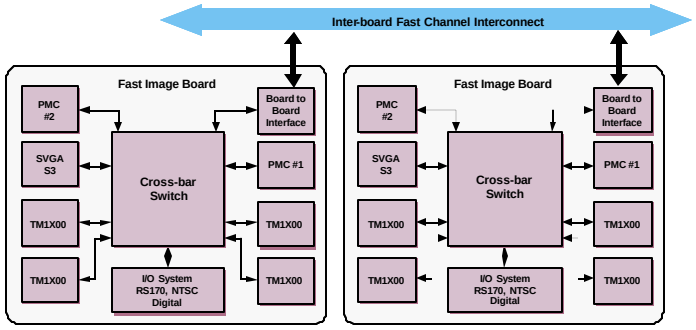
Technical Paper

How To Communicate With Your Processing Environment Without Impacting PCI Activity

Alacron's FastChannel is a mechanism for the FastSeries components to communicate with the processing environment without impacting the PCI bus.

Alacron has acknowledged the need for a non-bussed form of data transfer within any high performance DSP or Imaging application. Bussed communication schemes are subject to bus saturation and contention, limiting their usefulness. The ideal interconnection scheme is to allow point to point communication from a data source to one or more data sinks. Each interconnection supports its data transfer and is isolated from any other data transfer, preventing bus saturation and contention.

FastChannel is Alacron's implementation of a point to point or point to many points connection between a data source and its sinks. FastChannel is available on Alacron's FastImage product and supports connections between the FastImage's internal resources – on the P4 connector of the PMC locations and on two ribbon cable connections for interboard communication.



FastChannel Diagram

In addition to its support for the one to many data transfers, FastChannel is configurable at startup. During operation the interconnections are static. Alacron has found that the need for an interconnection between a data source and sink is not dynamic in real-time and in high performance data processing applications – especially when the data rates are high. This fact allows for a significantly lower cost interconnect solution, and at the same time a simplification in software. No special hardware is required for source and destination addresses, arbitration, and control of the channel. Very simple software protocols can be implemented as the only operation allowed is the transfer of one 'word' of data.

The FastChannel is made up of three things, a parallel data path from 1 to 32 bits, a clock, and a data valid. In the current implementation, clock speeds are limited to 80 MHz and below, making the highest peak data transfer rate between a source and its sinks of 320 MB/s. The many connections in the FastChannel make it difficult to report an "overall" performance of the FastChannel – one specification that is often quoted is the cross section band-width, which is the sum of all active channels (non-blocked) data rates in the best cast. The cross-section bandwidth is 2.4 GB per second per FastImage board. Interboard communication is limited to 320 MB/s.

Mask Inspection Using the FastChannel

In the mask inspection application, a circular mask used in IC fabrication is inspected for contamination and damage. The inspection apparatus contains one or more line scan cameras which are swept over the surface of the mask imaging the surface in stripes. The mask is lit in a dark field configuration so that defects scatter light into the camera resulting in bright spots in a background of black.

Application detail		Units
Line Scan Camera(s)	4096	pixels
Mask Diameter	200	mm
Pixel Area	0.00025	mm
Mask Area	31,416	sq-mm
Mask Area	502,655	M-pixels

The optics have an optical resolution of 0.5 um. The line scan camera outputs data on 4 taps at up to 40 MHz using LVDS signaling. Up to two cameras can be provided so that the peak data rate is 320 MB/s. The masks being inspected are 200 mm in diameter, which when imaged present over 500 gigabytes of data.

Data processing

Image data is via the following steps:

1. The data is corrected for a flat field. (Offset and gain correction on a per pixel basis)
2. The data is filtered with a 3x3 median filter to eliminate shot noise

3. The filtered image is compared to a threshold and if the threshold is exceeded, the image is processed further
4. If the threshold is not exceeded, the image data is discarded

The image is processed as it comes in so that only the data of interest is retained. Sub-images are extracted from the image data to characterize the defect. This processing occurs very infrequently and does not effect the processing bandwidth required significantly.

The TM1300 can perform these tasks at an average pixel rate of 81.8 mega-pixels per second.

Image data can be provided to the TM1300 processor via two routes – its PCI bus or the digital video input from the FastChannel.

Inspection Time vs. Data Rate

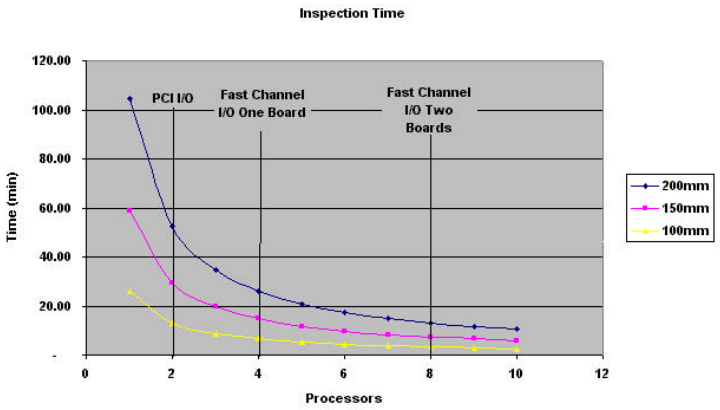
If two cameras are used, then 4 TM1300 processors are required to process the 320 MB/s input data rate. This data rate is too high to be transferred over the PCI bus, but can be transferred over the FastChannel at 80 MB/s. The TM1300s are able to accept data at 80 MHz, or 80 mega pixels per second, and is able to process that data slightly faster than that. At 80 MB/s, one TM1300 processor is all that is required. Below 133 MB/s the PCI bus could be used to transfer the data, but the FastChannel provides the additional benefit of isolation of this transfer from the host CPU.

The table below illustrates how lower data rates significantly increase the time needed to inspect the mask. At the highest rate, the mask can be inspected in less than ½ an hour. At the slower data rates it can take over 3½ hours to inspect the mask. The cost of the higher data rate, due to additional processors and camera required, is offset by the savings obtained from the shorter mask inspection time.

Due to the fact that many masks must be inspected (sometimes over 10 masks), the high data rate allows that to be done in less than a day while the lower data rates may take almost a week, when setup and tear down time is considered.

CPUs (TM1300)	4	2	2	1	1
Data Rate	320 MB/s	160 MB/s	133 MB/s	80 MB/s	40 MB/s
Time to Scan					
FastChannel	0h 26m	0h 52m	1h 3m	1h 45m	3h 29m
PCI I/O	Can't	Can't	1h 3m	1h 45m	3h 29m

The higher bandwidth of the FastChannel provides a significant savings over using the PCI bus in this data intensive application, even though additional CPUs and cameras are required to achieve the higher data rates.



As can be seen from the figure above, using the PCI bus for I/O limits the number of useful processors to 2. With the addition of the FastChannel, the increased I/O band-width allows the use of 4 processors, improving the performance by over a factor of two when compared to that obtained with the PCI bus. Adding an additional board with its FastChannel I/O allows an additional factor of two improvements in performance. Additional performance improvements, in this application, require the addition of cameras.

FastChannel Specifications

- 1 to 32 Data bits
- LVDS, RS422, PECL board to board signaling
- TTL compatible on board signaling.
- 80 MHz clock max for LVDS and PECL signaling
- 2.4 GB/s cross-section-bandwidth per board (80 MHz).
- 320 MB/s maximum interboard signaling rate

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