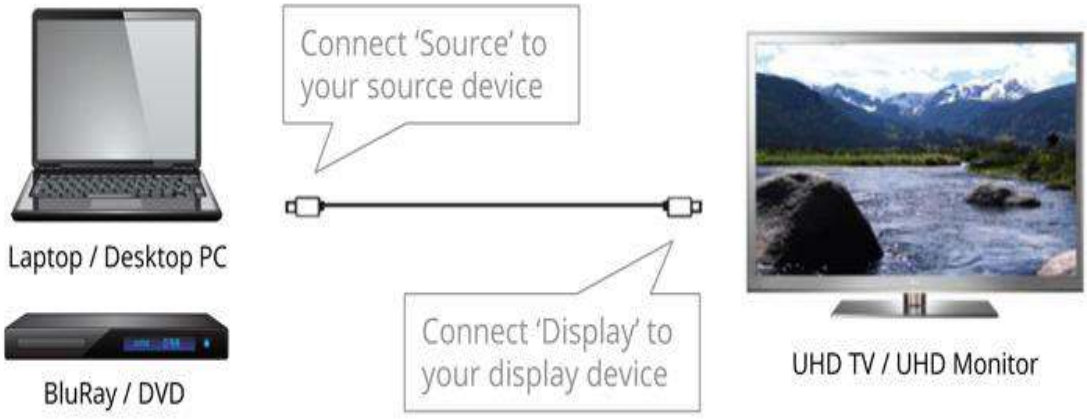
# Active Optical Cables for Educational, Commercial and Residential Audio-Video Installations

Active optical cables (AOCs) are a relatively new option in the data transmission world. Their basic purpose is to combine the very high data transfer rates, long transmission distance, reduced weight, and low EMI of optical fiber with the simplicity of a copper cable. AOCs allow the use of optical fiber technology without any special user training. They plug into the standard electrical ports of source and sink devices, including HDMI, DisplayPort, and USB.




In a traditional passive optical cable, the ends are terminated with passive fiber optic connectors – e.g., SC, LC, MPO, etc. These optical connectors then plug into optical ports on the source and sink, which convert the optical signals to and from electrical signals. The optical connectors – whether you are using pre-terminated or field-terminated cables – must be kept completely clean and dust-free to make a reliable connection. This is relatively easy for trained technicians in data centers or telecom central offices. It is more difficult to ensure a clean connection in a lecture hall, sports bar, conference room, or residential environment.

Active optical cables solve all of these problems by burying the optical-to-electrical signal conversion in the "end modules" at the ends of the cable. The small black cases on the ends of the AOC shown to the right actually contain a lot of sophisticated hardware, including multiple semiconductor lasers and laser drivers (on the source side) and high-speed photodetectors and amplifiers (on the sink side).

*Figure 1: HDMI Active Optical Cable*

Figure 2 on the right shows a look "under the hood" of an AOC end module. The optical fibers (4 fibers in the case of an HDMI cable) come in on the top side of the PCB, and couple to the lasers or photodetectors through a set of micro-lenses at one end of the black plastic block shown in the picture. Between the block and the external gold HDMI electrical connector are integrated circuits with laser drivers or amplifiers that interface between the standard HDMI electrical signals and the optical signals.

*Figure 2: Interior of AOC End Module*

## AOCs for HDMI Links

HDMI AOCs are the most common type of non-data-center AOC, and support HDMI 1.4 and HDMI 2.0. Almost all models use four optical fibers to transmit the high-speed video signals, but the better-quality AOCs also use separate copper wires inside the cable to transmit the lower-speed signals (DDC, HPD, EDID and CEC) as well as power. While there are some all-optical HDMI AOCs that multiplex the lower-speed signals among the video signals, these are more prone to incompatibility problems, and require external power supplied to both ends of the AOC.

*Figure 3: HDMI Active Optical Cable*

| Pros | Cons |
|---|---|
| • longer distances at 1080p and 4K<br>• thinner, more flexible than comparable length copper cables<br>• some require no external power<br>• typically less expensive, faster and less complicated installations than using baluns or extender boxes | • cannot repair or upgrade in the field<br>• typically, more difficult to pull through conduit than unterminated bulk cable |

## AOCs for DisplayPort Links

DisplayPort (DP) is a video display interface that is popular in gaming hardware, and which is spreading into ProAV, digital signage, and AR/VR/CAVE simulation applications. As with HDMI, DisplayPort AOCs use four fibers to transmit the high-speed video signals, and separate copper wires to transmit the AUX and HPD signals, as well as power. One reason for the growing popularity of DisplayPort is its technical superiority for very high data rate transmission, especially 4K and 8K video. DisplayPort AOCs support considerably higher data rates than HDMI 1.4 and 2.0 cables, with DP 1.2 AOCs going up to 21.6 Gb/s, and DP 1.4 AOCs going up to 32.4 Gb/s.

*Figure 4: DisplayPort Active Optical Cable*

| Pros | Cons |
|---|---|
| • resolutions up to 8K UHD<br>• longer-distance support than copper cables<br>• thin, flexible cables<br>• available with no external power required<br>• cheaper, faster installations than extender boxes or baluns | • cannot repair or upgrade in the field<br>• larger connectors can be more difficult to pull through conduit |

## USB 3.x with AOCs

As USB 3.x copper cables are typically limited to 5 meters or less, AOCs offer a much-needed extension solution. However, in choosing AOCs, you must determine your needs for backward compatibility and power support. Although some USB AOCs do support power transmission, many are all-fiber, meaning that they can't be used to supply power from a computer to a camera or other peripheral. Also, few USB 3.x AOCs are backwards compatible without an adapter.

*Figure 5: USB 3.1 Active Optical Cable*

| Pros | Cons |
| --- | --- |
| • 5 Gb/s data rate up to ~50 meters<br>• very thin, flexible cables<br>• a good option for signal extension for PTZ cameras, electronic whiteboards in digital classrooms, and similar uses when power transmission is not needed | • may not be backward compatible with USB 2.0 or earlier without adapter<br>• may not support charging |

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