



Video op amps are being put under pressure by the latest high definition consumer requirements.

By **Brian Black**.

**V**ideo op amps, like the good engineers who design with them, are constantly being asked to do more with less. Higher video resolution requires higher analogue video signal bandwidths – and that means ever faster amplifiers. At the same time, designers are looking for ways to achieve these higher resolutions with lower voltages and even single supply rails. Fortunately, a new crop of signal conditioning products can achieve this.

For some time now, amplifiers have been able to achieve standard definition video and svga (800 x 600pixel) using low voltage supplies. For example, the LT6550 and LT6551 offer 110MHz bandwidth and 400V/ $\mu$ s slew rate, yet can operate on

# Under pressure

supplies as low as 3.3V. But until recently, high resolution video such as uxga (1600 x 1200pixel) required amplifiers with supplies of 6V or higher. This is needed to avoid clipping the signal, because the fastest op amps typically require additional headroom.

To better understand the increasing performance requirements of video amplifiers, it's helpful to take a closer look at the video signals involved. Digital studio equipment for NTSC broadcast television typically uses pixel rates of around 14million/s. In contrast, the xga computer format (1024 x 768) operates at around 80Mpixel/s. The latest high definition consumer formats put out a comparable 75Mpixel stream and the increasingly pop-

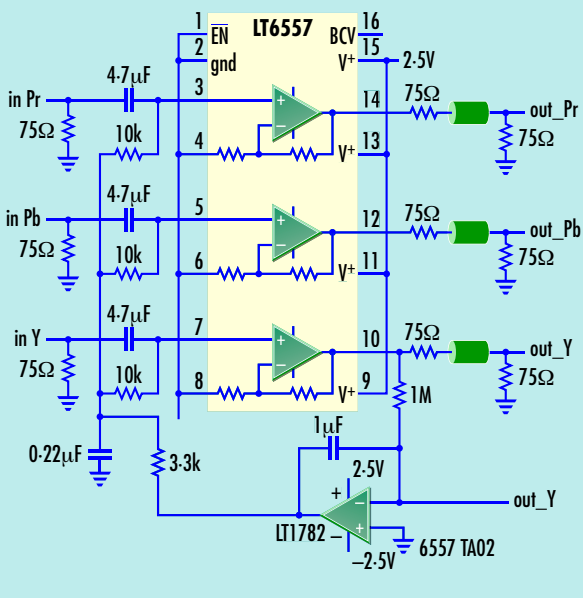
ular uxga professional graphics format (1600 x 1200) generates 200Mpixel/s.

As a result, achieving accurate video reproduction with these newer formats is placing exceptional demands on the frequency response of video amplifiers. Specifically, pulse amplitude waveforms like those of baseband video generally require reproduction of high frequency content up to at least the fifth harmonic of the fundamental frequency component. This is 2.5 times the video pixel rate. So, for uxga resolution, a frequency response up to and beyond 500MHz is required. Whilst products such as the LT6553 can achieve uxga speeds and resolutions, they typically require more than a single 5V supply because of the video

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**Figure 1: 5V UXGA ac coupled triple video driver**



*"The increasingly popular uxga professional graphics format generates [a video stream of] 200Mpixel/s."*

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signal amplitude.

In NTSC and PAL video systems, the approximate difference between the maximum signal voltage and black level is 700mV. Another 300mV below black level is used for sync tips that carry timing information. So typical video applications are specified to have to have a nominal 1V peak to peak amplitude.

Most video amplifiers drive cables that are series terminated (back terminated) at the source and load terminated at the destination with resistances equal to the cable characteristic impedance,  $Z_0$  (usually 75Ω). This configuration forms a 2:1 resistor divider in the cabling that must be corrected in the driver amplifier by delivering 2Vp-p output into an effective  $2 \times Z_0$  load (or 150Ω).

Driving the cable can require more than 13mA, while the output is approaching the saturation limits of the amplifier

output. In ac coupled systems, this is further complicated by the fact that the video waveform's average signal voltage is affected by picture content, meaning the black level at the amplifier wanders with scene brightness. The amount of wander can be as much as 0.56V for 1Vp-p NTSC video. Assuming a gain of 2, the minimum voltage swing that the amplifier must drive is 3.12V. In addition to the signal swing, the supply voltage must accommodate the amplifier headroom (or the difference between the max and min output swing and the supply range, specified as  $V_{oh}$  and  $V_{ol}$ ), to avoid clipping the signal. Thus we can calculate:

$$V_{Smin} = 3.12V + V_{oh} + V_{ol}$$

### A 5V video amp for uxga

The recently released LT6557 RGB amplifier drives high resolution video on a single 5V supply, without requiring external or internal charge pump circuits. It does this by achieving 500MHz bandwidth, 2200V/μs slew rate and 7ns settling time, whilst offering an output that extends to 0.8V of supply rails. On a 5V single supply, it achieves 3.4V of dynamic range, suitable for standard video. In addition, the LT6557 has a 0.1dB gain flatness that extends to 120MHz facilitating use over a wide range of video signals.


The LT6557 also uses an internal architecture that simplifies implementation of high speed video signals in single supply applications. An internal biasing circuit allows the user to program the inputs of all three amplifiers to a desired dc bias voltage level with a single resistor. This minimises the external component count and provides ease of use in ac coupled applications, yet can be disabled for dc coupled applications. Furthermore, the internal fixed gain of 2 eliminates six external gain setting resistors required for driving double terminated cables. A fixed gain of 1 version LT6558 is also available for applications that do not require a gain of 2, such as when driving an a/d converter. The LT6557/8 is the industry's first wideband RGB amplifier capable of providing full video swing when operated from a single 5V supply. Available in either a 16-lead SSOP or a tiny 3mm x 5mm DFN pack-

age, each of the three amplifiers has a separate power and ground pin to minimize crosstalk and simplify supply bypassing. Crosstalk performance is -80dB at 10MHz using 2Vp-p inputs.

In cost sensitive applications like consumer video playback equipment and keyboards, video and mouse switches, the LT6559 provides more bang for the buck in a qfn16 package. As a basic triple current feedback op amp (CFA) with individual channel enables, the LT6559 offers flexibility in forming various multiplexer, cable-driver, and a/d converter driver functions at low cost. Even though the LT6559 is not a true rail to rail output device, there remains approximately 3Vp-p of available output swing on +5V. As a general purpose CFA, the feedback resistor value (301Ω) optimises the frequency response. This circuit can be used as an output buffer/driver for following passive reconstruction filters such as for the increasingly popular 1080p HD format (for instance, 60MHz low pass).

Another part that's applicable to single 5V video applications is the LT6556. High performance multimedia video display systems usually include a multiple input feature to select between a VESA compliant D type pc connection and consumer component video that uses RCA jacks. The incoming video signal is, at most, 1Vp-p nominal (Y-channel, 1.5Vp-p worst case when ac coupled) and the required gain is unity when digitising by an a/d converter set or simple signal routing. This input selection function is readily implemented using the LT6556 operating on 5V.

### Conclusion

As system designers continue to reduce the number of supply voltages used within their products, pressure to maximise analogue performance on available +5V logic supplies has led to the need for viable low voltage high performance video solutions. Linear Technology's devices are all well suited to the 5V environment. 

### Author profile:

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