What are HDMI® and Dual-Mode DisplayPort?

TI Precision Labs – Video interface

Prepared by Ikechukwu Anyiam
Presented by Nicholaus Malone
Hot Plug Detect (HPD)
Display Data Channel (DDC)
Display Data Channel (DDC)

Video source

HDMI TX

Video
Audio
Control/status

DDC

Video sink

HDMI RX

Video
Audio
Control/status

EDID

Resolution: 4096x2160 @60Hz
HDMI Transition-Minimized Differential Signaling (TMDS) characteristics
Dual-Mode DisplayPort (DP++) signal interface

HDMI source

- Main link lane 0
- Main link lane 1
- Main link lane 2
- Main link lane 3
- AUX
- Config
- Config 2
- HPD

Adapter

Cable

HDMI RX

- TMDS channel 2
- TMDS channel 1
- TMDS channel 0
- TMDS clock
- DDC
- CEC
- Utility/HEAC+
- HPD/HEAC-

EDID

Video sink

- Video
- Audio
- Control/status

Video source

DisplayPort (DP) connector

- TMDS channel 0
- TMDS channel 1
- TMDS channel 2
- TMDS clock
- DDC
- CEC
- Utility/HEAC+
- HPD/HEAC-

HDMI connectors
HDMI TMDS characteristics

- \( R_T = Z_O = 50 \, \Omega \pm 10\% \)
- \( AV_{CC} = 3.3 \, V \pm 5\% \)
Source TX and sink RX design challenge

DC-coupled HDMI 6 Gbps
- TMDS data in 2
- TMDS data in 1
- TMDS data in 0
- TMDS CLK

DDC
HPD

HDMI connector

HDMI TMDS retimer
- Clock recovery
- EQ
- DRV

Display Data Channel
- Hot Plug Detect

HDMI RX/display
- DC-coupled HDMI 6 Gbps
- TMDS data out 2
- TMDS data out 1
- TMDS data out 0
- TMDS CLK
- Control/I2C

DDC
HPD
When to use a redriver

Laptop

HDMI TX

TMDS channel 2
TMDS channel 1
TMDS channel 0
TMDS clock

DDC

CEC

Utility/HEAC+

HPD/HEAC-

CPU

Redriver

HDMI

Long cable
When to use a retimer

- Laptop with HDMI TX
- Game machine with HDMI TX
- Retimer
- HDMI cable: 3m
- 10m HDMI cable
- HDTV
- GPU

Diagram showing the connection between a laptop, game machine, retimer, and HDTV.
Placement of the redriver / retimer

\[
\text{Insertion Loss } (\text{dB/in}) \approx \frac{f^{1/2}}{w} + 2.3 \times f \times D_f \times D_k^{1/2}
\]

- \( w \) = trace width [mils]
- \( f \) = Nyquist frequency [GHz] \( \rightarrow \) HDMI data rate / 2
- \( D_f \) = the PCB dissipation factor
- \( D_k \) = the PCB dielectric constant
Placement of the redriver / retimer
Placement of the redriver / retimer

Source

TMDS2  TMDS1  TMDS0  TMDCLK

12-in trace

Cable emulator

[Image of a diagram showing the placement of the redriver/retimer and the signal traces]
Placement of the redriver / retimer

Source
- TMDS2
- TMDS1
- TMDS0
- TMDSCLK

Cable emulator
- TMDS2
- TMDS1
- TMDS0
- TMDSCLK

Redriver/Retimer
- TMDS2
- TMDS1
- TMDS0
- TMDSCLK

12-in trace
Short quiz

True or false: HDMI is a DC-coupled interface.
Short quiz

True or false: A DP++ source can directly interface with an HDMI sink.

FALSE
Short quiz

True or false: Hot Plug Detect is used to determine the capabilities of the sink.

FALSE
Short quiz

True or false: A redriver is best used on the sink side rather than on the source side.
Short quiz

True or false: A retimer can be used anywhere a redriver can be used.
Short quiz

True or false: The correct placement of the HDMI redriver / retimer is important to the design of system signal integrity margin.

TRUE
Thank you