DESIGN NOTES

Current Feedback Amplifier “Do's and Don'ts”– 46

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Introduction

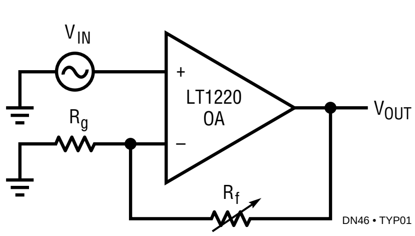
The introduction of current feedback amplifiers, such as the LT®1223, has significantly increased the designer's ability to solve difficult high speed amplifier problems. The current feedback architecture has very high slew rate and the small signal bandwidth is fairly constant for all gains. Current feedback amplifiers are used in broadcast video systems, radar systems, IF and RF stages, RGB distribution systems and many other high speed circuits.

As with any new circuit, there are several new rules that must be kept in mind to prevent problems. Because current feedback amplifiers act very much the same as regular op amps, it is important to note the differences and show how some standard op amp circuits should be implemented.

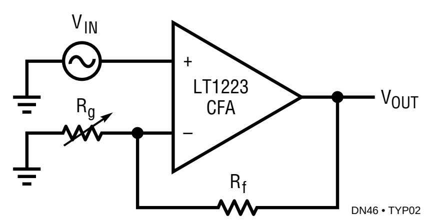
The most important thing to remember about current feedback amplifiers is that the impedance at the inverting (negative) input sets the bandwidth and therefore the stability of the amplifier. It should be resistive, not capacitive. To slow the amplifier down, increase the resistance driving the inverting input. If the amplifier peaks too much due to capacitive loading or anything else, increase the value of the feedback resistors.

The best way to demonstrate how to use current feedback amplifiers is to show some example circuits. To make it as painless as possible, I will show the traditional op amp implementation next to the current feedback amplifier version.

Op Amp Adjustable Gain Amp

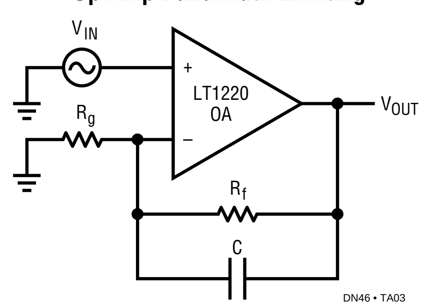


Current Feedback Amp Adjustable Gain Amp

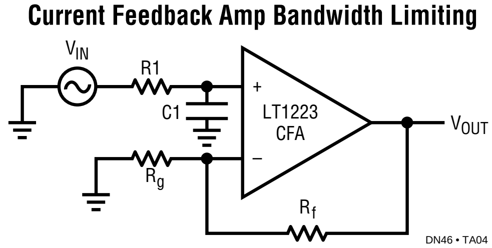


With a standard op amp you can vary the gain of the amplifier with either R_f or R_g. The only real restriction on the values is the loading affect the resistors have on the amplifier output. With a current feedback amplifier the value of R_f should not be varied. Do not make R_f the variable resistor or the bandwidth will be reduced at maximum gain and the circuit will oscillate when R_f is very small.

Op Amp Bandwidth Limiting

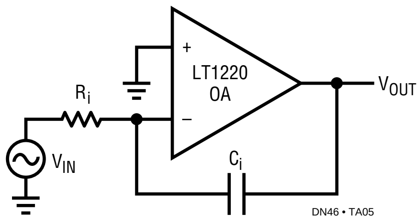


Current Feedback Amp Bandwidth Limiting

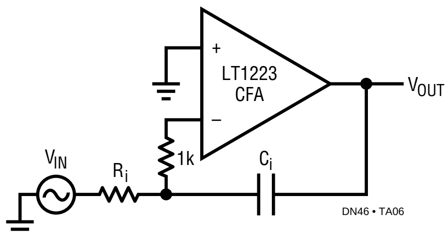


It is very common to limit the bandwidth of an op amp by putting a small capacitor in parallel with R_f. This works with all unity gain stable op amps; DO NOT PUT A SMALL CAPACITOR FROM THE INVERTING INPUT OF A CURRENT FEEDBACK AMPLIFIER TO ANYWHERE, ESPECIALLY NOT TO THE OUTPUT. The capacitor on the inverting input will cause peaking or oscillations. If you need to limit the bandwidth of a current feedback amplifier, use a resistor and capacitor at the non-inverting input (R1 and C1). This technique will also cancel (to a degree) the peaking caused by stray capacitance at the inverting input. Unfortunately, this will not limit the output noise the way it does for the op amp.

Op Amp Integrator

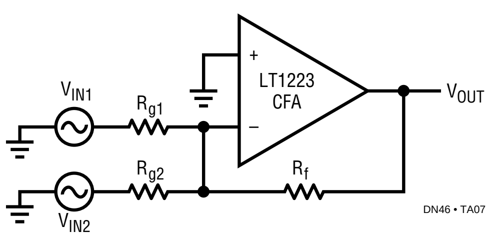


Current Feedback Amplifier Integrator



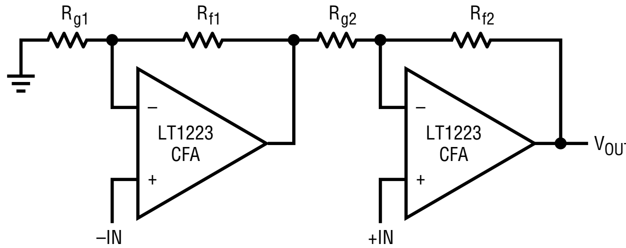
The integrator is one of the easiest circuits to make with an op amp. However, the circuit must be modified before a current feedback amplifier can be used. Since we remember that the inverting input wants to see a resistor, we can add one to the standard circuit. This generates a new summing node where we can apply capacitive feedback. The new current feedback amplifier compatible integrator works just like you would expect; it has excellent large signal capability and accurate phase shift at high frequencies.

Current Feedback Amplifier Summer (DC Accurate)



There is no I_{OS} spec on current feedback amplifiers because there is no correlation between the two input bias currents. Therefore we will not improve the DC accuracy of the inverting amplifier by putting an extra resistor in the non-inverting input. This is also true of input bias current canceled op amps where the I_{OS} spec is the same as the I_B spec, such as the LT1220.

Two Amplifier Instrumentation Amp



TRIM R_{g2} FOR GAIN, THEN TRIM R_{g1} FOR CMRR. VOLTAGE GAIN, G, IS V_{OUT} DIVIDED BY DIFFERENCE BETWEEN +IN AND –IN.

OP AMP DESIGN EQUATIONS:

$R_{f1} = R_{g2}$; $R_{f2} = (G–1)\,R_{g2}$; $R_{g1} = R_{f2}$

CURRENT FEEDBACK AMP DESIGN EQUATIONS:

$R_{f1} = R_{f2}$; $R_{g1} = (G–1)\,R_{f2}$; $R_{g2} = \frac{R_{f2}}{G–1}$

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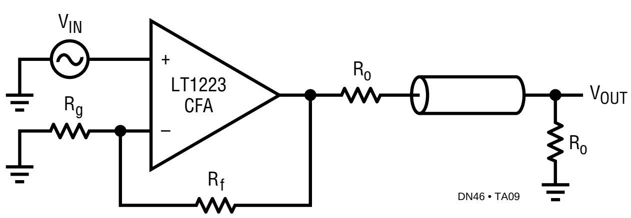
The two amplifier instrumentation amp is easily modified for current feedback amplifiers. The only necessary change is to make the feedback resistor of each amplifier the same and therefore make the gain setting resistors different. This way the bandwidth of both amps is the same and the common mode rejection at high frequencies is better than that of the op amp circuit. In the op amp circuit one amplifier has maximum bandwidth, since it runs at about unity gain, while the other is limited to its gain bandwidth product divided by the gain.

Cable Driver



The cable driver circuit is the same for both types of amplifiers. But because most op amps do not have enough output drive current, they are not often used for heavy loads like cables. When driving a cable it is important to properly terminate both ends if even modest high frequency performance is required. The additional advantage of this is that it isolates the capacitive load of the cable from the amplifier so it can operate at maximum bandwidth.

For literature on our Current Feedback Amplifiers, call **1-800-4-LINEAR**. For applications help, call (408) 432-1900, Ext. 2593

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