FAQ MicronViewer 7290A Frequently Asked Questions (and their answers)

How is the MicronViewer IR Camera different from silicon CCD cameras?

The MicronViewer has several important differences over silicon CCD cameras. Foremost, the camera has an extremely wide spectral response characteristic that extends to over two microns. This is twice the bandwidth of silicon CCD cameras. The reason for the difference is due to the sensor. The camera is based on a vidicon that contains a photoconductor as sensor (and so it is not "solid state"). The photoconductor is a continuous material that changes conductivity when illuminated by different amounts of energy (depending on the wavelength). The image is created as a result of a scanning electron beam that creates a current related to the conductivity. (CCD cameras, on the other hand, are based on a self-scanning semiconductor imaging device in which minority carrier charges accumulate in an array of wells). Two anomalies of the photoconductive technology are: slower response time and non-unity gamma.

Other differences of the 7290A over CCD cameras include: wider spectral response, continuous detector rather than a discrete array of detectors, vidicon rather than solid state.

How is the MicronViewer IR Camera different from thermal IR cameras?

As an infrared camera, the MicronViewer can be used to see radiation emitted by objects. However, because of the camera's short-wave spectral response (0.4-2.2 m), it can be used to see radiation from objects hotter than 250°C. Similar to other thermal infrared cameras (such as the Electrophysics PV-320), the MicronViewer produces black and white video images where white areas denote hotter objects and black areas, cooler objects.

What is image lag and how does it affect performance?

Because of the photoconductive target material used as the imaging detector, the 7290A has some image lag (the conductivity does not change instantaneously). Quantitatively, most 7290A cameras exhibit less than 60% lag. That is, 50ms after removal of a step input, the output image degrades to 60% of its original value. Lag after image saturation can be significantly longer (several minutes).

How do I use the MicronViewer IR Camera for quantitative measurements?

Because the MicronViewer has a non-unity gamma, the calculation of input illumination must be performed with some care. The MicronViewer has a gamma of 0.7. This value is the slope of the curve describing the light transfer characteristic of the camera. If the gamma had been 1.0, then the calculation of illumination would be linear. (And, if the dark current was negligible and the gamma unity, a doubling of input illumination would result in a doubling of output current — until saturation). The characteristic is obtained by plotting the log of the signal output current versus the log of the illuminance at the faceplate. The gamma provides the exponent relating illuminance to the signal output current: $[I/i_d] = [I/I_d]^g$

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Where:

i = output current from MicronViewer's detector

i_d = dark current due to MicronViewer's detector

I = illuminance onto MicronViewer's detector

I_d = equivalent input illuminance (that would result in the same detector output as the dark current).

g = gamma, slope of Light Transfer Characteristic – typically 0.7, however, the actual value should be measured.

Typically, a value of i_d=5 nA can be used. However, as the camera ages, its dark current may increase. In addition, if the camera gain (back-panel) is increased from its minimum manual setting, the dark current value will also increase. For the value of id=5 nA, the equivalent input illumination is about 0.3 lx. (Although this value can be estimated by extrapolating the Typical Light Transfer Characteristic, it is best if it is measured).

In performing experiments for which it is desired to quantify the output video signal, it may be possible to group all the unknown quantities together and to rewrite the equation above as:

$$K[V_s]^{1/g} = I$$

Where:

V_s = Video signal voltage from MicronViewer

K = Bulk constant (this must be recalculated if the camera settings such as gain are changed)

Thus, if an illumination of I_1 results in a video signal of V_{s1} and I_2 results in V_{s2}, then the unknown bulk constants can be removed and the relative calculations are straightforward:

$$[I_2/I_1]^g=[V_{s2}/V_{s1}].$$

Of course the above is only valid for the operating range of the camera before saturation.

How does the performance of the MicronViewer 7290A-06 compare with the 7290A camera?

The MicronViewer Model 7290A-06 utilizes an infrared vidicon having an extended spectral response capability reaching beyond 2 microns. It is extremely useful when viewing infrared radiation at wavelengths from 2.0–2.2µm. However, in the 1–2 micron region, its performance is slightly inferior to the 7290A (non-extended range version) in terms of dynamic range (50:1 instead of 100:1), resolution (650 TV lines instead of 700 TV lines) and shading. It is recommended that the 7290A-06 be considered only for those applications requiring the superior sensitivity in the extended wavelength region.

How can one use a MicronViewer 7290A to assemble an infrared microscope?

An infrared microscope is an effective tool for sub-surface inspection of near-infrared transparent materials (such as semiconductor substrates). Although an optimized system can be quite complicated (contact us for different customized systems), one can combine the MicronViewer 7290A with standard optical microscope components and produce reasonable results. In so doing, please note the following useful information:

1) Although standard microscope objective lenses are designed for optimum performance in the visible wavelength range (400–750nm) most have reasonable performance at the longer near-infrared wavelengths, that is 400–1500nm, even as long as 2000nm. Alternatively, microscope objective lenses are available that are optimized for the near-infrared range.

2) Tungsten-halogen illuminators are rich in near-infrared radiation and consequently are ideal for use in these inspection applications. However, be sure that there are no infrared-blocking filters in the illumination path. These blocking filters are more common in biological microscopes to

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prevent heating of live samples. Near-infrared blocking filters can often be identified by their coating that often shows as a red tint.

3) For applications where transmitted light can be used for illumination (specifically, when there are no opaque substrates), no optical filters are required since the near-infrared transparent sample under inspection (SUI) acts as a filter and blocks unwanted components so that they do not impinge on the MicronViewer's detector. However, in reflected light applications (bright-field or dark-field), an optical filter must be placed in the illumination path in order to prevent those wavelength components that will not penetrate the surface of the SUI. For example, if they are not blocked, visible light components from the illuminator will be reflected from the top surface of the SUI and will be detected by the MicronViewer (which also detects visible light).

   When observing silicon, a filter made of silicon is an easy choice since it will nicely pass all the wavelengths that are transparent to silicon and block the rest. (In addition, silicon has high transmissivity to near infrared radiation). On the other hand, interference filters are very effective since they transmit only a small spectral band resulting in highly contrasted images.

What is the smallest element resolvable with the MicronViewer?

Since the MicronViewer has a continuous detector scanned with an electron beam rather than a discrete detector (like a CCD camera), it does not have "pixels" (discrete picture elements). The minimum resolvable element, then, depends on the raster scan (in the vertical direction) and the resolution (in the horizontal direction). The Amplitude Response (MTF) is available to show how the contrast of the image depends on the size of the objects being viewed (see Mid-Range Infrared Viewing Cameras Product Note). The smallest resolution element can be estimated as follows:

- In the vertical direction, the resolution is primarily limited by the raster scan, 525 lines for 60Hz cameras, 625 lines for 50Hz cameras. Since the 7290A's vertical detector size is 9.5mm, the equivalent "pixel" height is about 18 microns (9.5mm/525) for 60Hz cameras and 15 microns (9.5mm/625) for 50Hz cameras.
- In the horizontal direction, since the limiting horizontal resolution of the 7290A is 700TV lines, the equivalent "pixel" width is also about 18 microns (12.7mm/700).

How does one use the MicronViewer 7290A to image laser pulses?

The 7290A can be used to image both CW and pulsed laser beams. For pulsed lasers, there are four methods available for imaging:

1) To view individual laser pulses, the pulses must occur at exactly the camera's frame rate of 30Hz (25Hz for CCIR cameras). To synchronize the two 30Hz signals (one from the camera, the other from the laser), the 7290A's GEN-lock feature can be used.

2) In some cases, it is possible to synchronize the laser to the MicronViewer by using the 7290A's video output signal to control the laser pulse generator electronics.

3) If the laser's pulse repetition frequency is not exactly identical to the camera's frame rate, then the number of pulses that illuminate the 7290A's faceplate during a video frame will differ from frame-to-frame. For example, for a 20Hz signal, this would mean that one video frame may be the result of a single pulse while other frames may have no contribution. The resulting image will oscillate (beat) bright and dark. On the other hand, if the pulse repetition frequency were 1000Hz, each frame would be the result of the contribution of 32–33 pulses. In this case, the 3% fluctuation may not produce a noticeable flashing.

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4) If the laser pulses occur randomly and a single pulse-per-frame is desired, it may be possible to record sequential frames (either with a real-time video segment frame grabber or simply by video recording the output). Then, the desired frame can be located and studied.

What does GEN-lock mean for the 7290A?

The GEN-lock input connector on the 7290A camera is used to synchronize the camera's video signal with an external 60Hz signal (50Hz for CCIR cameras). For example, if two cameras are used and it is desirable to have their scanning synchronized so that both cameras start their video frame at exactly the same time and synchronize their master clock signal (that produces the horizontal scanning protocol), simply attach the video output from one camera to the GEN-lock input of the other camera.

What are the characteristics of the MicronViewer's faceplate?

The detector in the MicronViewer cameras is positioned behind a borosilicate glass faceplate. The front of the faceplate is located approximately 16.5mm from the front flange of the C-mount. The characteristics of the faceplate are:

thickness:	2.4mm + 0.3mm
index of refraction:	1.489
transmission coefficient:	>80% from visible to 1.8m

How can the MicronViewer be used as a thermal imager?

Because of its near-infrared response, the 7290A (with a 25mm F1.4 objective lens) can be used to image the infrared radiation from objects hotter than about 250°C; it will saturate due to the radiation of objects hotter than about 350°C. In this circumstance, the temperature resolution would be less than 2°C. For viewing hotter objects, the radiation would need to be attenuated with either a lens iris or optical filter.

Because the 7290A responds to near-infrared and visible radiation, the camera must be shielded from this light to be effective as a thermal imager. A long-pass filter will help eliminate the most ambient radiation. However, sunlight or incandescent light which is rich in 1-2É m radiation must still be eliminated.

How is the MicronViewer best used without an objective lens (for beam profiling applications, for example)?

The MicronViewer has a very sensitive detector located behind the chassis C-mount opening. When used in a high EMI environment, noise can appear on the video reducing the ability to perform measurements. In these situations, it is recommended that a Faraday shield be added to the opening in such a way as to shield some of the noise without affecting the input infrared radiation. For example, an aluminum tube (such as an extension tube with the anodizing removed from the threaded part) can be screwed into the C-mount opening. The tube should be as long as possible, at least 50mm. Aluminum foil can also be used. In any case, it is important to assure that the shield makes good electrical contact with the housing.

Besides the threads serving as a good chassis ground contact, the steel chassis screw can also be used as a ground contact and attached to the shield with an alligator clip.

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