Biquad IIR Filter Megafunction

Solution Brief 3 **October 1996, ver. 2**

Target Application:
Digital Signal Processing

Family: FLEX 10K

Vendor:

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Features

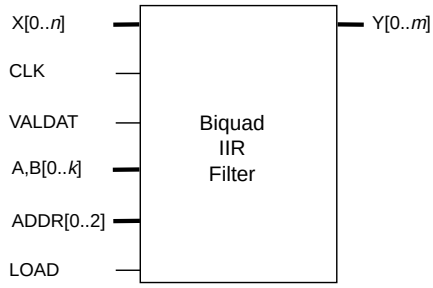
- Optimized for performance and density
- Fully parameterized functionality
- Support for 30-MHz filter performance

General Description

The biquad infinite impulse response (IIR) filter megafunction from Integrated Silicon Systems Ltd. can be used for a broad spectrum of applications and signal bandwidths. Typical applications include digital audio processing, digital video processing, signal conditioning, and channel selection filtering. This megafunction is implemented in VHDL or Verilog HDL, and is optimized for the Altera® FLEX® 10K device architecture. See Figure 1.

Figure 1. Biquad IIR Filter Megafunction Symbol

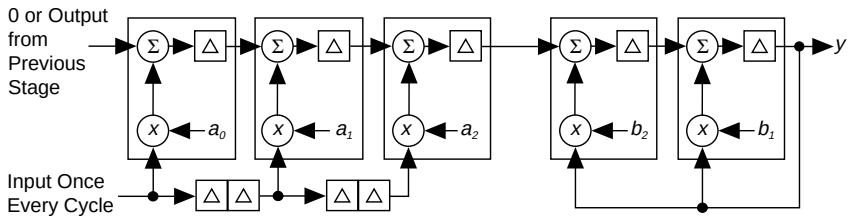
VALDAT, ADDR, LOAD, and A,B are optional inputs.



Functional Description

The biquad IIR filter megafunction is optimized for implementation size and processing speed. The optimization is achieved through the use of distributed arithmetic techniques that obtain the best balance between area and performance for each application. Figure 2 shows the IIR filter functional block diagram.

Figure 2. Biquad IIR Filter Functional Block Diagram



The biquad IIR filter, shown in the following equation, is a second order filter that can be used to construct higher orders of IIR filters by simply cascading the required number of biquad sections. Thus, the biquad IIR filter from ISS is a basic building block for many IIR filter implementations.

$$y_t = \sum_{i=0}^{2} a_i x_{t-i} + \sum_{j=1}^{2} b_j y_{t-j}$$

y = Filter output
x = Filter input
a, b = Coefficient parameters

Performance and Implementation

Performance of the biquad IIR filter varies depending on how the megafunction is implemented. For example, a high-performance biquad IIR filter may have a sample rate of over 32 megasamples per second (MSPS). Table 1 shows the parameters, performance, and implementation size of an IIR filter targeted for the EPF10K50 device.

Table 1. Biquad IIR Filter Parameters

Parameter	Values	Sample Implementation
Input data wordlength	8 to 24 bit	8 bit
Output data wordlength	8 to 32 bit	8 bit
Coefficient wordlength	8 to 24 bit	8 bit
Data word formats	Two's complement, signed binary	Two's complement, bit parallel
Internal accuracy	8 to 32 bit	8 bit
Coefficient programmability	Fixed coefficients, simple programmability, full programmability	On-the-fly coefficient programming, full programmability
Maximum sample rate (MSPS)	32 MSPS	30 MSPS
Logic elements used	Filter-dependent	430
Embedded array blocks used	Filter-dependent	6
Percentage of EPF10K50 device utilized	Filter-dependent	29%

Coefficient Programmability

Implementation of filter coefficients depends on the final application. There are three options for instantiating the megafunction:

- *Embedded coefficients*—Provides the most compact implementation and allows higher sample rates to be processed.
- *Full coefficient programmability*—Directly addresses the desired coefficient and enables on-the-fly updates.
- *Simple coefficient programmability*—Functions as a compromise between the area efficiency of embedded coefficients and the functional advantages of full coefficient programmability.

Also, a completely new set of coefficients can be loaded sequentially, maximizing the functionality and optimization of the user's design. A designer can specify the data wordlength, the number of filter taps, and data word formats. This flexibility enables the designer to select the level of programmability required for a particular application before the megafunction is delivered.

For information on choosing the best parameter settings to meet the requirements of a specific application, contact ISS technical support.