

Discrete Cosine Transform Megafunctions

Solution Brief 9

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Target Application:

Digital Signal Processing

Family:

FLEX[®] 10K

Vendor:



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Features

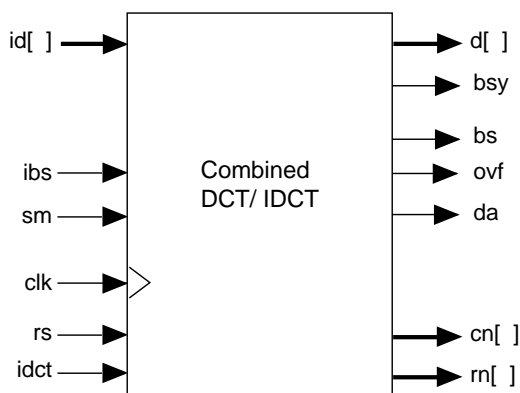
- Three megafunctions available
 - Discrete cosine transform (DCT)
 - Inverse discrete cosine transform (IDCT)
 - Combined DCT/IDCT
- Parameterized options
 - Input and output data word lengths
 - Coefficient word lengths
 - Internal data word lengths
 - Data word format

General Description

The DCT megafunctions transform data into a format that can be easily compressed. These megafunctions are suitable for image compression algorithms that minimize the amount of data needed to recreate a digitized image. They are used for video compression systems that need to minimize transmission bandwidth and power consumption while maintaining a high level of performance. The megafunctions also make ideal basic building blocks for video compression systems, where inputs are processed as 8×8 samples. They are primarily used in multimedia, set-top box, video telephony, and broadcast systems that use the following standards: H.261, H.263, JPEG, MPEG-1, and MPEG-2.

Figure 1 shows a block diagram of the combined DCT/IDCT megafunction.

Figure 1. Combined DCT/IDCT Megafunction Block Diagram



Functional Description

Table 1 describes the ports for the combined DCT/IDCT megafunction. The data available (*da*), busy (*bsy*), row number (*rn*), column number (*cn*), overflow (*ovf*), and sign-magnitude (*sm*) ports add functionality.

| Name | Type | Description |
|---------------|--------|---|
| <i>id</i> [] | Input | Input data bus. |
| <i>ibs</i> | Input | Input block start signal. |
| <i>sm</i> | Input | Word format selection. This signal allows the user to select between sign-magnitude and two's complement number representation. |
| <i>clk</i> | Input | Clock. |
| <i>rs</i> | Input | Reset. |
| <i>idct</i> | Input | IDCT or DCT selector for combined DCT/IDCT megafunction. |
| <i>d</i> [] | Output | Output data bus. |
| <i>bsy</i> | Output | Busy signal for asynchronous operation. This signal indicates when the megafunction is ready to accept a new block of data. |
| <i>bs</i> | Output | Block start signal. |
| <i>ovf</i> | Output | Overflow signal which indicates that the selected data word length can cause overflow errors. |
| <i>da</i> | Output | Data available signal for asynchronous operation. This signal remains high while the output data bus is active. |
| <i>cn</i> [] | Output | Column number bus. This output indicates column numbers for the current result. |
| <i>rn</i> [] | Output | Row number bus. This output indicates row numbers for the current result. |

Compliance with the various video compression standards is determined by the internal accuracy of the design. If a megafunction cannot be implemented onto a single device because of the accuracy required, the megafunction can be partitioned onto two devices. This will provide multiple options with different levels of accuracy.

Performance

The combined DCT/IDCT megafunction operates at a maximum speed of 53 MHz. **Table 2** summarizes the typical utilization results for the 8×8 2D DCT megafunction.

| Parameter | Values | Sample Implementation |
|---------------------------|----------------------------------|-----------------------|
| Input data word length | 4 to 16 bits | 8-bit |
| Output data word length | 4 to 16 bits | 8-bit |
| Coefficient word length | 8 to 18 bits | 8-bit |
| Internal data word length | 8 to 24 bits | 12-bit |
| Data word format | Two's complement, sign magnitude | Two's complement |
| Logic elements (LEs) used | – | 4386 |
| Performance (f_{MAX}) | – | 17.45 MHz |

