

Application Note 52

Filters

CASCADED 8TH-ORDER BUTTERWORTH FILTERS PROVIDE STEEP ROLL-OFF LOWPASS FILTER

by Philip Karantzalis and Richard Markell

Sometimes a design requires a filter that exceeds the specifications of the standard “dash-number” filter. In this case, the requirement was a low-distortion (-70dB) filter with roll-off faster than that of an 8th-order Butterworth. An elliptic filter was ruled out because its distortion specifications are too high. Two low power LTC1164-5s were wired in cascade to investigate the specifications that could be achieved with this architecture. The LTC1164-5

is a low power (4 milliamperes with ± 5 volt supplies), clock-tunable, 8th-order filter, which can be configured for a Butterworth or Bessel response by strapping a pin. Figure 12 shows the schematic diagram of the two-filter system. The frequency response is shown in Figure 13, where it can be seen that the filter’s attenuation is 80dB at 2.3 times the cutoff frequency. The distortion, as shown in Figure 14, is nothing less than spectacular. From 100Hz to 1kHz , the two filters have less than -74dB distortion specifications. At the standard measurement frequency of 1kHz , the specification is -78dB .

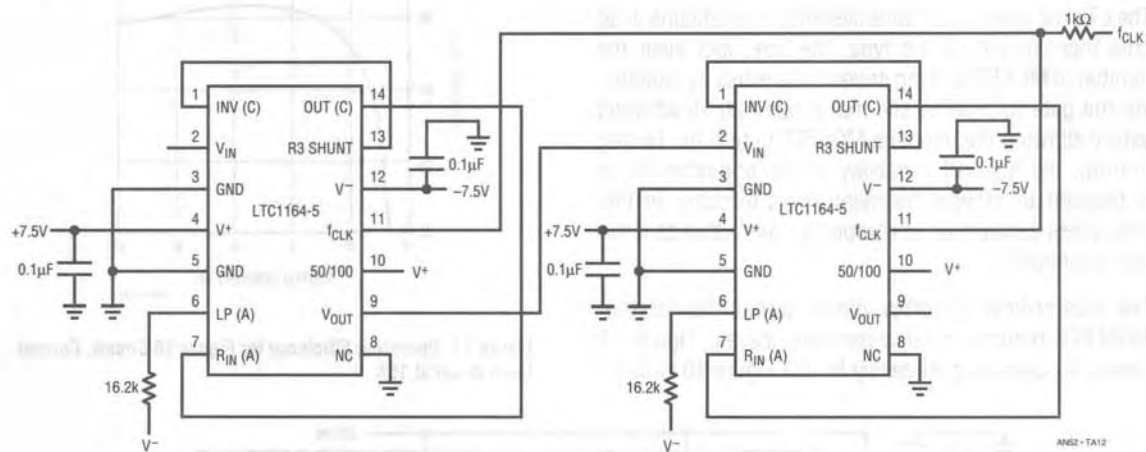


Figure 12. Schematic Diagram: Low Power, 16th-Order Lowpass Filter (Two 8th-Order Butterworths Cascaded)

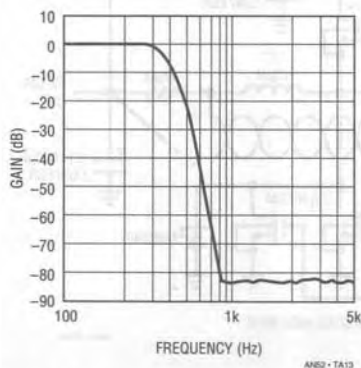


Figure 13. Frequency Response for $f_{CLK} = 20\text{kHz}$

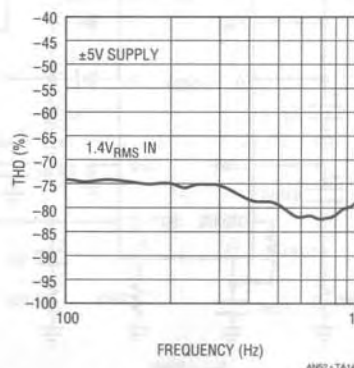


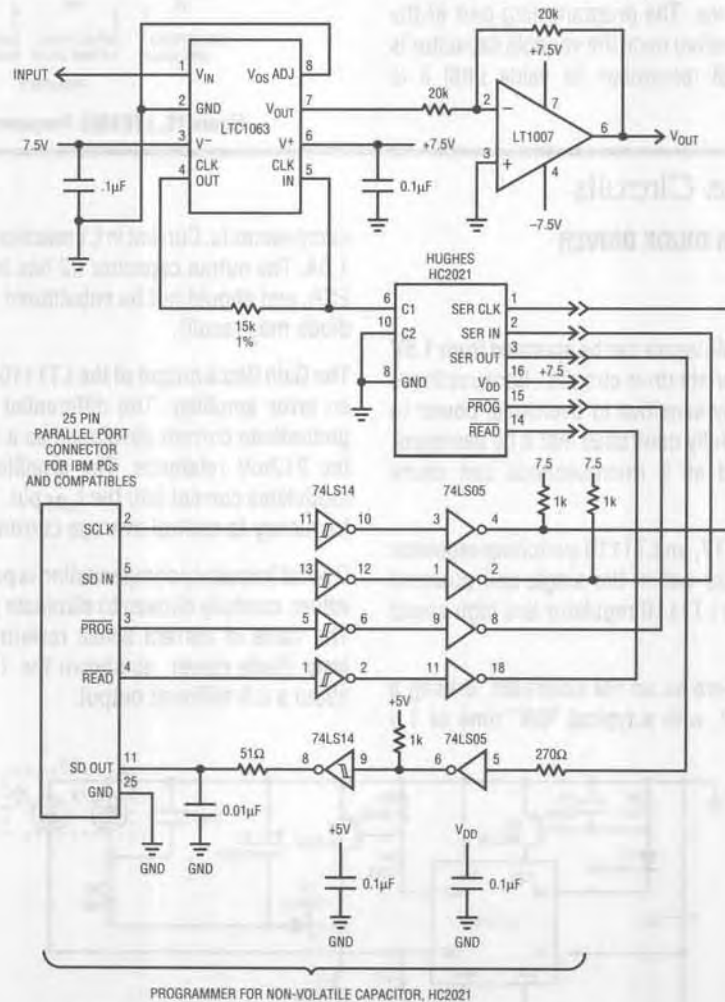
Figure 14. Distortion Performance: Two LTC1164-5s, $f_{CLK} = 60\text{kHz}$ (57:1) Pin 10 Connected to $V+$

DC-ACCURATE, PROGRAMMABLE-CUTOFF, FIFTH-ORDER BUTTERWORTH LOWPASS FILTER REQUIRES NO ON-BOARD CLOCK

by Richard Markell

The new LTC1063 is a clock-tunable, monolithic filter with low-DC output offset (1mV typical with $\pm 5V$ supplies). The frequency response of the filter closely approximates a fifth-order Butterworth polynomial.

Most users choose to tune the filter with an on-board microprocessor and/or timer. This is quite convenient if these components are available. If a clock is not available, the LTC1063 can be tuned with an external resistor and capacitor. The scheme shown here allows the filter's cutoff frequency to be programmed using an external microprocessor or the parallel port of a personal computer. This allows the cutoff frequency of the filter to be set before the product is shipped.



- NOTES:
1. THE HC2021 SHOULD BE LOCATED CLOSE TO THE LTC1063 FOR BEST RESULTS.
 2. $+3.5 \leq V_{DD} \leq +18.8$.
 3. POSITIVE POWER SUPPLY FOR DEVICES 74LS05 AND 74LS14 IS +5V.
 4. HUGHES TELEPHONE NUMBER (714) 759-2665.

AN52-1A15

Figure 15. Schematic Diagram of LTC1063 with Programmable Cutoff Frequency

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The tuning scheme makes use of non-volatile, tunable capacitors available from Hughes Semiconductor. These capacitors allow approximately a decade of tuning range. More range could be obtained by using dual devices. Figure 15 shows the schematic diagram of the application. Be sure to place the variable capacitor as close as possible to the LTC1063 to minimize parasitic elements. Figure 16 shows the frequency response of the filter when the capacitor is varied from minimum to half-value, and then to maximum capacitance. The programming part of the circuit may be disconnected once the variable capacitor is set. The capacitor will remember its value until it is reprogrammed.

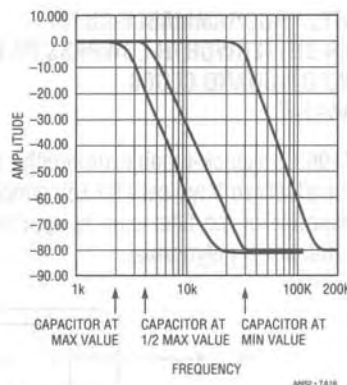


Figure 16. LTC1063 Frequency Response

Miscellaneous Circuits

A SINGLE CELL LASER DIODE DRIVER USING THE LT1110

by Steve Pietkiewicz

Recently available visible lasers can be operated from 1.5V supplies, given appropriate drive circuits. Because these lasers are exceptionally sensitive to overdrive, power to the laser must be carefully controlled lest it be damaged. Over-currents as brief as 2 microseconds can cause damage.

In the circuit of Figure 17, an LT1110 switching regulator serves as the controller within the single cell powered laser diode driver. The LT1110 regulator is a high speed LT1073.

The LT1110 is used here as an FM controller, driving a PNP power switch Q2, with a typical "ON" time of 1.5

microseconds. Current in L1 reaches a peak value of about 1.0A. The output capacitor C2 has been specified for low ESR, and should not be substituted (damage to the laser diode may result).

The Gain Block output of the LT1110 functions with Q1 as an error amplifier. The differential inputs compare the photodiode current developed as a voltage across R2 to the 212mV reference. The amplifier drives Q1, which modulates current into the I_{LIM} pin. This varies oscillator frequency to control average current.

Overall frequency compensation is provided by R1 and C1, values carefully chosen to eliminate power-up overshoot. The value of current sense resistor R2 determines the laser diode power, as shown the 1000 ohms results in about a 0.8 milliwatt output.

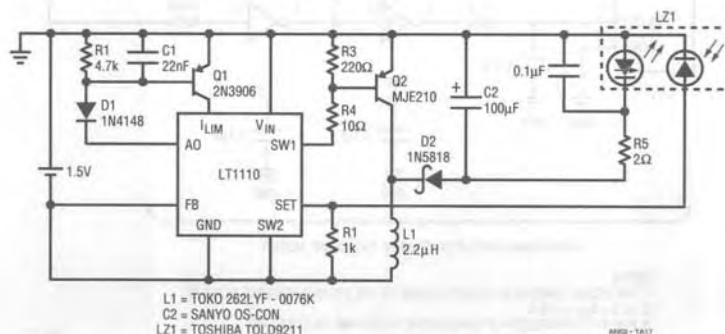


Figure 17. LT1110 Laser Diode Driver Operating from a Single Cell