UNIGRAF

Ensuring Functionality of HDMI Interface

HDMI™
HIGH-DEFINITION MULTIMEDIA INTERFACE

Background – General

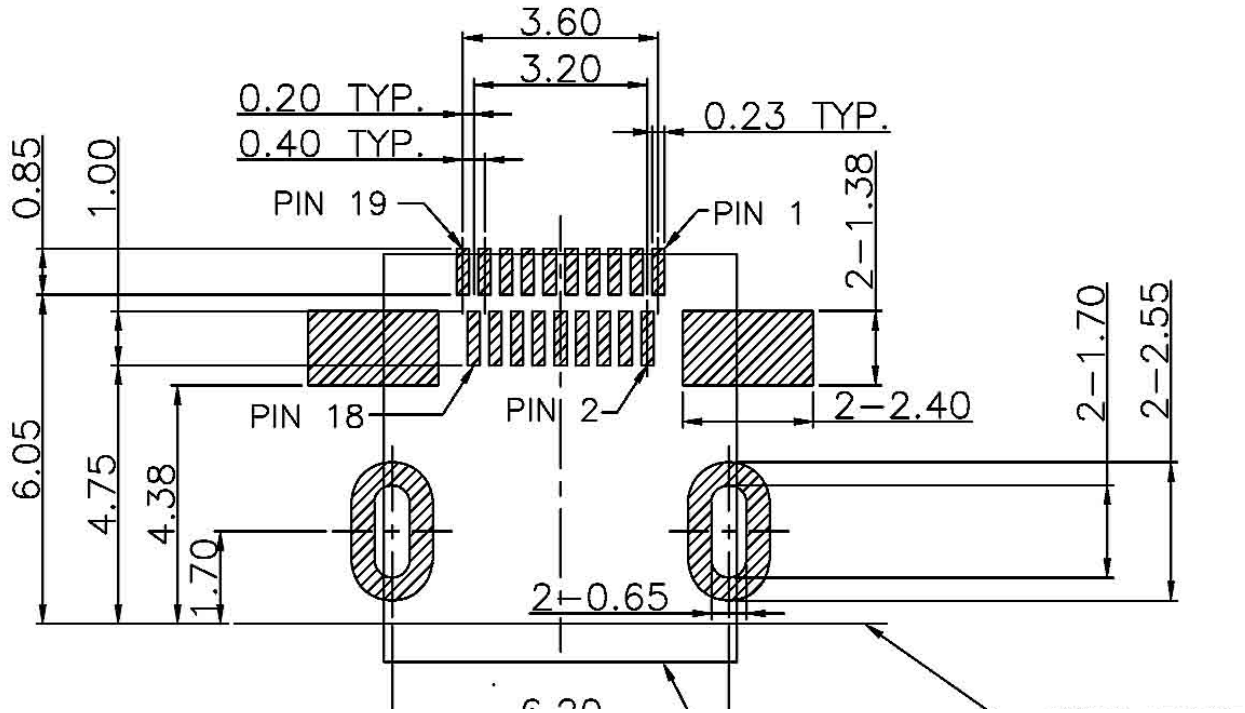
- HDMI connection problems are a common cause of customer complaints for a Set-Top-Box, Game Console or Media Player.
- There are several possible root causes
  - ✓ Bad connection (worn, dusty or contaminated connector),
  - ✓ PCB assembly problems (connector, components, soldering),
  - ✓ EDID interpretation problems,
  - ✓ HDCP handshake problems.
- In this presentation we will concentrate on three problem types
  - ✓ Case Study 1: Ensure correct HDMI connector signals
  - ✓ Case Study 2: Ensure correct EDID interpretation
  - ✓ Case Study 3: Ensure proper HDCP setup

Case 1 – Testing HDMI Signals

- As an peripheral connector HDMI connector cannot be easily verified in bed-of-nails during production.
  >> HDMI signal needs to be verified with an external HDMI Sink
- Some of the HDMI Rx chips compensate for weak signaling, but not all, i.e. performance may vary
  >> Carefully select the HDMI Sink for testing

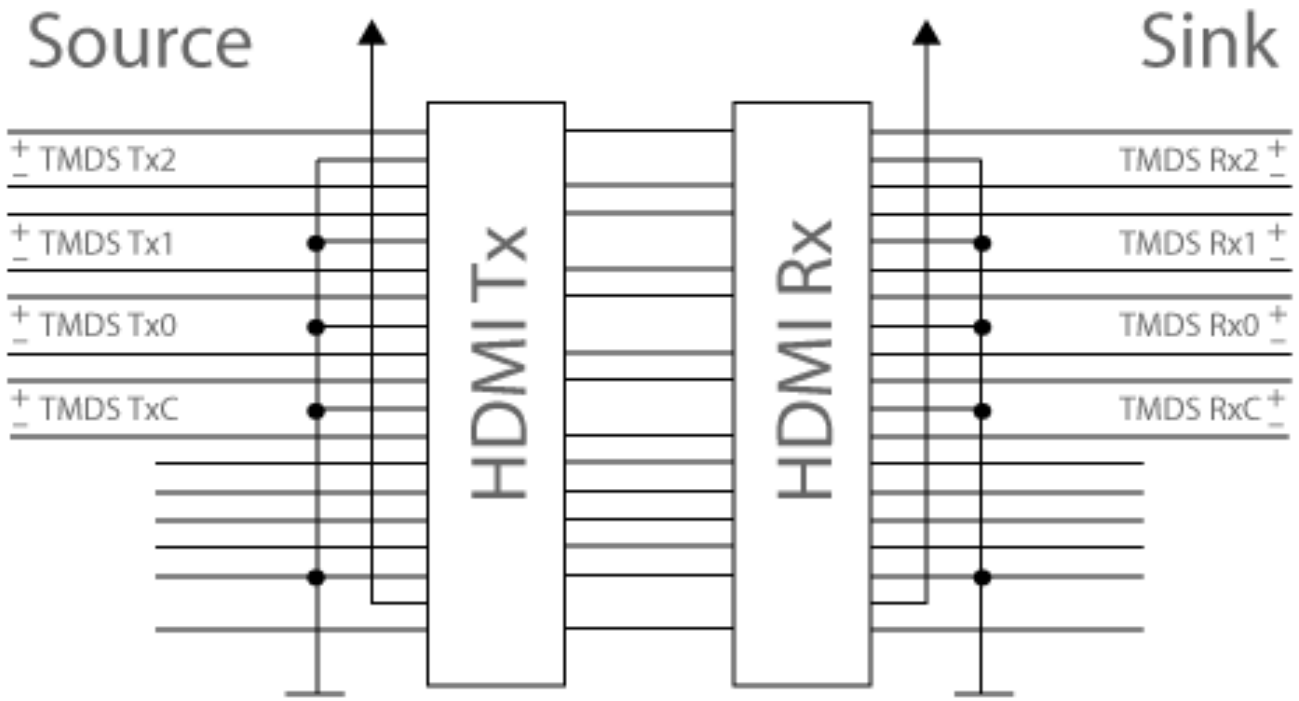
- Conclusion: Testing the quality of HDMI signal lines is a vital part of functional testing in production line.

Background – HDMI Connector Dimensions



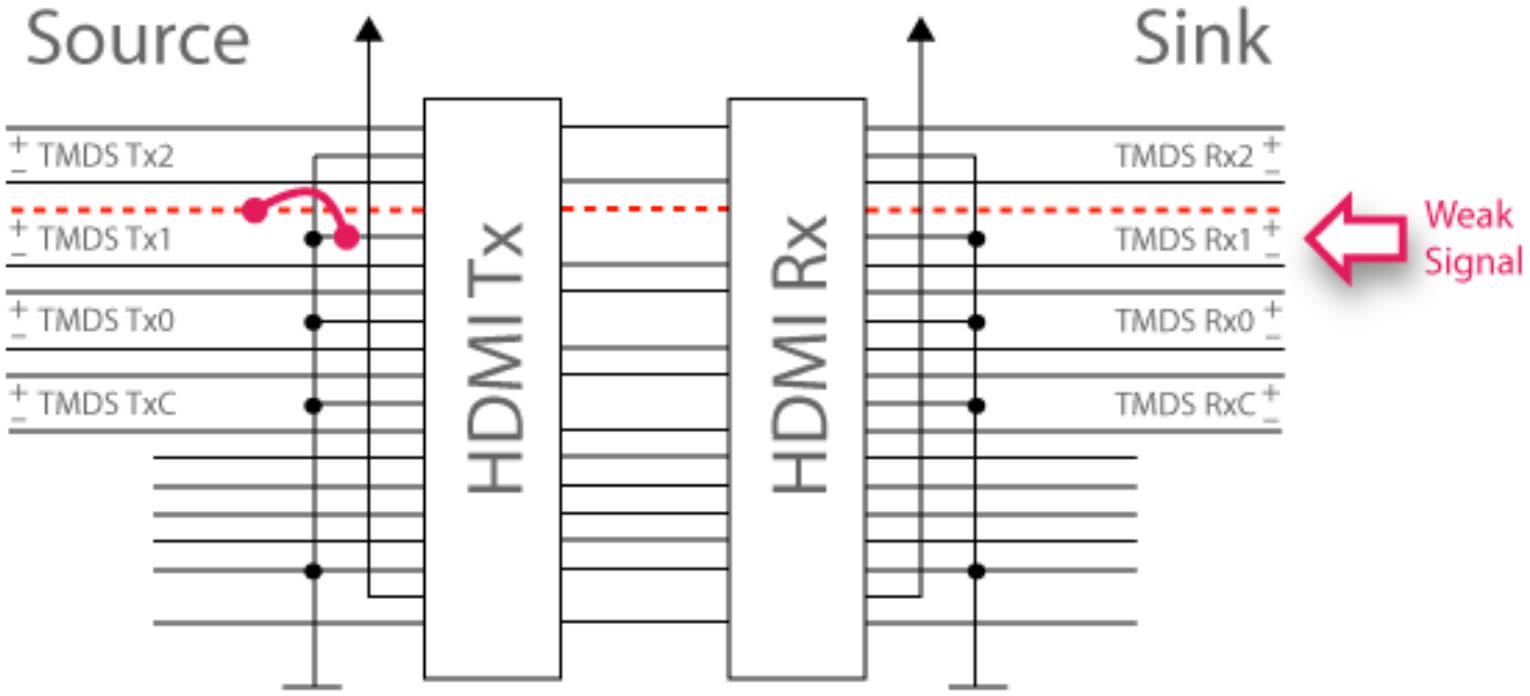
- Tight signal paths
- Connector misalignment?
- Bad soldering?
- Insufficient grounding?

Background – HDMI TMDS Signaling



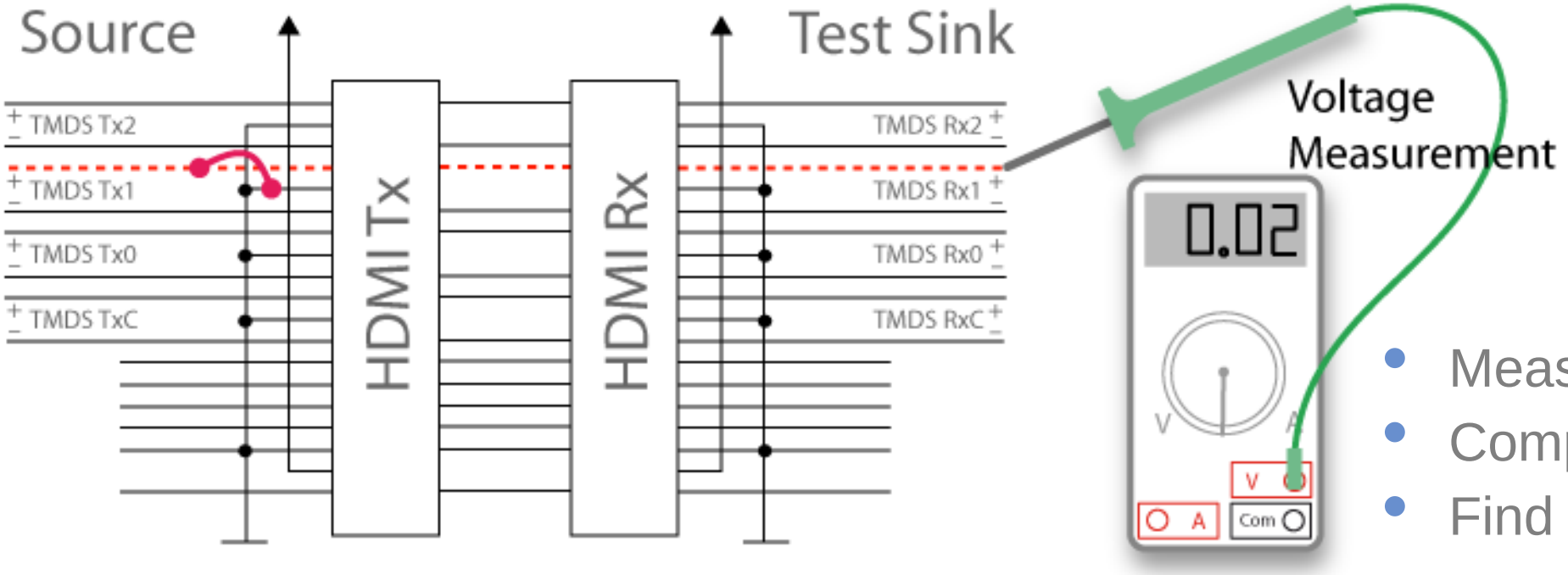
- Three differential TMDS signal pairs
- One differential Clock signal pair
- DC balanced

Case 1 Problem: HDMI Signal Short to Ground



- One of the differential TMDS signals is weak
- Uses only ½ amplitude
- HDMI video / audio reception may fail
- Not reliably detected with a HDMI sink
- Depends on the quality of HDMI Rx chip

Case 1 Solution: HDMI Signal Condition Check



- Measure signal voltages
- Compare to standard
- Find weak signals

Background – EDID

- *Extended Display Identification Data **(EDID)** is a data structure provided by a digital display to describe its capabilities to a video source. (Wikipedia)*
- Key EDID data for interoperability of a HDMI connection:
  - ✓ Preferred timing
  - ✓ Supported timings
  - ✓ Supported color modes
  - ✓ Supported audio modes

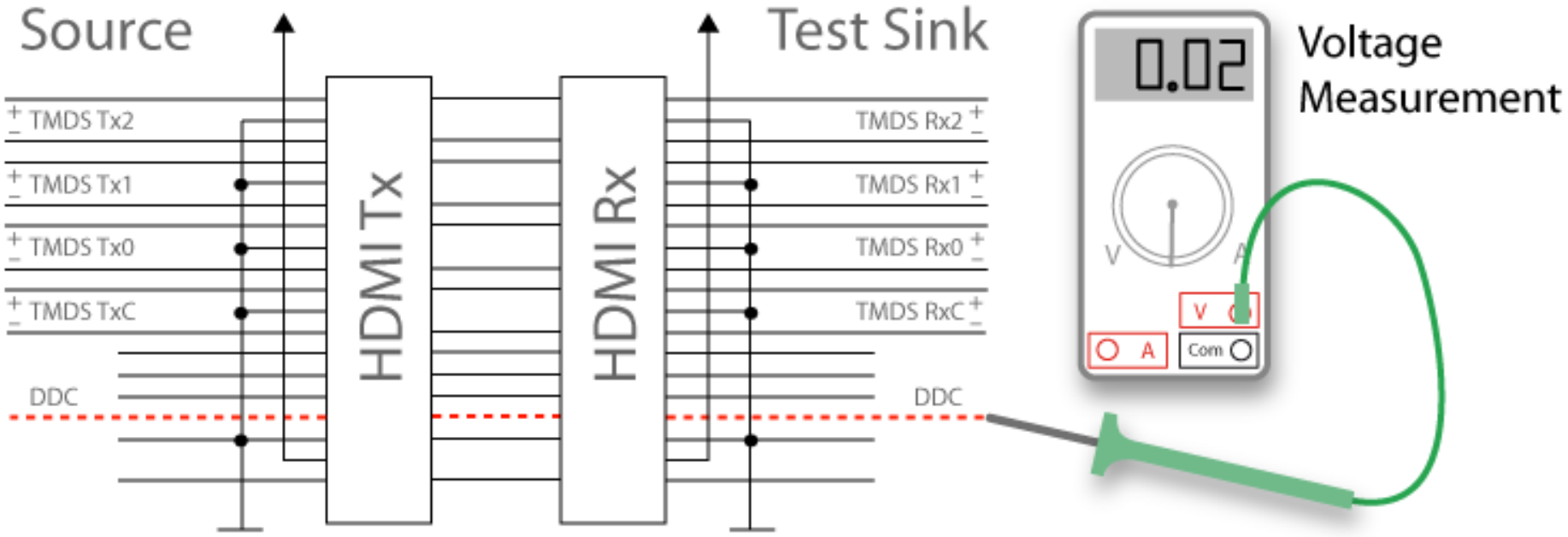
Case 2 Problem: Incompatible Timing Used

- Interpretation of EDID information is designed in the software of the HDMI source (DVD player, Game Console, Set-top-box)
- Problems arise, if reading of the EDID data from sink (TV) fails
- As a result, the source will send video or audio with modes that the sink does not support.

- Conclusion: Testing proper reading of EDID data is vital for functionality testing in production.

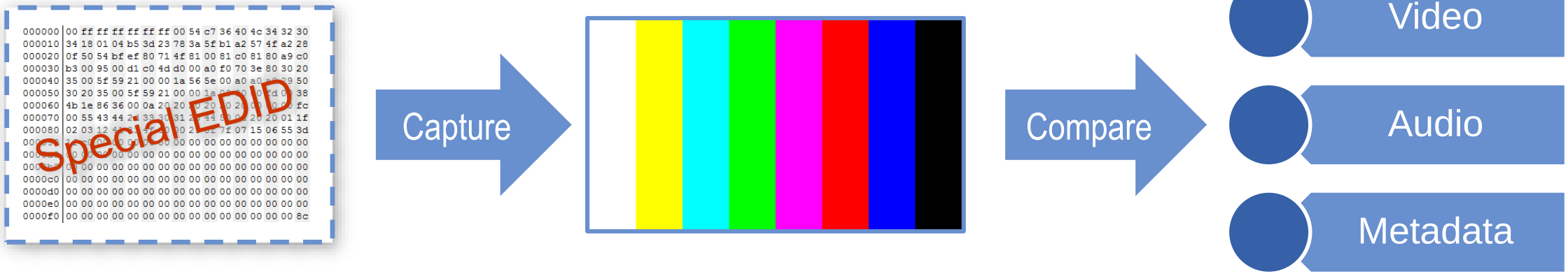
Case 2 Solution: Ensure EDID Reading

- Step #1: Measure interface signals
  - ✓ Make sure that signal level in DDC is OK



Case 2 Solution: Ensure EDID Reading

- Step #2: Swap EDID
  - ✓ Use special EDID that reveals if the reading is successful
  - ✓ Capture frame & Detect audio & Record metadata
    >> Compare to reference



Background – HDCP

- *High-bandwidth Digital Content Protection (HDCP) is a form of digital copy protection developed by Intel Corporation to prevent copying of digital audio and video content as it travels across connections. (Wikipedia)*
- During HDCP encryption content is scrambled over HDMI interface to avoid copying
- Compliant source and the sink exchange decryption keys to enable the preview
- HDCP 1.4 needed for HD and FHD
- HDCP 2.2 needed for UHD

Case 3 Problem: HDCP Authentication Fails

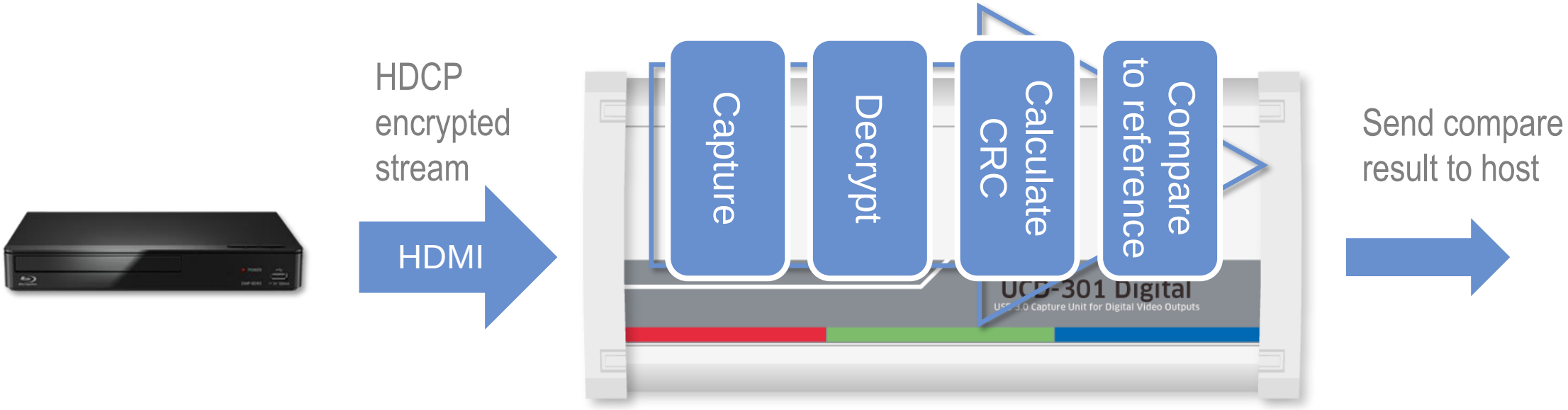
- Possible causes of the problem
  - ✓ Incompatible HDCP version
  - ✓ HDCP protocol implementation problem (normally solved in R&D)
  - ✓ Programming of HDCP keys failed during production

Original

Encrypted signal

Case 3 Solution: Verify HDCP Decryption

- Encrypted video frames or audio stream are not allowed to be saved in a PC for SW comparison
- Comparison must be done inside the test equipment
- Solution: CRC (check sum) test.



Problem Cost Scenario

- 100,000 units produced
- 1% have potential problems
- 25% of the problems materialize during warranty period
- $300 communication, repair and handling cost per unit

$$100{,}000 \times 0.01 \times 0.25 \times \$300 = \underline{\$75{,}000}$$

(Hits on the brand value may greatly exceed the direct costs!)

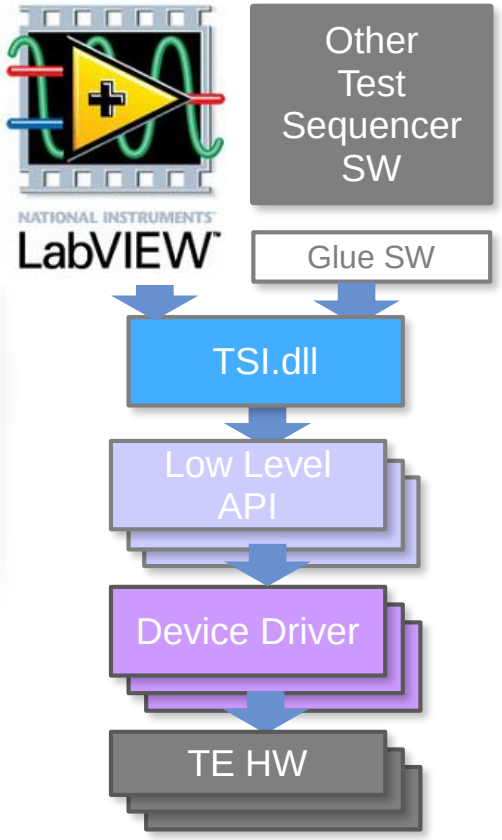
UNIGRAF

Test Equipment for Production Line

- Unigraf UCD-301
- 4K capable HDMI and DP Test Receiver
- Electrical Testing of interface signals
  - ✓ TMDS pair signal levels
  - ✓ HPD, DDC and CEC signals levels
  - ✓ Power line voltage levels
- HDCP 1.4 and HDCP 2.2 capable
- In-unit video frame CRC calculation

Test Automation Ready

UCD-301



- Unigraf High level SW API (TSI)
  - ✓ Test Cases with example code
  - ✓ No low level programming needed
  - ✓ Fast design and debugging
  - ✓ Highly portable
- Flexible test routines
  - ✓ Severity set by parameters
  - ✓ Fast HW driven routines

Summary

- Efficient functional testing potentially saves extensive repair costs
- Do not forget to test:
  - ✓ HDMI signal electrical integrity
  - ✓ Proper EDID reading
  - ✓ HDCP reception
- Unigraf **UCD-301** TE hardware with TSI API provides a firm and flexible platform for Test Automation
  - ✓ Capture and compare audio, video metadata
  - ✓ Electrically measure signal lines
  - ✓ HDCP compliant
  - ✓ Calculate CRC on-board

Please contact us for
more detailed information.

Thank you.

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