

# DESIGN NOTES

## The "Smart Rock": A Micropower Transponder

Design Note 161

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### INTRODUCTION

A "smart rock" is a locating device that is buried at a specific site. It is interrogated by a portable source and responds with information about its position, identification number or any data that it has collected since its last interrogation. Ideally, a smart rock, once placed, will wait, listening for its interrogator, for many years, or even for decades. A smart rock buried on a nature trail might send its identification number to a traveler's handheld transponder, which would decode the identification number and play a message describing the surrounding sights. It could also be used to direct the traveler which way to turn at a trail junction. Smart rocks are sometimes placed along the edges of cliffs so that interrogators built into vehicles, such as bulldozers, will cause them to stop before they get too close to the edge.

### THE MICROPOWER SUBCIRCUITS

#### The Oscillator

Figure 1 shows the LTC<sup>®</sup>1440 implementing a micropower oscillator. This circuit provides the references for both voltage and frequency needed in our rock; it draws only a few microamps of battery current.

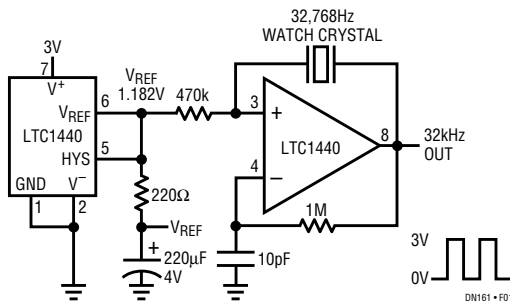


Figure 1. Ultralow Power Crystal Oscillator

#### IF Amplifier

Figure 2 details the IF amplifier, which has a gain of 2500 at a center frequency of 20Hz. By selecting the LT1495 for our amplifier, we can do this while consuming only 2μA.

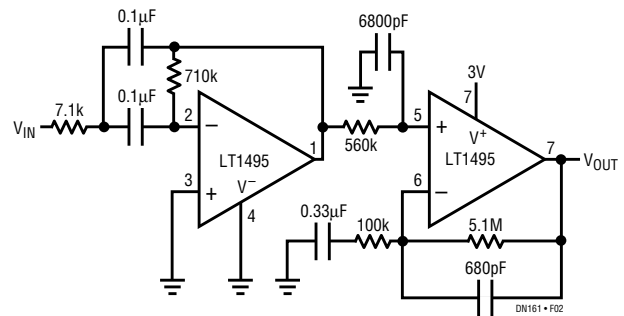


Figure 2. Ultralow Power IF Amplifier (Gain of 2500 at 20Hz)

#### Power Driver

Figure 3 introduces the LTC1480 ultralow standby power RS485 transceiver. In our rock, we only use the LTC1480 in its transmit mode, where it provides currents of about 100mA. The rest of the time the LTC1480 is shut down, drawing a microampere of quiescent current.

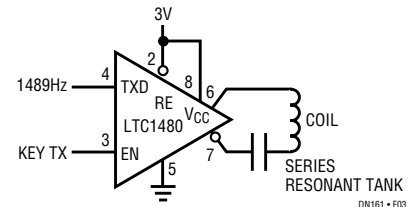


Figure 3. Hefty Driver with Ultralow Sleep Current

### THE SMART ROCK SYSTEM

#### Receiver

The 32kHz reference frequency generated by Y1 and U1B (as shown in Figure 4) is divided by eleven in U2 and by two in U3A to yield 1489.5Hz, the local oscillator frequency. This LO output is applied to mixer Q3 while Q1 and Q2 are fully enhanced, causing C4 and L1 to act as a parallel resonant antenna. The output of the mixer, Q3, is fed into the IF amplifier created by U5A and U5B, where the signal

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is multiplied by approximately 2500. When the signal on U5B Pin 7 reaches  $1.2V_{P-P}$ , Q4 turns on, pulling the START signal line low.

### Transmitter

Once the interrogating tone burst is over and the IF amplifier's output has decayed below  $1.2V_{P-P}$ , Q4 stays off and R11 is allowed to charge C11, raising the voltage on the START node. When the threshold of the clock pin of U3B is crossed, the Q output goes high and the  $\bar{Q}$  signal goes low. D5 quickly discharges C13, pulling the D pin of U3B low and preventing false retriggering of U3B. D3 pulls the START signal low, preventing an early termination of a transmit cycle caused by IF overload. Q1 and Q2 turn off, causing C4 and L1 to form a series resonant circuit connected to the output of U4 (the power driver). At the same time, U4 is enabled and drives the LO frequency into the series resonant tank circuit. This transmitting action continues until R12 discharges C12 to the threshold of the reset pin (Pin 13) of U3B, at which time the flip flop is reset ( $\bar{Q} = 3V$ ). U4 is disabled and Q1 and Q2 are enhanced.

### Blanking

Resetting the flip-flop causes the  $\bar{Q}$  output to toggle to 3V, which causes D3 to go into the blocking state, releasing the START signal from its forced low condition. Because the delay of R13 and C13 is longer than the delay of R11 and C11, U3B is clocked into the off state ( $\bar{Q} = 3V$ , the state in which it already exists) as the START signal goes through the clock pin's threshold. Meanwhile, the IF amplifier's output is decaying from the disturbance of transmitting. It decays to well below  $1.2V_{P-P}$  before R13 charges C13 to the threshold of the D pin of U3B. This prevents false tripping while waiting to enable the reception of the next interrogation signal.

### CONCLUSION

It is easy to design circuits that, when powered by a single lithium cell, will last for years or even decades while performing real-world significant functions. Linear Technology offers an extensive line of nanopower ICs, including precision operational amplifiers, comparators, voltage references, analog-to-digital converters and line drivers and receivers.

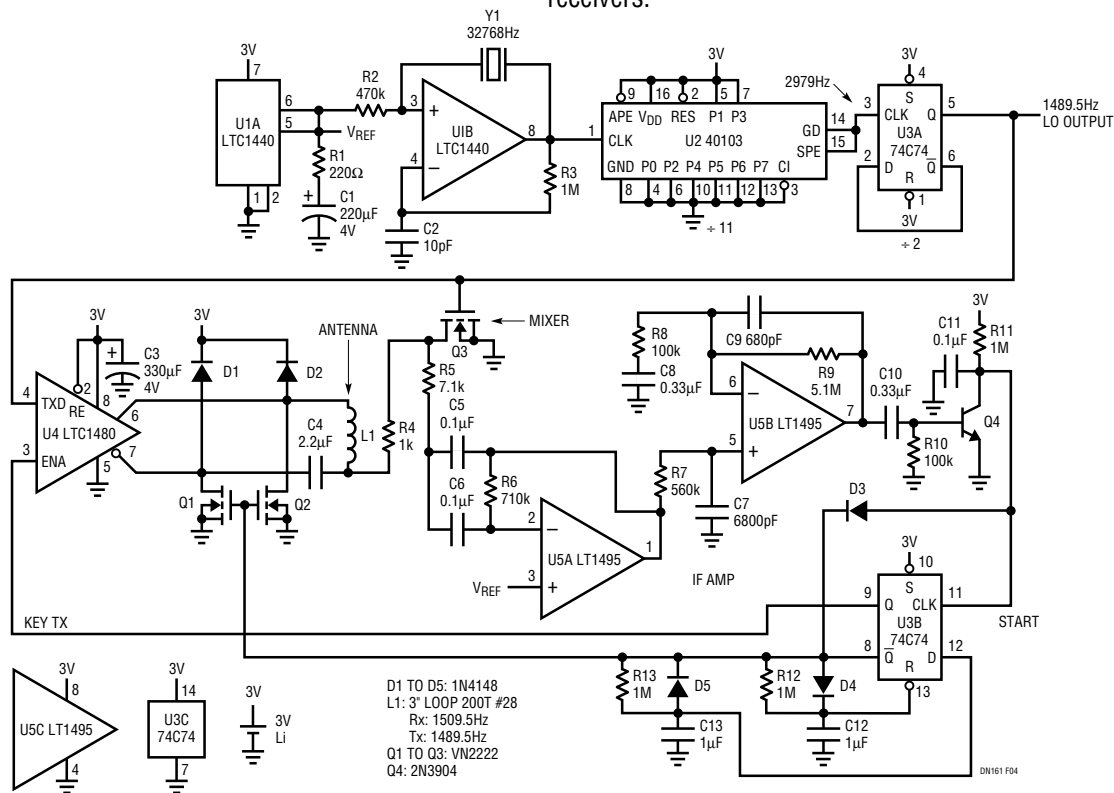


Figure 4. (Lapis Orbus Astutus)

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