HDMI™

HIGH DEFINITION MULTIMEDIA INTERFACE

A Basic Guide

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A Basic Guide

Contents

Yamaha's HDMI equipped RXV2700 AV Receiver and DVDS2700 DVD Player

This guide has been written and distributed by Yamaha Electronics UK Ltd

Preliminary Information

Many of the explanations of the HDMI technologies in this guide will assume you already have a reasonable amount of prior knowledge of many aspects of the AV industry, especially AV amplifiers.

If you do not, the following glossary of terms will be of use:

Optical Discs - CD, DVD SACD, DVD/Audio, Bluray and HDDVD are all optical discs. A CD is used to store uncompressed digital audio in stereo (two channel sound). A DVD is used to store both sound and video signals. The sound can be in more than two channels (surround sound) to add effects to the soundtrack. SACD and DVD/Audio are high quality multi channel music formats. Bluray and HDDVD are the new up and coming formats designed to eventually replace DVD - they again store film and sound but can store both in a higher quality than DVD. Different optical disc formats used different types of picture and sound formats. So different equipment is required to play and make use of the data on these discs.

Digital Audio Compression - sound is saved onto optical discs in a special "file" called a CODEC (Compressor Decompressor). This CODEC needs to be both decoded and converted to analogue before we can hear it. Different devices can decode different CODECs.

Dolby Digital - is a type of CODEC. It is used to save up to 5.1 sound channels onto a DVD disc. To hear this sound we need to have a Dolby Digital decoder.

DTS - is another type of CODEC. Again, to hear this we need a DTS decoder.

Other examples of CODECs are MP3 (used for stereo music) and MLP (used for high quality Audio DVD music). There are may other CODECs which all have specific advantages and are therefore ideal for specific uses.

DVI - is a connection used to carry digital video (no audio). It is compatible with HDMI using either a simple adaptor or a DVI to HDMI lead. Unlike HDMI, DVI does not always handle HDCP, so some DVI devices can not work with HDMI devices if the DVI devices does not support this copy protection system.

HD TV - or "High Definition" Is a term used to describe the quality of the picture that a TV or display device (projector, plasma etc..) can display. This is quoted in resolution. Different screens can handle different resolutions. Standard definition TV is described as 480 or 576 lines whereas high definition is described as 720 or 1080 lines - the more lines the more information so the better the image.

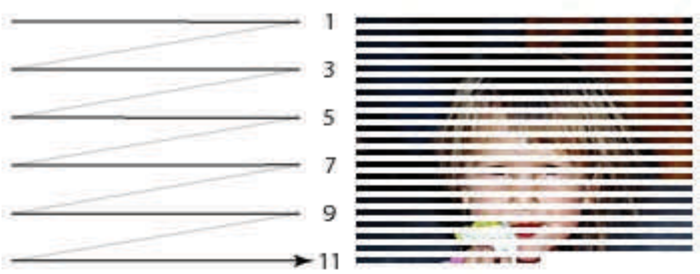
HD Ready - A group of industry experts got together and created the "HD Ready" logo which is designed as a guide to let consumers know which TV's and display devices will work with HD images. An HD Ready Display device must satisfy the following criteria:

Have an HDMI input or HDCP enabled DVI input
Have an analogue YUV (component) input
Be able to display 720p at 50Hz and 60Hz
Be able to display 1080i at 50Hz and 60Hz
Have at least 720 horizontal lines

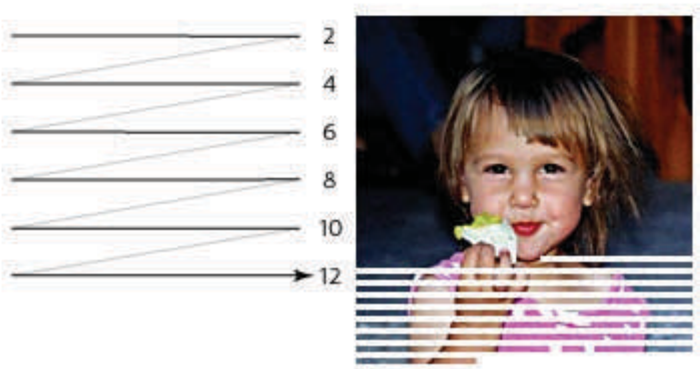
Pixels - display devices such as plasma screens, LCD and most projectors are made up from tiny squares called pixels (pixel is an acronym for Picture Element). These pixels change colour to make up the image that we see. The capacity of a screen is often quoted in number of pixels, or resolution. The number of pixels wide is quoted first, then the number of pixels high. For example, a screen with a resolution of 1920 x 1080 has 1920 pixels wide and 1080 high, so a total number of 2, 073,600 pixels.

Progressive Scan - to understand what progressive scan is, we first need to understand how an image is made when shown on a TV or monitor. We know the image is made up from pixels. These pixels change colour to create the effect of a moving image. The pixel colours are changed one line at a time. In a standard definition image there are 576 lines. These are displayed in what is known as an **interlaced** pattern. This means the odd lines are coloured first. So line 1 is coloured, then line 3, then 5, 7, 9 etc.. Up to line 575. After line 575 is coloured, line 2 is coloured, then line 4, then 6, 8, 10 etc.. up to line 576. This is repeated indefinitely. This process happens 50 times a second - this is known as 50Hz.
To improve the quality of an image, some images are made up in what is known as a **progressive scan** pattern. In this system the lines are coloured in sequential order; line 1, line 2, 3, 4, 5 etc.. up to line 576. This again happens 50 times a second. We can therefore see that in one second, an image made up progressively shows twice as many changes as an interlaced image:

Interlaced

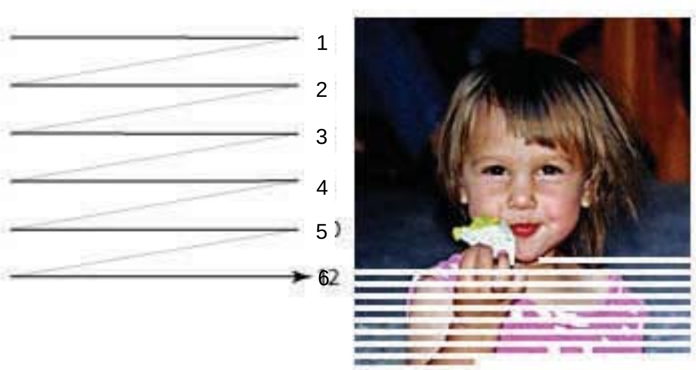


Odd lines



Even lines “interlaced” between odd lines

Progressive Scan



All lines displayed “progressively”

Introduction

High Definition Multimedia Interface, or HDMI, as it's name suggests, is an interface that can carry more than one type of media - namely audio and video, and is able to carry these at high bandwidths - in other words, lots of data in a short period of time.

The first thing to understand about HDMI is that it, itself, does not make images or sounds better, but simply that it has the potential to carry high quality audio and video. It is entirely possible to transfer a low quality image and low quality sound using an HDMI cable, just as it is also possible to carry high quality images and sound using other transfer methods such as component or optical connections.

HDMI has several benefits to both manufacturers and consumers, and therefore dealers too:

Only one cable is required to carry picture and sound between compatible devices

As mentioned above, HDMI can carry both audio and video. This requires both the sending and receiving device to support this.

Content which is subject to copyright can be transferred in it's native resolution

HDMI devices must support a copy protection system called HDCP, which is explained in further detail in this guide. This has enabled film companies and record labels to release films in high definition picture quality without risking it being copied and distributed illegally.

Image scaling can be applied to copy protected content

The HDCP system has also meant that manufacturers can now allow products to improve standard definition images which are protected by copyright. This is called image scaling and is not allowed from copy protected sources (such as DVD) unless the scaled output is still protected - HDMI with HDCP allows this and prevents unlawful copying and distribution.

In the following pages we will look at how HDMI works, it's advantages, limitations and general misconceptions about this relatively new technology.

HDMI to DVI cable

Misconceptions

As HDMI is so new many consumers hear some information from one person, read another bit of information (which is often written by other people who are not fully literate about the technology) and tend to fill in the blanks as they think equipment will operate. This leads to information being spread by word of mouth which is often incorrect. Below are some misconceptions about HDMI:

HDMI will give a better picture

HDMI is just a connection type, the image quality will depend on the content and the products being used to send and display the image. Don't forget - HDMI does not mean high definition, it can be standard definition too!

HDMI is always able to carry audio and video

HDMI can carry audio and video, but again only if the source and receiving device support this. HDMI is only able to transfer the data that is supported by the connected devices.

AV amps equipped with HDMI will scale video

Scaling is a totally separate process and an amp with HDMI may scale or may not. Scaling is explained later in this guide.

AV amps equipped with HDMI will convert non HDMI inputs to an HDMI output

Again, just having HDMI does not mean that an amp can convert other video input to an HDMI output. This function is available on some HDMI amps but not on others.

A device with HDMI will be superior to one without

HDMI can be a benefit on products, but high quality devices do still exist without HDMI, just as poor devices do exist with it.

HDMI cables are all the same

HDMI cables are available in different qualities. These will, just as other cables do, vary the quality of the passing signal. Some cables can carry high bandwidth data over a greater distance than others as a consequence of this degradation.

HDMI can carry both standard definition and high definition images

Both standard definition and high definition data can be carried by HDMI, again, only if the source and receiving device support this.

HDMI can carry any type of video signal

An HDMI device should be able to support picture resolutions of 480p, 576p, 1080i and 720p - it is not required to carry 480i or 576i, again this is dependant of the connected equipment. Some devices can now support 1080p.

HDMI Versions

There are currently (December 2006) five versions of HDMI that have been finalised. Three versions have now been superseded, one is current, and one is not yet launched but the standard has been agreed and finalised.
Please remember that the HDMI version is specific to the device, not the cable being used, and when connecting two devices together, all versions are backwards compatible but only the lowest version will be able to be used - ie, if two devices are connected, one is version 1.2a and one is version 1.0, both devices will behave as if they both had version 1.0.

HDMI version 1.0:

This version of HDMI supports only video data. A device that supports HDMI version 1.0 can never accept or send audio data, regardless of the device to which it is connected.

HDMI version 1.1:

In this version, audio is also supported as well as video. Audio comes in many different types - HDMI version 1.1 supports PCM, AC3 (known as Dolby Digital), DTS and MLP Lossless (Audio DVD audio).

HDMI version 1.2:

This version is as version 1.1 but adds an additional audio type - DSD (Super Audio CD data). It also adds support for PC video display resolutions.

HDMI version 1.2a:

In version 1.2a, no extra information can be carried but there are more finalised Consumer Electronic Control (CEC) features and command sets. There are also options for a manufacturer to submit new cable lengths or connector designs, which must be approved by the HDMI Compliance Testing Specifications (CTS) - before it can be used.

HDMI version 1.3:

Version 1.3 has recently been finalised and should be on production devices in mid 2007.

It can carry extra audio types - known collectively ad high definition audio. These are Dolby Digital Plus, Dolby TrueHD, DTS HD and DTS Master Audio. In addition to these extra audio types, HDMI 1.3 has the capacity to carry more colours (deeper colour space) and carry more information due to it's potentially higher speed transfer rate. This will allow future devices (when available in several years time) to use higher frame rates and resolutions to achieve even higher definition images. It also has the potential to automatically correct lip-sync errors caused by video processing in fixed pixel displays such as Plasma, LCD or projectors.

The Yamaha RXV1700 uses HDMI version v1.2a

HDMI Versions

	Version 1.0	Version 1.1	Version 1.2	Version 1.2a	Version 1.3
Maximum Video Resolution	1080p	1080p	1080p	1080p	1440p
xvYCC Colour space support	☒	☒	☒	☒	☑
Maximum Colour Depth	24 bit	24 bit	24 bit	24 bit	30/36/48bit
DVD Audio	☒	☑	☑	☑	☑
SACD	☒	☒	☑	☑	☑
HD Audio	☒	☒	☒	☒	☑

Please note: the data above is the maximum offered by a device supporting that particular HDMI version, not a guarantee that the particular device will support that function.

Yamaha's RXV2700 has three HDMI inputs using a repeater system

HDMI Communication and HDCP

Any HDMI device must also support a copy protection system called HDCP. HDCP (High Bandwidth Digital Content Protection) is a system which ensures that a connecting device will not allow unauthorised copying of protected content.

The film industry has, over the last few years, worked very hard to prevent illegal copying and downloading of their material. One reason for the implementation of HDMI was not only to give consumers an easier way to connect their products together, but also to ensure that content, especially high definition content, is not copied and redistributed without consent.

In this section we will look at exactly what happens when two HDMI devices try to communicate.

The first thing we need to understand is that HDMI is a two way communication system. Although the signal (the audio or video) only passes one way, communication and control protocols work in both ways.

Just as when two people meet for the first time, HDMI devices first ascertain if the other device is suitable to talk to and then introduce themselves to each other:

HDCP

The HDCP "handshake" allows the two HDMI devices to ensure that the other is suitable to operate with. If both devices confirm that they are HDCP compliant, the two devices can then introduce themselves to the other device - this is done by the display device giving information called EDID data and contains information such as the type of device that it is, the data that it supports (such as picture resolution) and even the name of the device.

The way HDCP works is quite simple and requires that HDCP devices be given two numbers. Every new device is assigned these numbers by the HDCP central authority (a group of people) – one number is called the secret vector and the other an additional rule.

The secret vector is a sequence of 40 numbers and it is never revealed to anyone or anything else.

The additional rule is not a secret and simply instructs a connected device on how to ad up these numbers.

On the next page we will look more closely at what happens when two devices try to "handshake".

Below is a simplified example which details an HDCP handshake. We have used a vector of 4 secret numbers rather than 40, and used two digit numbers to keep it simple:

Device	Secret Vector	Additional Rule
Yamaha	(26,19,12,7)	[1] + [2]
Denon	(13,13,22,5)	[2] + [4]
Onkyo	(22,16,5,19)	[1] + [3]
Pioneer	(10,21,11,14)	[2] + [3]

(The data in the table is an EXAMPLE only and not the true HDCP information for this equipment! The numbers are actually around 17 digits each in reality)

If a Yamaha and Denon device from above want to communicate, first they send each other their additional rule. The Yamaha device applies the Denon additional rule to its vector, and the Denon device applies the Yamaha additional rule to its vector.

So: Yamaha takes Denon's addition rule ([2] + [4]) and applies it to its secret vendor (26,19,12,7) so adds 19 and 7 = 26

The Denon device will then take the Yamaha additional rule ([1] + [2]) and apply this to it's secret vector – 13 + 13 = 26

Now both the Yamaha and Denon device have a secret key (which only they know). The way in which the HDCP central authority assigns devices with these additional rules and secret vector is designed to ensure that two devices which are allowed to communicate (both HDCP enabled) will get the same answer – hence both being 26 in this example.

You can try this with any of the four devices above and will see that the answer that the two communicating devices always come up with will be identical as the other. If this is the case, the device is HDCP compliant.

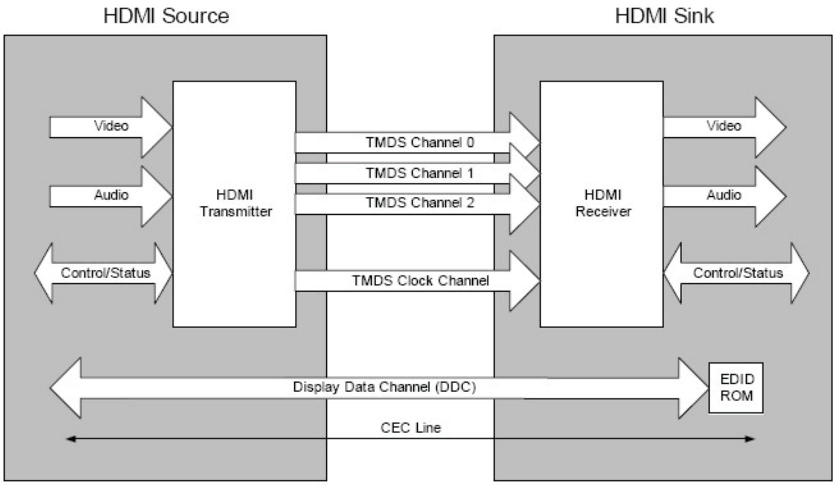
Once this "handshake " and introduction have taken place, audio and video data can be transferred from the source device to the destination. Also, control signals can be transferred from either device to the other. This could be a signal from a display device to a DVD to stop playback (if the TV channel was changed) for example.

The above information should give you an idea that HDMI is not as straight forward as previous connections have been. It is important to be aware of this, especially the two way communication part, when troubleshooting as you can no longer apply a simple process of elimination method to determine the problem device - as HDMI COMMUNICATION ALWAYS INVOLVES TWO DEVICES - you can therefore never rule one devices as being the problem.

We can look at the HDMI communication system in more detail:

We know that HDMI can carry high bandwidth audio and video as well as communication and control data. In this section we will see how this works.

The diagram below shows the basic communication system between two HDMI devices, an HDMI Source (the source device) and an HDMI Sink (the display device):

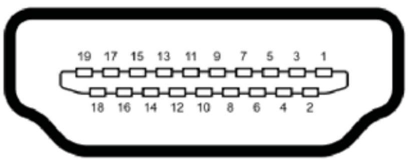


We can see in the diagram above that the audio and video data is passed one way from source to sink using part of the devices called HDMI transmitter and HDMI receiver. We can also see that we have a line called Display Data Control (DDC) which is used to passed the sink devices EDID - which we know from earlier section tells the connected HDMI source it's capabilities. These is also a CEC line (Consumer Electronics Control) to allow one HDMI device to control another. This CEC line is optional. One final line is called HPD (Hot Plug Detect) which is used to tell connecting devices that another HDMI is trying to initiate a connection.

The data transferred between the HDMI transmitter (in the HDMI source) and the HDMI receiver (in the HDMI sink) is transferred across four pairs of wires within the HDMI cable. These four pairs are known as Transmission-Minimized Differential Signalling (TMDS). TMDS is a special technology created by Silicon Image for the HDMI system. Three of these TMDS channels are used for data whilst the fourth (the TMDS Clock Channel) is used by the HDMI receiver for data recovery on the three TMDS Data Channels.

Video can be transferred by TMDS at rates between 25MHz up to 165MHz using either RGB or YUV colour spaces. Video signals such as 720p or 1080i use 37MHz so this will pass through HDMI, whereas 480i or 576i use 13.5MHz, so do not fall within the HDMI specification (these can be sent using a repetition system but do not fall within the HDMI standard - you can get very odd results sending 480i or 576i images down HDMI!)

Audio streams can be carried at 32kHz, 44.1kHz and 48kHz. This can accommodate standard PCM signals. Also, HDMI can carry PCM streams at up to 192kHz. Up to four of these stereo streams can be carried at once (to give multi channel PCM) at rates of up to 96kHz. The ability to carry surround sound streams at up to 192kHz is also available.



Pin 1	TMDS Data 2+	Pin 11	TMDS Clock Shield
Pin 2	TMDS Data 2 Shield	Pin 12	TMDS Clock-
Pin 3	TMDS Data 2-	Pin 13	CEC
Pin 4	TMDS Data 1+	Pin 14	No Connection
Pin 5	TMDS Data 1 Shield	Pin 15	SCL (Serial Clock)
Pin 6	TMDS Data 1-	Pin 16	SDA (Serial Data)
Pin 7	TMDS Data 0+	Pin 17	DDC/CEC Ground
Pin 8	TMDS Data 0 Shield	Pin 18	+5 volts power
Pin 9	TMDS Data 0-	Pin 19	Hot Plug Detect
Pin 10	TMDS Clock+	Shell	Ground

HDMI Switches

HDMI sources are becoming more and more common. Most DVD players now feature this connection and HD Ready TV's by definition, must have an HDMI or DVI connection. Therefore, it is now becoming more common for AV Amplifiers and Receivers to accommodate this by having HDMI inputs and outputs.

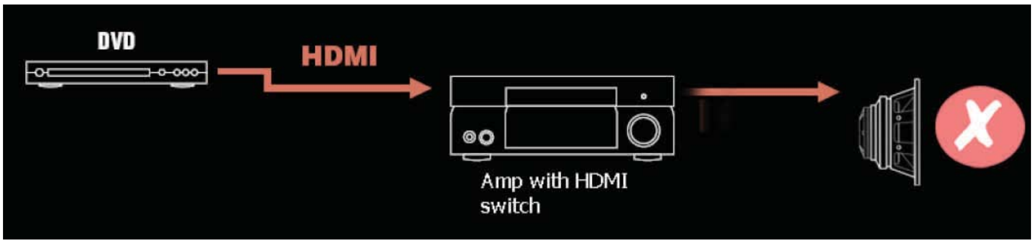
HDMI Receivers can work in different ways. Most cheaper products use what is called an HDMI switch. This is just an HDMI socket that is connected to nothing in the receiver except the HDMI output.

The data that is transferred by an HDMI cable is always digital. So digital audio and digital video can be passed from an HDMI source, such as a DVD player to an HDMI AV amp. In order for us to hear this audio and see this video, the digital data must be converted into analogue data.
Devices called Digital to Analogue Converters (DACs) do this.
The digital data is also compressed, so decoders are required to "translate" this information into pictures and sounds that we can understand.

If we look at the signal paths of the audio and video separately:

Audio:

The digital audio is read from the DVD disc by the DVD player. This is usually Dolby Digital 5.1 sound. The player then outputs this digital audio via HDMI into the AV amp. We know from above that in AV amps that use HDMI switches, the HDMI input is not connected to anything other than the HDMI output. This means the digital audio can only pass straight out the AV amp and into the display device. The sound can NOT be heard at speakers connected to the AV amp. The sound is still digital when it reaches the display device and as display devices generally only deal with analogue audio, can not perform digital to analogue conversion on the digital audio, so we can not hear it. To get around this problem we must connect the DVD player to the AV amp with an additional digital audio cable, such as an optical cable. Now the digital audio can be processed by the AV amps DAC and can be heard at the speakers.

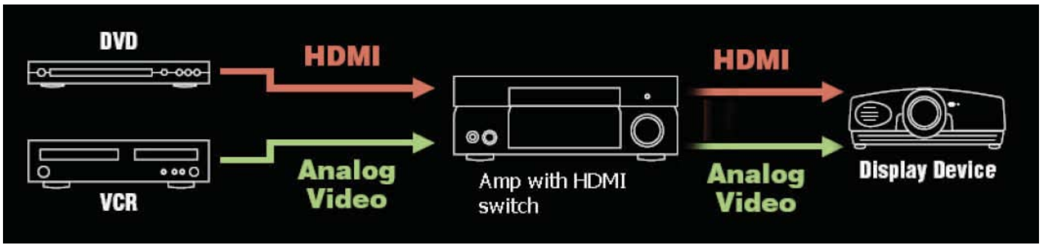


HDMI audio can not be processed in the amp so can not be heard at the speakers - additional cabling is required

Video:

The digital video is read from the DVD disc by the DVD player. The player then outputs this digital video via HDMI into the AV amp. We know from above that in AV amps that use HDMI switches, the HDMI input is not connected to anything other than the HDMI output. This means the digital video can only pass straight out the AV amp and into the display device. The display device can now use it's video DAC and digital processors to convert the digital video into an image that we can see.

However, as the HDMI output of the AV amp is only connected to the AV amps HDMI inputs, no other type of inputs can be output using HDMI. In other words, an AV amp that uses an HDMI switch can never perform and video conversion to HDMI.



HDMI video is not processed in any way so extra input and output cables are required as no video conversion is possible

HDMI Switches do not really add any functionality to an AV amp, in fact they actually mean more cables are required in order to make use of the HDMI Switch and get the most from your AV amp.

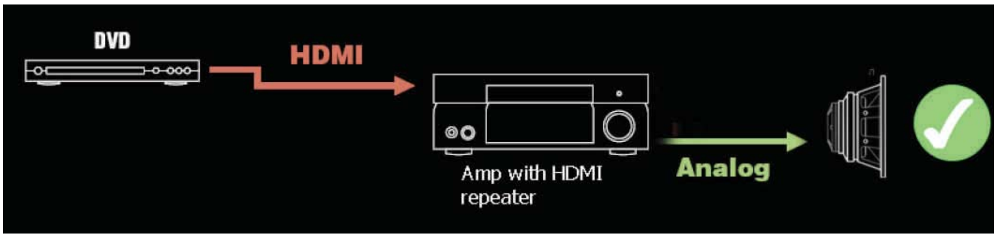
HDMI Repeaters

The alternative option to manufacturers to fit to an HDMI AV amp is called an HDMI Repeater. This device still allows users to switch between HDMI inputs to a common output but has fundamental differences to an HDMI Switch.

As we know, the data that is transferred by an HDMI cable is always digital. Digital audio and digital video can be passed from an HDMI source, such as a DVD player to an HDMI AV amp. We also know that in order for us to hear this audio and see this video, the digital data must be converted into analogue data by DACs and decoded by decoders. Again we can look at the signal paths when using an AV amp with an HDMI repeater:

Audio:

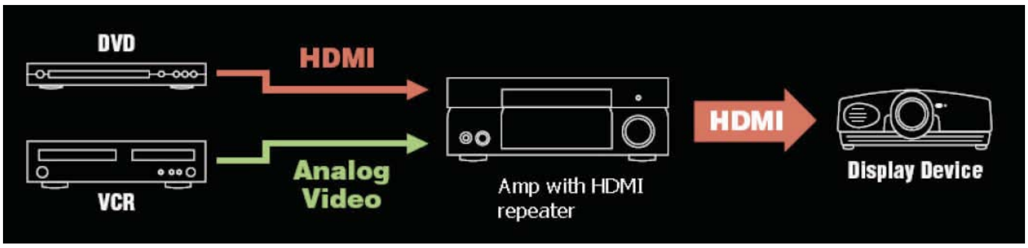
The digital audio is read from the DVD disc by the DVD player. This is usually Dolby Digital 5.1 sound. The player then outputs this digital audio via HDMI into the AV amp. Unlike the HDMI Switch AV amps, the HDMI Repeater is connected to the internal electronics of the AV amp. This means the AV amp can perform the necessary DAC and decoding to the digital signal so that it can be amplified and output to the speakers connected to the AV amp. This means no further connections are necessary from your HDMI source device to the HDMI AV amp as all data can be sent and handled by the HDMI repeater.



HDMI audio is decoded and can be head at the connected speaker

Video:

The digital video is read from the DVD disc by the DVD player. The player then outputs this digital video via HDMI into the AV amp. We know from above that in AV amps that use HDMI switches, the HDMI input is not connected to anything other than the HDMI output. This means the digital video can only pass straight out the AV amp and into the display device. The display device can now use it's video DAC and decoders to convert the digital video into an image that we can see.
As the HDMI output from the repeater is connected to the internal electronics of the amp, self generated data such as an On Screen Display (OSD) can be output too.
Also, options such as converting analogue video inputs (such as composite or component) to digital to allow them to be output using HDMI (less cables) can be used, as can options such as video scaling and deinterlacing to improve the picture.



Video signals can all be converted to HDMI so only one monitor cable is needed.

HDMI Repeaters add a great deal of functionality to the amp and have potential quality improvements over HDMI Switching amps, as well as requiring less connecting cables making them easier to install and use.

HDMI Upconversion

Up conversion is often misunderstood and confused with other terminology which refer to totally different functions.

AV amplifiers are able to accept inputs from various inputs - normally composite video, s video, component video and HDMI. More expensive AV amplifiers are able to convert these different input types to different output types, such as a composite input to a component output. This is useful as it requires less connecting cables to your display device. This then means that all inputs to the AV amp can be viewed on one input on the display device rather than having to switch inputs on both the AV amp **and** display device to change inputs.

Whilst little or no quality difference will be achieved, this feature is very useful and becoming a standard feature on amplifiers around the £500 mark.

Converting to HDMI when an AV amplifier has HDMI inputs and outputs is therefore also desirable. If an AV amp does this, all video data can be sent to the display device using one HDMI cable, rather than needing a component cable too.

However, we know from previous information in the guide that HDMI can not carry all types of video signals. In particular, 480i and 576i are not supported. This poses a potential problem - signals input to the AV amp as s video or composite video from source devices will only ever be 480i or 576i (as composite and S video can only carry this data) and many component video signals will too be 480i or 576i. To allow these inputs to be carried by HDMI after the conversion process, they need to be changed into a compatible signal that HDMI can carry. A device called a deinterlacer is used to change the 480i or 576i signals into 480p or 576p - this signal can now be transferred using HDMI. As a result of this deinterlacing, the image quality may improve slightly (this will depend on several factors such as cadence detection which are not discussed in this guide).

An AV amplifier that can upconvert to HDMI should always have a deinterlacer too. Some do not, which causes problems and means that often a second connection from the AV amplifier to display device is required (either composite, s video or component). This is worth noting when considering an HDMI equipped amplifier.

This diagram shows the conversion possibilities of a typical HDMI AV Amplifier that uses both an HDMI repeater and has HDMI upconversion facilities with a deinterlacer. Market examples would be the Yamaha RXV1600 or Yamaha RXV1700. An AV amplifier that did not perform any video conversion would only perform the signal transfers drawn in grey above.

One important point - many people confuse HDMI Conversion with Scaling. We will look at scaling later in this guide but it is important to never refer to HDMI conversion as HDMI scaling as this means something totally different and can be very confusing and misleading.

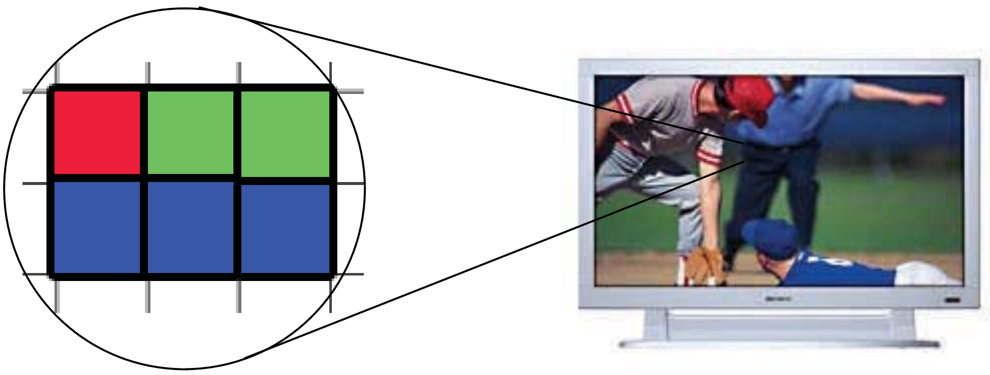
Scaling Using HDMI

As we have established in the previous section, video scaling is very different to video upconversion. From this guide we now know that upconversion to a superior cable type, makes very little, if any, difference to the end result.

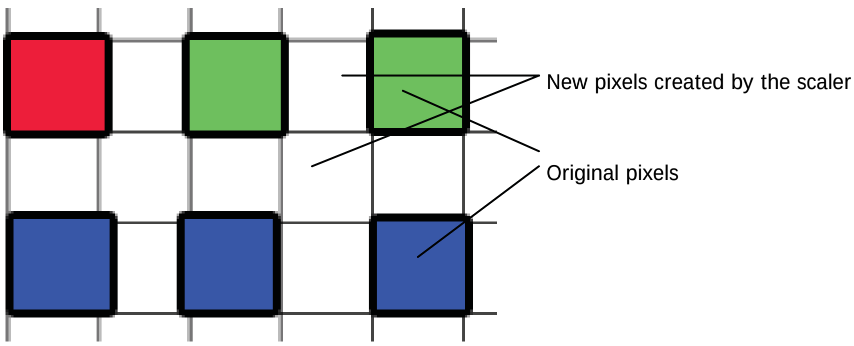
Put simply, scaling is just the resizing of an image. Images need to be resized in order to fill a fixed pixel display device (such as a plasma screen). Scaling is needed if the input resolution is not exactly that of the displays resolution. It does not improve the image, it simply makes it fill the screen. Sometimes people will use external scalers or AV amplifiers with built in scalers - the idea in this is that these scalers will perform better than the scaler inside the display device - giving a final image that would be better than without using the external scaler, but this still will not be as good as using no scaling at all.

Different scalers will work in slightly different ways but simply use a multiplication system to resize the image. Pixels are added to the original image to enlarge it. The scaler uses an average of the colour of the surrounding pixels to determine the colour of the added pixels.

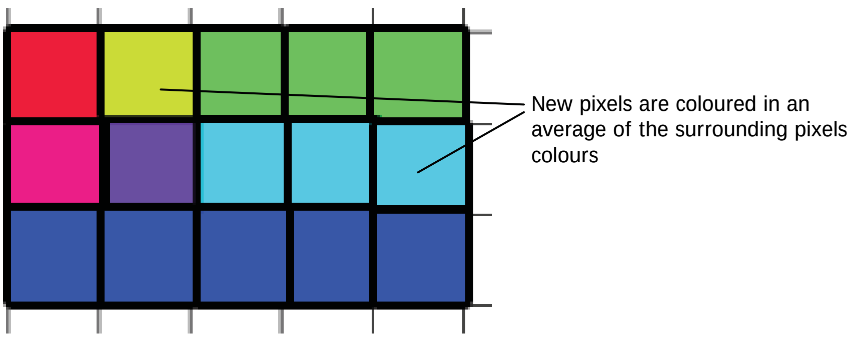
This image shows our starting "input" image before scaling. We can look at a small section of the image. On the right hand side we can see 6 pixels that go to making up the complete image.



The scaler will resize this image. We started with a picture size of six pixels but the scaler has resize the image here to 15 pixels. The six original pixels remain their same colours. The image on the right shows these original pixels and the added pixels. In the next step we will see how the scaler works out how to colour in these "new" pixels.



The scaler will take an average of the surrounding pixels to work out the best colour to make the extra "new" pixels.
We are left with a larger image than the original.



In the previous example we “scaled” from 6 pixels up to 15 pixels. This is scaled by a factor of 2.5 (15 divided by 9 equals 2.5).

This is a very “round” number and therefore easy to work with. Just as you would find it easy to multiply by “round” numbers and much harder to multiply by more complex numbers and numbers with many decimal places, scalers also have more trouble with this.

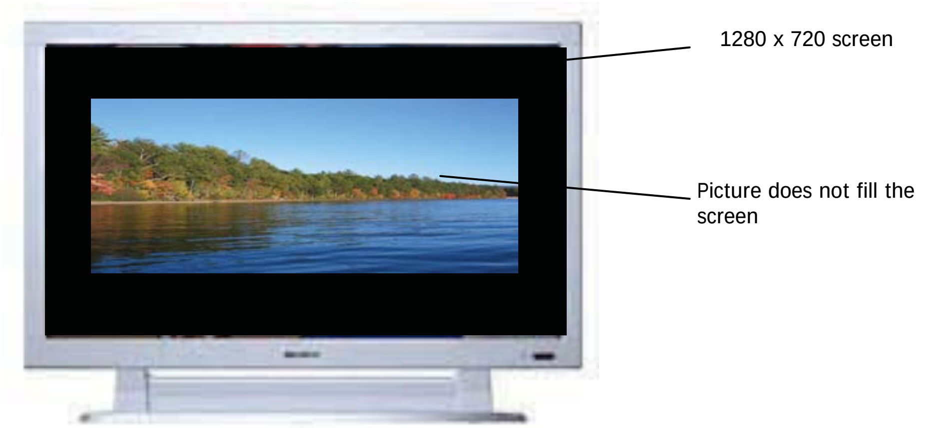
Scaling is often performed in the following ways:

576 to 720 - a standard definition signal displayed on a 1280 x 720 fixed pixel display (a factor of 1.25)
576 to 1080 - a standard definition signal displayed on a 1280 x 720 fixed pixel display (a factor of 1.875)
576 to 768 - a standard definition signal displayed on a 10240 x 768 fixed pixel display (a factor of 1.33333)

As you can see, in the above example, scaling from 576 to 768 is harder than to 720.

As with many processes in the AV industry, the less you do to a signal, the better it will be. This also applies to video scaling. The image can not get better, only be reduce in quality by processing it.

Scaling is necessary to allow an image to fit the screen (when the display device is a fixed pixel display such as plasma, DLP or LCD). If you applied a 576 signal to a 1280 x 720 display, the best image you could get would be achieved by viewing an image that was of the native resolution of the input (which is 576) so you would see an image that did not fill the screen:



In order to fill the screen, scaling is used. The better the scaler, the closer the resulting image will be to that of the original input. AV amps, such as the Yamaha RXV2700 have high quality scalers in, which can output a resized image. This scaler may well perform better than the scaler in the fixed pixel display device and therefore give you a better image.

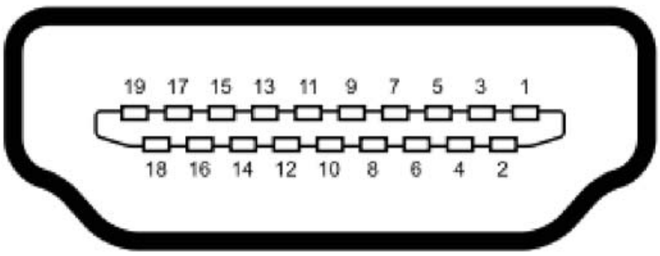
If you were using a fixed pixel projector; these often have a zoom function. The best result here would be to feed the projector with a native resolution (no scaling) and resize the image by using the projectors zoom function. In this situation the image is resized in the analogue domain, rather than digital, and will give you the best possible image as here the image has not been processed at all. The image size in this case has been altered not by adding pixels but by enlarging the image as one.

HDMI Connectors

There are three types of HDMI connector which has been finalised to date (December 2006). Two are currently in use, the third is yet to be introduced to the industry. Below are the connectors ad their pin configurations:

Type A

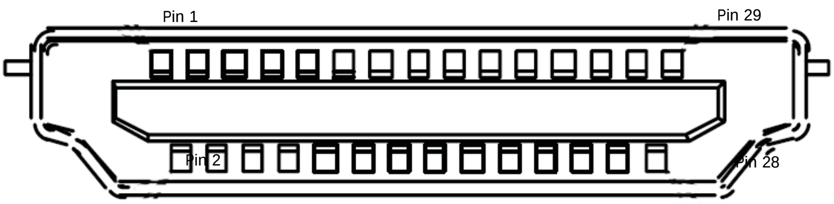
19 pin



Pin 1	TMDS Data 2+	Pin 11	TMDS Clock Shield
Pin 2	TMDS Data 2 Shield	Pin 12	TMDS Clock-
Pin 3	TMDS Data 2-	Pin 13	CEC
Pin 4	TMDS Data 1+	Pin 14	No Connection
Pin 5	TMDS Data 1 Shield	Pin 15	SCL (Serial Clock)
Pin 6	TMDS Data 1-	Pin 16	SDA (Serial Data)
Pin 7	TMDS Data 0+	Pin 17	DDC/CEC Ground
Pin 8	TMDS Data 0 Shield	Pin 18	+5 volts power
Pin 9	TMDS Data 0-	Pin 19	Hot Plug Detect
Pin 10	TMDS Clock+	Shell	Ground

Type B

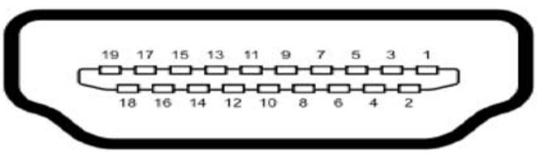
29 pin



Pin 1	TMDS Data 2+	Pin 16	TDMS Data 4+
Pin 2	TMDS Data 2 Shield	Pin 17	TDMS Data 4 Shield
Pin 3	TMDS Data 2-	Pin 18	TDMS Data 4-
Pin 4	TMDS Data 1+	Pin 19	TDMS Data 3+
Pin 5	TMDS Data 1 Shield	Pin 20	TDMS Data 3 Shield
Pin 6	TMDS Data 1-	Pin 21	TDMS Data 3-
Pin 7	TMDS Data 0+	Pin 22	CEC
Pin 8	TMDS Data 0 Shield	Pin 23	No Connection
Pin 9	TMDS Data 0-	Pin 24	No Connection
Pin 10	TMDS Clock+	Pin 25	SCL (Serial Clock)
Pin 11	TDMS Clock Shield	Pin 26	SDA (Serial Data)
Pin 12	TDMS Clock-	Pin 27	DDC/CEC Ground
Pin 13	TDMS Data 5+	Pin 28	+5 volts power
Pin 14	TDMS Data 5 Shield	Pin 29	Hot Plug Detect
Pin 15	TDMS Data 5-	Shell	Ground

Type C

19 pin Mini Connector



Pin 1	TMDS Data 2+	Pin 11	TMDS Clock Shield
Pin 2	TMDS Data 2 Shield	Pin 12	TMDS Clock-
Pin 3	TMDS Data 2-	Pin 13	CEC
Pin 4	TMDS Data 1+	Pin 14	No Connection
Pin 5	TMDS Data 1 Shield	Pin 15	SCL (Serial Clock)
Pin 6	TMDS Data 1-	Pin 16	SDA (Serial Data)
Pin 7	TMDS Data 0+	Pin 17	DDC/CEC Ground
Pin 8	TMDS Data 0 Shield	Pin 18	+5 volts power
Pin 9	TMDS Data 0-	Pin 19	Hot Plug Detect
Pin 10	TMDS Clock+	Shell	Ground

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