



**The LTC6602  
Dual Bandpass Filter**

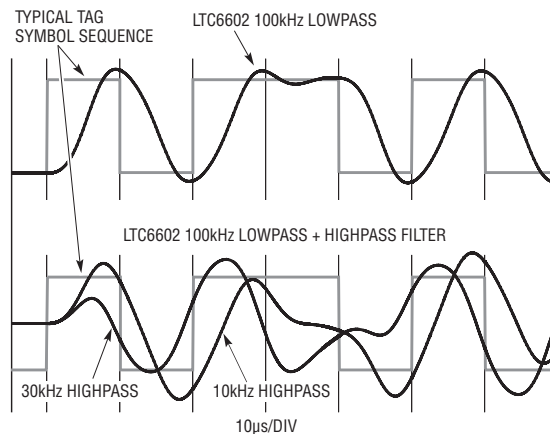
The LTC6602 features two identical filter channels with matched gain control and frequency-controlled lowpass and highpass networks. The phase shift through each channel is matched to  $\pm 1$  degree. A clock frequency, either internal or external, positions the passband of the filter at the required frequency spectrum.

The lowpass and highpass corner frequencies, as well as, the filter bandwidth are set by division ratios of the clock frequency. The lowpass division ratio options are 100, 300, 600 and the highpass division ratios are 1000, 2000, 6000. Figure 1 shows a typical filter response with a 90MHz internal clock and the division ratios set to 6000 and 600 for the highpass and lowpass, respectively. A sharp 4th order elliptical stopband response helps eliminate out-of-band noise. Controlling the baseband bandwidth permits software definition of the operating mode of the RFID receiver as it adapts to the operating environment.

**An Adaptable Baseband Filter for an RFID Reader**

Figure 2 shows a simple LTC6602-based filter circuit that uses SPI serial control to vary the filter's gain and bandwidth to adapt to a complex set of data rates and encoding. (The backscatter link frequency range is 40kHz to 640kHz and the data rate range is 5kbps to 640kbps.)

For fine resolution positioning of the filter, the internal clock frequency is set by an 8-bit LTC2630 DAC. A 0V to 3V DAC output range positions the clock frequency between 40MHz and 100MHz (234.4kHz per bit). The lowpass and highpass division ratios are set by serial SPI control of the LTC6602. The cutoff range for the highpass filter is 6.7kHz to 100kHz and 66.7kHz to 1MHz for the lowpass filter. The optimum filter bandwidth setting can be adjusted by a software algorithm and is a function of the data clock, data rate and encoding. The filter bandwidth must be sufficiently narrow to maximize the dynamic range of the ADC input and wide enough



**Figure 3. Filter transient response to a tag symbol sequence**

to preserve signal transitions and pulse widths (the proper filter setting ensures reliable DSP tag signal detection).

Figure 3 shows an example of the filter's time domain response to a typical tag symbol sequence (a "short" pulse interval followed by a "long"

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pulse interval). The lowpass cutoff frequency is set equal to the reciprocal of the shortest interval ( $f_{CUTOFF} = 1/10\mu s = 100kHz$ ). If the lowpass cutoff frequency is lower, the signal transition and time interval will be distorted beyond recognition. The setting of the highpass cutoff frequency is more qualitative than specific. The highpass cutoff frequency must be lower than

the reciprocal of the longest interval (for the example shown, highpass  $f_{CUTOFF} < 1/20\mu s$ ) and as high as possible to decrease the receiver's low frequency noise (of the baseband amplifier and the down-converted phase and amplitude noise). The lower half of Figure 3 shows the filter's overall response (lowpass plus highpass filter). Comparing the filter outputs with a 10kHz and a 30kHz highpass setting, the signal transitions and time intervals of the 10kHz output are adequate for detecting the symbol sequence (in an RFID environment, noise will be superimposed on the output signal). In general, increasing the lowpass  $f_{CUTOFF}$  and/or decreasing the highpass  $f_{CUTOFF}$  "enhances" signal transitions and intervals at the expense of increased filter output noise.

**Conclusion**

The LTC6602 dual bandpass filter is a programmable baseband filter for high performance UHF RFID readers. Using the LTC6602 under software control provides the ability to operate at high data rates with a single interrogator or with optimum tag signal detection in a multiple or dense interrogator physical setting. The LTC6602 is a very compact IC in a 4mm x 4mm QFN package and is programmable with parallel or serial control. **LT**

**References:**

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- <sup>2</sup> Class-1 Generation-2 UHF RFID Protocol for Communications at 860 MHz to 960 MHz, Version 1.1.0, www.epcglobalinc.org/standards/specs/