

Light Matters

Designing illumination systems with high-brightness LEDs



Multispectral imaging can offer unique perspectives into nature. The concept of multispectral imaging (MSI) and sensing is simple.

Imagine if your eyes could see/sense a much wider set of spectral wavelengths. Certain flowers, for example, would look quite different (many have interesting “landing patterns” to aid and attract insects, only visible under UV). In the Life Sciences, MSI can be useful in early disease detection and mapping, since it reveals hemoglobin oxygenation, lipids, water content and melanin at various positions and depths. And of course there are innumerable applications of MSI in satellite imaging for real-time agricultural, ecological and military information.

USGS’s Landsat series of satellites uses MSI, with specific spectral bands optimized for areas of interest, as in Table 1.

Wavelength	Landsat Satellite Use
430 – 450nm	Coastal studies and marine aerosol
450 – 510nm	Bathymetric maps, distinguishing soil vs. plants and deciduous vs. coniferous vegetation
530 – 590nm	Emphasizes peak vegetation, useful for assessing plant vigor
640 – 670nm	Discriminates vegetation slopes
850 – 880nm	Emphasizes biomass content and shorelines
1.57 – 1.65µm	Discriminates moisture content of soil and vegetation; penetrates thin clouds
2.11 – 2.29µm	Improved moisture content of soil and vegetation also thin cloud penetration

Table 1 – Some of the spectral bands used by Landsat satellites¹

Back down here on Earth, most MSI applications are geared towards scientific, industrial, medical and high-end lighting. The desired end-result isn’t necessarily an image, either—sometimes the requirement is for a small inexpensive multispectral sensor. In these designs, especially for color inspection, process control or closed-loop feedback, common RGB (red, blue, green) peaked sensors are not precise enough. That’s because the “chasms” between the RGB peaks have less sensitivity if the three sensing elements have steep roll-offs, and less selectivity if the three sensing elements overlap each other’s spectra. In other words, R, G and B are too far apart for some applications.

You’ll need to fill in the gaps. I may have a solution.

The device resting on my forefinger in Figure 1 is a MMCS6 precision 6-channel multispectral sensor, with peaks at 425nm, 475nm, 525nm, 575nm, 625nm and 675nm. It’s intended for high-volume commercial applications ranging from fabric dye color process control to agile color feedback control loops in sophisticated multi-color theatrical lighting.

This device is fabricated using stacks of optical interference filters (semi-transparent metalized thin films) layered over photodiodes. The filters allow



Figure 1 – A precision 6-channel multispectral sensor IC resting on my fingertip

only a selected, narrow band of wavelengths to pass through them, and are exceptionally stable over time and temperature. The output consists of seven analog signals; one for each peaked sensor, and one for a seventh sensor which is sensitive to the entire visible spectrum—it can be used to offset the others, etc.

Spectral Sensitivity of Sensors 1 - 6 (peaked) and 7 (wide)

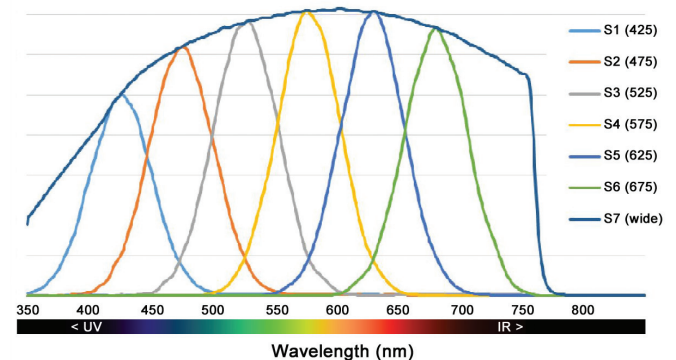


Figure 2 – Relative sensitivity of the tiny MSI sensor pictured in Figure 1 (Chart colors are arbitrary, so I placed a correlated spectrum at the bottom)

In a typical design, the sensor’s photodiode outputs (small currents) are first converted into voltages with a transimpedance amplifier IC then fed to the A/D converter of a microcontroller. Evaluation boards are available from Avnet in the Americas, and at EBV and Silica in Europe.

Although simple in concept, using MSI sensors effectively is not trivial and requires more information than I can present here. If you’re interested in the MMCS6 for commercial applications, feel free to send me a note at www.em.avnet.com/LightSpeed

¹ Data from <http://landsat.usgs.gov>



To learn more about designing an LED-based illumination system, go to:

www.em.avnet.com/LightSpeed