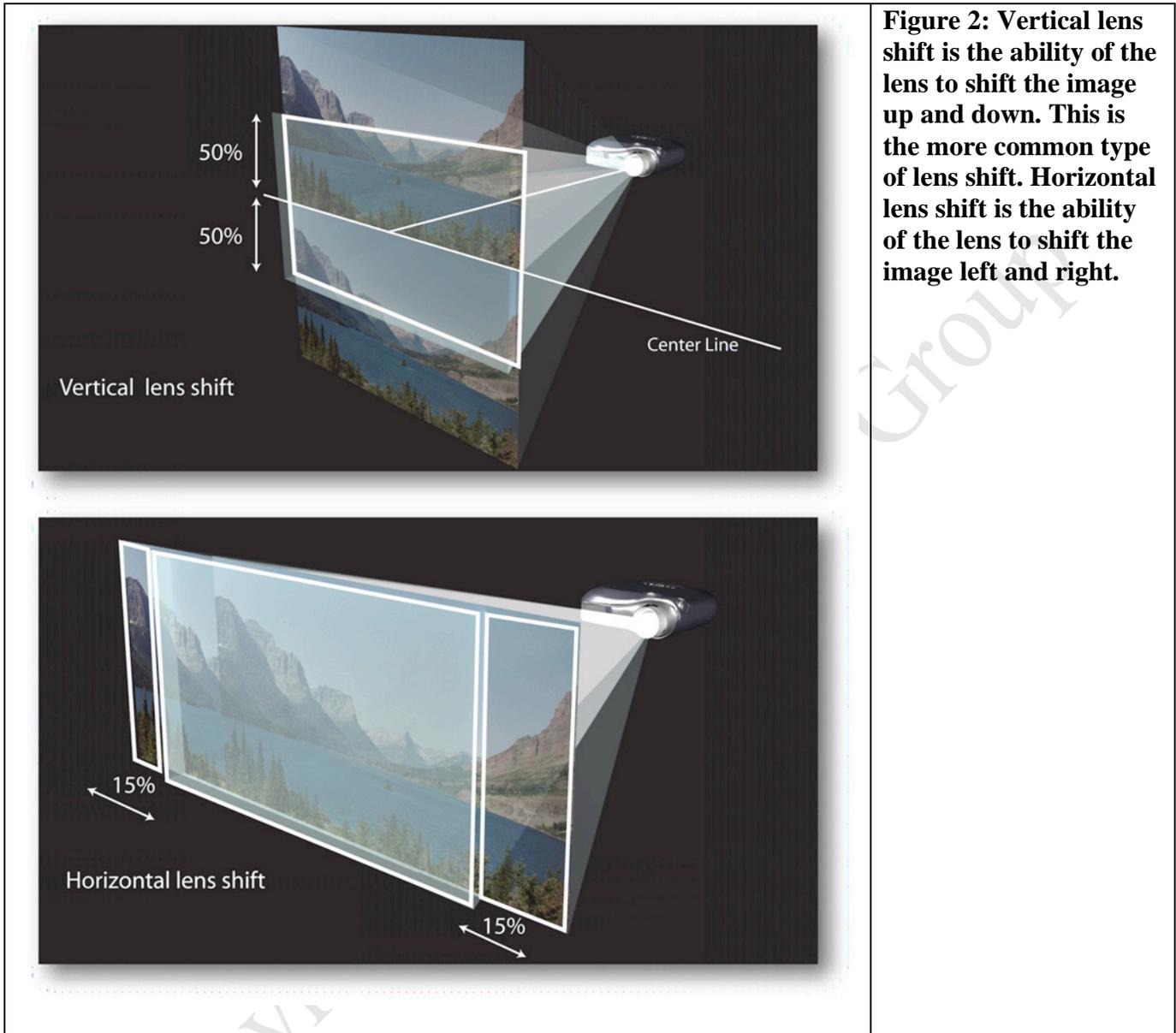


Figure 2: Vertical lens shift is the ability of the lens to shift the image up and down. This is the more common type of lens shift. Horizontal lens shift is the ability of the lens to shift the image left and right.

Lens shift offers a much better solution to keystone, because the adjustment is to the optics in the projector rather than to the image itself. Projectors with lens shift also offer a wider degree of keystone correction, and can often offer as much as a 50% adjustment to the height, or a 30% adjustment to the width.

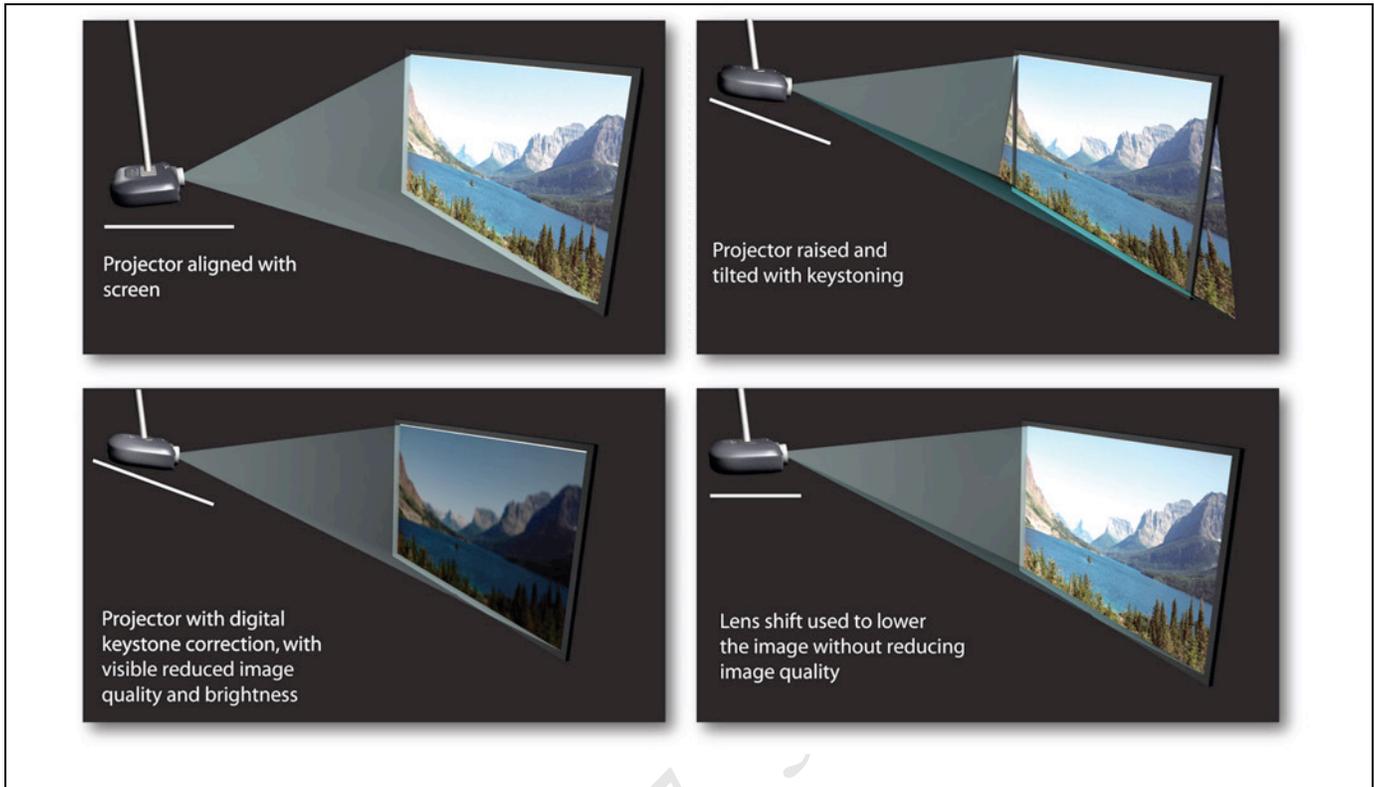


Figure 3: A projector aligned properly with the screen has optimal image quality. A projector tilted to compensate for improper alignment results in keystoneing, a trapezoid-shaped image. A tilted projector with digital keystone correction results in a properly shaped image, but reduced image quality and brightness. A projector using lens shift does not need to be tilted to move the image onto the screen and results in optimal image quality and brightness while the projector is still placed out of the way.

The availability of projectors with lens shifts in a wide price range has made the design and installation process much easier for designers and integrators. “It is much easier to work with clients when we have this flexibility,” said Gary Kayye of Chapel Hill Home Theatre Design, a CEDIA design firm. “Even if you take every measurement and plan for every possibility, the client, or the architect, or the contractor, inevitably wants to change something after you’ve started construction. You never know if your home theater is suddenly going to switch places with another room, or if the interior designer is going want to add something right where your projector was supposed to go. Features like lens shift give us the flexibility to make changes mid-way through the installation and that is incredibly valuable to

both us and our clients.” Projectors with lens shift are also a great choice for presenters, who need flexibility for constantly-changing projection situations without losing image quality, and for commercial applications where projectors are portable or need a lot of flexibility, such as in schools.

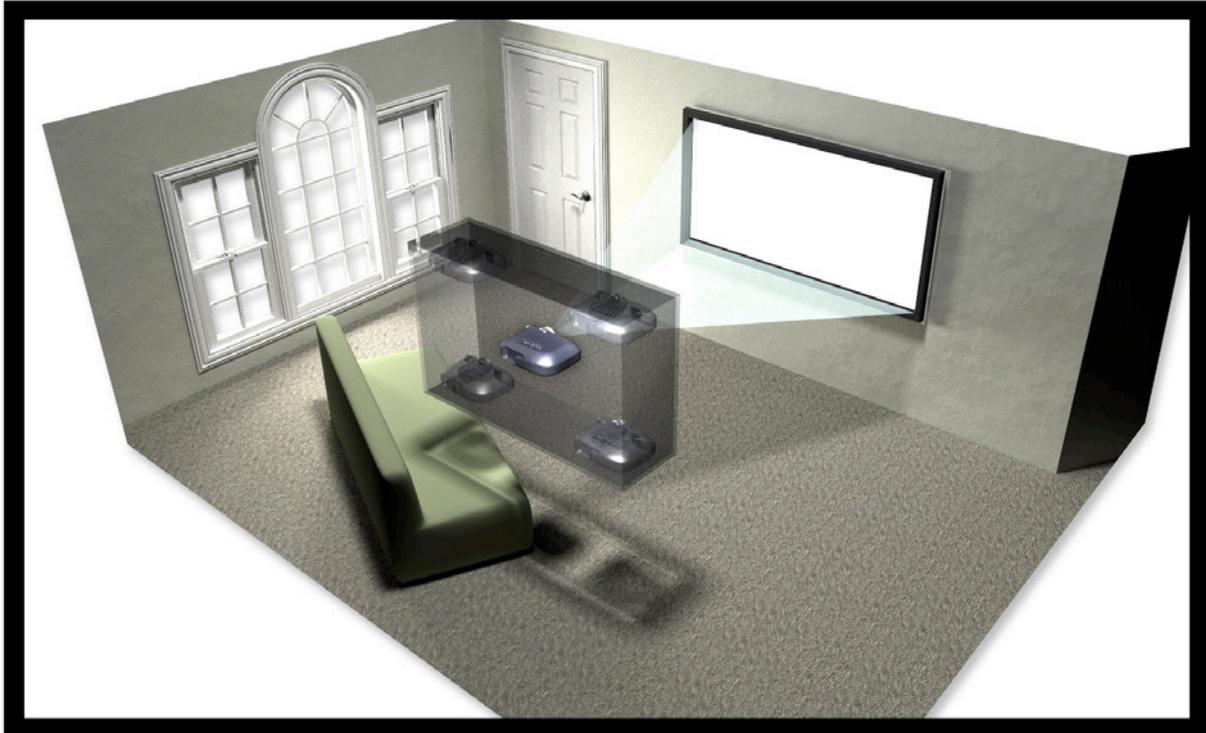


Figure 4: A gray box shows the typical area a projector with lens shift could be moved to while still projecting the image onscreen.

There are many scenarios in which using a projector with lens shift would be important to the integrator. CEDIA designers experience this frequently, especially in retrofits. In residential AV installations, the customers never want to see the technology, but they want it accessible. Perhaps they want the projector to be under a coffee table and have the image shot at an upward angle onto the screen. Or the projector is placed on a table beside a seating area. Most commonly, the projector will be

mounted to the ceiling and projecting the image at a downward angle so the projector itself, along with the wiring, are out of the way and are mostly unnoticed.



Another scenario in which lens shift is valuable is if you are changing out a projector in an existing installation. On some projectors, the lens is in the middle, but on others, it's offset to one side. If the new projector doesn't have the lens in exactly the same place as the old one, the picture will be off by a couple inches. It's a lot easier to be able to use a dial and shift the lens to the appropriate location than it is to move the wiring and mount over.



Ultimately, it would still be most ideal for a projector to be aligned with the screen to ensure optimal picture quality, contrast, brightness, uniform luminance, and minimize hot-spotting. This is mainly because placing a projector off-center will also sometimes reduce the amount of light, though this can be managed by choosing a high-quality screen.

In reality, using projectors with variable lens shift is the best choice for most integrators and customers. Without it, something else must be sacrificed – flexibility, image quality, ease of use for the customer – all deal breakers for a lot of end users. Fortunately, lens shift is available on projectors in a wide range of prices, making the benefits of lens shift available to everyone.

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