Introduction
The LT1813 is a 100MHz dual operational amplifier that has been optimized for supply voltages under 12V. It features an easy-to-use voltage feedback topology with high impedance inputs, yet it slews 750V/µs with only 3mA supply current. DC performance has not been neglected—the device has a 1.5mV maximum $V_{OS}$ and a 400nA maximum $I_{OS}$.

Performance
A summary of important specifications of the LT1813, compared to its higher voltage brethren, is shown in Table 1. A key figure of merit is the ratio of gain bandwidth to supply current (GBW/$I_{SUPPLY}$, expressed in units of MHz/mA). The new process employed by the LT1813 forsakes high supply voltage operation for a 3–4x increase in MHz/mA compared to the LT1361 and LT1364. Blazing speed from such a modest amount of supply current is extremely attractive for low power applications. The LT1813 also propagates the family traits of matched, high input impedance inputs and low $V_{OS}$, $I_{B}$, $I_{OS}$ and input noise. The improved common mode input range of the LT1813 adds to its utility in low supply voltage applications. Stability with capacitive loading is another distinctive and desirable feature. Although the LT1813 is not stable with unlimited capacitive loads, it is stable with nearly two orders of magnitude more capacitance than competitors’ high speed amplifiers. The small-signal transient response in unity gain with $C_{LOAD} = 1000\text{pF}$, 500pF and 1000pF is shown in Figure 1.

The LT1813 extends the frequency response of applications such as active filters, instrumentation amplifiers and buffers. Figure 2 shows the LT1813 converting a single-ended signal to a differential drive for the LTC1417 14-bit analog-to-digital converter (ADC). Note that the top amplifier provides unity voltage gain, but the amplifier is configured in a noise-gain of 2 to match the phase response of the bottom amplifier, which has a gain of –1. The filter in front of the ADC reduces broadband noise. The spurious free dynamic range (SFDR) of this circuit is –79dB for a 425kHz, 2Vp-p input.

Circuit Design
A simplified schematic of the circuit is shown in Figure 3. The circuit looks similar to a current feedback amplifier, but both inputs are high

![Figure 1. LT1813 in a gain-of-one configuration, no $R_L$; $C_L = 100\text{pF}, 500\text{pF or 1000pF}$](image-url)
impedance as in a traditional voltage feedback amplifier. A complementary cascade of emitter followers, Q1–Q4, buffers the noninverting input and drives one side of resistor R1. The other side of the resistor is driven by Q5–Q8, which form a buffer for the inverting input. The input voltage appears across the resistor, generating currents in Q3 and Q4 that are mirrored by Q9–Q11 and Q13–Q15 into the high impedance node. Transistors Q17–Q24 form the output stage. Bandwidth is set by R1, the $g_m$'s of Q3, Q4, Q7 and Q8 and the compensation capacitor, $C_T$.

The voltage drops of Q1–Q4 and the diodes Q10 and Q14 set the input common mode range of the amplifier. The emitters of Q3 and Q4 follow the noninverting input. As the input approaches either supply rail, the limiting voltage is determined by the saturation of Q3 or Q4, which occurs at approximately a $V_{BE}$ plus a $V_{SAT}$ from the supply rail. Typically, the input common mode range is 1V from either supply rail, and is guaranteed by the CMRR specification to be 1.5V from either rail. This excellent input range is achieved without compromising the output impedance of the mirrors Q9–Q11 and Q13–Q15, because Q25 and Q26 provide floating bias points for cascode devices Q9 and Q13. Lower bandwidth processes cannot successfully use this technique and maintain high bandwidth, due to phase shift in the mirror.

The current available to slew compensation capacitor $C_T$ is proportional to the voltage that appears across R1. This method of “slew boost” achieves low distortion due to its inherent linearity with input step size. Large slew currents can be generated without increasing quiescent current. A low value for R1 reduces the input noise voltage to $8nV/\sqrt{Hz}$ and helps reduce input offset voltage and drift. The LT1813 is built with small-geometry, multi-GHz transistors that produce abundant bandwidth with meager operating currents and allow for further reduction of idling supply current. The output stage buffers the high impedance node from the load by providing current gain. The simplest output stage would be two pairs of complementary emitter followers, which would provide a current gain of $\beta_{NPN} \times \beta_{PNP}$. Unfortunately, this gain is insufficient for driving even modest loads. Adding another emitter-follower or a Darlington configuration reduces output swing and creates instability with large capacitive loads.

The solution used on the LT1813 was to create a pair of composite transistors formed by transistors Q19–Q21 and Q22–Q24. The current mirrors attached to the collectors of emitter followers Q9 and Q22 provide additional current gain. The ratio of transistor geometries Q20 to Q21 and Q23 to Q24 increase the current gain by approximately fifteen.

Figure 2. Single-ended to differential ADC buffer: 2Vp-p input at 425kHz yields –79dB SFDR

Figure 3. LT1813 simplified schematic
Single-Supply RGB Video Amplifier

The LT1399 can be used with a single supply voltage of 6V or more to drive ground-referenced RGB video. As seen in Figure 10, two 1N4148 diodes, D1 and D2, have been placed in series with the output of the amplifier A1, but within the feedback loop formed by resistor R8. These diodes effectively level-shift A1's output downward by 2 diodes, allowing the circuit output to swing to ground.

Amplifier A1 is used in a positive gain configuration. The feedback resistor R8 is 324Ω. The gain resistor is created from the parallel combination of R6 and R7, giving a Thevenin-equivalent 80.4Ω connected to 3.75V. This gives an AC gain of five from the noninverting input of amplifier A1 to the cathode of D2. However, the video input is also attenuated before arriving at A1's positive input. Assuming a 75Ω source impedance for the signal driving V_in, the Thevenin-equivalent signal arriving at A1's positive input is 3V + (0.4 • V_in), with a source impedance of 714Ω. The combination of these two inputs gives an output at the cathode of D2 of 2V in with no additional DC offset. The 75Ω back termination resistor R9 halves the signal again such that V_out equals a buffered version of V_in.

It is important to note that the 4.7µF capacitor C1 is required to maintain the voltage drop across diodes D1 and D2 when the circuit output drops low enough that the diodes might otherwise be reverse biased. This means that this circuit works fine for continuous video input, but will require that C1 be charged after a period of inactivity at the input.

Conclusion

Linear Technology has introduced the LT1399 and LT1399HV triple 300MHz current feedback amplifiers. Both of these products are well suited for use in component video applications. The higher supply voltage rating of the LT1399HV makes it an excellent choice for LCD driver applications. Both products feature 4.6mA of supply current per amplifier, 300MHz –3dB bandwidth, an exceptional 0.1dB gain flatness of 150MHz, 800V/µs slew rate and a shutdown pin for each channel.