

# Analyzing the Effect VEE has on Viewability and Estimating the Power Savings of DPO Using a Standard Set of Images on a Handheld Device



••••• QuickLogic Application Note 106

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## Overview

This application note describes how to load a standard set of QuickLogic- or OEM-provided images to a handheld device to determine how VEE (Visual Enhancement Engine) can improve viewability and estimate the amount of power that DPO (Display Power Optimizer) can save.

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## Testing Requirements

The following items are required for testing:

- Two identical handheld devices, possessing the same firmware, battery size, firmware revision, operating system, etc
- The auto-brightness profile of the devices (display brightness levels versus measured ambient light levels)
- The ability to measure power-consumption on the device real-time, or at minimum power consumption values for each brightness level
- A light meter to measure ambient light levels in lux

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## Testing Procedure

### Step 1: Load Images on Devices

Use two identical handheld devices, one will be the “control device,” while the other will be used to analyze VEE, hereafter called the “test device.”

For this application note, the assumption is that both devices are running a later version (4.0 or higher) of Android. Other operating systems can be supported using these instructions, but the OEM will have to make appropriate changes in file locations and programs chosen to view the files.

QuickLogic provides a standard suite of images that can be loaded onto the device. These images have all been pre-processed using VEE. Each of these images are of the same scene, with numbers 0 through 31 at the top right corner. The number is also saved within the actual file name of each image.

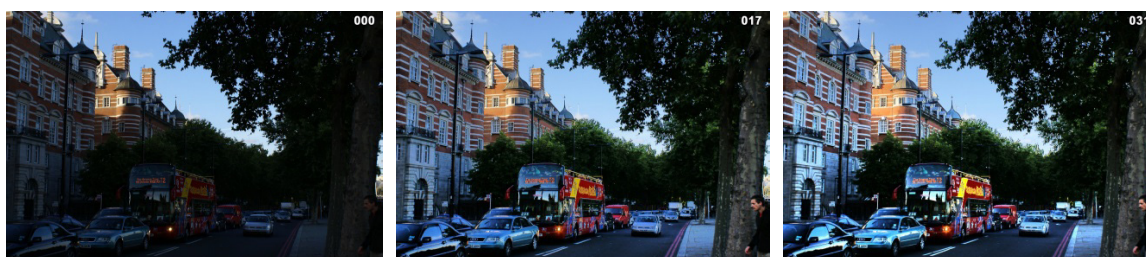


Figure 1: Images Processed using VEE

**NOTE:** The number at the top right represents the VEE “Strength” applied to each of the pictures.

In addition to the standard suites of images that QuickLogic provides, the OEMs can use their own set(s) of images. QuickLogic will pre-process those images and return the resulting images (which will be labeled in the same manner) to the OEM.

To load the images on the devices:

1. Load the series of images on the test device.
2. Load only the “0” strength images on the control device.

## Step 2: Determine Brightness Settings

To determine brightness settings:

1. Before analysis of the images takes place, determine the standard Auto-Brightness settings for the devices. Most systems have a standard auto-brightness table which matches the ambient light measured by the on-board ambient light sensor to the display brightness.
2. Note these settings for analysis later, as well as the whole device power consumption at each of these levels.

## Step 3: Analyze VEE Indoors

To analyze VEE indoors:

1. In typical indoor lighting (approximately 150 lux) activate both devices, enable auto-brightness, and then view the “0” strength images on both devices. The viewing experience of both devices should appear identical; neither should be more or less viewable, or appear brighter to the eye.

**NOTE:** If one device does appear better or worse than the other, check to ensure that both devices are identical in architecture, both have auto-brightness activated, and that no stray light or shadows are affecting the display brightness.

2. Once identical viewability has been confirmed, view the strength 1 image on the test device, with the control device remaining at strength 0.
3. Then, view the strength 2 image and so forth on the test device. The viewability improvements that VEE offers should be seen immediately. The viewer should recognize that once VEE reaches certain strengths (typically around 8 to 10, indoors), viewability improvements begin to plateau, and artifacts may begin to appear. The ideal VEE strength setting is one where noticeable improvements have happened, but artifacts have not yet occurred.

4. If multiple suites of images are used, repeat this process with those additional images. Ideal VEE strength for different images may vary slightly—this is expected behavior. Choose the VEE value that is lowest chosen amongst the multiple suites of images.
5. Note the VEE strength applied (the number on the top right of the image) to the test device, and that this was done using indoor lighting.

## Step 4: Analyze VEE in Additional Lighting Conditions

To analyze VEE in additional lighting conditions:

1. Repeat step 3 in a dark room (10 lux), as well as outdoor conditions (2500 to 10,000 lux). Additional lighting conditions can be tested if desired, which will form a more holistic view of VEE and DPO.
2. Note VEE strengths and ambient light levels at the end of testing for each ambient light level (such as in the chart shown below).

Lux	Description	Ideal VEE Strength
10	Dark room	8
150	Indoors	9
5,000	Direct sunlight	13

The result of steps 3 and 4 is visual evidence that QuickLogic VEE technology can be applied to any device to increase viewability. Results will vary based on individual preferences and the quality/brightness of display used.

## Step 5: Analyze DPO Indoors

While VEE increases viewability, DPO can reduce power consumption of the system.

To analyze DPO:

1. In an indoor environment (ideally the same ambient light conditions as step 3), disable auto-brightness on both devices.
2. Using the auto-brightness versus ambient light values gathered in step 2, manually set the brightness of the display to the correct value on both devices based on the ambient light measured.
3. View the 0 strength images on both devices. Both devices should look identical.
4. Once confirmed, view the image on the test device using the strength that was determined (in step 3) as the ideal VEE strength. The VEE strength device should now be providing a significantly better viewing experience.
5. On the VEE strength device, begin lowering the display brightness in 5% increments. The control device should remain unchanged. As the brightness is lowered, again view to the chosen strength image determined in step 3 to analyze how the viewability is affected versus the control device. Notice that even as the brightness is dropped (and power is saved), the test device will provide better viewability versus the control device, but the gap will narrow as brightness on the test device is dropped.
6. Once viewability is identical, note the brightness level of test device.

## Step 6: Analyze DPO in Additional Lighting Conditions

To analyze DPO in additional lighting conditions:

1. Repeat step 5 in a dark room (10 lux), as well as outdoor conditions (2500 to 10,000 lux).
2. Check additional lighting conditions used in step 3.
3. Note the display brightness levels at the end of testing for each ambient light level (such as in the chart shown below). Results will vary based on individual preferences and the quality/native brightness of display used.

Lux	Control System Brightness (auto-brightness default settings)	Test System Brightness
10	50%	20%
150	60%	30%
5,000	100%	55%

## Step 7: Calculate DPO Power Savings

To quantify the amount of power DPO can save:

1. Modify the chart generated in step 6 by replacing the brightness values with actual system power consumption at those brightness levels. The power consumption is noted in watts. The chart below uses letters in place of actual values, as actual values vary greatly depending on the individual system characteristics.

Lux	Control System Power Consumption (W)	Test System Power Consumption (W)
10	A	B
150	C	D
5,000	E	F

2. For a fair comparison, account for the power consumption of the VEE/DPO device in the test system. Add this value, which varies based on display resolution and frame rate, into the test system power consumption line, as shown below. Power consumption can be obtained from a product data sheet, or by contacting QuickLogic.

Lux	Control System Power Consumption (W)	Test System Power Consumption (W)
10	A	B + VEE/DPO device = G
150	C	D + VEE/DPO device = H
5,000	E	F + VEE/DPO device = I

3. Subtract the values to determine the actual power savings. In the chart below, the power savings column will show exactly how much power is saved in each lighting condition. This represents the power savings that DPO can offer.

Lux	Control System Power Consumption (W)	Test System Power Consumption (W)	Power Savings (W)
10	A	G	A - G
150	C	H	C - H
5,000	E	I	E - I

## Step 8: Varying VEE and DPO

During the VEE strength and DPO measurement process, once display brightness is adjusted down, VEE strength can be increased beyond the original ideal determined levels without causing artifacts or negatively affecting the viewing experience. This is expected behavior. The OEM can continue to change VEE strength values and brightness settings until an ideal combination is reached.

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## Integrating a VEE/DPO Device into an OEM System

The process described in this document is closely followed when a QuickLogic device containing VEE and DPO is integrated into customer systems. The process is spearheaded by QuickLogic engineers at the OEM facility, working in close cooperation with the OEM (and ODM, if desired).

VEE and DPO offer the OEM the unique ability to increase the viewing experience and lower system power by reducing display brightness, a combination found nowhere else.

These OEM-proven technologies are available from QuickLogic in the ArcticLink II and III VX product families. Contact QuickLogic for details on these products for various applications.

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## Revision History

Revision	Date	Originator and Comments
A	May 2013	Paul Karazuba and Kathleen Bylsma

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