

Introduction to FPGA Architectures: SRAM FLASH and Antifuse



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Let's take a closer look and FPGA Architecture to see how these devices are put together and why.

FPGA Architectures

- ⇒ In the first week, we introduced programmable logic devices and the FPGA.
- ⇒ In week 2, we used Quartus Prime to work through a sample FPGA Design.
- ⇒ This week, we will extend our knowledge of FPGA capabilities so that we can choose the right one when working on a design.

Designing digital devices is a creative process, much like cooking up a new recipe, or painting a new picture. To be proficient, we need to know what ingredients are available to make our new creation.



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<https://thechicsite.com/wp-content/uploads/2014/10/ingredients-for-chicken-noodle-soup.jpg> source for image. Also <http://emptyeasel.com/wp-content/uploads/2014/05/split-primary-color-wheel-001-1.jpg>.

FPGAs of many Flavors

- =D- Xilinx, Altera, Microsemi and Lattice all make great devices
 - but they will not work for every application.
- =D- Each vendor has their specialties.
- =D- Why use this one instead of that one?
- =D- In this module we will determine a set of criteria to evaluate these devices to help us decide which one is best for a particular application.



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Xilinx, Altera, Microsemi and Lattice all make great programmable logic devices – but they will not work for every application. Each vendor has their specialties. Have you wondered, why use this one instead of that one? If so, you are in luck because we are going to answer this question. In this module we will look at a set of criteria to evaluate these devices to help us decide which one is best for a particular application.

Criteria for selecting FPGAs

- What are the essential capabilities that we need to get from an FGPA?
- First, it needs to provide ample amounts of logic.
- This is measured a number of ways: system gates, logic elements, slices, macrocells, LABs, ALMS, etc.
- Cost per gate is also important.



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What are the essential capabilities that we need to get from an FGPA?

First, it needs to provide ample amounts of logic, the more the better as the value tends to rise faster than the cost as FPGAs get large. Smaller FPGA process geometries usually translates into higher logic density. The amount of logic is measured a number of ways: system gates, logic elements, slices, macrocells, LABs, ALMS, etc. Of course, if the part costs too much for a design budget, then the benefits from the logic device won't be accrued, so cost, and particularly cost per gate is important.

Criteria for selecting FPGAs

- ⇒ Speed is a major criteria, measured by maximum clock frequency.
- ⇒ In direct opposition to speed is the requirement for low power consumption. Power consumption can vary from microwatts to hundreds of watts, and is dependent on configuration cell type.
- ⇒ Reprogrammability is also dependent on the configuration memory type, and is an important characteristic to help speed development.



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Another essential FPGA characteristic is processing speed, often measured by the maximum clock frequency, or fMAX. Speed is also important in the I/O as well as the fabric.

In direct opposition to speed is the requirement for low power consumption. FPGAs can consume considerable power, both when operating at high frequencies, but also as the part does nothing it draws static power. Depending on architecture and configuration memory type, power consumption can vary from microwatts to hundreds of watts.

Reprogrammability is also dependent on the configuration memory type. SRAM and FLASH are reprogrammable, Antifuse is not.

Reprogrammability makes development much easier, as new designs can be programmed into the same part over and over again.

Criteria for selecting FPGAs

- ⇒ Amount and type of I/O is also a crucial value proposition for FGPAs, often thought of in terms of cost per I/O and I/O density.
- ⇒ Another way to increase the value of an FPGA is by inclusion of Hard IP cores, like those for Memory, DSP Blocks, Transceivers, and even hard processors.
- ⇒ Some devices, particularly CPLDs and smaller FPGAs, are structured so that the timing is deterministic



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Criteria for selecting FPGAs

- ⇒ In some applications, like safety critical designs, Reliability is a major concern, measured by FIT rate or MTBF.
- ⇒ Endurance of the configuration memory can be an issue for long lifetime products, and is an important parameter in FLASH based FPGAs.
- ⇒ Increasingly important is the ability to protect design information held in the FPGA bit pattern, and also the data that travels through the FPGA.



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Programmable Logic Device Selection Criteria

1. Reprogrammability (Configuration Memory Type)
2. Size or Logic Density (amount of logic in systems gates, LEs, Slices, ALMs, etc.)
3. Cost per logic gate
4. Speed (Maximum clock frequency)
5. Power Consumption (static and dynamic)
6. Cost per I/O (I/O Density)
7. Hard IP available on chip (Memory, DSP Blocks, Transceivers, etc.)
8. Deterministic timing (timing is consistent in every implementation)
9. Reliability (FIT rate)
10. Endurance (number of programming cycles and years of retention)
11. Design and Data Security



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In summary, here is the programmable logic device selection criteria we will use as we survey available FPGA devices and technology from all the major vendors. There are 11 criteria:

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2. Size or Logic Density (amount of logic in systems gates, LEs, Slices, ALMs, etc.)
3. Cost per logic gate
4. Speed (Maximum clock frequency)
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