



Latency Tester Specification

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1 Revision History

Revision	Date	Description
0.1	30-1-2013	Preliminary specification.
0.2	7-2-2013	Change button behavior, add bootloader.
0.3	23-2-2013	Add usage instructions.
0.4	3-3-2013	Rename reports and add Display report.

2 Introduction

Latency Tester is an HID class Full Speed USB device used to measure full system latency for the Oculus Rift. For more information about HID, see the Device Class Definition for Human Interface Devices¹

- **Vendor ID:** *0x2833*
- **Product ID:** *0x0101*
- **Vendor String:** *Oculus VR, Inc.*
- **Product String:** *Latency Tester*
- **Serial String:** *Custom generated per device*

¹http://www.usb.org/developers/devclass_docs/HID1_11.pdf

3 Using the Latency Tester

3.1 Timing the System

The simplest way to use the Latency Tester is to use it directly to time an event.

1. Flip the screen buffer from a color that is not the target color to the target color.
2. Send a StartTest report containing the target color.
3. Wait for the Latency Tester to return a ColorDetected packet, containing the time elapsed.

3.2 Emulating the Tracker

The usage of the Latency Tester can be tweaked slightly to more closely match the motion-to-photon behavior of the Tracker and Rift.

1. Make sure the screen is not at the target color.
2. Send a StartTest report containing the target color.
3. Wait for the Start packet from the Latency Tester.
4. Flip the screen buffer to the target color.
5. Wait for the Latency Tester to return a ColorDetected packet, containing the time elapsed.

3.3 Calibration

The Latency Tester comes calibrated for the Oculus Rift DK. It can also be re-calibrated to be used to test other displays. The calibration values are reset to the Oculus Rift DK values after resetting the device.

1. Set the screen to (0, 0, 0).
2. Send a Calibrate report with (0, 0, 0).
3. Set the screen to (255, 255, 255).
4. Send a Calibrate report with (255, 255, 255).

3.4 Getting Sensor Samples

The Latency Tester can be configured to report a constant stream of color samples at 1000 Hz.

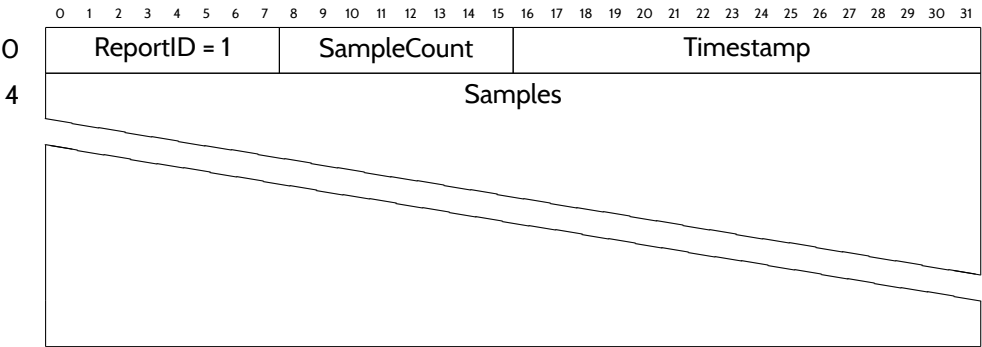
1. Send a Configuration report with the SendSamples bit set.
2. Read the Samples reports coming from the Tester.

4 HID In Reports

The IN reports appear on Endpoint 1.

4.1 Samples

The 64 byte Sample report contains up to 20 RGB samples of light intensity data.



- **ReportID** (8 bits): The USB Report ID for this report is 1.
- **SampleCount** (8 bits): The number of RGB samples in the Samples field.
- **Timestamp** (16 bits): The timestamp of the first sample in the report. As the internal sampling rate is 1000 Hz, this unit is equivalent to milliseconds.
- **Samples** (60 bytes): Each sample is 3 bytes long and contains 8 bits each of red, green, and blue, which represents the luminosity values detected on the screen for each color at each sampling time.

4.2 ColorDetected

The 13 byte ColorDetected report is fired when the Latency Tester detects that the screen has switched to within a threshold of the target value. The trigger is armed by a StartTest feature report.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31								
0	ReportID = 2								CommandID																Timestamp[0:7]															
4	Timestamp[8:15]								Elapsed																TriggerValue[0:7]															
8	TriggerValue[8:23]																TargetValue[0:15]																							
12	TargetValue[16:23]																																							

- **ReportID** (8 bits): The USB Report ID for this report is 2.
- **CommandID** (16 bits): An ID to identify related events, like a StartTest set, TestStarted report, and the resulting ColorDetected report.
- **Timestamp** (16 bits): The timestamp of the trigger fire. As the internal sampling rate is 1000 Hz, this unit is equivalent to milliseconds.
- **Elapsed** (16 bits): The time elapsed between the StartTest and the screen switching to within the threshold of the target value. The value is in milliseconds.
- **TriggerValue** (24 bits): The RGB sample that was within the threshold and triggered the firing of the report.
- **TargetValue** (24 bits): The RGB value that the display was set to.

4.3 TestStarted

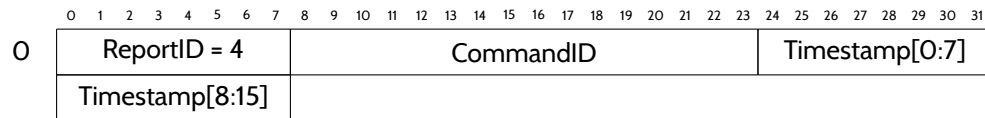
The 8 byte TestStarted report is fired when a StartTest report is sent to it, indicating the start of the timer. A ColorDetected report will then be sent after the color change is detected.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	ReportID = 3								CommandID																Timestamp[0:7]							
4	Timestamp[8:15]								TargetValue																							

- **ReportID** (8 bits): The USB Report ID for this report is 3.
- **CommandID** (16 bits): An ID to identify related events, like a StartTest report, TestStarted report, and the resulting ColorDetected report.
- **Timestamp** (16 bits): The timestamp of the test start. As the internal sampling rate is 1000 Hz, this unit is equivalent to milliseconds.
- **TargetValue** (24 bits): The RGB value that the display should be set to. This can be changed in the ButtonConfig feature report.

4.4 Button

The 5 byte Button report is fired when the button on the Latency Tester is pressed. It can be used by the application similarly to a keyboard button press to begin the StartTest, TestStarted, ColorDetected sequence.



- **ReportID** (8 bits): The USB Report ID for this report is 4.
- **CommandID** (16 bits): An ID to identify related events, like a StartTest, Test-Started report, and the resulting ColorDetected report.
- **Timestamp** (16 bits): The timestamp of the button press. As the internal sampling rate is 1000 Hz, this unit is equivalent to milliseconds.

5 Feature Reports

Feature Reports are read from and written to Endpoint 0, which is the Control Endpoint.

5.1 Configuration

The 5 byte Configuration report has a ReportID of 5. It contains a bitfield used to query or alter the operation of the Latency Tester.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	ReportID = 5								a									Threshold[0:15]														
4	Threshold[16:23]																															

- **ReportID** (8 bits): The USB Report ID for this report is 5.
- **(a) SendSamples** (1 bit): Enables the Samples report. The default value is 0.
- **Threshold** (24 bits): The threshold for triggering a detected display change. For example, with a TargetValue of (255, 255, 255) a threshold set to (50, 50, 50) would result in a trigger at the first sample (205, 205, 205) or higher.

5.2 Bootload

The 4 byte Bootload report has a ReportID of 6. Setting the payload to non-zero reboots the device into a bootloading mode where new firmware can be loaded onto the Latency Tester over USB.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	ReportID = 6								CommandID																Bootload							

- **ReportID** (8 bits): The USB Report ID for this report is 6.
- **CommandID** (16 bits): Unused.
- **Bootload** (8 bits): Setting this to a non-zero value reboots the device into bootloader mode immediately.

5.3 Calibrate

The 4 byte Calibrate report has a ReportID of 7. It is used to calibrate the color sensor in the Latency Tester to the display being tested. Set the display to a color, wait for the display to be completely switched, and then set the Calibrate report with that color. This should be repeated on any new display for the colors (255, 255, 255) and (0, 0, 0).

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	ReportID = 7								Value																							

- **ReportID** (8 bits): The USB Report ID for this report is 7.
- **Value** (24 bit): The RGB value being calibrated to.

5.4 StartTest

The 6 byte StartTest report tells the Latency Tester to setup the change to the color specified in the report. The TestStarted report is sent back with the specified color when the timer starts.



- **ReportID** (8 bits): The USB Report ID for this report is 8.
- **CommandID** (16 bits): An ID to identify related events, like a StartTest, Test-Started report, and the resulting ColorDetected report.
- **TargetValue** (24 bits): The RGB value that the display is being set to.

5.5 Display

The 6 byte Display report configures and allows the setting of data on the 3.5 digit 7-segment display on the Latency Tester.

	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
0	ReportID = 9								Mode								Value[0:15]															
4	Value[16:23]																															

- **ReportID** (8 bits): The USB Report ID for this report is 9.
- **Mode** (8 bits):
 - 0: The default mode, where the Latency Tester automatically sets the value on the display when tests are run and completed. The Value field is ignored with this mode.
 - 1: The display is set to the 32-bit unsigned integer in the Value field in milliseconds.
 - 2: Raw access to the segments on the display using Value as a set of bitmasks. Byte 0 is Digit 1, byte 1 is the Colon digit, byte 2 is Digit 2, and byte 3 is Digit 3. See the LTC-4624 datasheet² for bit to segment mapping.
- **Value** (32 bits): The field depends on the Mode.

²<http://optoelectronics.liteon.com/en-us/api/DwonloadFileHandler.ashx?txtSpecNo=DS30-2000-182&txtPartNo=LTC-4624JR>