LINEAR TECHNOLOGY DESIGN NOTES

LT1399/LT1399HV Triple 300MHz Current Feedback Amplifiers Drive Component Video and LCD Displays – Design Note 213

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Introduction

With the advent of HDTV and DVD video, there is a renewed focus on RGB and color-difference component video to maximize picture quality. LCD displays have also entered the mainstream for high-end and portable computer displays. These applications often require high speed triple amplifiers for routing and conditioning video signals. With these applications in mind, Linear Technology has introduced the LT®1399 and LT1399HV triple current feedback amplifiers. The LT1399 and LT1399HV contain three independent 300MHz current feedback amplifiers, each with a shutdown pin. Each amplifier has exceptional 0.1dB gain flatness of 150MHz and a slew rate of 800V/µs. Output drive current is a minimum of 80mA over temperature.

The LT1399 operates on all supplies from a single 4V to ±6V. If higher supply voltages are required, the LT1399HV supports voltages up to ±7.5V. Each of the three amplifiers draws 4.6mA when active. When disabled, each amplifier draws virtually zero supply current and its output becomes high impedance. Each amplifier can be enabled in 30ns and disabled in 40ns, making the LT1399 and LT1399HV ideal in spread-spectrum and portable equipment applications.

With the addition of a small series resistor at the output, the LT1399 and LT1399HV are capable of driving large capacitive loads. The LT1399HV's high voltage operation, when combined with its ability to drive capacitive loads, makes it ideal for driving LCD displays.

Buffered RGB to Color-Difference Matrix

Two LT1399s can be used to create buffered color-difference signals from RGB inputs. In the application shown in Figure 1, four amplifiers are used to create color-difference signals. The luminance signal Y is created using amplifiers A2 and A3. The remaining color-difference signals each use a single amplifier and the newly created Y output to perform the appropriate difference function.

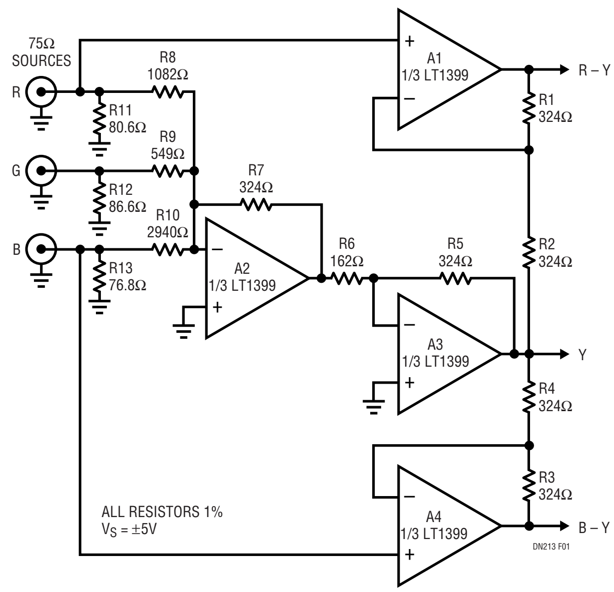

Figure 1. Buffered RGB to Color-Difference Matrix

The R input arrives via 75Ω coax and is routed to 1082Ω resistor R8 and the noninverting input of LT1399 amplifier A1. There is also an 80.6Ω termination resistor, R11, which results in a 75Ω input impedance at the R input. R8 connects to A2, which sums the weighted R, G and B inputs to create a –0.5 • Y output. Amplifier A3 then takes the –0.5 • Y output and amplifies it by a gain of –2, resulting in the Y output. Amplifier A1 is configured in a noninverting gain-of-two configuration, with the bottom of the gain resistor R2 tied to the Y output. The output of amplifier A1 thus results in the color-difference output R – Y.

The B input is similar to the R input. R10 adds the B contribution to the Y signal while the output of amplifier A4 is the color-difference output B – Y.

The G input adds its contribution to the Y signal via a 549Ω resistor R9 that is tied to the inverting input of A2. There is also an 86.6Ω termination resistor, R12, which yields a 75Ω input impedance. Using superposition, it is straightforward to determine the output of amplifier A2. Although inverted, it sums the R, G and B signals in the standard proportions of 0.3R, 0.59G and 0.11B, which are used to create the Y signal. Amplifier A3 then inverts and amplifies the signal by 2, resulting in the Y output. Two additional LT1399 amplifiers remain unused, available for additional signal conditioning as needed.

Buffered Color-Difference to RGB Matrix

The LT1399 can be used to create buffered RGB outputs from color-difference signals. As seen in Figure 2, the R output is a back-terminated 75Ω signal created using resistor R5 and LT1399 amplifier A1 configured for a gain of 2 via 324Ω resistors R3 and R4. The noninverting input of A1 is connected via 1k resistors R1 and R2 to the Y and R – Y inputs, respectively, resulting in cancellation of the Y signal at the amplifier input. The remaining R signal is then amplified by A1. The B output is generated from amplifier A3 in a similar manner.

The G output is a weighted sum of the Y, R – Y and B – Y inputs. The Y input contributes 2Y at the output of A2. The R – Y input contributes 1.02Y – 1.02R at the output of A2. The B – Y input contributes 0.37Y – 0.37B at the output of A2. Summing the three contributions at the output of A2, we get:

$$A2_{OUT} = 3.40Y - 1.02R - 0.37B$$

Remembering that Y is a weighted sum of R, G, and B such that:

$$Y = 0.3R + 0.59G + 0.11B.$$

If we substitute for Y at the output of A2, we get:

$$A2_{OUT} = (1.02R - 1.02R) + 2G + (0.37B - 0.37B) = 2G$$

The back-termination resistor R16 then halves the output of A2, resulting in the G output.

Using the LT1399HV to Drive LCD Displays

Current XGA and UXGA LCD displays require drive voltages of up to 12V, usually present a capacitive load of over 300pF and require fast settling. The LT1399HV is particularly well suited for driving these LCD displays because it is capable of swinging more than ±6V on ±7.5V supplies and, with a small series resistor R_S at the output, can drive large capacitive loads with good settling time. As seen in Figure 3, at a gain of three, with a 16.9Ω output series resistor and a 330pF load, the LT1399HV is capable of settling to 0.1% in 30ns for a 6V step.

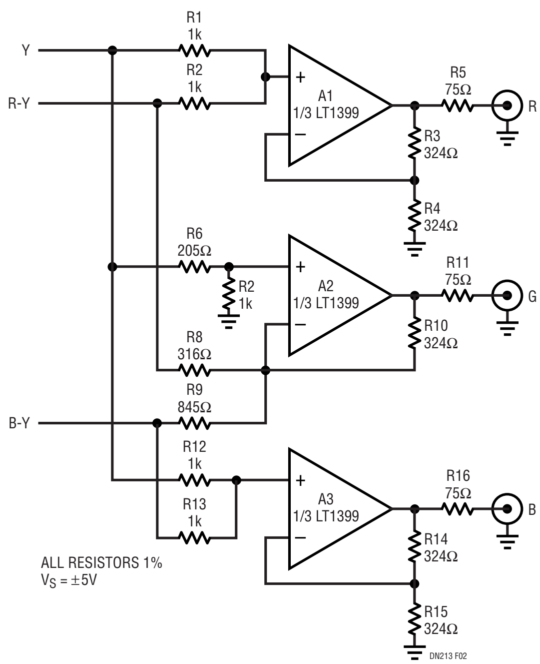

Figure 2. Buffered Color-Difference to RGB Matrix

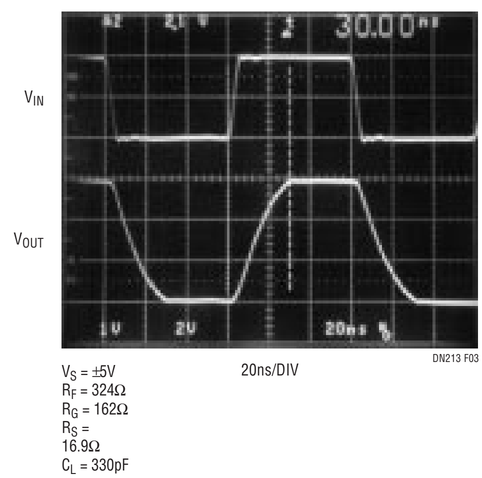

Figure 3. LT1399/LT1399HV Large-Signal Pulse Response

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