

## 360 Frames Per Second Camera

October 4, 2000

Higher frames rates are available as an option on all FTÅ 200, 2000, and 4000 instruments. A special camera, the JAI-M30, also called the CoStar CV-M30, is fitted along with a special control cable and frame grabber. The M30 can be operated in several different user selected modes. It is important to understand the capabilities and limitations of M30 when setting up a measurement.

The M30 can be used with any FTÅ microscope, manual or motorized. The camera and the microscope are two independent entities, although they are often referred to as one.

### Pixel Clock ("Speed")

The user may select either normal (NTSC RS170 or PAL CCIR) pixel rates ( $\approx 12.47\text{MHz}$  for NTSC) or double these. When running is double speed, each CCD cell collects light for one half the time and this makes the image slightly more noisy. Therefore choose normal speed for all slow measurements where the frame rate is 30 or less per second.

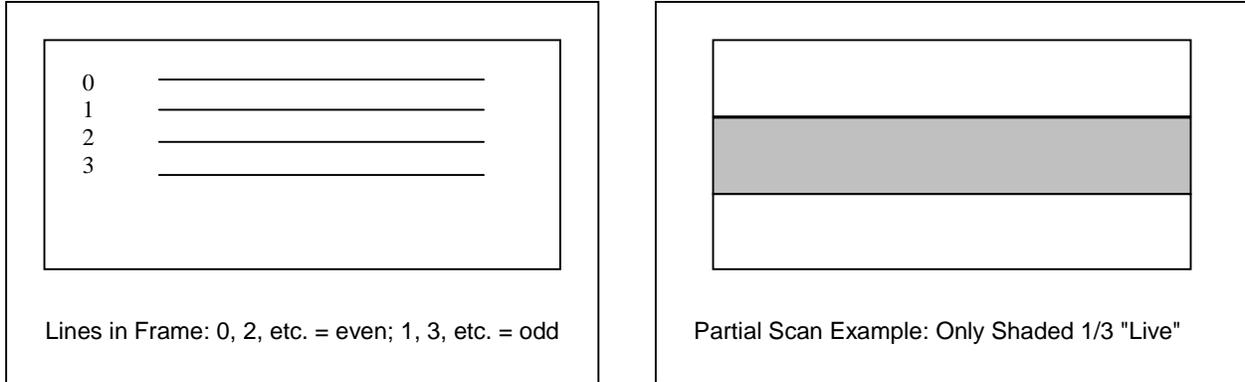
### Interlace

Normal image frames are interlaced, meaning one half of the lines (the "even" or "odd" alternating lines) are collected each field and two fields (one of even plus one of odd lines) are combined to make the complete frame. This means there is a significant time delay between collecting the even and odd fields: in the case of NTSC, 1/60 second between the two fields. As a consequence, any motion in the image between fields can create artifacts, typically a comb pattern. However, interlacing gives better overall image quality because there are more independent lines in the image. With slow images, interlacing is good.

When interlacing is *not* used, only the odd lines in the image are transmitted by the camera. Where do we get the even lines for the image? We can not simply skip them because the vertical height will then be only one half what it should be; the image will appear squeezed down. Instead, the missing vertical lines are supplied by mathematical interpolation. In other words, they are filled in by an algorithm that looks at the available, real, lines immediately above and below the missing lines. See figure on reverse page.

### Partial Scanning

In this mode, only a portion of the image is scanned. Think of taking a slice from the middle of the image. The correct aspect ratio is maintained for pixels, but the very top and bottom of the image are not scanned and not visible. By only partial scanning, more complete images of *what is scanned* can be had without increasing the pixel rate further.



The M30 offers full vertical scanning (normal mode), 1/2 and 1/3 vertical scans. The illustration above shows the middle third of an image being scanned, as indicated by the shaded area. Note that only the shaded area is "live" in this mode, so the area to be measured must appear in this portion. However, this allows some things to be measured with very high time resolution.

### Setup Combinations

The table below shows the set of possible combinations available to the user. When Image Lines are greater than Camera Lines, the extra lines are provided by interpolation. The normal full image has 480 lines. When Image Lines = 240, the vertical scan is a 1/2 partial scan; when Image Lines = 160, the vertical scan is a 1/3 partial scan. The lightly shaded combinations are the most useful.

Frames/Second	Camera Lines	Image Lines	Pixel Clock	Size & Mode
30	480	480	×1	1: Interlaced
60	480	480	×2	1: Interlaced
60	240	480	×1	1: Interpolated
120	120	240	×1	1/2: Interpolated
120	240	480	×2	1: Interpolated
180	80	160	×1	1/3: Interpolated
240	120	240	×2	1/2: Interpolated
360	80	160	×2	1/3: Interpolated

Finally, note the *aperture time* of the camera is an entirely separate setting. This is the time the electronic shutter stays open during each acquisition. It may be set for a time as short as 100μs = 1/10000s. This is useful for "freezing" motion, but does not affect the number of independent images captured per second.