1. DC-DC Fundamentals

XIANG FANG: Hello everyone, and welcome to the DC-DC fundamentals.In this section, we'll give you an introduction to the DC-DC converter.

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2. What is DC-DC converters?

So what is the DC-DC converter?As you know, the power supply is needed everywhere.Almost all electronic systems need a constant voltage supply.And a DC-DC converter is a circuit devised to provide the DC power from a source to a load.

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3. Types of Converters

So there's different types of converters.In general, there's two basic types.One is called a linear type.In linear-type converter, the power delivery is continuous from the source to the load.And the past elements, which regulate the current flow from the source to the load, operate in the linear region.And the other type we call it switcher type.The power delivery in the switcher type converter is in bursts from the source to the load.And the past element of the switch is switching on and off, cycle by cycle.

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4. Converters Characteristics

And there's a different basic converters characteristics to be reminded of.And in this system, when you're doing converter design or power IC selections, this characteristic is better to keep inmind.For example, the system requirement, we want to know the output voltage level, the current rating, and the input voltagerange.And one key specification is the efficiency of the DC-DC converter and the steady state operation.It measures the performance of the DC-DC converter and also, sometimes, the transient response is very important.And always, the size and cost matters.

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5. Linear Regulator

So in this slide, I will talk about the linear regulator.The linear regulator is usually used in the radio frequency and precise analog applications.It's usually using those applications where you have a narrow V in to V out difference.And that requires a lot of precision and low noise.The advantage off using a linear regulator is, it has low output ripples and noise.And it has a fast transient response, and, usually, it has low cost and few external components is needed tomake a linear regulation work.Also, there's some disadvantage of linear regulator is, the low efficiency, especially when your V in is much larger thanV out.And when using linear regulator, you can only generate a V out lower than your V in.Converters characteristics--so when you're doing DC-DC converter design or selection, there's some key specs you need to keep in mind.For example, the system

requirements--what's the output voltage?What's the current rating and input voltage range of your DC-DC power converter design?And performance-wise, the efficiency of your power converter, the steady-state operation, and the transient response is also very important.And last but not least, the size and the cost is very important for your power design, also.Linear regulator--linear regulator is usually used in the application that requires high precisions and low noise as you can see inthe slides, with these couple of typical applications for this type of regulator.An advantage of using a linear regulator is, it has low output ripples and noise.And you can achieve fast transients, and it's relatively low cost and fewer external components needed.So it's a simple-to-use kind of regulator.But the disadvantage of this type of topology is that you need to keep in mind that if your Vinis much higher than your V out, you have a very low efficiency.And the power generated from the regulator is dissipated through the whole regulator.So that will be a heat dissipation problems.And you can only generate a V out lower than your V in.That means you cannot boost your voltage.

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6. Inductive Switcher

Inductive switcher--we call it inductive because there is an inductor in this type of converter.As you can see, in this graph, we show example of a buck-boost converter.That's an inductor in the middle.And there's a switch going on and off by pumping through the inductor and the capacitance.So in this way, the energy can be delivered to the output load.For this type of off switcher, it's widely used in all kinds of applications and it's usually for its highperformance about efficiency and for those applications that requires high power density and have heat dissipation problems.So the advantage of this type of converter--it can give you a high performance and also can create isolation if that's required.And it can generate multiple output by using one DC-DC converter.The disadvantage of this type of switcher is that a switch in current, since its in and out, is kindof discontinuously.So there's EMI issues.Also, the output noise and ripple is relatively high comparing to a linear regulator.And it's more difficult to design, and more external components is required to configure such type of converter.Charge pump--charge pump, we also call it up inductive release DC-DC converter because there's no inductor in this type of converter.

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7. Charge Pump

The application of charge pump is that, for those of application that requires low output currents, moderate input or outputvoltage difference.And it's suitable for those applications with space constraints.The advantage of using this type of converter is, it can give you moderate very efficiency, and it's slightly lesscostly than the inductor type of switcher.And also, since the charge pump switches voltage across capacitors, so we all can be a larger, and can besmaller than your input voltage.And fewer components is needed to make this charge pump converter.The disadvantage is also related to the EMI issue.And since the charge pump depends on the charging and discharging of a capacitor, it has the limit of thecurrent capacities.

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8. Converter Comparison

So in this slides, we show a summary of the comparison between these three types of the DC-DC converters.As you can see here, the linear regulator has a relatively low efficiency, but you can achieve low ripple andlow EMI noise.And the solution size is usually small.And the cost, it's the lowest comparing to the other type.And the inductive type has the highest efficiency, but the ripple, it's kind of larger than the linear regulator.And it takes the largest PCB area and has the highest cost.And the charge pump has the moderate ripples, has the moderate efficiency, and the PCB size, and the cost ismedium.

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9. Summary

So in this section, we give you an introduction of different types of the DC-DC converters.

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10. Thank you!

Thanks for watching.

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