



superMHL™ Specification: Experience Beyond Resolution

Introduction

MHL® has been an important innovation for smartphone video-out connectivity. Since its introduction in 2010, more than 750 million devices with MHL technology have been shipped across the globe. The past three specifications (MHL 1, 2 and 3) focused on connecting mobile devices to displays, with each new version of the specification enabling enhanced video resolution, audio formats, charging and control. The superMHL™ Specification is the next evolution of MHL and introduces a consumer-friendly reversible connector for the home theater market.

Innovative features of the superMHL specification include the world's first 8K 120fps Ultra High Definition (UHD) resolution and immersive object audio technology from Dolby and DTS. To enable these features, the superMHL connector was designed to deliver the highest video resolution available today to ensure that MHL remains on the forefront of technology. The superMHL specification also provides up to 40 watts of power, providing faster charging ideal for tablets, and is backward compatible with the earlier versions of the specification.

This white paper provides an overview of superMHL's capabilities for consumer electronic and mobile device designs. If you would like additional information, the superMHL specification is available from the www.mhltech.org website for all MHL adopters.

superMHL Technology Overview

The superMHL specification is designed to transmit video, audio and data, and enable control and power charging from a wide variety of MHL sources to MHL sinks.

As shown in Figure 1, the link contains multiple Transition Minimalized Data Signaling (TMDS) pairs, a control bus (CBUS), a voltage bus (VBUS) and an associated ground pin. Each TMDS signal pair is capable of transporting 6Gbps of data and is one audio video (A/V) lane. The superMHL link may contain up to six TMDS pairs, enabling sources and sinks to achieve a throughput of 36Gbps. superMHL supports visually lossless DSC (Display Stream Compression v1.1 from VESA) compression, which increases the throughput capabilities of the link to 108Gbps.

The enhanced control bus (eCBUS) is a multipurpose pin. One function of the eCBUS is to transmit the link reference clock, which is transformed by the superMHL sink as the pixel clock. The eCBUS pin is also used as a bi-directional data pin to carry MHL command data, display data, and MHL configuration formats. A dedicated voltage bus (VBUS) and an associated ground pin are defined to provide power from the sink to the source or source to adapter, with the expanded ability to operate in different charging voltages.

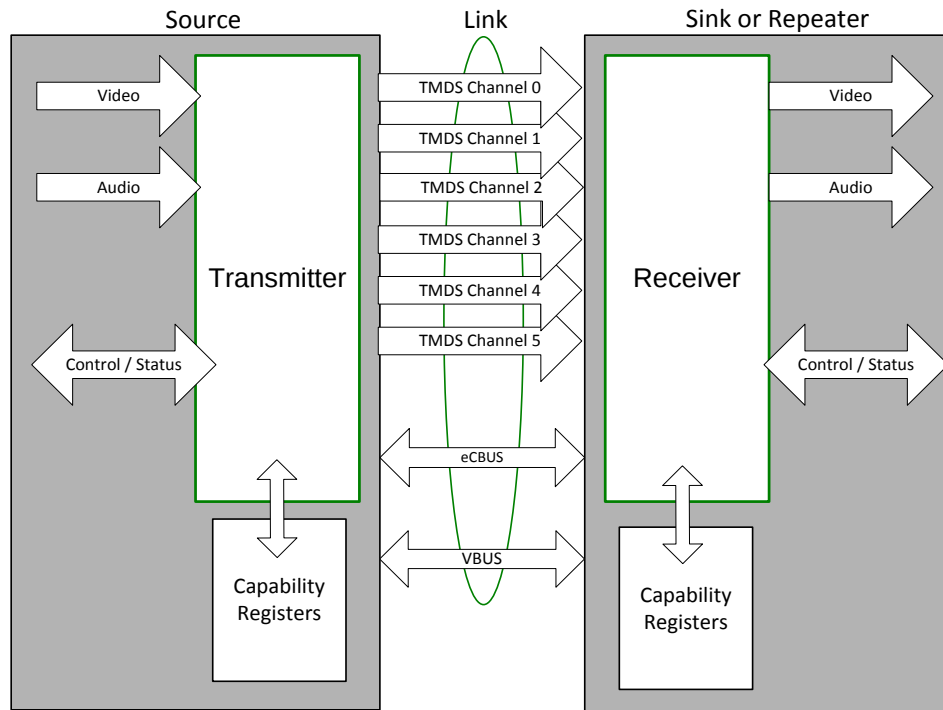


Figure 1: 6- superMHL (source) over superMHL (sink) Connector Diagram

Figure 2 shows the link between the USB Type-C connector on the source and the superMHL connector on the sink, supporting one to four A/V lanes, and concurrent USB 2 and power charging.

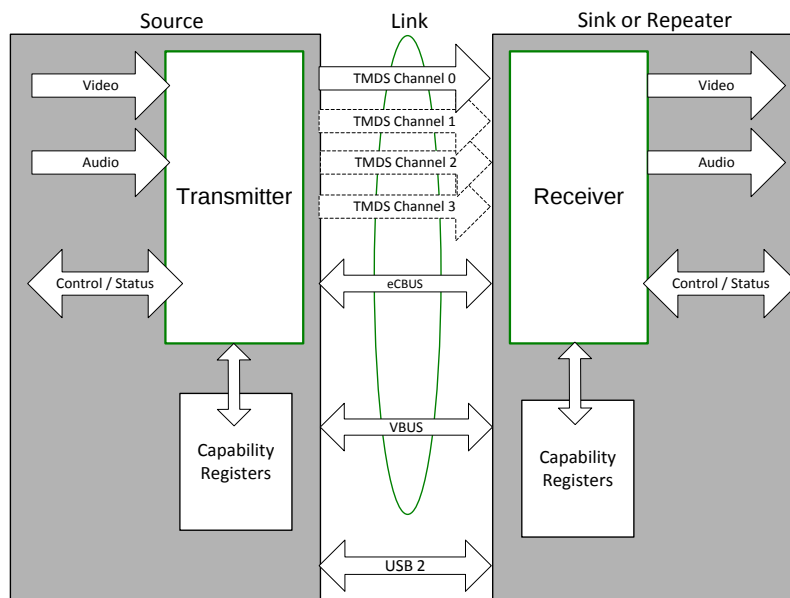


Figure 2: USB Type-C (source) to superMHL (sink) Connector Diagram

Figure 3 shows the link between micro-USB connector on the source and HDMI® Type A connector on the sink, with one A/V lane.

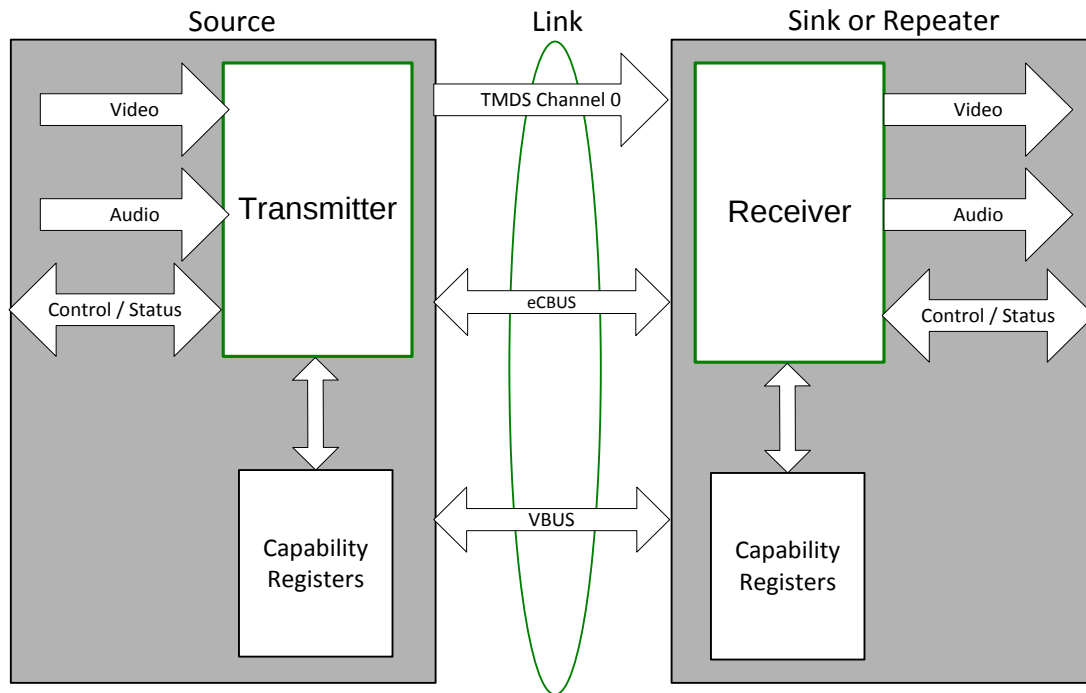


Figure 3: micro-USB (source) to HDMI Type A (sink) Connector Diagram

8K Video Formats and Higher Frame Rates

superMHL is the first connectivity standard to bring 8K 120fps resolution into the living room. Shown in Figure 4, 8K UHD (7680 x 4320 pixels) resolutions have four times the pixels of 4K UHD and 32 times the pixel density of 1920x1080p HD resolution. superMHL devices can support 8K UHD resolution with refresh rates up to 120fps.

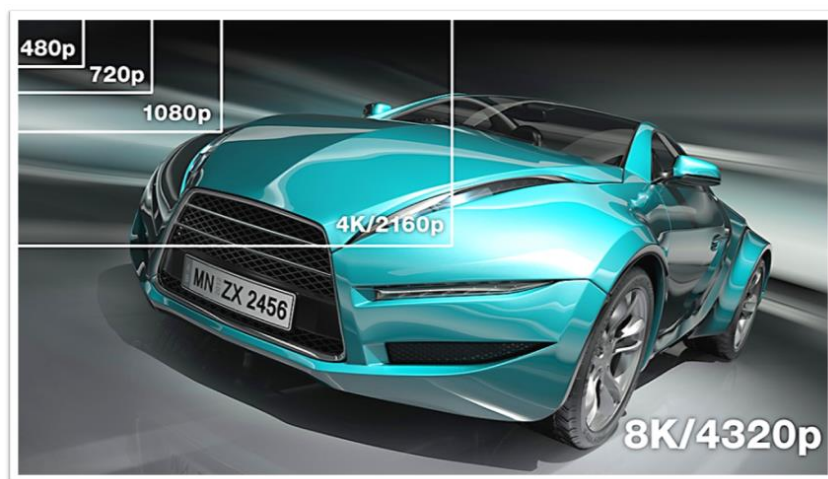


Figure 4: 8K UHD Resolution Comparison

A wide array of specification resolutions are supported by MHL, with each resolution strictly adhering to the specified video timing format. This ensures that all HDTVs and UHDTVs are able to work when connected to an MHL source without compatibility issues. Key resolutions supported include, but are not limited to:

- 720x480p@ 59.94/60Hz
- 720x576p@ 50Hz
- 1280x720p@ 50/59.94/60Hz
- 1920x1080i @ 50/59.94/60Hz
- 1920x1080p@ 50/59.94/60Hz
- 3840x2160@ 24/25/30/48/50/60Hz - 4K UHD
- 5120x2880@ 24/25/50/60Hz - 5K UHD
- 7680x4320@ 24/25/30/50/60/120Hz – 8K UHD

Additionally, many 3D formats are supported by all MHL specifications.

Advanced Color Space Support

Since superMHL was designed to address the needs of both the consumer electronics ecosystem and the content producers, the following pixel encodings and additional color spaces are supported:

- RGB 4:4:4 pixel encoding
- YCbCr 4:4:4 pixel encoding
- YCbCr 4:2:2 pixel encoding
- YCbCr 4:2:0 pixel encoding (4K resolution and above)
- xvYCC
- BT.2020 (8K and 4K UHD)
- Rec.709
- sYCC601
- AdobeYCC601
- AdobeRGB

With the support of BT.2020, superMHL adds a much wider color gamut compared to Rec.709. As shown in Figure 5, BT.2020 expands the rendered color range from Rec.709's 35% to 80% of the visual color spectrum. This provides a stunning visual experience for consumers and it is expected to be widely implemented in TVs, digital recording equipment, enhanced broadcasting, and next generation Blu-ray Disc™ players.

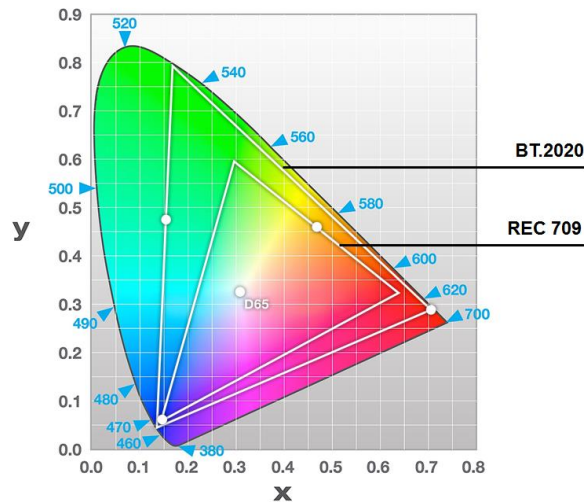


Figure 5: BT.2020 vs Rec.709 Color Gamut

High Dynamic Range (HDR)

superMHL is the first video connectivity specification to support the latest HDR using static metadata adhering to the SMPTE 2084 specification. HDR offers a unique method to render videos and images that are hyper realistic, with lighting exposure levels that approach the dynamic range of the Human Visual System (HVS). Viewers will be able to see the most brilliant whites and the darkest darks with extremely dazzling transitions in both 8K and 4K UHD resolutions. This allows a true-to-life rendition of video scenes with shadows, sunsets, low lights and panoramic scenes. superMHL is also geared to support HDR with dynamic metadata once it's specified by organizations like SMPTE.



Figure 6: Image With HDR and Without

Standard and Deep Color Support

superMHL sources and sinks support different color depths to ensure that consumers are able to see the most accurate color representations possible. Benefits of supporting deep color include the ability to eliminate color banding and ensure smooth tonal transitions between colors. superMHL supports up to 48-bits of color per pixel.



Figure 7: Deeper Color

Multi-Lane Support

To achieve higher bandwidth than previous versions of the MHL specification, multiple A/V lanes can be used, depending on the device type, system implementation, and connector type used in the system.

superMHL sources can support a minimum of one A/V lane to a maximum of six A/V lanes. The number of A/V lanes is dependent on the connector type used. The list below summarizes the maximum number of lanes supported by each connector type:

- micro-USB – one A/V lane
- HDMI Type-A – one A/V lane
- USB Type-C – four A/V lanes
- superMHL – six A/V lanes

Advanced Connector Support

superMHL supports several different connector types, each offering different capabilities, performance, charging, size and reversibility. Connectors supported, illustrated in Figure 8, by the superMHL specification include:

- micro-USB (Source)
- USB Type-C (Source)
- Proprietary connectors (Source)
- HDMI Type-A (Sink)
- superMHL connector (Source and Sink)

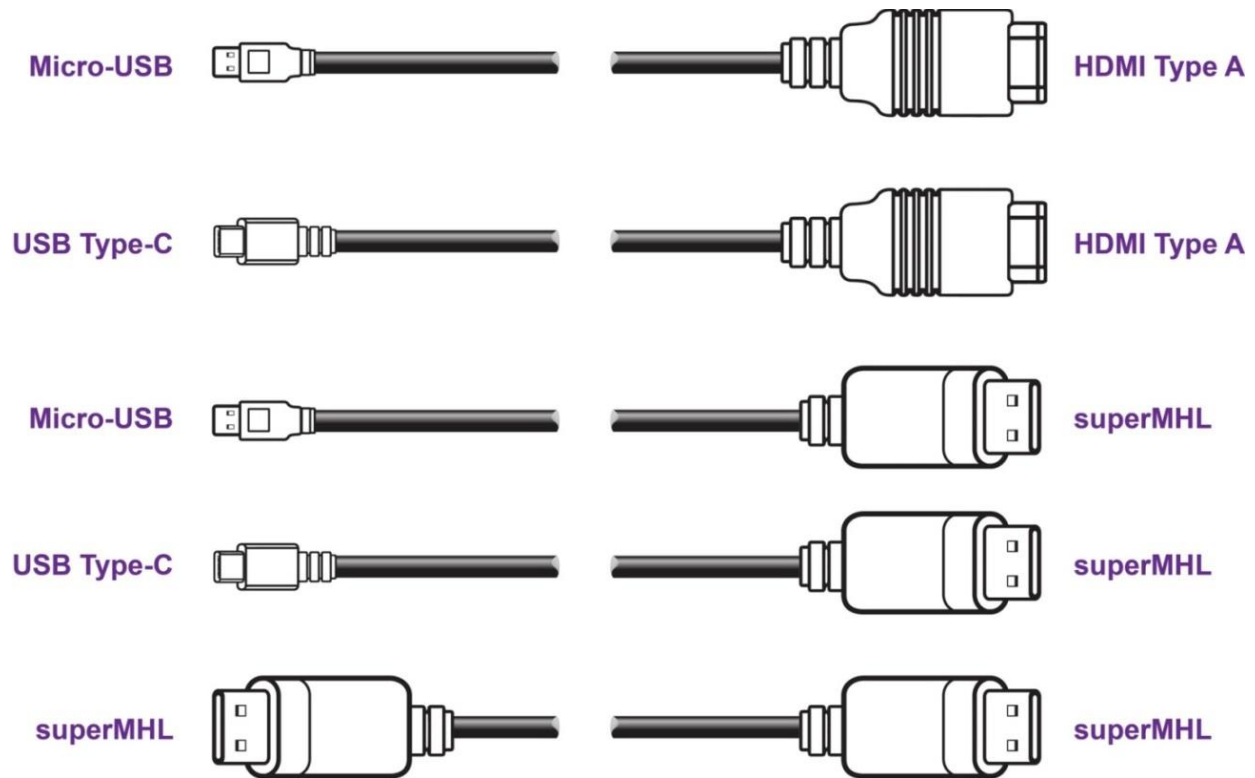


Figure 8: superMHL Cable Support

The micro-USB connector is the de facto connector for mobile devices since it can provide USB data, power charging and MHL A/V connectivity from a single connector. micro-USB features a small 5-pin form factor that is fully compatible with MHL and has the ability to support 4K 60fps offered in the superMHL specification.

USB Type-C is a new small form factor connector introduced by the USB Promoters Group in September 2014. USB Type-C has 24-pins, which allows one up to four high speed lanes. USB Type-C is a reversible connector designed for smartphones, tablets, laptops and desktop PCs. A reversible connector ensures that the connector can be plugged in either orientation, with the system automatically remapping the signals to function correctly. superMHL technology supports the USB Type-C connector using MHL through the USB Type-C Alternate Mode (“Alt Mode”). superMHL sources can use the USB-PD messaging system to enter Alt Mode and operate up to four MHL A/V lanes simultaneous with USB 2, or up to two MHL A/V lanes simultaneous with USB 3 (for instance in a dock configuration).

superMHL Connector

One of the highlights of the superMHL specification is the introduction of a 32-pin, reversible superMHL connector. This connector can carry up to six A/V lanes and is designed to operate beyond the 6Gbps in the superMHL specification to provide room for future bandwidth expansion. The superMHL connector is rated to 3A of current, which enables 40W of charging at higher voltage and current. The reversibility of the superMHL connector simplifies device connectivity.

Figure 9 provides images of the superMHL cable.



Figure 9: superMHL Cable

DSC Support

The Display Stream Compression (DSC) standard version 1.1 defined by VESA® is supported by superMHL devices. This compression standard not only provides a visually lossless video compression algorithm but also saves power by using less system resources.

DSC can be enabled by the MHL source in the case where the bandwidth of the lane is unable to meet the uncompressed rate of the video format or to reduce power of battery operated superMHL sources such as smartphones. DSC supports a compression rate up to 3.0x offering bandwidth savings of up to 3:1. For example, 4K UHD 60 fps transmission over a single lane is achieved in conjunction with a DSC compression rate of 3.0x.

Higher Charging Power

Using the higher current and/or higher voltage properties of the USB Type-C and superMHL connectors, the power across the cable can be increased up to 20V with 2A of charging current. This allows for a maximum of 40 watts of charge from the superMHL sink to the source. Higher power allows for super-fast charging of mobile devices and enables consumer electronic devices such as streaming media sticks, set top boxes and Blu-ray Disc players to get operating power from the display itself. superMHL defines cable voltage detection technology that only enables higher voltages from the superMHL sink if the cable is capable of carrying it.

Stream Control Protocol

Stream Control Protocol (SCP), newly defined in the superMHL specification, is a command and control protocol that can control multiple superMHL products linked together in the same SCP network using one remote. MHL devices can be physically linked together from point-to-point or connected logically

via intermediary devices. With SCP, each superMHL device is assigned a unique SCP ID. Each device can be addressed and requested to perform particular commands as long as the devices are logically connected in the SCP network. This includes basic functions such as disabling power, to advanced functions such as transmitting video content from the DVR to the TV through an intermediary A/V receiver.

Multi-Display Support

Consumer expectations and productivity have increased over time and users now want to be able to view content on multiple monitors or displays for additional screen real estate. superMHL source devices can output up to 32 displays, with up to 8 different concurrent resolutions. This includes the ability to send different audio transmissions to each attached display. The image or video displayed can come from the master image, which can be mapped into the multiple displays, or each have independent images that are unrelated to one another.

Advanced Audio Technology Support

In addition to supporting existing Blu-ray audio formats and legacy-based uncompressed PCM formats, superMHL technology supports leading-edge 3D, object audio, 1-bit audio formats, and an exclusive audio-only mode. This offers consumers an advanced listening experience not only with existing audio formats, but also next-generation immersive audio.

Object audio encompasses multiple protocols that carry audio streams where the sound energy is mapped to individual objects instead of fixed position speakers. This is compared to channel-based audio that only works in predefined locations and uses a specific number of speakers to provide an optimal audio experience. Object based audio can adapt to the content of the movie and ensures the best audio experience regardless of the number of speakers and their placement. Object audio protocols and metadata defined by Dolby and DTS can be carried by superMHL.

superMHL allows an audio source to connect to an audio sink without sending concurrent video data, opening up speaker and headset markets to the superMHL specification.

Content Protection

Premium content distributed and streamed by movie studios is copyrighted material. High-Bandwidth Digital Content Protection (HDCP) has been designed to protect copyrighted source material from duplication. HDCP 2.2 introduced by the Digital Content Protection LLC in June 2014 is a content protection scheme. The entertainment industry is actively driving the adoption of HDCP 2.2. The superMHL specification supports HDCP 2.2 using public RSA key authentication and 128-bit AES encryption into the MHL data stream without latency.

The superMHL specification supports HDCP 2.2 content encryption in all operating MHL A/V link data streams without latency even at the maximum resolution of 8K UHD 120fps. Also, superMHL ensures that devices are able to operate with HDCP 1.4 encryption when linked with MHL 1 and 2 capable products.

Feature Comparison Summary Table

Table 1 summarizes the differences between each of the MHL specifications.

Table 1. MHL Specification Comparison Chart

Features	superMHL	MHL 3	MHL 2	MHL 1
Maximum Resolution	8K120	4K30	1080p60	1080p60
High Dynamic Range/BT.2020/ Deep Color (10, 12 16-bit)	✓			
Up to 8 Channel Audio	✓	✓	✓	✓
Blu-ray Audio (Dolby TrueHD, DTS HD)	✓	✓		
Dolby Atmos®, DTS:X, 3D Audio, Audio Only Mode	✓			
MHL Control (RCP) – Single Remote	(Including mobile, TV, AVR, STB, BDP)	✓	✓	✓
Power Charging	40W	10W	7.5W	2.5W
Content Protection	HDCP 2.2	HDCP 2.2	HDCP 1.4	HDCP 1.4
Multi-Display Support	Up to 32 displays	Up to 4 displays		
Connectors	superMHL USB Type-C micro-USB HDMI Type A Proprietary	Connector Agnostic	Connector Agnostic	Connector Agnostic

A Thriving Ecosystem

To date there are more than 750 million MHL devices shipped and counting. With the introduction of superMHL and backward compatibility with previous MHL 1, 2 and 3 specifications, manufacturers and original device manufacturers (ODMs) have a choice of which specification to adopt. For example, a 1080p smartphone may choose the MHL 1 or 2 specifications while a 4K tablet may choose superMHL. 4K or 8K TVs are ideally suited for superMHL because of its advanced A/V capabilities and new connector.

Compliance Testing

One of the benefits of the MHL Consortium is the interoperability assurance that comes with the compliance testing requirements. The MHL Consortium has established global Authorized Test Centers (ATCs) to perform compliance testing of products before they enter the market. Compliance on both sides of the link is critical to interoperability between MHL devices and provides a consistent consumer experience.

Each MHL member company must submit their device for testing and pass all of the mandatory tests in the MHL Compliance Test Specification (CTS) in order to be certified as an MHL-compliant product. Multiple test equipment companies provide equipment to perform testing following the CTS methodology, including electrical, protocol and system-level tests. Each superMHL product certified by the ATC is registered with MHL before it enters the market.

Summary

superMHL technology is the most advanced MHL specification developed by the MHL Consortium to date. There are many new features including the ability to support 8K UHD, hyper realistic video color depths, high dynamic range support, multi-device control, the latest HDCP 2.2 encryption, and immersive object based audio technologies from Dolby Atmos, and DTS:X. superMHL also supports the reversible USB Type-C and superMHL connectors that allow the concurrent transmission of UHD video, multi-channel audio, USB data, and power. With the introduction of superMHL, and an existing base of hundreds of millions of MHL products, MHL technology is poised to become the leading contender for video connectivity across mobile and home theater devices.

For more information visit www.mhltech.org

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