Topic **Rates of DAQ and Control Boards -**

PCI, CompactPCI/PXI, ME-Synapse USB, LAN

Rates of DAQ and control boards

Rates quoted for A/D and D/A conversion in technical product specifications are **maximum values of the converter chips**, as listed by the chip producers. These maximum rates are reached by the converter in case of a conversion directly into the boards FIFO or from the boards FIFO. As soon as data is transmitted via a bus (PCI/CompactPCI, PCI-Express, USB, Ethernet) to the PC or data is received from the PC via a bus, rate are depending on the system (eg. bus traffic etc.) and maximum rates can only be reached under optimum conditions. The following table show some examples::

Conversion	Number of values	Configuration	max. rate
A/D conversion	≤ A/D FIFO size	ME-46xx in PCI/cPCI/PXI PC	500 kHz
		ME-46xx in PCI-Express PC	500 kHz
		ME-46xx in ME-Synapse USB	500 kHz
		ME-46xx in ME-Synaspe LAN*	500 kHz
	> A/D FIFO size	ME-46xx in PCI/cPCI/PXI PC	500 kHz
		ME-46xx in PCI-Express PC	250 kHz
		ME-46xx in ME-Synapse USB	mind. 20 - 25 kHz
		ME-46xx in ME-Synaspe LAN*	500 kHz
D/A conversion	≤ D/A FIFO size	ME-46xx, ME-6x00 in PCI/cPCI/PXI PC	500 kHz
		ME-46xx in PCI-Express PC	500 kHz
		ME-46xx, ME-6x00 in ME-Synapse USB	500 kHz
		ME-46xx, ME-6x00 in ME-Synaspe LAN*	500 kHz
	> D/A FIFO size or for models without D/A FIFO	ME-46xx, ME-6x00 in PCI/cPCI/PXI PC	depd. on system
		ME-46xx in PCI-Express PC	depd. on system
		ME-46xx, ME-6x00 in ME-Synapse USB	depd. on system
		ME-46xx, ME-6x00 in ME-Synaspe LAN*	depd. on system

Optimum conditions, ie. ...

- **Low/no traffic** on the PCI, CompactPCI, PXI, PCI-Express bus etc.
- **Low/no traffic** on USB or LAN/Ethernet, or direct connection without hubs/other bus clients.
- Only **one DAQ board** active.
- **On-board FIFO buffer used best** (FIFO is an option for the analog output boards): Buffering can compensate temporary bottlenecks. If the number of values is smaller than or the same as the buffer size, the maximum rate can probabely be reached independently from the system. If the number of values is larger than the buffer size the rate depends on the system.

ME-Synapse USB performance

Interrupt control and DMA vs. USB

USB has become a standard for professional data acquisition. USB is used as interface for products like lowcost mini DAQ labs (eg. RedLab series, LabJack), modular measurement intruments (eg. oscilloscopes or multifunctional devices like the MEphisto Scope) and desktop instruments. Even these “classic” instruments now have USB instead of (or in addition to) GPIB, eg. the Agilent DSO series 3000, 5000 and

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6000. Modern PCs have one or more USB ports and PC users use USB every day for external drives, cameras, printers, scanner etc. On the other hand, users of USB DAQ and control products have to be aware of the fact, that USB, being a serial interface, has different rules than parallel busses like PCI (ie. using a DAQ board directly in a PC).

Interrupt

Many DAQ and control boards for PCI make use of **interrupt control**. When the DAQ board requests an interrupt, the CPU's momentary activity is interrupted and the CPU will dedicate all its activity to that interrupt and the execution of the corresponding interrupt routine. This functionality requires a dedicated line for the interrupt signal, as available on the classic parallel PCI bus (incl. the CompactPCI/PXI version of PCI). The serial USB on the other hand does not have a dedicated interrupt line. An interrupt request has to be packed into a data package within the USB protocol and then be sent to the PC. The CPU has to "unpack" the information, that an interrupt request has been sent. The CPU will react to the interrupt and send its acknowledgement to the external device via USB. Only then the data transmission/execution of the interrupt routing can start. This process will be repeated for every single interrupt. The overhead of this procedure can significantly slow down the performance.

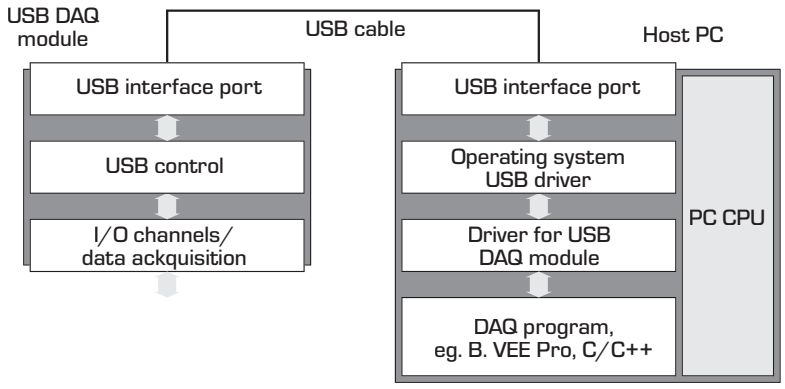
DMA

An other way to control the data transmission from DAQ boards to a PC is **DMA/ Direct Memory Access**. The CPU is "bypassed" and data from the DAQ board is transmitted directly into the PC's memory via the bus. The CPU is not involved. So data can be transmitted directly into the memory at nearly max. speed. On the other hand, this procedure also has a disadvantage for many DAQ, control and realtime applications: Any reaction to the transmitted data, which requires the CPU's activity, is possible only when the DMA transfer is completed. For example, if a threshold is exceeded and this is supposed to cause a reaction (like an alarm), the DMA transfer has to be completely finished. Then the CPU has to get the data from the memory, analyse it and generate the reaction. As for the interrupt controlled solution, this reaction can already be generated within the interrupt routine.

So **both operating modes have their legitimacy**, depending on the board's application. Either you have to get a large amount of data into your memory at high speed, but without looking at it at once - or the CPU has to "see" and analyse data at once to react on certain statuses, which requires a little more time.

USB

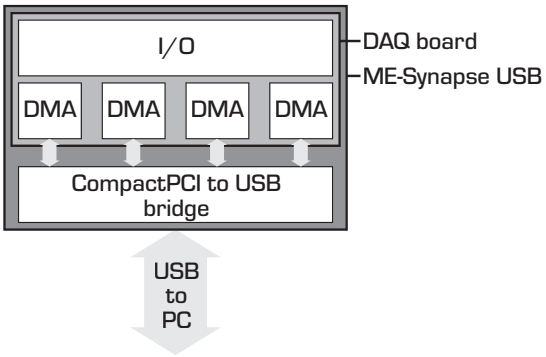
Back to **USB** - how does USB handle data transmission? At first, an application program sends a request for a data block to an USB device via the device driver and the USB routine of the operating system. The driver will recognize the corresponding device and the desired I/O channel within. As mentioned above, data from the USB device are divided into packages which are transmitted sequentially. Every package requires a request from the operating system. After all packages have been transmitted, the transmission will be closed and the data is available for the application program.



ME-Synapse

DAQ board in the ME-Synapse USB – interrupt and DMA

To make use of the tried and tested technology of the ME series DAQ boards, Meilhaus Electronic has developed the ME-Synapse USB, a converter (bridge, "docking-station") from 3 U CompactPCI to USB. Or to put it in a nutshell: "Insert the 3 U CompactPCI board at one side and get USB at the other side". The reliable ME series boards are embedded in a flexible system of accessories and extensions. With the ME-Synapse full compatibility of PCI, PXI/CompactPCI and USB, as well as Ethernet/LAN and PCI-Express (coming soon) is achieved for the ME series boards. As the multifunctional boards from ME (ME-FoXX ME-46xx series) are used in industral and lab DAQ/control applications where the CPU has to react on incoming data, the models ME-FoXX ME-46xx use interupt control. This is a big advantage for PCI and CompactPCI/PXI systems, but not optimal for USB. That's why with certain operating modes the perfomance can be reduced, see table above. Comming generations of ME series boards will have the function to select the DMA or interrupt mode, so that full performance can be achieved also with USB. With DMA the data transmission will no longer be interrupt controlled, but data will be transmitted from the boards to the USB to CompactPCI bridge via DMA (see picture below). Data can then be transmitted via USB at optimal performance.



*** Note: ME-Synapse LAN - how did we test?**

Performance of the ME-Synapse LAN has been tested in three configurations:

(1) Direct connection of ME-Synapse LAN and PC via Cat7 cable.
Transfer 100 MB/s, transmission of 100 MB in blocks of 4 kB.
Conclusion: Rates of 500 kHz are possible.

(2) Direct connection of ME-Synapse LAN and PC via Cat5 cable.
Transfer 100 MB/s, transmission of 100 MB in blocks of 4 kB.
Conclusion: Rates of 500 kHz are possbile.

(3) ME-Synapse LAN and PC connected over a LAN with Cat7 cable.
Conclusion: Rates of 500 kHz are possbile under optimal conditions (depending on other traffic). Any traffic on the network may reduce the performance.