REFRESH RATE

The **refresh rate** (or "vertical refresh rate", "vertical scan rate" for CRTs) is the number of times in a second that a display is illuminated. This is distinct from the measure of frame rate in that the refresh rate includes the repeated illumination of identical frames, while frame rate measures how often a display can change from one image to another. For example, a movie projector advances from one frame to the next 24 times each second. But each frame is illuminated twice before the next frame is projected. The result, the movie projector runs at 24 frames per second, but has a 48 hz refresh rate

Cathode Ray Tubes

In a CRT, the scan rate is controlled by the vertical sync signal generated by the video controller, ordering the monitor to position the electron gun at the upper left corner of the raster, ready to paint another frame. It is limited by the monitor's maximum horizontal scan rate and the resolution, since higher resolution means more scan lines. Increasing the refresh rate decreases flickering, reducing eye strain.

The refresh rate can be calculated from the horizontal scan rate by dividing by the number of horizontal lines and multiplying the result by 0.95 (since about 5% of the time it takes to scan the screen is spent moving the electron gun back to the top). For instance, a monitor with a horizontal scanning frequency of 96 kHz at a resolution of 1280 × 1024 a refresh rate of 96,000 / 1024 × 0.95 = 89 Hz (rounded down).

A high speed exposure shows an electron beam in the process of scanning an image. At any given time, most of a TV's screen is actually black.

LCD display

Much of the discussion of refresh rate does not apply to LCD monitors. This is because while a phosphor on a CRT will begin to dim as soon as the electron beam passes it, LCD cells open to pass a continuous stream of light, and do not dim until instructed to produce a darker color. Pertaining to LCDs, see also response time.

Computer displays

On smaller monitors (14") few people notice any change above 60–72 Hz. On larger monitors (17", 19") most people would experience mild discomfort unless the refresh is set to a more comfortable 85 Hz or higher. 100 Hz is comfortable for most people.

Different operating systems set the default refresh rate differently. Windows 95 and Windows 98 set the highest possible refresh rate. Windows NT and its descendant Windows 2000, however, by default set the refresh rate to the lowest supported, usually 60 Hz.

Old monitors could be damaged if a user set the video card to a higher refresh rate than supported by the monitor. Nowadays most monitors would simply display a notice that the video signal uses an unsupported refresh rate.

Stereo displays

When LCD shutter glasses are used for stereo displays, the effective refresh rate is halved, because each eye needs a separate picture. For this reason, it is usually recommended to use a display capable of at least 120 Hz, but 170 Hz is optimal. Unfortunately most monitors cannot handle this rate, especially if the screen resolution is high. Common screen resolutions are: 640×480, 800×600, 1024×768, 1280×1024 and 1600×1200.

Televisions

When the cathode ray tube was developed in the 1920s, technology limitations of the time made it difficult to run monitors at anything other then a multiple of the AC line frequency used to power the set. Thus producers had little choice but to run sets at 60 Hz in America, and 50 Hz in Europe. These rates formed the basis for the NTSC (60 Hz) and PAL & SECAM (50 Hz) sets used today. It was widely perceived that this accident of chance gave European sets an advantage, because the slower 50 Hz refresh rate gave the CRT time to scan more detail. However this rate also introduced more flicker, and exacerbated the negative effects of interlace, so sets that use digital technology to double the refresh rate to 100 Hz are now popular.

Another problem with 50 Hz standards is that motion pictures cannot be presented in the typical 24 fps rate used for 35 mm film. These must be accelerated by 4% - with an accompanying slight shift in the pitch of the audio. NTSC sets can display both 24 fps and 25 fps material without speed shift by using a technique called 3:2 pulldown.

Unlike computer monitors and some HDTVs, television broadcasts use interlace, which can increase flicker compared to a progressive scan image at the same refresh rate. The amount of extra flicker is largely dependent on the content of the image, and the brightness of the screen. Some newer televisions are flicker-free.