

DIFFERENCE BETWEEN FPGA AND ASIC

- This question is very popular in VLSI fresher interviews. It looks simple but a deeper insight into the subject reveals the fact that there are a lot of things to be understood !! So here is the answer.

FPGA vs. ASIC

- Difference between ASICs and FPGAs mainly depends on costs, tool availability, performance and design flexibility. They have their own pros and cons but it is designers responsibility to find the advantages of each and use either FPGA or ASIC for the product. However, recent developments in the FPGA domain are narrowing down the benefits of the ASICs.

FPGA

- **Field Programmable Gate Arrays**

FPGA Design Advantages

- **Faster time-to-market:** No layout, masks or other manufacturing steps are needed for FPGA design. Readymade FPGA is available and burn your HDL code to FPGA ! Done !!
- **No NRE (Non Recurring Expenses):** This cost is typically associated with an ASIC design. For FPGA this is not there. FPGA tools are cheap. (sometimes its free ! You need to buy FPGA.... thats all !). ASIC you pay huge NRE and tools are expensive. I would say "very expensive"...Its in crores....!!
- **Simpler design cycle:** This is due to software that handles much of the routing, placement, and timing. Manual intervention is less. The FPGA design flow eliminates the complex and time-consuming floorplanning, place and route, timing analysis.
- **More predictable project cycle:** The FPGA design flow eliminates potential re-spins, wafer capacities, etc of the project since the design logic is already synthesized and verified in FPGA device.
- **Field Re-programability:** A new bitstream (i.e. your program) can be uploaded remotely, instantly. FPGA can be reprogrammed in a snap while an ASIC can take \$50,000 and more than 4-6 weeks to make the same changes. FPGA costs start from a couple of dollars to several hundreds or more depending on the hardware features.
- **Reusability:** Reusability of FPGA is the main advantage. Prototype of the design can be implemented on FPGA which could be verified for almost accurate results so that it

can be implemented on an ASIC. If design has faults change the HDL code, generate bit stream, program to FPGA and test again. Modern FPGAs are reconfigurable both partially and dynamically.

- FPGAs are good for prototyping and limited production. If you are going to make 100-200 boards it isn't worth to make an ASIC.
- Generally FPGAs are used for lower speed, lower complexity and lower volume designs. But today's FPGAs even run at 500 MHz with superior performance. With unprecedented logic density increases and a host of other features, such as embedded processors, DSP blocks, clocking, and high-speed serial at ever lower price, FPGAs are suitable for almost any type of design.
- Unlike ASICs, FPGA's have special hardwares such as Block-RAM, DCM modules, MACs, memories and highspeed I/O, embedded CPU etc inbuilt, which can be used to get better performance. Modern FPGAs are packed with features. Advanced FPGAs usually come with phase-locked loops, low-voltage differential signal, clock data recovery, more internal routing, high speed, hardware multipliers for DSPs, memory, programmable I/O, IP cores and microprocessor cores. Remember Power PC (hardcore) and Microblaze (softcore) in Xilinx and ARM (hardcore) and Nios(softcore) in Altera. There are FPGAs available now with built in ADC ! Using all these features designers can build a system on a chip. Now, do you really need an ASIC ?
- FPGA synthesis is much more easier than ASIC.
- In FPGA you need not do floor-planning, tool can do it efficiently. In ASIC you have to do it.

FPGA Design Disadvantages

- Power consumption in FPGA is more. You don't have any control over the power optimization. This is where ASIC wins the race !
- You have to use the resources available in the FPGA. Thus FPGA limits the design size.
- Good for low quantity production. As quantity increases cost per product increases compared to the ASIC implementation.

ASIC

- **Application Specific Intergrated Circiut**

ASIC Design Advantages

- **Cost....cost....cost....Lower unit costs:** For very high volume designs costs comes out to be very less. Larger volumes of ASIC design proves to be cheaper than implementing design using FPGA.

- **Speed...speed...speed....ASICs are faster than FPGA:** ASIC gives design flexibility. This gives enormous opportunity for speed optimizations.
- **Low power....Low power....Low power:** ASIC can be optimized for required low power. There are several low power techniques such as power gating, clock gating, multi vt cell libraries, pipelining etc are available to achieve the power target. This is where FPGA fails badly !!! Can you think of a cell phone which has to be charged for every call.....never.....low power ASICs helps battery live longer life !!
- In ASIC you can implement analog circuit, mixed signal designs. This is generally not possible in FPGA.
- In ASIC DFT (Design For Test) is inserted. In FPGA DFT is not carried out (rather for FPGA no need of DFT !).

ASIC Design Diadvantages

- **Time-to-market:** Some large ASICs can take a year or more to design. A good way to shorten development time is to make prototypes using FPGAs and then switch to an ASIC.
- **Design Issues:** In ASIC you should take care of DFM issues, Signal Integrity issues and many more. In FPGA you don't have all these because ASIC designer takes care of all these. (Don't forget FPGA isan IC and designed by ASIC design enginner !!)
- **Expensive Tools:** ASIC design tools are very much expensive. You spend a huge amount of NRE.

Structured ASICS

- Structured ASICs have the bottom metal layers fixed and only the top layers can be designed by the customer.
- Structured ASICs are custom devices that approach the performance of today's Standard Cell ASIC while dramatically simplifying the design complexity.
- Structured ASICs offer designers a set of devices with specific, customizable metal layers along with predefined metal layers, which can contain the underlying pattern of logic cells, memory, and I/O.

Source : http://asic-soc.blogspot.in/2007/11/what-is-difference-between-fpga-and_06.html