Simple LED Flasher Yields 99% Power Reduction

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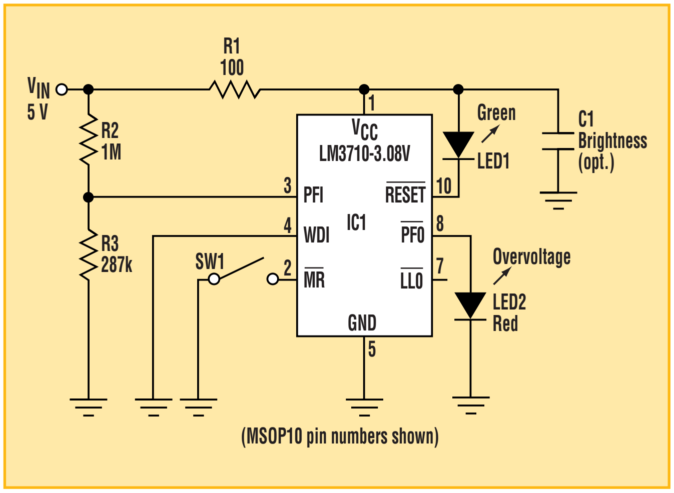
CIRCLE 520

An LED is commonly used as a "power on" indicator for many electronic devices. For the LED to produce discernible visible light in daylight, the forward-bias current needs to be in the moderate range (10 to 20 mA). This amount of current may be too large for many low-power designs. Also, it results in wasted power. All that is needed in most cases is a once-in-a-while or on-demand indication that there is power to an electronic device. In Figure 1, National Semiconductor's LM3710, a supervisory circuit, is configured to reduce the power consumption of a traditional LED indicator by 99%.



1. **This controller blinks the green "Power-Good" LED1, resulting in less than a 0.2-mA average current drain.**

When V_{IN} is above 4.4 V, green LED1 blinks on for 200 ms and off for 25.6 s, repeatedly. IC1's reset timeout pulses the LED1 on for 200 ms. This 200-ms on period is customizable from 1.4 to 1600 ms at the factory. The LED1 off period is controlled by IC1's watchdog timeout period, which is also customizable from 6.2 ms to 25.6 s.

The watchdog input monitors transitions at WDI. If there are no changes at WDI, then the reset engages. The WDI in Figure 1 is grounded to prevent a change. Thus, the reset timeout and watchdog timeout form two one-shots that produce a repetitive pulse train. The 25.6-s pause between the LED1 flashes can be short-cycled by pressing the momentary switch, SW1.

LED1's current is limited by IC1's RESET pin, which is approximately 13 mA. The 28-µA quiescent current of IC1 can be ignored. The approximate V_{IN} set-point equation to initiate blinking is:

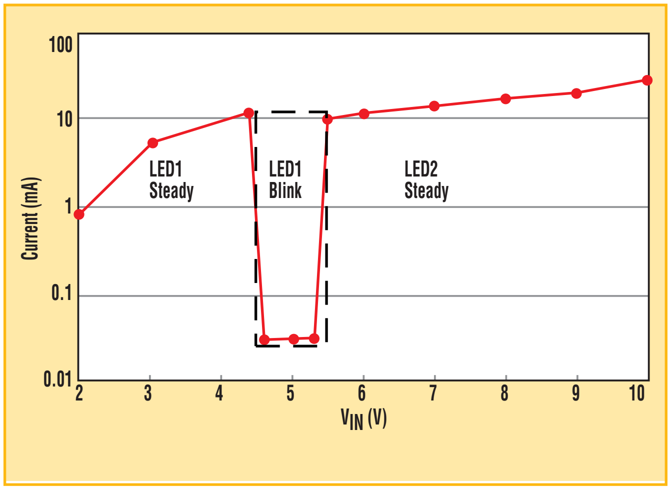
$$V_{IN(BLINK)} = 3.08\ V + R1\ (I_{RESET})$$

where

$$I_{RESET} = 13\ mA$$

(for R1 < 200 Ω)

The average current in LED1 is reduced by the ratio of the two time intervals. A 13-mA continuous bias current would be reduced to 0.1 mA in average LED1 current—a 130× power savings.



2. **The average input current becomes very low for input voltages between 4.5 and 5.5 V.**

If V_{IN} goes above 5.5 V, red LED2 illuminates as an overvoltage indicator. The resistor divider of R2 and R3 and the PFI input of IC1 set this power-fault level. IC1's PFI threshold voltage is 1.225 V. This overvoltage condition causes the PFO output to drive LED2 continuously. The V_{IN} set-point equation to initiate an overvoltage condition is:

$$V_{IN\ (OVERVOLTAGE)} = (1.225\ V)(R2 + R3)/R3.$$

In the brief time before V_{IN} reaches 4.4 V, the LED1 is on continuously. Figure 2 shows the current-voltage waveform of the circuit.

Here are a couple of other

examples. For a 5-V, ±5% monitor, set R1 = 121 Ω and R3 = 301 kΩ. For a 3.3-V, ±10% monitor, set R1 = 0 Ω and R3 = 511 kΩ. Keep the absolute maximum ratings of IC1 in mind during the design.

An optional capacitor, C1, can be added to provide an energy reservoir that will increase the brightness of LED1's flash and its average current. Values in the microfarad range are needed to create a noticeable change.

Universal Impedance Generator Handles Biomedical Applications

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CIRCLE 521

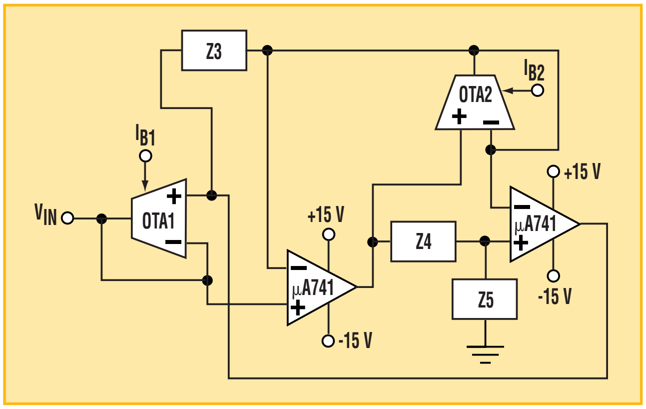
Components like inductors and capacitors constitute an integral part of filters and oscillators used for communication and biomedical applications. A common problem intrinsic to passive inductors is their enormous size as their value increases. Efforts have been made to actively simulate such passive devices.

In biomedical applications, various filter and oscillator structures need to operate at very low frequencies (less than 50 Hz). Brain-wave frequencies are typically in the low-Hertz range (e.g., Delta: 0-4 Hz, Theta: 4-8 Hz, Alpha: 8-12 Hz, Beta1: 14-16 Hz, Beta2: 16-20 Hz, etc.). Hence, very high-value inductors and capacitors are often required when designing devices such as EEG instruments.

To achieve such high values (e.g., greater than 1000 H) using conventional impedance simulating circuits, very high-value resistors would be needed. This is not feasible for integrated circuit technology.

An economical and versatile circuit is presented here that can simulate high-value, grounded inductors. It can also function like an impedance multiplier/scalar. In addition, this arrangement provides the added advantage of tunability, since a wide range of values can be achieved without disturbing the design. The design, as shown in Figure 1, is robust and economical. It uses a commonly available dual transconductance op amp (OTA) chip from National Semiconductor (LM13600) and off-the-shelf µA741 op amps. With G_M as the OTA transconductance, the input impedance of the circuit is:

$$V_{IN}/I_{IN} = Z_5/(G_{M1}G_{M2}Z_3Z_4)$$



1. This arrangement is used to realize an input impedance given by $Z_5/(G_{M1}G_{M2}Z_3Z_4)$. I_{B1} and I_{B2} are the OTA bias currents.

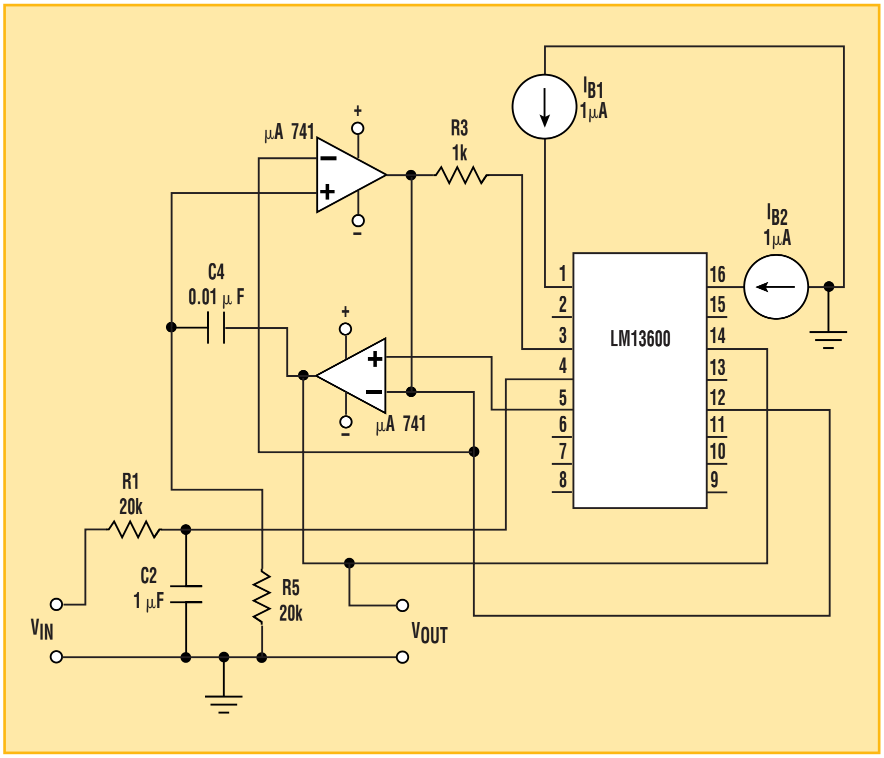
where Z_I can be resistors or capacitors and

$$G_M = I_B/2V_T$$

where I_B is the OTA bias current.

Since G_M can be varied theoretically up to six decades (per datasheet), the overall impedance function can be varied up to 12 decades. This yields a possible multiplication factor of nearly 2.5×10^{11}.

Figure 2 shows a bandpass filter (BPF), using this scheme, which is very useful when designing EEG instruments. Though the BPF has been configured to pass Theta-type waves (associated with lifelike imagination, particularly dominant in children), the



2. This prototype bandpass filter was designed to pass Theta waves in EEG applications. The filter's f_C is approximately 7 Hz, and its Q factor is about one.

intuitive use of OTA for design makes it possible to program the filter for any wave frequency by simply tuning the bias current.

With the component values shown, the filter yields a center frequency of approximately 7 Hz and a Q factor of about one.

The OTA amps are biased with 1-µA currents. (Widlar-type current mirrors are capable of supplying such low currents while using nominal resistor values). It should be mentioned that, although the scheme synthesizes grounded impedances, the circuit can easily be converted into a floating structure using only an additional OTA and an on-chip buffer (This grounded-to-floating conversion method is attributed to Prof. Raj Senani).

Single-Gate VHF Temperature Transmitter Runs On 3.6 V

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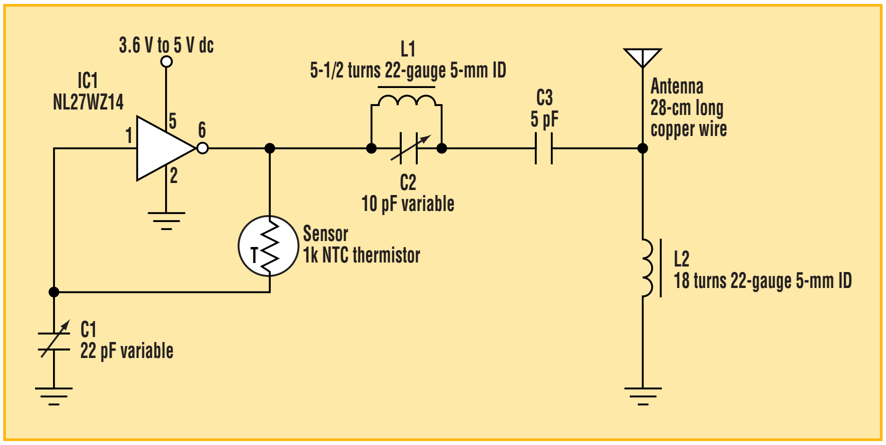
CIRCLE 522

This design idea illustrates what may be the simplest and smallest temperature transmitter in the VHF 50- to 100-MHz range. As seen in the figure, the design employs an ON SEMI single-gate IC (NL27WZ14). The sensor is a negative-temperature-coefficient 1-kΩ SMD thermistor. It causes an increase in the oscillator frequency as temperature increases. Since the design of the circuit is not critical, the value of C1 can be selected high enough to lower the transmission-frequency band down to 1 MHz if necessary. The thermistor-resistance value, however, is critical and should not exceed 3 kΩ. If the resistance value exceeds this limit, the circuit may not oscillate properly.

The data is transmitted as a slowly modulated FM signal (i.e., the frequency shifts as temperature changes). Therefore, rapid signal modulations, typical in audio FM receiver systems, are not involved in this design. At the receive end, the receiver locks on to the transmission frequency and monitors the frequency variation directly as the temperature signal. C1 must not have a positive temperature coefficient or frequency compensation will be required to cancel the temperature dependency in the R1C1 time constant.

To limit the size of the transmitter, a small wire hanging from the tiny pc board is used as the antenna. Other types of antennas may also be used.

Since this circuit draws less than 10 mA from a NiCd cell, its operating time with a small cell is reasonably high (i.e., a few days). Power can also be supplied from other types of cells in the 3- to 5-V dc range.



The values of L1 and C1 are tuned to the center frequency of the desired transmission band.

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