

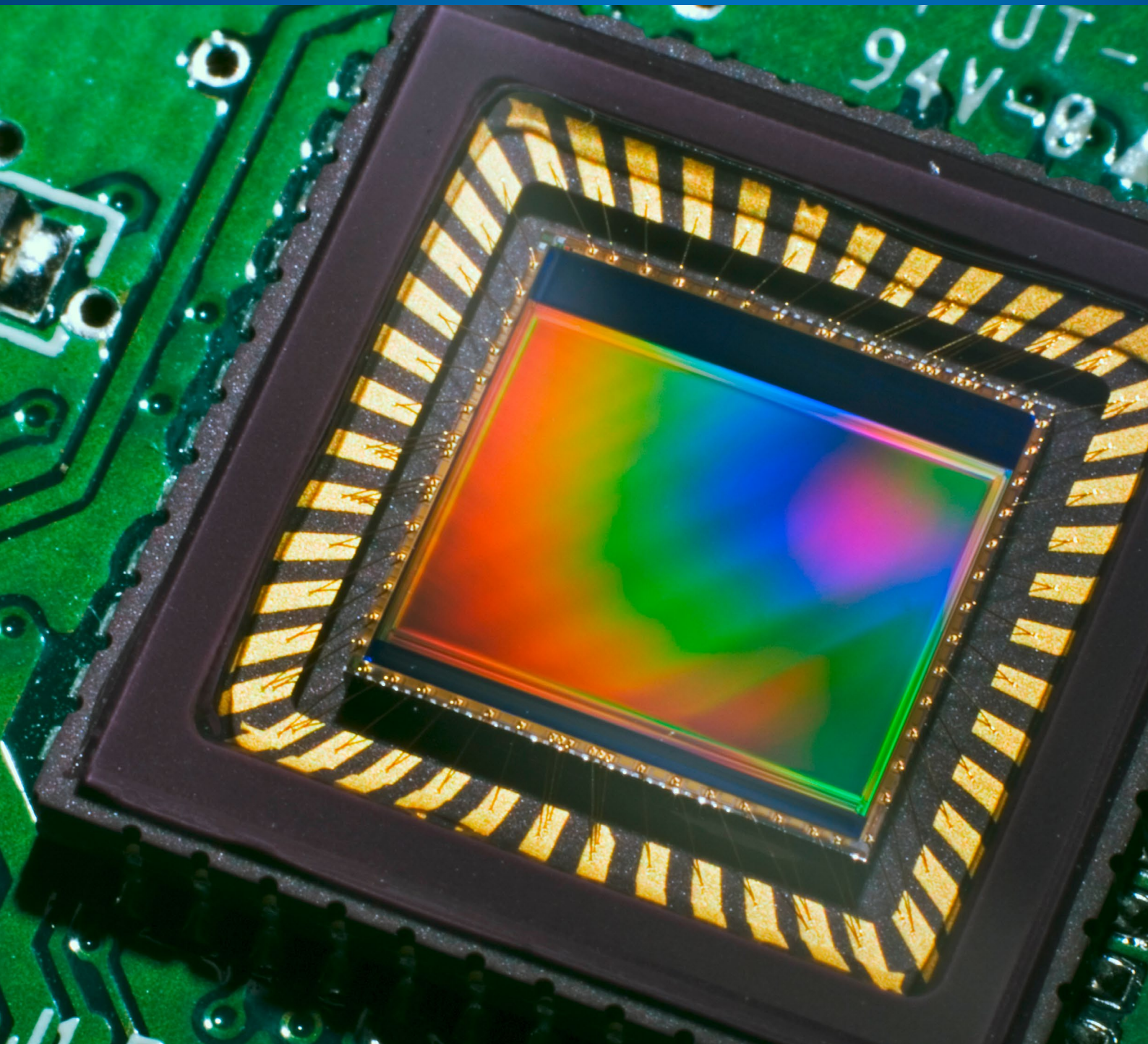


Baumer

Passion for Sensors

Digital industrial cameras

Sensor performance review.





Technical information

Camera EMVA data overview

This document gives an overview on Baumer cameras of the LX, CX and EX series. Their sensor properties are measured according to the EMVA Standard 1288.

The properties quantum efficiency, dark noise, saturation capacity, absolute sensitivity threshold, and dynamic range are organized in charts, with better performance first. The intention is to help to choose the right camera for the application.

The presented values are single sample data measured with the ACC3 (AEON® Camera Calibrator Tool) at room temperature. A different camera of the same type would have similar – but not identical – values.

Each camera is measured in the production process as part of our quality assurance system.

1 Image quality characteristics

The combination of different camera and sensor parameters allow selection of the right camera for a specific application. If, for example, the application requires very low light, the sensor has to be very sensitive. This means, that the absolute sensitivity threshold of the suitable sensor should be very low. The main performance characteristics are described in the following.

Quantum efficiency [%]

An imaging sensor converts photons into electrons. The conversion ratio, the quantum efficiency (QE), depends on the wavelength. The more photons are converted into electrons, the more sensitive to light the sensor is and the more information can be obtained from the image.

For monochrome cameras we give values measured at 536 nm (green). For color cameras 3 values for red, green, and blue are depicted. The values measured in a camera can differ from image sensor supplier data, as a camera might use a cover glass or filters.

K-Factor [DN/e⁻]

A camera converts the electrons (e⁻) from the image sensor into digital numbers (DN). This conversion is described by the overall system gain K, measured in digital number (DN) per electron (e⁻). K electrons are required to increase the grey level by 1 DN.

The K-Factor depends on the camera design. A slightly increased K-Factor may improve linearity at the cost of saturation capacity.

Temporal dark noise [e⁻]

Even if the sensor is not illuminated each pixel shows a (dark) signal. With increasing exposure time and temperature electrons are generated in each pixel without light. This dark signal varies, which is called dark noise (measured in electrons). A lower dark noise is preferred for most applications.

The dark noise together with the photon shot noise and the quantization noise describe the noise of the camera.

Full-well capacity [e⁻] and saturation capacity [e⁻]

Think of a pixel as a well and of the full-well capacity as the maximum number of electrons that can be stored in this well. This corresponds to the maximum number of photons which would generate such electrons (saturation irradiance).

The saturation capacity actually used for the characterization of a camera is measured differently and directly from camera images. The value is typically smaller than the full-well capacity.

This difference might cause discussion if comparing imaging sensor data and camera data. A high saturation capacity allows for longer exposure times.

If a pixel is over-exposed it is set to maximum DN and it does not contain useful information.

Maximum Signal-to-Noise Ratio (SNR_{max}) [dB]

The signal-to-noise ratio (SNR) is the ratio between the grey value (corrected for the dark value) and the signal noise. It is often measured in dB. SNR depends mainly on K and dark noise. SNR increases with the number of photons.

The maximum SNR (SNR_{max}) is reached for the saturation irradiance.

Absolute Sensitivity Threshold (AST) [e⁻]

The absolute sensitivity threshold describes the lowest number of photons (minimum detectable irradiation) where the camera can differentiate useful image information in a picture from noise. This means, the lower the threshold, the more sensitive the camera. You should take the AST into account in very low light applications. It is more significant than only referring to the QE, as the AST combines QE, dark noise, and the shot noise (which is caused by the quantum nature of the photons).

The value is determined from the value where SNR is equal 1 (signal is as large as noise).

In this document we use the value transferred into electrons (AST = minimum detectable irradiance * QE) to compare it to the full-well / saturation capacity.

Dynamic range [dB]

The dynamic range (DR) is the ratio between saturation irradiance and the minimum detectable irradiation. DR is measured in dB. Cameras with a high DR are able to give more detailed image information for dark and bright areas in a single image at the same time. So a high DR is especially important in applications with dark and bright areas in one image or with rapidly changing light conditions.

2 Camera Overview

| Camera | Sensor | Sensor Size | Shutter | Resolution (px) | Pixel Size (µm ²) | fps | Interface |
|------------------|------------------------------|-------------|-----------------|-----------------|-------------------------------|-----|-----------|
| CX Series | | | | | | | |
| VCXG-02C | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | GigE |
| VCXG-02M | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | GigE |
| VCXG-04C | Sony® IMX287 | 1/2.9" | Global Shutter | 728 × 544 | 6.9 | 436 | GigE |
| VCXG-04M | Sony® IMX287 | 1/2.9" | Global Shutter | 728 × 544 | 6.9 | 436 | GigE |
| VCXG-13M | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-13C | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-13M.I | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-13C.I | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-13M.I.XT | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-13C.I.XT | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VCXG-15C | Sony® IMX273 | 1/2.9" | Global Shutter | 1456 × 1098 | 3.45 | 226 | GigE |
| VCXG-15M | Sony® IMX273 | 1/2.9" | Global Shutter | 1456 × 1098 | 3.45 | 226 | GigE |
| VCXG-15M.I | Sony® IMX273 | 1/2.9" | Global Shutter | 1456 × 1098 | 3.45 | 226 | GigE |
| VCXG-15M.I.XT | Sony® IMX273 | 1/2.9" | Global Shutter | 1456 × 1098 | 3.45 | 226 | GigE |
| VCXG-23C | Sony® IMX174 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 53 | GigE |
| VCXG-23M | Sony® IMX174 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 53 | GigE |
| VCXG-24C | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | GigE |
| VCXG-24M | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | GigE |
| VCXG-25M | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-25C | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-25C.I | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-25M.I | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-25M.I.XT | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-25C.I.XT | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | GigE |
| VCXG-32M | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-32C | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-32C.I | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-32M.I | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-32C.I.XT | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-32M.I.XT | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | GigE |
| VCXG-51C | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-51M | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-51M.I | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-51C.I | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-51M.I.XT | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-51C.I.XT | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | GigE |
| VCXG-53M | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-53C | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-53M.I | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-53C.I | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-53C.I.XT | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-53M.I.XT | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | GigE |
| VCXG-124M | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-124C | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-124M.I | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-124C.I | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-124C.I.XT | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-124M.I.XT | Sony® IMX304 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 10 | GigE |
| VCXG-201C.R | Sony® IMX183 | 1" | Rolling Shutter | 5544 × 3694 | 2.4 | 60 | GigE |
| VCXU-02M | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | USB3.0 |

| Camera | QE blue (465nm) (%) | QE green (536nm) (%) | QE red (631nm) (%) | K-Factor (536nm) (DN/e-) | Dark Noise (536nm) (e-) | SNR (536nm) (dB) | SNR (536nm) (bits) | Absolute Sensitivity Threshold (e-) | Saturation Capacity (Well Depth) (e-) | DR (536nm) (dB) | DR (536nm) (bits) |
|------------------|---------------------------|----------------------------|--------------------------|--------------------------------|----------------------------------|------------------------|--------------------------|--|---|-----------------------|-------------------------|
| CX Series | | | | | | | | | | | |
| color | 39.1 | 43.1 | 45.6 | 0 | 10.97 | 39 | 6.5 | 11.8 | 7931 | 56.5 | 9.4 |
| monochrom | 0 | 56.3 | 0 | 0 | 10.3 | 39 | 6.5 | 11.2 | 7876 | 57 | 9.5 |
| color | 47 | 56.6 | 52.9 | 0 | 3.11 | 39.6 | 6.6 | 3.72 | 9198 | 67.9 | 11.3 |
| monochrom | 0 | 64.5 | 0 | 0 | 3.11 | 39.7 | 6.6 | 3.73 | 9266 | 67.9 | 11.3 |
| monochrom | 0 | 56.8 | 0 | 0 | 10.37 | 39 | 6.5 | 11.3 | 8008 | 57 | 9.5 |
| color | 38.6 | 42 | 45.8 | 0 | 9.7 | 38.8 | 6.4 | 10.6 | 7552 | 57.1 | 9.5 |
| monochrom | 0 | 55.1 | 0 | 0 | 9.89 | 38.9 | 6.5 | 10.8 | 7682 | 57.1 | 9.5 |
| color | 38.6 | 41.7 | 45.3 | 0 | 9.9 | 38.8 | 6.5 | 10.7 | 7647 | 57 | 9.5 |
| monochrom | 0 | 54.6 | 0 | 0 | 9.92 | 38.8 | 6.4 | 10.8 | 7619 | 57 | 9.5 |
| color | 53 | 57.3 | 56.6 | 0 | 9.45 | 38.8 | 6.5 | 10.3 | 7646 | 57.4 | 9.5 |
| color | 46 | 57.5 | 53.8 | 0 | 2.09 | 39.6 | 6.6 | 2.75 | 9068 | 70.4 | 11.7 |
| monochrom | 0 | 65.10001 | 0 | 0 | 2.09 | 39.7 | 6.6 | 2.75 | 9231 | 70.5 | 11.7 |
| monochrom | 0 | 65.5 | 0 | 0 | 2.07 | 39.7 | 6.6 | 2.73 | 9266 | 70.6 | 11.7 |
| monochrom | 0 | 65.6 | 0 | 0 | 2.06 | 39.7 | 6.6 | 2.73 | 9345 | 70.7 | 11.7 |
| color | 55.6 | 60.7 | 47.1 | 0 | 6.2 | 45 | 7.5 | 7.1 | 31887 | 73 | 12.1 |
| monochrom | 0 | 68.6 | 0 | 0 | 6.16 | 45 | 7.5 | 7.1 | 31414 | 72.9 | 12.1 |
| color | 56.2 | 60.9 | 46.6 | 0 | 6.27 | 45.1 | 7.5 | 7.2 | 32261 | 73 | 12.1 |
| monochrom | 0 | 69.1 | 0 | 0 | 6.13 | 45.1 | 7.5 | 7.1 | 32059 | 73.1 | 12.1 |
| monochrom | 0 | 57.2 | 0 | 0 | 10.93 | 39.6 | 6.6 | 11.8 | 9207 | 57.9 | 9.6 |
| color | 44.1 | 47.3 | 51.5 | 0 | 10.33 | 39.3 | 6.5 | 11.2 | 8490 | 57.6 | 9.6 |
| color | 43 | 47.4 | 51.3 | 0 | 10.62 | 39.7 | 6.6 | 11.5 | 9229 | 58.1 | 9.7 |
| monochrom | 0 | 57.8 | 0 | 0 | 11.17 | 39.7 | 6.6 | 12 | 9271 | 57.7 | 9.6 |
| monochrom | 0 | 58.2 | 0 | 0 | 11.17 | 39.5 | 6.6 | 12 | 8989 | 57.5 | 9.5 |
| color | 42.2 | 46.3 | 50.1 | 0 | 11.25 | 39.4 | 6.6 | 0.52 | 8790 | 57.3 | 9.5 |
| monochrom | 0 | 65.4 | 0 | 0 | 2.23 | 40.1 | 6.7 | 2.9 | 10272 | 71 | 11.8 |
| color | 47.2 | 58.8 | 54.3 | 0 | 2.13 | 40.2 | 6.7 | 2.8 | 10503 | 71.4 | 11.9 |
| color | 46.2 | 56.9 | 53 | 0 | 1.98 | 39.7 | 6.6 | 2.65 | 9270 | 70.9 | 11.8 |
| monochrom | 0 | 65 | 0 | 0 | 1.9 | 39.6 | 6.6 | 2.57 | 9071 | 70.9 | 11.8 |
| color | 45.9 | 57.2 | 52.8 | 0 | 1.97 | 39.7 | 6.6 | 2.64 | 8252 | 70.9 | 11.8 |
| monochrom | 0 | 64.7 | 0 | 0 | 1.93 | 39.6 | 6.6 | 2.6 | 9130 | 70.9 | 11.8 |
| color | 47.2 | 58 | 53.4 | 0 | 2.15 | 40.1 | 6.7 | 2.8 | 10348 | 71.2 | 11.8 |
| monochrom | 0 | 65.6 | 0 | 0 | 2.15 | 40.2 | 6.7 | 2.8 | 10396 | 71.3 | 11.8 |
| monochrom | 0 | 64.7 | 0 | 0 | 2 | 39.7 | 6.6 | 2.67 | 9258 | 70.8 | 11.8 |
| color | 45.8 | 57.1 | 52.2 | 0 | 2 | 39.6 | 6.6 | 2.68 | 9219 | 70.7 | 11.8 |
| monochrom | 0 | 65.10001 | 0 | 0 | 1.98 | 39.6 | 0.66 | 2.65 | 9194 | 70.8 | 11.8 |
| color | 45.7 | 57.3 | 52.3 | 0 | 2 | 39.6 | 6.6 | 2.68 | 9190 | 70.7 | 11.7 |
| monochrom | 0 | 57 | 0 | 0 | 11.3 | 39.5 | 6.6 | 12.1 | 8957 | 57.4 | 9.5 |
| color | 44.5 | 48.5 | 50.7 | 0 | 11.18 | 39.7 | 6.6 | 12 | 9319 | 57.8 | 9.6 |
| monochrom | 0 | 57.5 | 0 | 0 | 11.84 | 39.6 | 6.6 | 12.7 | 9050 | 57.1 | 9.5 |
| color | 39.3 | 43.7 | 46.9 | 0 | 11.27 | 39.8 | 6.6 | 12.1 | 9488 | 57.9 | 9.6 |
| color | 43.5 | 47.8 | 50.6 | 0 | 11.2 | 39.6 | 6.6 | 12 | 9095 | 57.6 | 9.6 |
| monochrom | 0 | 57.3 | 0 | 0 | 11.02 | 39.6 | 6.6 | 11.9 | 9189 | 57.8 | 9.6 |
| monochrom | 0 | 64.60001 | 0 | 0 | 2.19 | 39.7 | 6.6 | 2.9 | 9323 | 70.3 | 11.7 |
| color | 45.9 | 58.2 | 53.3 | 0.422 | 2.11 | 39.6 | 6.6 | 2.78 | 9191 | 70.4 | 11.7 |
| monochrom | 0 | 65 | 0 | 0 | 2.07 | 39.6 | 6.6 | 2.73 | 9073 | 70.4 | 11.7 |
| color | 46 | 56.3 | 52.1 | 0 | 2.09 | 39.7 | 6.6 | 2.75 | 9338 | 70.6 | 11.7 |
| color | 46.4 | 57.1 | 52.3 | 0 | 2.1 | 39.6 | 6.6 | 2.76 | 9077 | 70.3 | 11.7 |
| monochrom | 0 | 64.8 | 0 | 0 | 2.08 | 39.6 | 6.6 | 2.75 | 9185 | 70.5 | 11.7 |
| color | 62.3 | 67.7 | 51.1 | 0 | 3.11 | 41.6 | 6.9 | 3.83 | 14540 | 71.6 | 11.9 |
| monochrom | 0 | 53.3 | 0 | 0 | 9.86 | 38.7 | 6.4 | 10.7 | 7352 | 56.7 | 9.4 |

| Camera | Sensor | Sensor Size | Shutter | Resolution (px) | Pixel Size (µm²) | fps | Interface |
|------------------|------------------------------|-------------|-----------------|-----------------|------------------|-----|-----------|
| CX Series | | | | | | | |
| VCXU-02C | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | USB3.0 |
| VCXU-04M | Sony® IMX287 | 1/2.9" | Global Shutter | 728 × 544 | 6.9 | 436 | USB3.0 |
| VCXU-13C | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | USB3.0 |
| VCXU-13M | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | USB3.0 |
| VCXU-15M | Sony® IMX273 | 1/2.9" | Global Shutter | 1456 × 1098 | 3.45 | 226 | USB3.0 |
| VCXU-22M.R | Sony® IMX290 | 1/2.8" | Rolling Shutter | 1945 × 1097 | 2.9 | 0 | USB3.0 |
| VCXU-23C | Sony® IMX174 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 53 | USB3.0 |
| VCXU-23M | Sony® IMX174 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 53 | USB3.0 |
| VCXU-24C | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | USB3.0 |
| VCXU-24M | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | USB3.0 |
| VCXU-25C | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | USB3.0 |
| VCXU-25M | ON Semiconductor® PYTHON2000 | 2/3" | Global Shutter | 1920 × 1200 | 4.8 | 167 | USB3.0 |
| VCXU-31C | Sony® IMX252 | 1/1.8" | Global Shutter | 2448 × 2048 | 3.45 | 120 | USB3.0 |
| VCXU-31M | Sony® IMX252 | 1/1.8" | Global Shutter | 2448 × 2048 | 3.45 | 120 | USB3.0 |
| VCXU-32C | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | USB3.0 |
| VCXU-32M | Sony® IMX265 | 1/1.8" | Global Shutter | 2048 × 1536 | 3.45 | 39 | USB3.0 |
| VCXU-50C | Sony® IMX250 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 77 | USB3.0 |
| VCXU-50M | Sony® IMX250 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 77 | USB3.0 |
| VCXU-51C | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | USB3.0 |
| VCXU-51M | Sony® IMX264 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 35 | USB3.0 |
| VCXU-53M | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | USB3.0 |
| VCXU-53C | ON Semiconductor® PYTHON5000 | 1" | Global Shutter | 2592 × 2048 | 4.8 | 23 | USB3.0 |
| VCXU-65M.R | Sony® IMX178 | 1/1.8" | Rolling Shutter | 3072 × 2048 | 2.4 | 60 | USB3.0 |
| VCXU-65C.R | Sony® IMX178 | 1/1.8" | Rolling Shutter | 3072 × 2048 | 2.4 | 60 | USB3.0 |
| VCXU-123M | Sony® IMX253 | 1.1" | Global Shutter | 4096 × 3000 | 3.45 | 27 | USB3.0 |
| VCXU-125M.R | Sony® IMX226 | 1/1.7" | Rolling Shutter | 4072 × 3046 | 1.85 | 60 | USB3.0 |
| VCXU-125C.R | Sony® IMX226 | 1/1.7" | Rolling Shutter | 4072 × 3046 | 1.85 | 60 | USB3.0 |
| VCXU-201C.R | Sony® IMX183 | 1" | Rolling Shutter | 5544 × 3694 | 2.4 | 60 | USB3.0 |
| VCXU-201M.R | Sony® IMX183 | 1" | Rolling Shutter | 5544 × 3694 | 2.4 | 60 | USB3.0 |
| EX Series | | | | | | | |
| VEXU-24C | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | USB3.0 |
| VEXU-24M | Sony® IMX249 | 1/1.2" | Global Shutter | 1920 × 1200 | 5.86 | 38 | USB3.0 |
| VEXG-02M | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | GigE |
| VEXG-02C | ON Semiconductor® PYTHON300 | 1/4" | Global Shutter | 640 × 480 | 4.8 | 403 | GigE |
| VEXG-13C | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VEXG-13M | ON Semiconductor® PYTHON1300 | 1/2" | Global Shutter | 1280 × 1024 | 4.8 | 222 | GigE |
| VEXG-52M.R | ON Semiconductor® MT9P031 | 1/2.5" | Rolling Shutter | 2592 × 1944 | 2.2 | 13 | GigE |
| VEXG-52C.R | ON Semiconductor® MT9P031 | 1/2.5" | Rolling Shutter | 2592 × 1944 | 2.2 | 13 | GigE |
| VEXG-100M.R | ON Semiconductor® MT9J003 | 1/2.3" | Rolling Shutter | 3864 × 2764 | 1.67 | 7 | GigE |
| VEXG-100C.R | ON Semiconductor® MT9J003 | 1/2.3" | Rolling Shutter | 3864 × 2764 | 1.67 | 7 | GigE |
| LX Series | | | | | | | |
| LXG-20M | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | GigE |
| LXG-20C | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | GigE |
| LXG-20NIR | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | GigE |
| LXG-20M.PS | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | GigE |
| LXG-20M.3D | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | GigE |
| LXG-40M | ams CMV4000 | 1" | Global Shutter | 2048 × 2048 | 5.5 | 56 | GigE |
| LXG-40C | ams CMV4000 | 1" | Global Shutter | 2048 × 2048 | 5.5 | 56 | GigE |
| LXG-40NIR | ams CMV4000 | 1" | Global Shutter | 2048 × 2048 | 5.5 | 56 | GigE |
| LXG-80C | ams CMV8000 | 4/3" | Global Shutter | 3360 × 2496 | 5.5 | 29 | GigE |
| LXG-80M | ams CMV8000 | 4/3" | Global Shutter | 3360 × 2496 | 5.5 | 29 | GigE |
| LXG-120C | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | GigE |

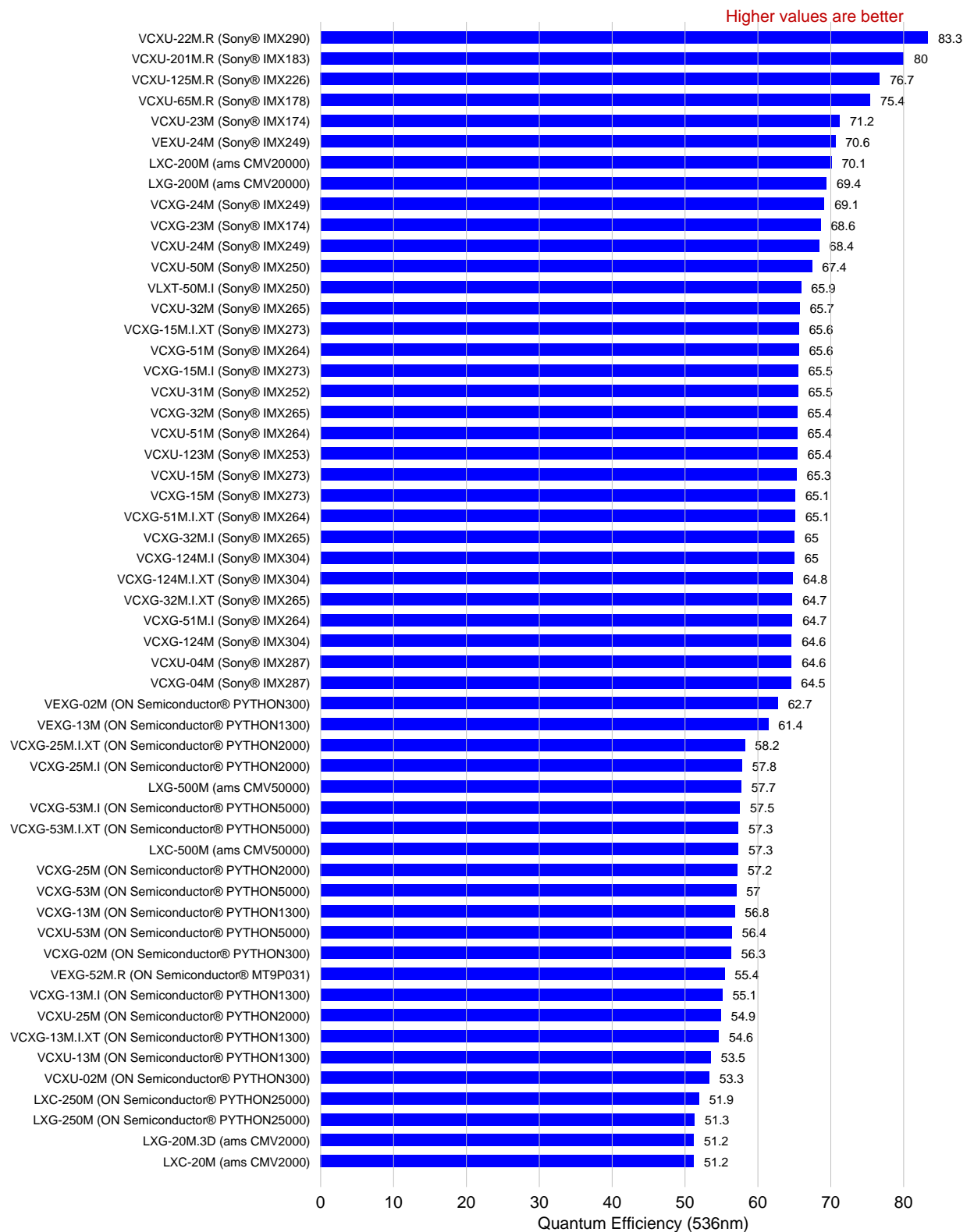
| Camera | QE blue (465nm) (%) | QE green (536nm) (%) | QE red (631nm) (%) | K-Factor (536nm) (DN/e-) | Dark Noise (536nm) (e-) | SNR (536nm) (dB) | SNR (536nm) (bits) | Absolute Sensitivity Threshold (e-) | Saturation Capacity (Well Depth) (e-) | DR (536nm) (dB) | DR (536nm) (bits) |
|------------------|---------------------------|----------------------------|--------------------------|--------------------------------|----------------------------------|------------------------|--------------------------|--|---|-----------------------|-------------------------|
| CX Series | | | | | | | | | | | |
| color | 39.8 | 43 | 45.4 | 0 | 10.87 | 38.6 | 6.4 | 11.6 | 7318 | 56 | 9.3 |
| monochrom | 0 | 64.60001 | 0 | 0 | 3.15 | 39.7 | 6.6 | 3.76 | 9322 | 67.9 | 11.3 |
| color | 38.7 | 42 | 45.3 | 0 | 10.88 | 38.8 | 6.4 | 11.7 | 7625 | 56.3 | 9.3 |
| monochrom | 0 | 53.5 | 0 | 0 | 9.78 | 38.4 | 6.4 | 10.6 | 6952 | 56.3 | 9.4 |
| monochrom | 0 | 65.3 | 0 | 0 | 2.07 | 39.7 | 6.6 | 2.73 | 9328 | 70.7 | 11.7 |
| monochrom | 0 | 83.3 | 0 | 0.278 | 2.89 | 41.4 | 6.9 | 3.61 | 13937 | 71.7 | 11.9 |
| color | 55.8 | 60.8 | 46.1 | 0 | 6.6 | 45.1 | 7.5 | 7.5 | 32102 | 72.6 | 12.1 |
| monochrom | 0 | 71.2 | 0 | 0 | 6.94 | 45 | 7.5 | 7.8 | 31693 | 72.2 | 12 |
| color | 55 | 60.6 | 46.5 | 0 | 6.35 | 45 | 7.5 | 7.3 | 31870 | 72.8 | 12.1 |
| monochrom | 0 | 68.4 | 0 | 0 | 6.24 | 45 | 7.5 | 7.2 | 31604 | 72.9 | 12.1 |
| color | 38.1 | 41.3 | 44.4 | 0 | 11.34 | 39.2 | 6.5 | 12.2 | 8338 | 56.7 | 9.4 |
| monochrom | 0 | 54.9 | 0 | 0 | 12.8 | 39.6 | 6.6 | 13.6 | 9168 | 56.6 | 9.4 |
| color | 47.5 | 57.7 | 53.2 | 0 | 2.14 | 40.2 | 6.7 | 2.8 | 10478 | 71.4 | 11.9 |
| monochrom | 0 | 65.5 | 0 | 0 | 2.13 | 40.3 | 6.7 | 2.8 | 10598 | 71.5 | 11.9 |
| color | 47 | 58.3 | 54.7 | 0 | 2.09 | 40.2 | 6.7 | 2.8 | 10444 | 71.5 | 11.9 |
| monochrom | 0 | 65.7 | 0 | 0 | 2.11 | 40.2 | 6.7 | 2.8 | 10362 | 71.4 | 11.9 |
| color | 47.3 | 57.9 | 53.1 | 0 | 2.14 | 40.1 | 6.7 | 2.8 | 10318 | 71.2 | 11.8 |
| monochrom | 0 | 67.4 | 0 | 0 | 2.15 | 40.2 | 6.7 | 2.8 | 10432 | 71.3 | 11.8 |
| color | 47.4 | 58.4 | 54 | 0 | 2.17 | 40.3 | 6.7 | 2.9 | 10632 | 71.4 | 11.9 |
| monochrom | 0 | 65.4 | 0 | 0 | 2.16 | 40.2 | 6.7 | 2.9 | 10379 | 71.2 | 11.8 |
| monochrom | 0 | 56.4 | 0 | 0 | 11.29 | 39.7 | 6.6 | 12.1 | 9260 | 57.7 | 9.6 |
| color | 38.7 | 42.3 | 45.2 | 0 | 11.77 | 39.5 | 6.6 | 12.6 | 8828 | 56.9 | 9.5 |
| monochrom | 0 | 75.4 | 0 | 0 | 2.92 | 41.6 | 6.9 | 3.65 | 14543 | 72 | 12 |
| color | 56.4 | 61.7 | 47.5 | 0 | 2.89 | 41.5 | 6.9 | 3.62 | 14231 | 71.9 | 11.9 |
| monochrom | 0 | 65.4 | 0 | 0 | 2.2 | 40.1 | 6.7 | 2.9 | 10179 | 71 | 11.8 |
| monochrom | 0 | 76.7 | 0 | 0 | 3.08 | 40.4 | 6.7 | 3.72 | 10993 | 69.4 | 11.5 |
| color | 58.5 | 63.2 | 47.1 | 0 | 3.1 | 40.4 | 6.7 | 3.74 | 10847 | 69.2 | 11.5 |
| color | 61.6 | 67.8 | 51.2 | 0 | 3.17 | 41.6 | 6.9 | 3.88 | 14532 | 71.5 | 11.9 |
| monochrom | 0 | 80 | 0 | 0 | 3.17 | 41.7 | 6.9 | 3.89 | 14959 | 71.7 | 11.9 |
| EX Series | | | | | | | | | | | |
| color | 55.8 | 61.5 | 47.2 | 0 | 7.41 | 45.1 | 7.5 | 8.28 | 32014 | 71.7 | 11.9 |
| monochrom | 0 | 70.6 | 0 | 0 | 7.13 | 45.1 | 7.5 | 8.01 | 32156 | 72.1 | 12 |
| monochrom | 0 | 62.7 | 0 | 0 | 9.9 | 40 | 6.6 | 10.8 | 9965 | 59.3 | 9.8 |
| color | 47.7 | 52.8 | 54.7 | 0 | 12.27 | 39.8 | 6.6 | 13.1 | 9612 | 57.3 | 9.5 |
| color | 46.3 | 50.9 | 53.9 | 0 | 10.91 | 39.9 | 6.6 | 11.8 | 9781 | 58.4 | 9.7 |
| monochrom | 0 | 61.4 | 0 | 0 | 9.68 | 39.8 | 6.6 | 10.6 | 9625 | 59.2 | 9.8 |
| monochrom | 0 | 55.4 | 0 | 0 | 4.13 | 37.2 | 6.2 | 4.68 | 5229 | 61 | 10.1 |
| color | 40.1 | 43.5 | 31.7 | 0 | 4.41 | 37.3 | 6.2 | 4.96 | 5423 | 60.8 | 10.1 |
| monochrom | 0 | 43.8 | 0 | 0 | 4.66 | 36.7 | 6.1 | 5.2 | 4715 | 59.1 | 9.8 |
| color | 39.3 | 31.1 | 20.6 | 0 | 4.57 | 37 | 6.2 | 5.11 | 5049 | 59.9 | 9.9 |
| LX Series | | | | | | | | | | | |
| monochrom | 0 | 48.6 | 0 | 0 | 15.7 | 40 | 6.6 | 16.5 | 10074 | 55.7 | 9.3 |
| color | 39.1 | 40.8 | 39.4 | 0 | 14.4 | 39.9 | 6.6 | 15.2 | 9848 | 56.3 | 9.3 |
| monochrom | 0 | 49.5 | 0 | 0 | 15.7 | 39.7 | 6.6 | 16.5 | 9327 | 55.1 | 9.1 |
| monochrom | 0 | 50.2 | 0 | 0.022 | 13.1 | 40.2 | 6.7 | 19 | 10443 | 54.8 | 9.1 |
| monochrom | 0 | 51.2 | 0 | 0.022 | 13.64 | 40.4 | 6.7 | 19.6 | 11081 | 55.1 | 9.1 |
| monochrom | 0 | 46.5 | 0 | 0 | 15.05 | 39.2 | 6.5 | 15.8 | 8326 | 54.4 | 9 |
| color | 38 | 40.2 | 40.9 | 0 | 14.95 | 39.5 | 6.6 | 15.7 | 8870 | 55 | 9.1 |
| monochrom | 0 | 47.4 | 0 | 0 | 15.18 | 39.1 | 6.5 | 16 | 8172 | 54.2 | 9 |
| color | 34.7 | 34.7 | 34.2 | 0 | 12.88 | 39.7 | 6.6 | 13.4 | 9378 | 56.9 | 9.4 |
| monochrom | 0 | 41.7 | 0 | 0 | 12.07 | 39.8 | 6.6 | 12.6 | 9614 | 57.7 | 9.6 |
| color | 36.3 | 35.5 | 34.5 | 0 | 12.89 | 39.9 | 6.6 | 13.4 | 9730 | 57.2 | 9.5 |

| Camera | Sensor | Sensor Size | Shutter | Resolution (px) | Pixel Size (µm ²) | fps | Interface |
|------------------|-------------------------------|-------------|----------------|-----------------|-------------------------------|-----|-------------|
| LX Series | | | | | | | |
| LXG-120M | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | GigE |
| LXG-120M.PS | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | GigE |
| LXG-120M.3D | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | GigE |
| LXG-200C | ams CMV20000 | 35mm | Global Shutter | 5120 × 3840 | 6.4 | 12 | GigE |
| LXG-200M | ams CMV20000 | 35mm | Global Shutter | 5120 × 3840 | 6.4 | 12 | GigE |
| LXG-250C | ON Semiconductor® PYTHON25000 | APS-H | Global Shutter | 5120 × 5120 | 4.5 | 9 | GigE |
| LXG-250M | ON Semiconductor® PYTHON25000 | APS-H | Global Shutter | 5120 × 5120 | 4.5 | 9 | GigE |
| LXG-500M | ams CMV50000 | 2.85" | Global Shutter | 7920 × 6004 | 4.6 | 30 | GigE |
| LXC-20C | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | CameraLink® |
| LXC-20M | ams CMV2000 | 2/3" | Global Shutter | 2048 × 1088 | 5.5 | 337 | CameraLink® |
| LXC-40C | ams CMV4000 | 1" | Global Shutter | 2048 × 2048 | 5.5 | 56 | CameraLink® |
| LXC-40M | ams CMV4000 | 1" | Global Shutter | 2048 × 2048 | 5.5 | 56 | CameraLink® |
| LXC-120C | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | CameraLink® |
| LXC-120M | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | CameraLink® |
| LXC-200C | ams CMV20000 | 35mm | Global Shutter | 5120 × 3840 | 6.4 | 12 | CameraLink® |
| LXC-200M | ams CMV20000 | 35mm | Global Shutter | 5120 × 3840 | 6.4 | 12 | CameraLink® |
| LXC-250C | ON Semiconductor® PYTHON25000 | APS-H | Global Shutter | 5120 × 5120 | 4.5 | 9 | CameraLink® |
| LXC-250M | ON Semiconductor® PYTHON25000 | APS-H | Global Shutter | 5120 × 5120 | 4.5 | 9 | CameraLink® |
| LXC-500M | ams CMV50000 | 2.85" | Global Shutter | 7920 × 6004 | 4.6 | 30 | CameraLink® |
| QX Series | | | | | | | |
| VQXT-120M.HS | ams CMV12000 | APS-C | Global Shutter | 4096 × 3072 | 5.5 | 60 | 10GigE |
| LX Series | | | | | | | |
| VLXT-50M.I | Sony® IMX250 | 2/3" | Global Shutter | 2448 × 2048 | 3.45 | 77 | 10GigE |

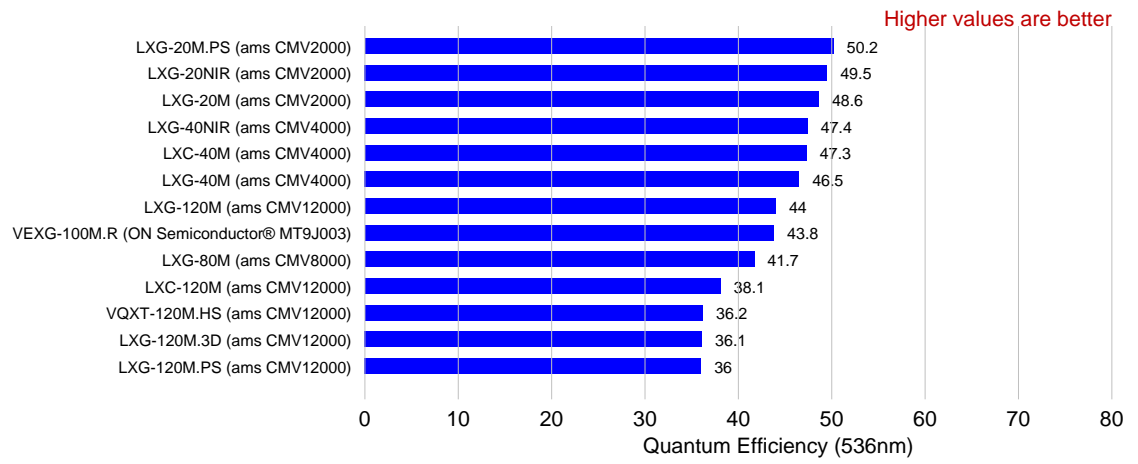
| Camera | QE blue (465nm) (%) | QE green (536nm) (%) | QE red (631nm) (%) | K-Factor (536nm) (DN/e-) | Dark Noise (536nm) (e-) | SNR (536nm) (dB) | SNR (536nm) (bits) | Absolute Sensitivity Threshold (e-) | Saturation Capacity (Well Depth) (e-) | DR (536nm) (dB) | DR (536nm) (bits) |
|------------------|---------------------------|----------------------------|--------------------------|--------------------------------|----------------------------------|------------------------|--------------------------|--|---|-----------------------|-------------------------|
| LX Series | | | | | | | | | | | |
| monochrom | 0 | 44 | 0 | 0.391 | 11.64 | 39.8 | 6.6 | 12.2 | 9452 | 57.8 | 9.6 |
| monochrom | 0 | 36 | 0 | 0.026 | 11.19 | 39.2 | 6.5 | 16.3 | 8291 | 54.1 | 9 |
| monochrom | 0 | 36.1 | 0 | 0.027 | 11.15 | 38.9 | 6.5 | 15.9 | 7755 | 53.7 | 8.9 |
| color | 41.5 | 46.6 | 41.6 | 0 | 8.3 | 41 | 6.8 | 8.9 | 12483 | 63 | 10.5 |
| monochrom | 0 | 69.4 | 0 | 0 | 9.45 | 42.1 | 7 | 10 | 16150 | 64.1 | 10.7 |
| color | 36.6 | 39.7 | 41.2 | 0 | 11.96 | 39.3 | 6.5 | 12.8 | 8425 | 56.4 | 9.4 |
| monochrom | 0 | 51.3 | 0 | 0 | 12.8 | 39.4 | 6.5 | 13.6 | 8637 | 56 | 9.3 |
| monochrom | 0 | 57.7 | 0 | 0 | 8.61 | 41.2 | 6.8 | 9.18 | 13134 | 63.1 | 10.5 |
| color | 42.5 | 43 | 42.9 | 0 | 16.3 | 39.6 | 6.6 | 17 | 9175 | 54.6 | 9.1 |
| monochrom | 0 | 51.2 | 0 | 0 | 16.11 | 39.6 | 6.6 | 16.8 | 9058 | 54.6 | 9.1 |
| color | 41.1 | 41.9 | 39.5 | 0 | 16.14 | 39.4 | 6.5 | 16.9 | 8696 | 54.3 | 9 |
| monochrom | 0 | 47.3 | 0 | 0 | 16.87 | 39.3 | 6.5 | 17.6 | 8428 | 53.6 | 8.9 |
| color | 33.8 | 33.2 | 33 | 0 | 12.89 | 39.5 | 6.6 | 13.7 | 8845 | 56.2 | 9.3 |
| monochrom | 0 | 38.1 | 0 | 0 | 12.25 | 39.5 | 6.6 | 13.1 | 8931 | 56.7 | 9.4 |
| color | 55.7 | 60.5 | 53.9 | 0 | 7.64 | 40.7 | 6.8 | 8.2 | 11673 | 63.1 | 10.5 |
| monochrom | 0 | 70.1 | 0 | 0 | 10.03 | 42.1 | 7 | 10.6 | 16092 | 63.6 | 10.6 |
| color | 35.8 | 38.9 | 39.2 | 0 | 11.97 | 39.3 | 6.5 | 12.8 | 8560 | 56.5 | 9.4 |
| monochrom | 0 | 51.9 | 0 | 0 | 12.59 | 39.3 | 6.5 | 13.4 | 8508 | 56.1 | 9.3 |
| monochrom | 0 | 57.3 | 0 | 0 | 8.46 | 41 | 6.8 | 9.03 | 12667 | 62.9 | 10.5 |
| QX Series | | | | | | | | | | | |
| monochrom | 0 | 36.2 | 0 | 0 | 14.09 | 38.9 | 6.5 | 17.8 | 7847 | 42.9 | 8.8 |
| LX Series | | | | | | | | | | | |
| monochrom | 0 | 65.9 | 0 | 0.412 | 2.14 | 39.8 | 6.6 | 2.81 | 9544 | 70.6 | 11.7 |

3 Monochrome Cameras

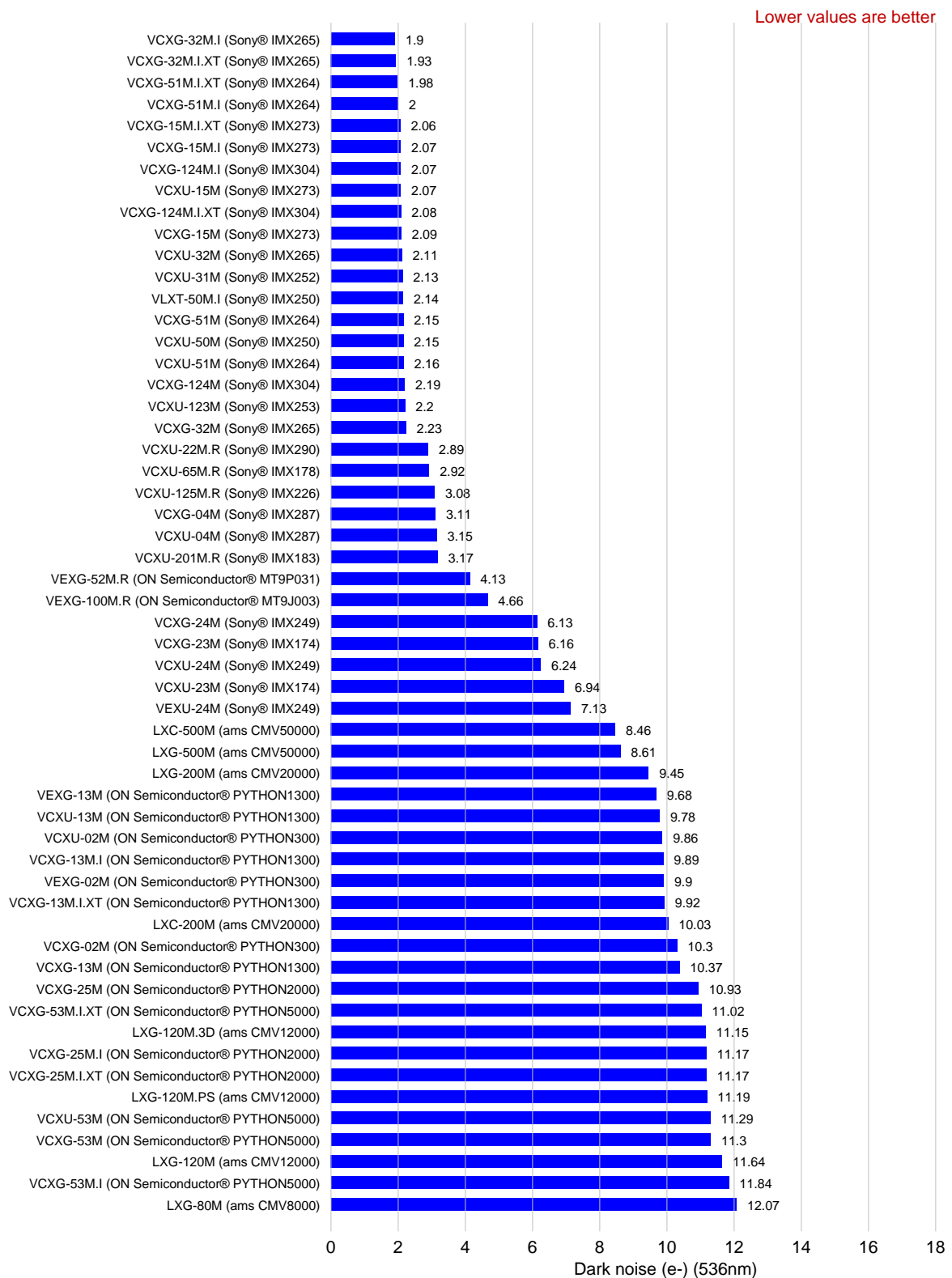
Quantum Efficiency QE [%]



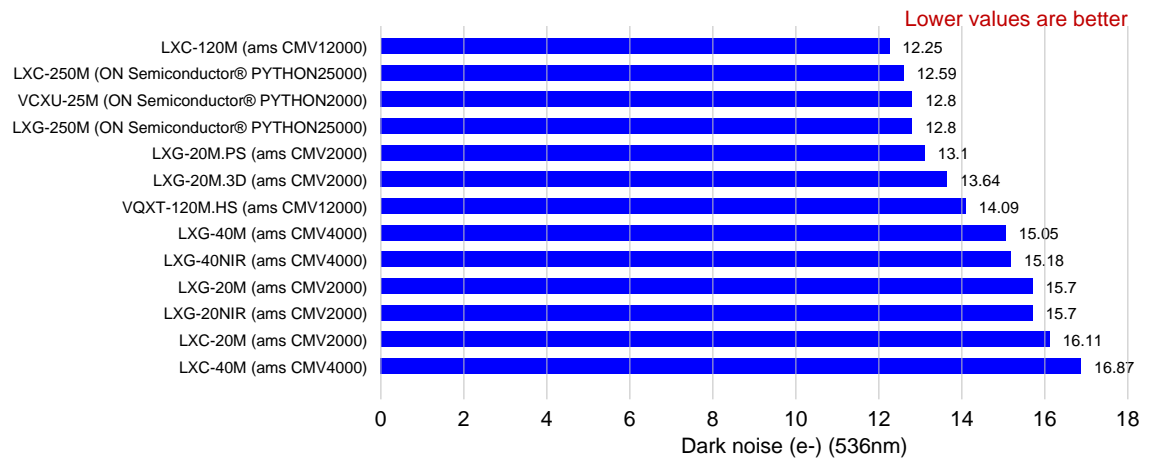
Quantum Efficiency QE [%]



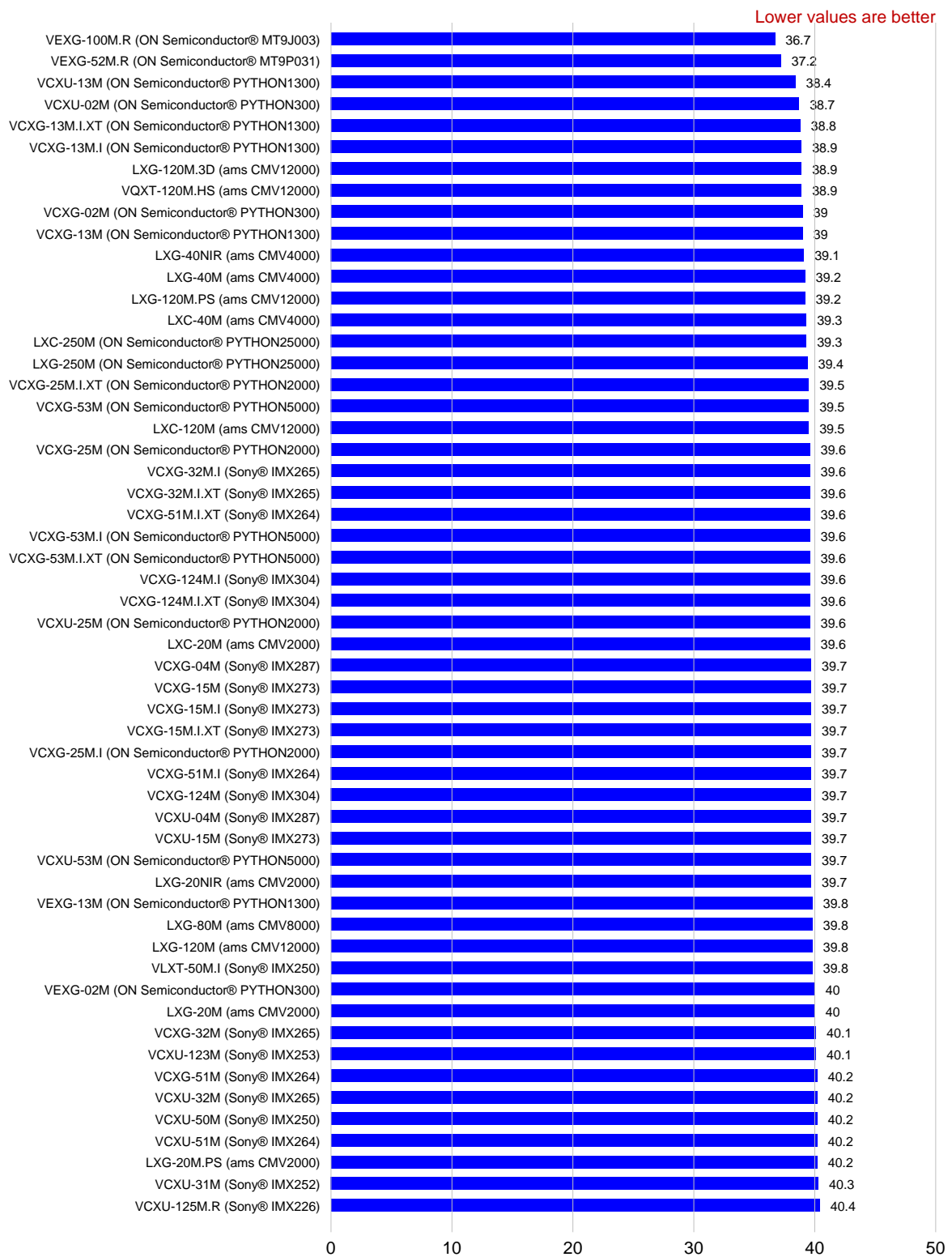
Dark Noise (536nm) (e-)



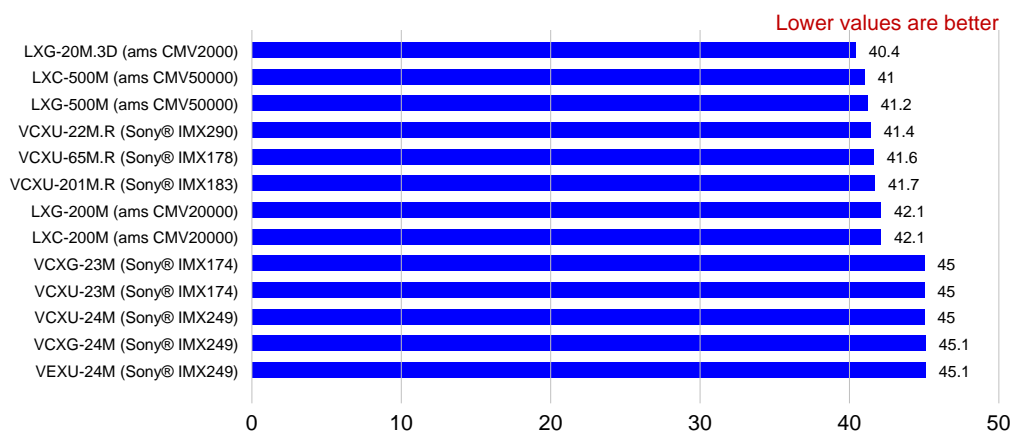
Dark Noise (536nm) (e-)



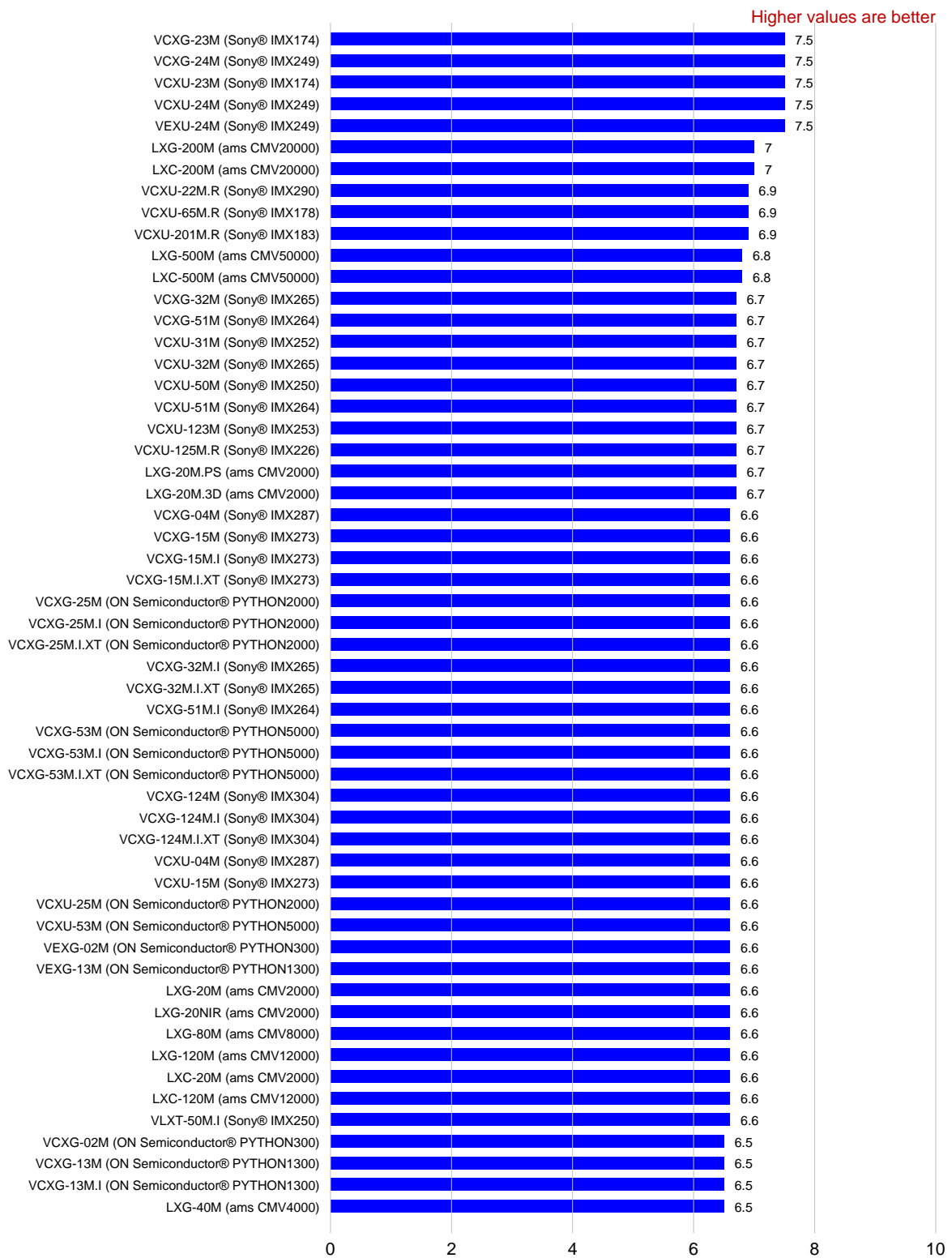
Signal-to-Noise-Ratio (536nm) (dB)



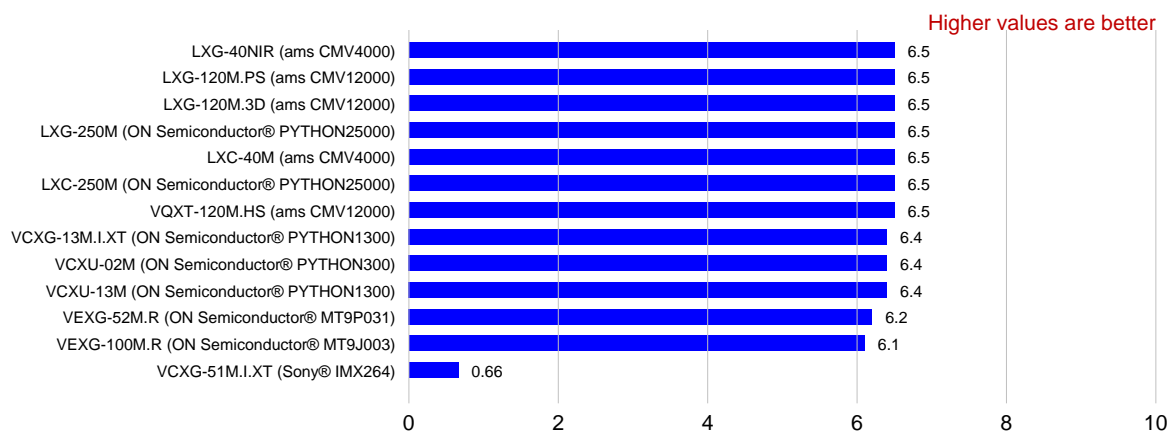
Signal-to-Noise-Ratio (536nm) (dB)



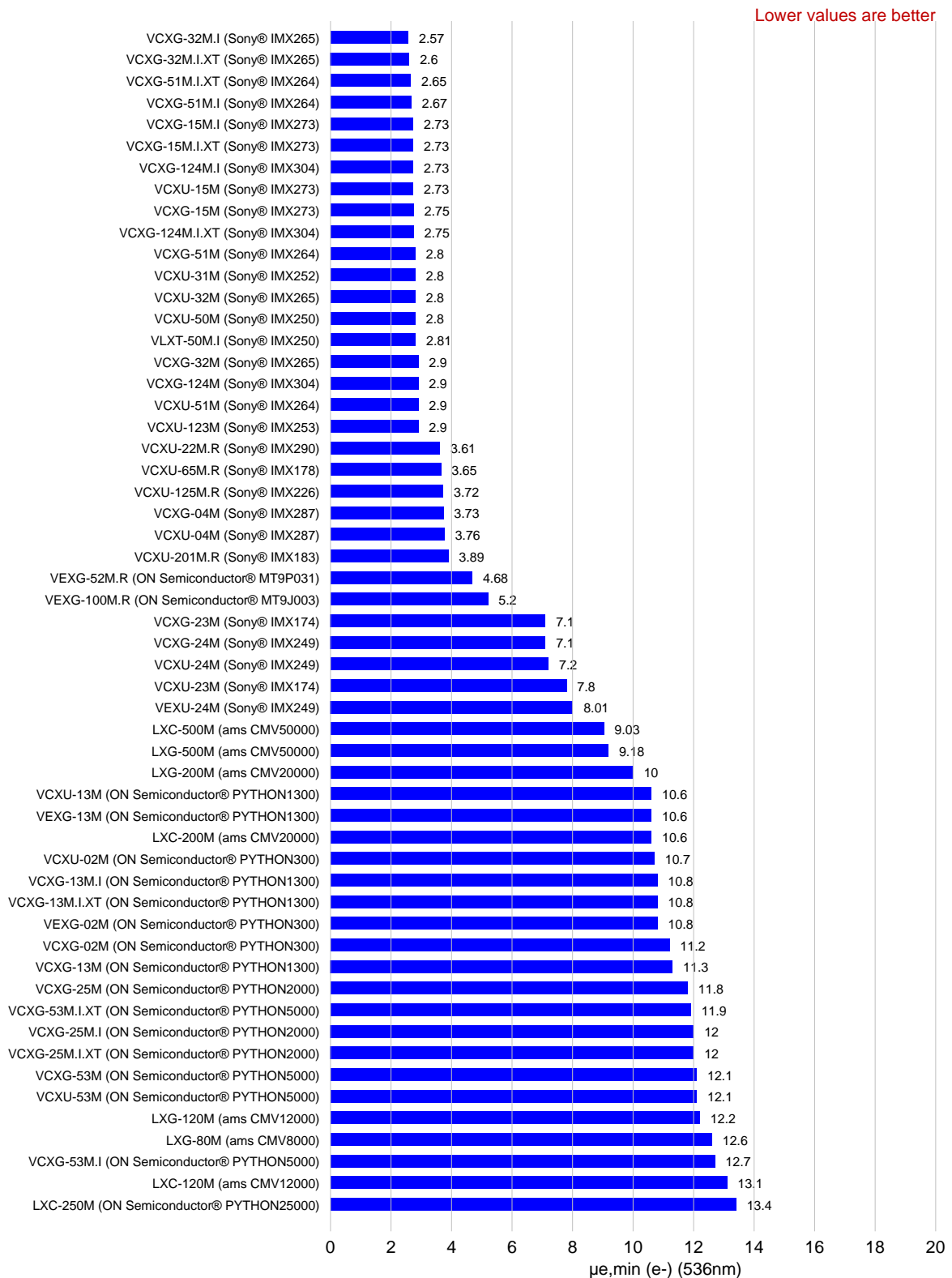
Signal-to-Noise-Ratio (536nm) (bits)



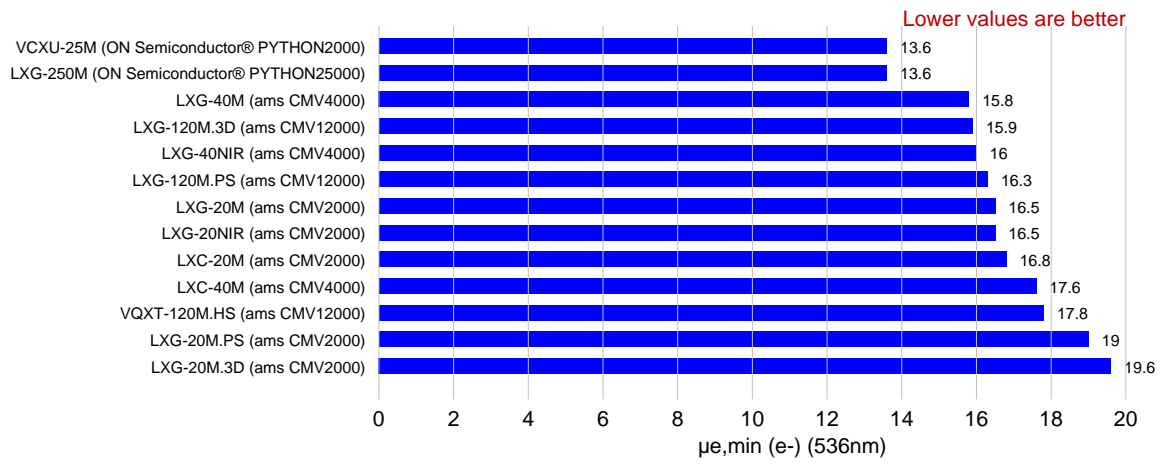
Signal-to-Noise-Ratio (536nm) (bits)



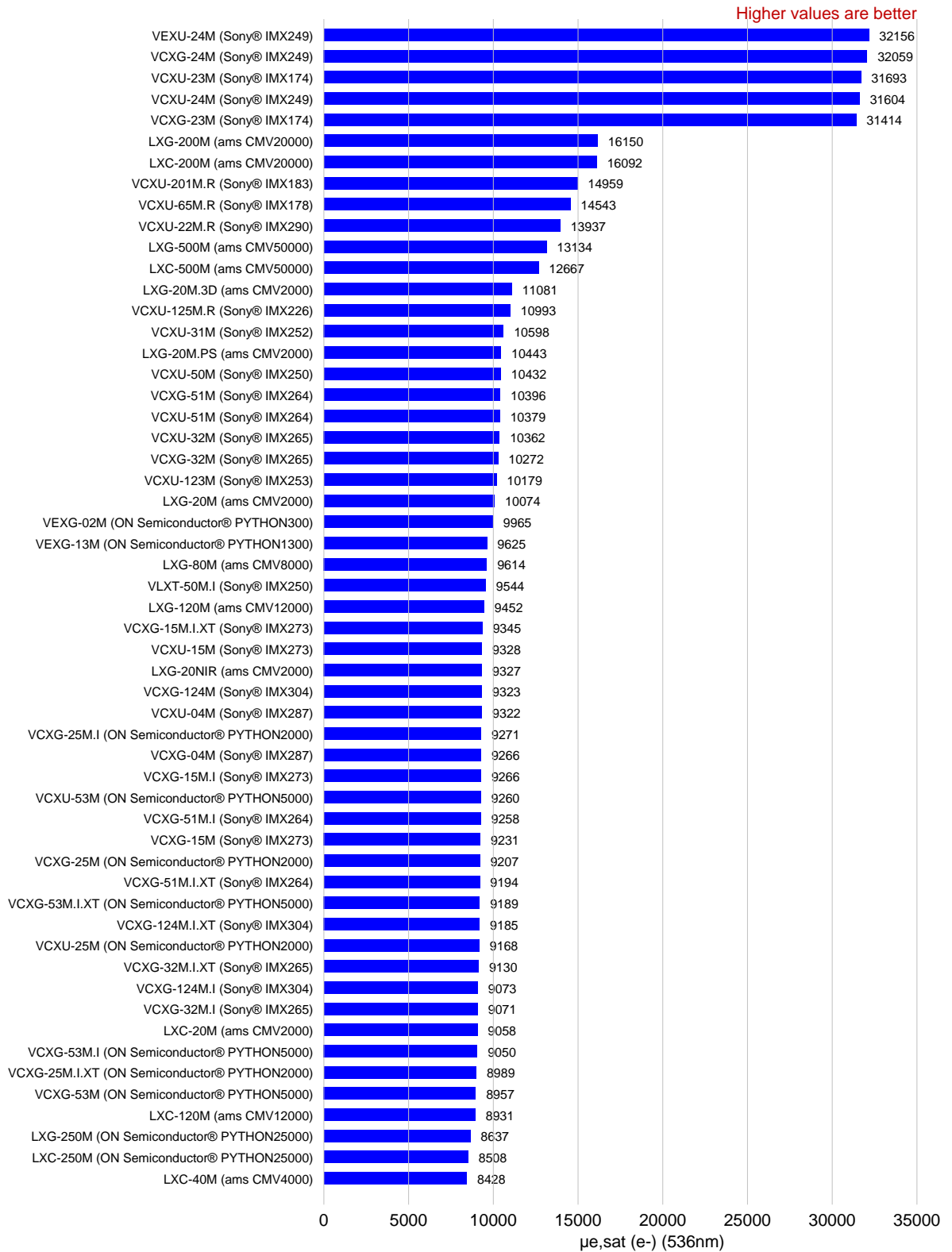
Absolute Sensitivity Threshold (e-)



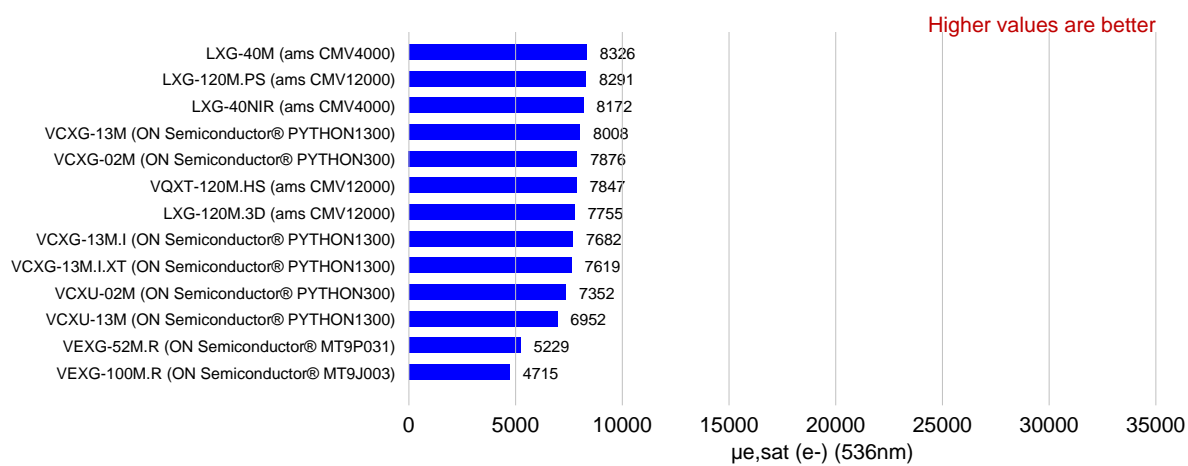
Absolute Sensitivity Threshold (e-)



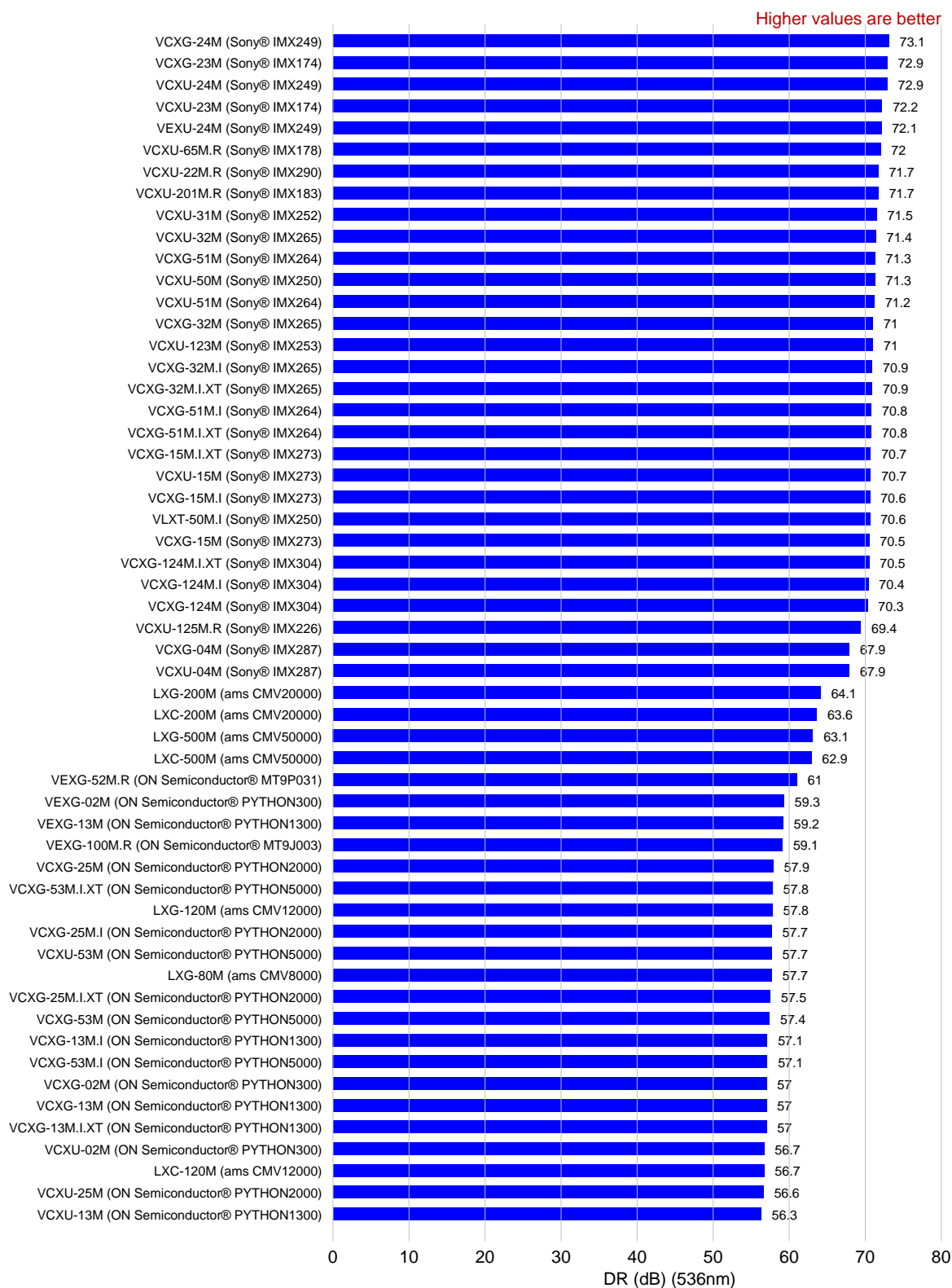
Saturation Capacity (Well Depth) (e-)



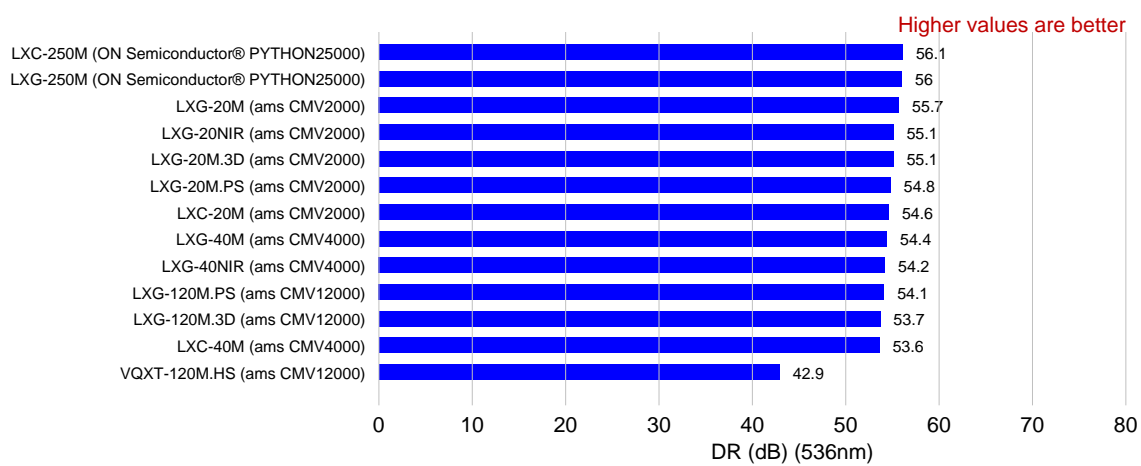
Saturation Capacity (Well Depth) (e-)



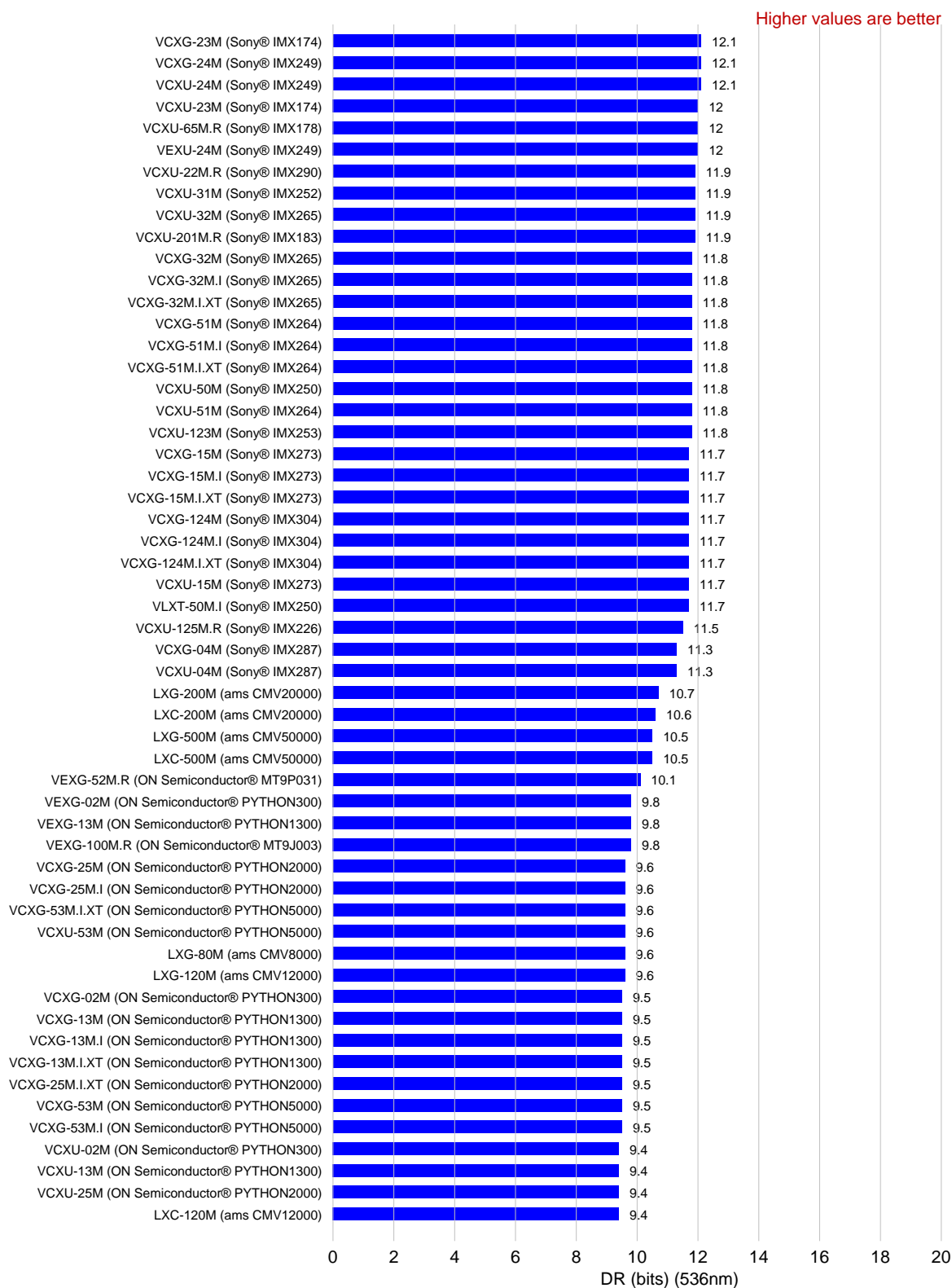
Dynamic Range (dB)



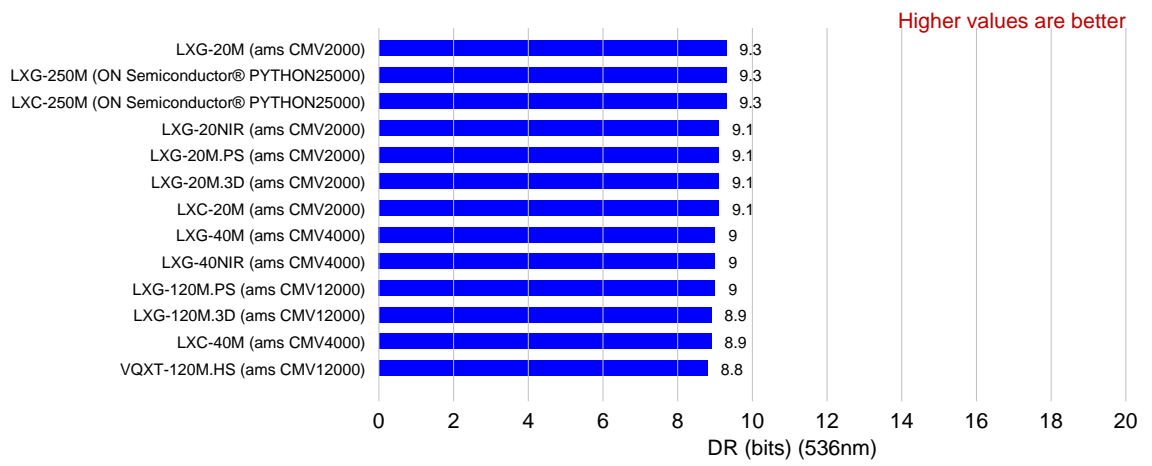
Dynamic Range (dB)



Dynamic Range (bits)

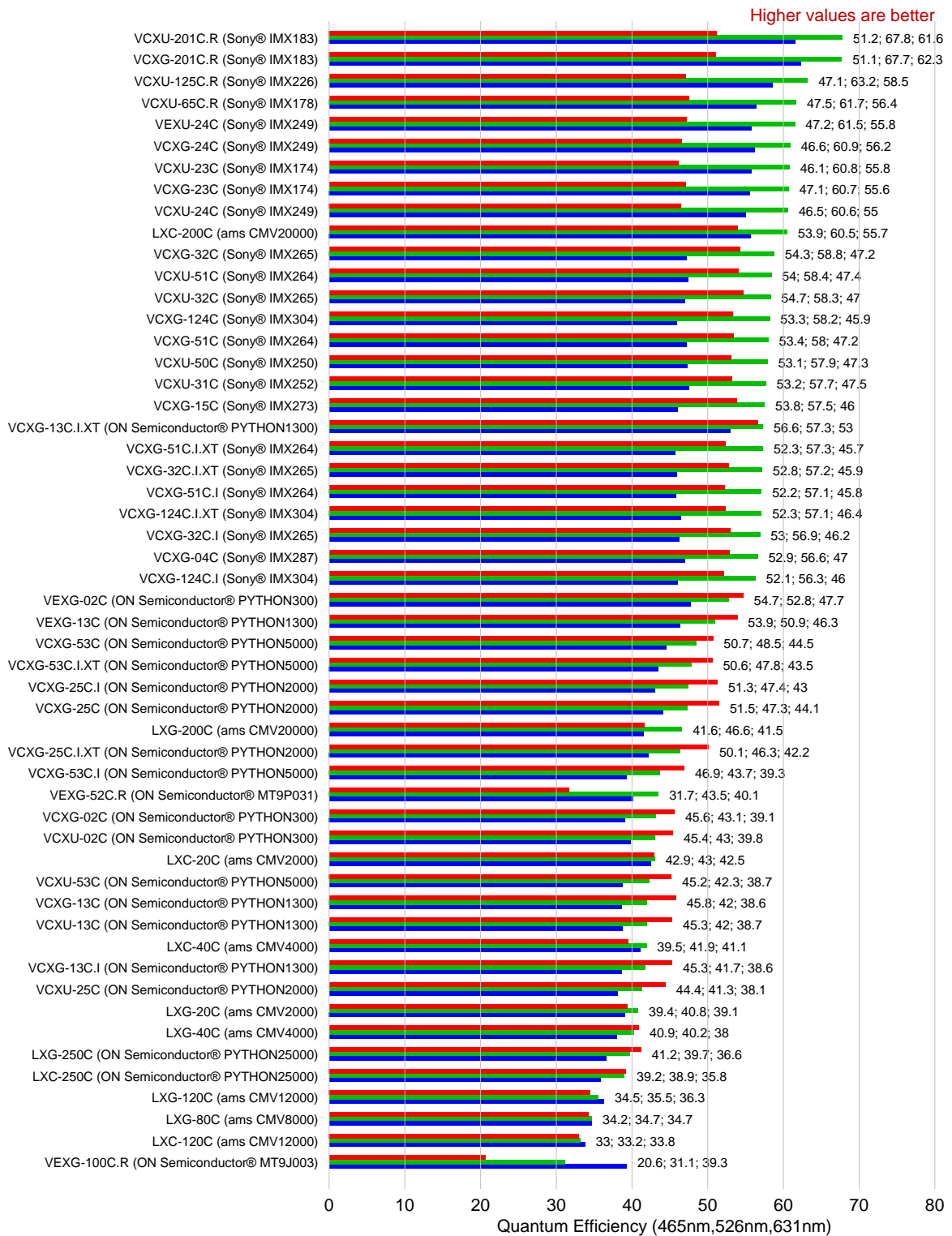


Dynamic Range (bits)

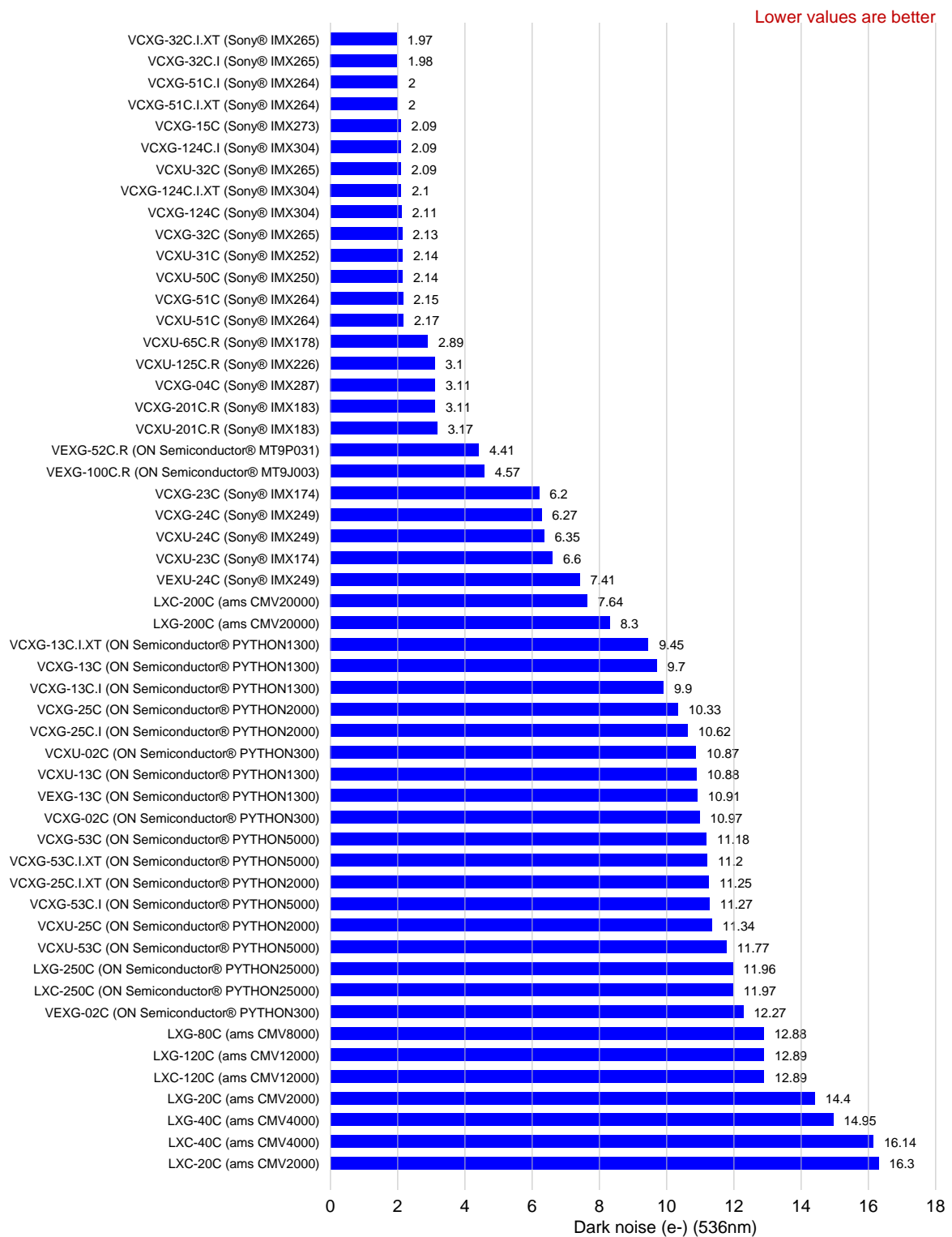


4 Color Cameras

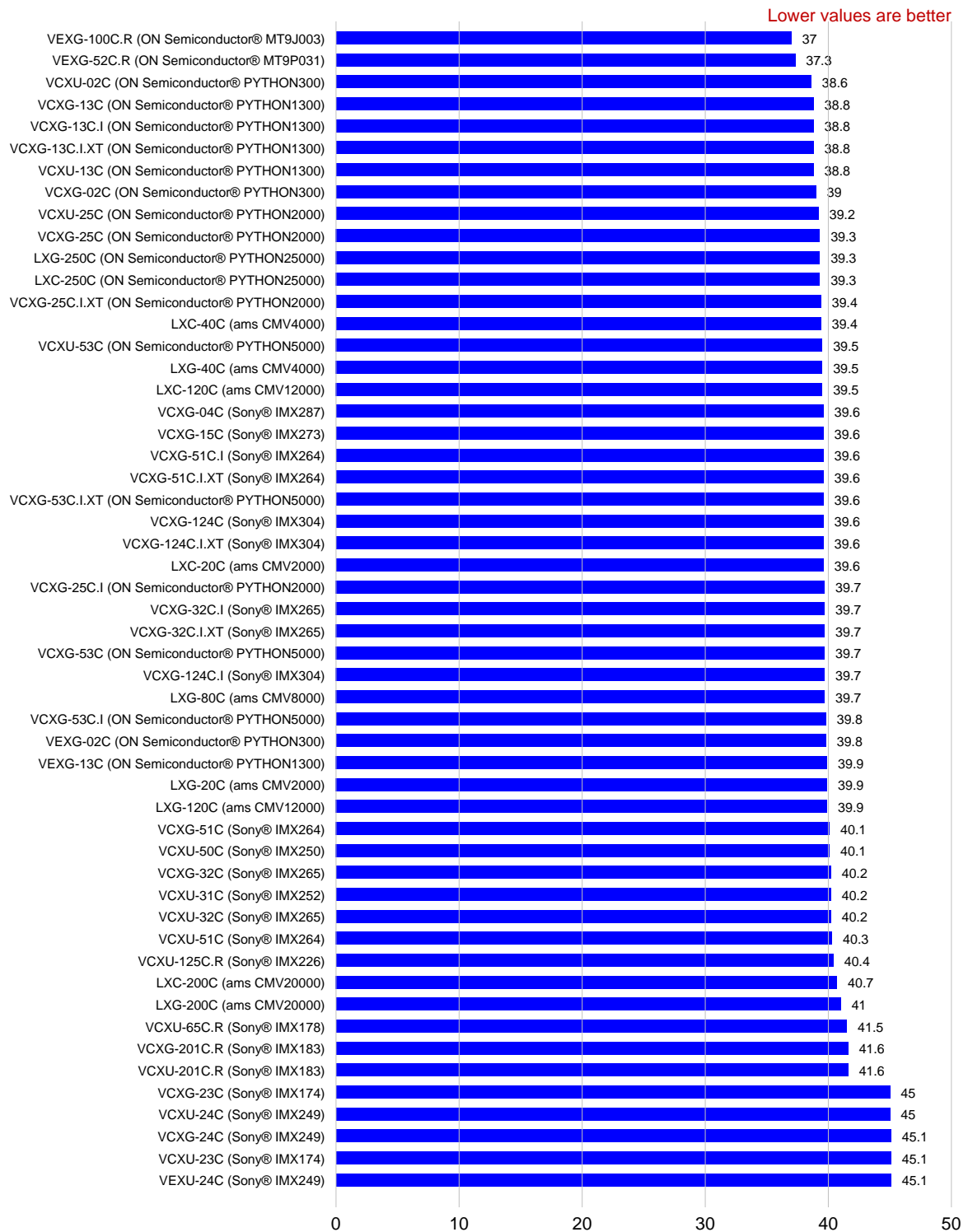
Quantum Efficiency QE[%]



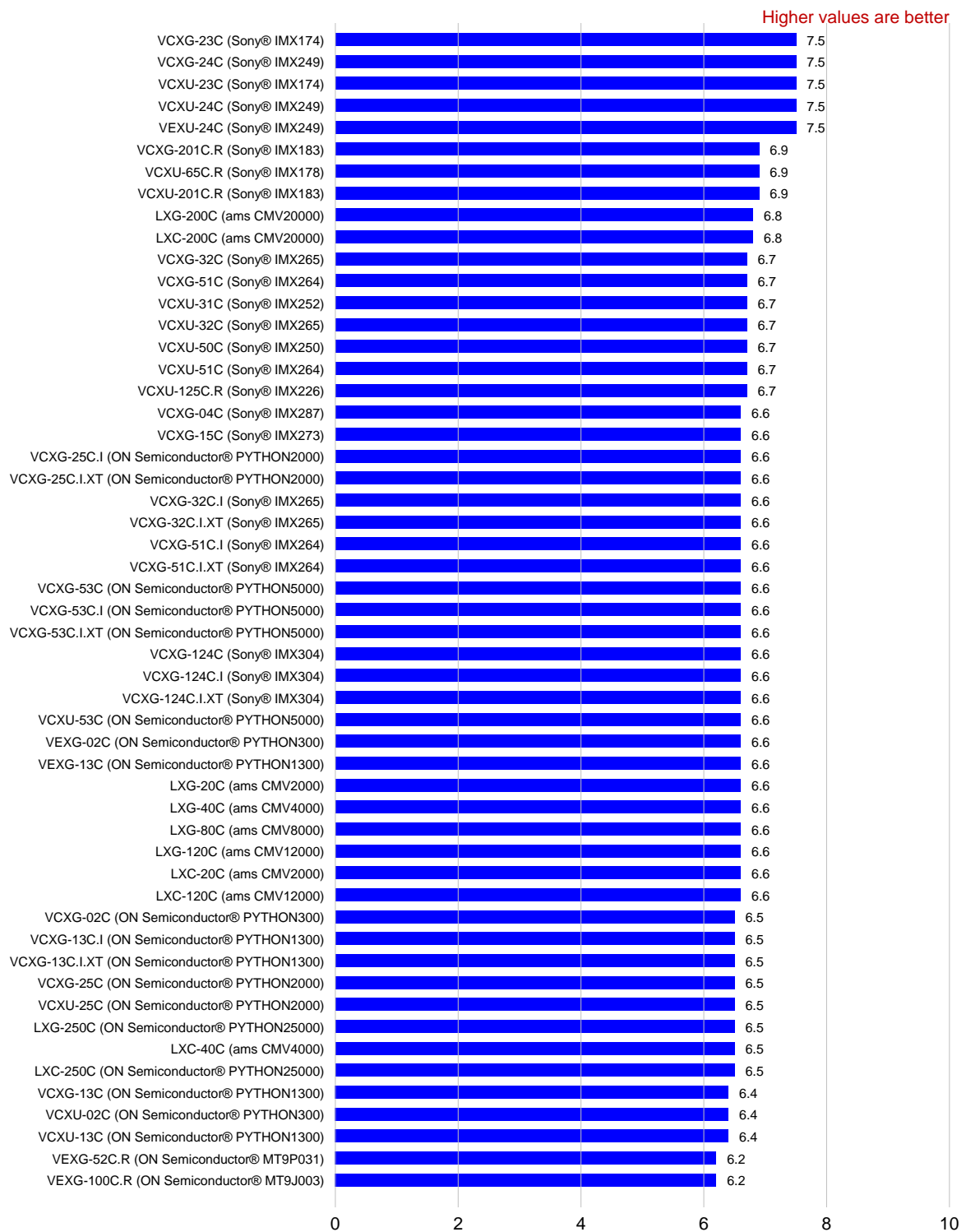
Dark Noise (536nm) (e-)



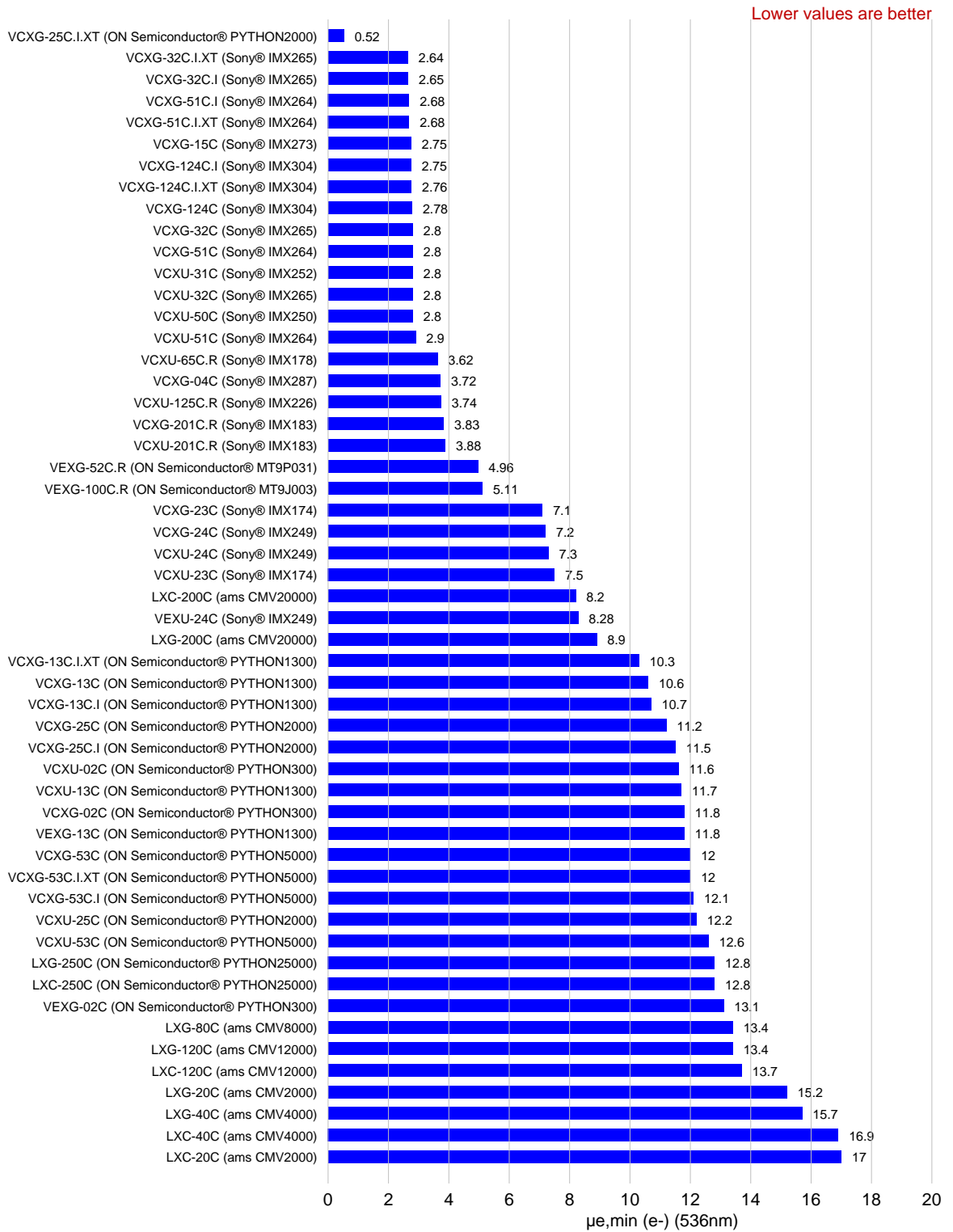
Signal-to-Noise-Ratio (536nm) (dB)



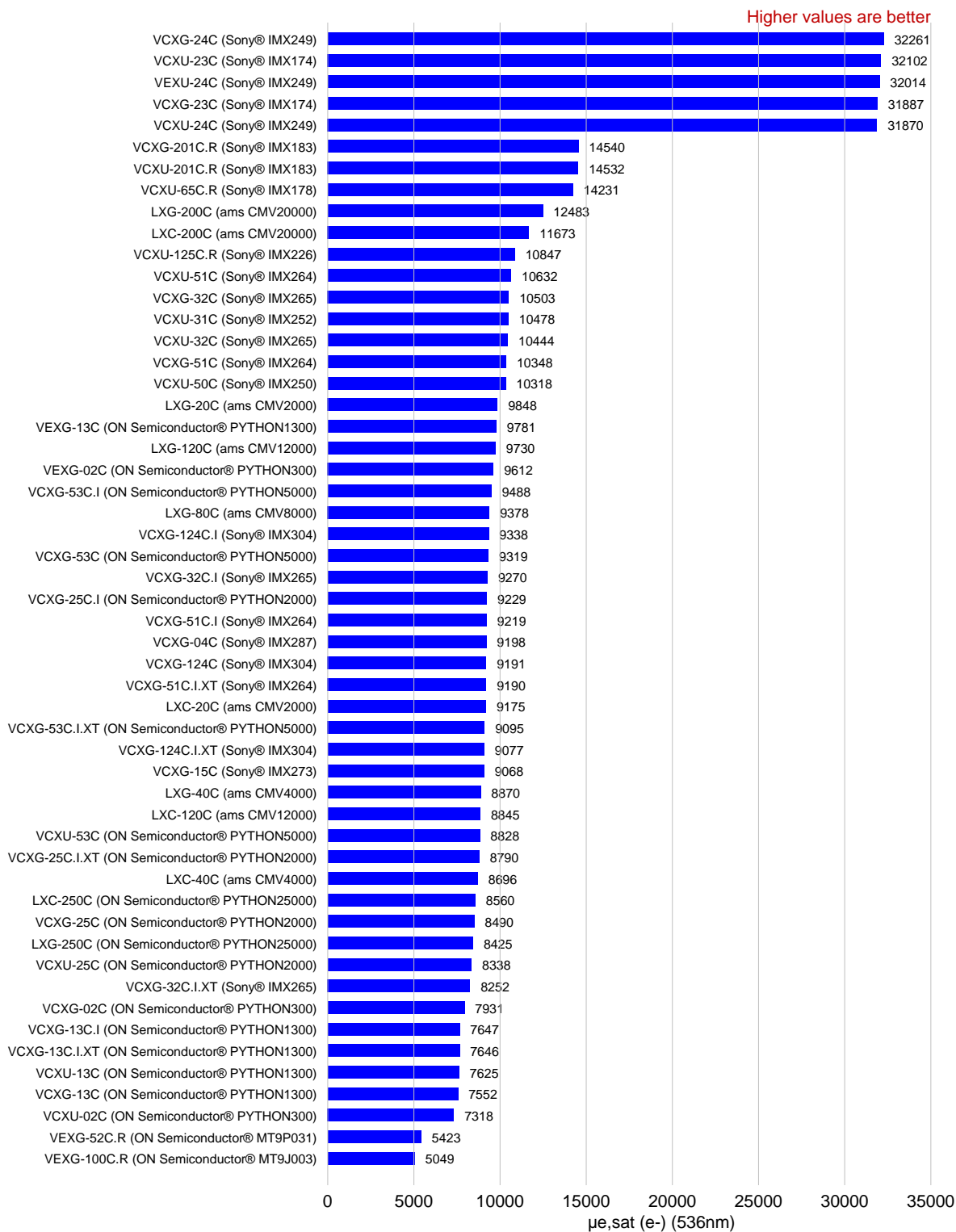
Signal-to-Noise-Ratio (536nm) (bits)



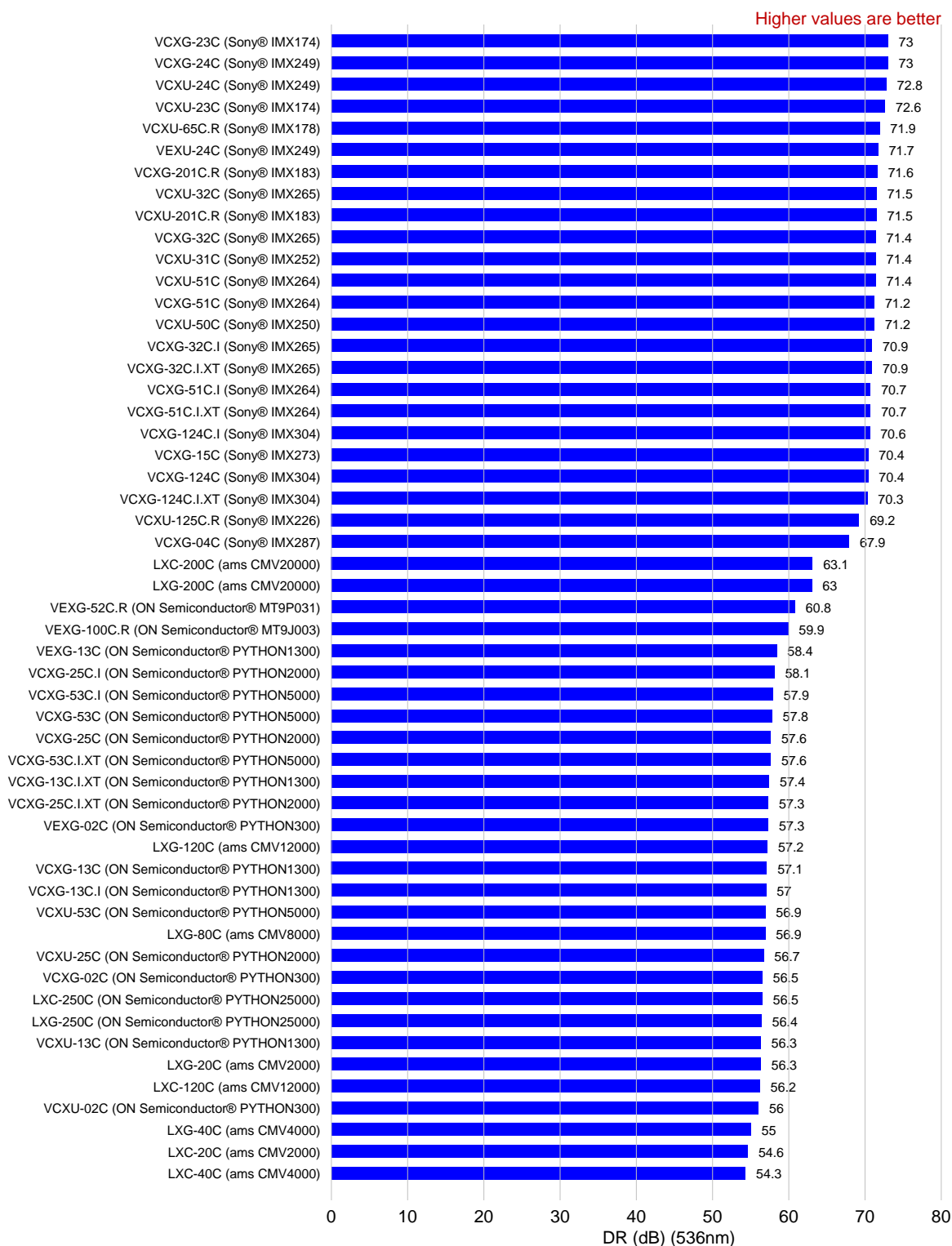
Absolute Sensitivity Threshold (e-)



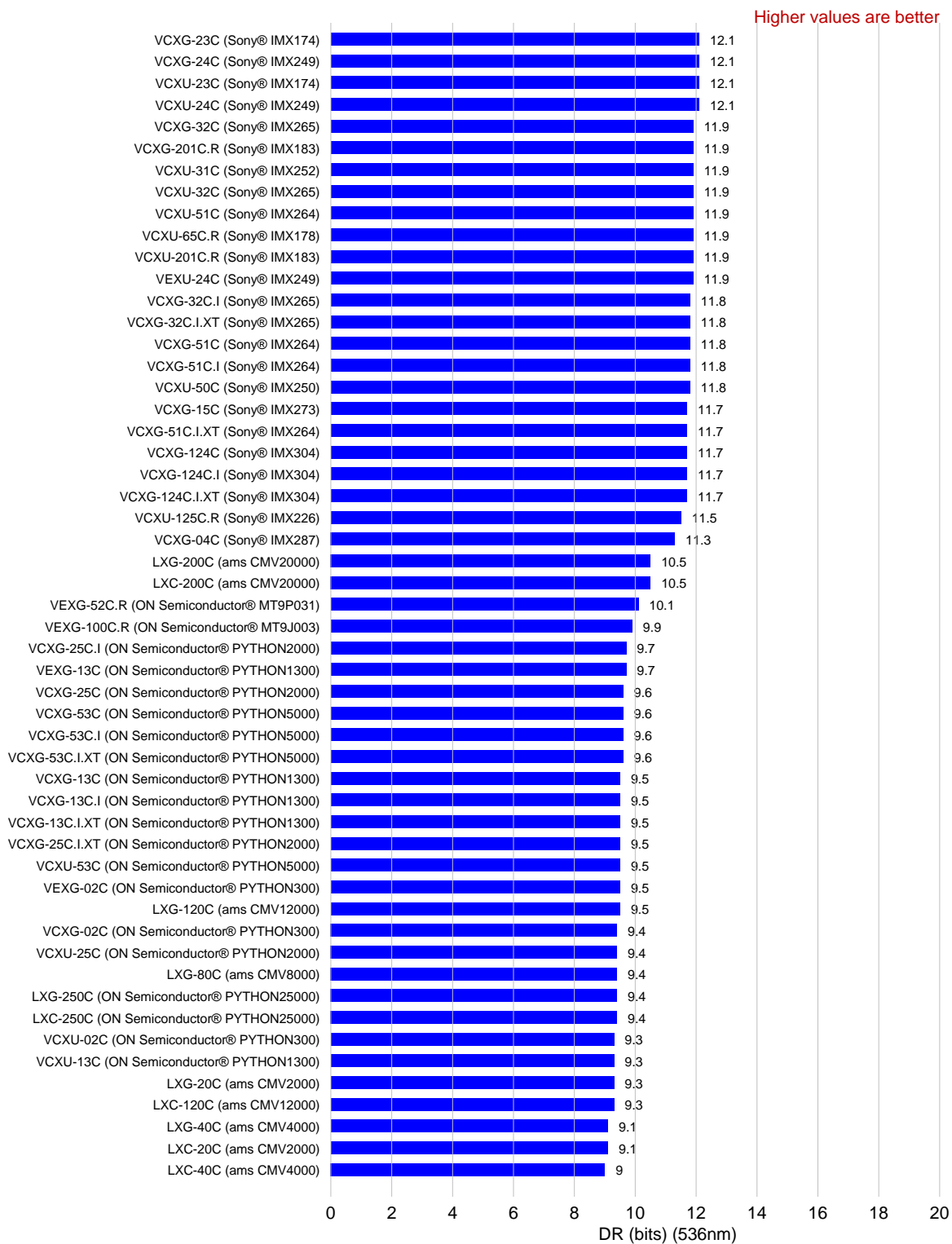
Saturation Capacity (Well Depth) (e-)



Dynamic Range (dB)



Dynamic Range (bits)



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