Video System Basics

By Julianne Wagner

TV LINE RESOLUTION

Both CCD and Monitor Resolutions are often given in terms of "TV line resolution," which is a test performed using an EIA Test Pattern target. Unfortunately, this specification has no physical units of measurement (such as mm or inches) and can therefore be rather ambiguous. To convert TV line resolution into lines per mm (for example), the following conversions can be used:

$$\text{HORIZONTAL RESOLUTION (lines/mm)} = \frac{\text{(TV lines [H] x 1.333)}}{\text{(2 x Horizontal Sensing Distance in mm)}}$$

$$\text{VERTICAL RESOLUTION (lines/mm)} = \frac{\text{TV lines [V]}}{\text{(2 x Vertical Sensing Distance in mm)}}$$

We recommend you use electronic components of increasing or equivalent resolution as components are added to the camera. Resolution, as well as contrast, is higher in monochrome systems due to lower signal degradation. Contrast is determined in discrete increments by using an EIA Gray Scale Pattern target.

PIXEL COUNT RESOLUTION (NUMBER OF PIXELS)

Many of our customers are concerned with pixel count resolution. Like TV line resolution, pixel count resolution can be misleading if not interpreted correctly. Most CCD's do not offer perfect rows and columns of pixels and often contain dead spaces in between. Even cameras that have no dead space can yield imperfect center to center pixel resolution. Factors such as signal-to-noise and pixel jitter all contribute to the camera's actual spatial resolution. Where pixel resolution proves to be the most beneficial is in the use of video capture devices. When using video capture devices, the only way to match the capture board's capabilities with that of the camera's is to compare the pixel count.

PRIMARY MAGNIGFICATION:

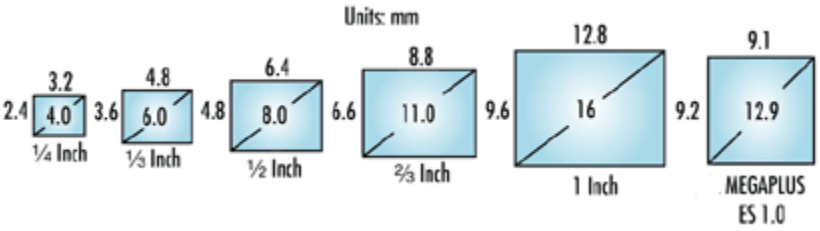
Many of our lenses list a primary magnification for calculating the field of view, which is dependent on CCD size. The following equation shows the relationship between primary magnification and field of view (taking into account overscan of an analog monitor.)

$$\text{FIELD OF VIEW} = 0.95 \times \frac{\text{CCD Sensing Distance}}{\text{Primary Magnification}}$$

CCD FORMAT

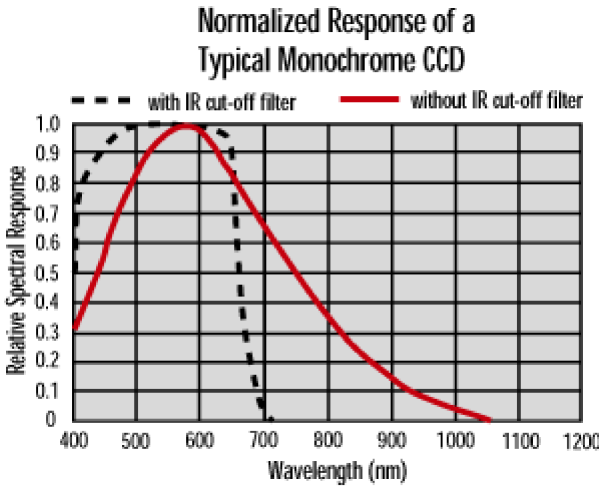
Aspect ratio for most Charge-Coupled Devices (CCD) is 4:3. Note that the sensor format size is not equivalent to the

sensor's active area. Video lenses can be used with any CCD camera, provided the lens design format is larger or equal to that of the camera.



C-MOUNT

This is a threaded mount (1-32 TPI) and is used on most industrial CCD cameras and lenses. The flange (back focal) distance to the sensor is 17.5mm. CS-Mount thread is the same, but the flange distance is 12.5mm. C-Mount lenses and CS-Mount cameras are compatible, using a 5mm spacer. (#03-618).



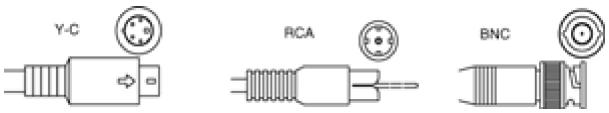
CCD CAMERA SENSITIVITY

Above is a typical response curve for silicon CCD's. All of our black and white cameras have a similar response (except for NIR versions). The color cameras typically come with an IR blocking filter that cuts off at 700nm.

SIGNAL FORMAT

There are four basic signal types used in CCD cameras: Composite (NTSC, EIA), Y-C (S-video), RGB and Digital (RS-422). NTSC (RS-170A/Color) and EIA (RS-170/Monochrome) signals are the most common and will accommodate most applications. Y-C and RGB separate the image into components and therefore provide superior image quality for video recording and image analysis. Digital cameras provide a level of performance that make them unique. Used in conjunction with image capture boards, digital cameras do not suffer from the visual constraints imposed by video formats. The result is greater flexibility in image acquisition and quality. In any electronic system, the signal format

should be constant. Any accessories added to the common camera-monitor system are added directly after the camera.



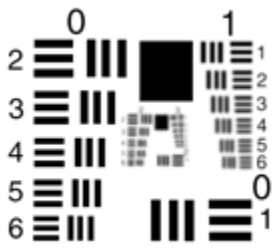
Each video signal format corresponds to specific cable connectors, as shown above. Composite signals can use either BNC or RCA type connectors. Y-C uses four-pin DIN type connectors and RGB uses four BNC connectors.

AUTOMATIC GAIN CONTROL (AGC)
This is an electronic option that automatically compensates for low light levels. Manual Gain Control is a similar option that is used to adjust the camera to changes in the system environment.

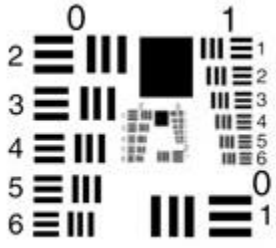
ELECTRONIC SHUTTER
This is an electronic function that controls the amount of light in a system in order to prevent overexposure and blooming. The shutter works in stepped increments, decreasing collected illumination by 50% for each increment. The shutter decreases exposure time in eight steps, from 1/60th second to 1/10,000 second.

Color vs. Monochrome Cameras

When choosing a camera for an industrial application, many system specifiers instinctively select color because they feel a monochrome image is inferior. That, however, is incorrect. Monochrome cameras have higher resolution, better signal-to-noise ratio, increased light sensitivity, and greater contrast than similarly priced color cameras. Although color imaging may be preferable, the eye perceives spatial differences more clearly in gradients of black and white. In addition, industrial applications requiring a computer interface typically operate with a black and white camera, since a color image requires more processing time and does not yield significantly more information about the object. When a high resolution color image is necessary, it is beneficial to use



Using a Single Chip Color Camera



Using a Black and White Camera

a 3-chip (also called 3-CCD or RGB) camera. By utilizing three CCD sensors, these cameras offer the best of both worlds, yielding greater spatial resolution and dynamic range than single chip color cameras. The image is directed to each sensor using a prism and is then filtered to provide independent red, green and blue signals. The RGB output from a three-chip camera is considered to be superior to the standard NTSC and Y-C formats, because the RGB color information is on three separate signals.

Julianne Wagner *joined Edmund Optics in June, 1996. She received a Optical Engineering Degree from the University of Rochester. She has served as an Applications Engineer and later Senior Applications Engineer before becoming a Product Line Manager.*