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How to Use Bus Switches for Future Devices

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Agenda

1. Bus Switches and Usage Examples in Memory System
2. IBIS Models of Basic Bus Switches
3. New Opportunities for Bus Switches
4. Summary

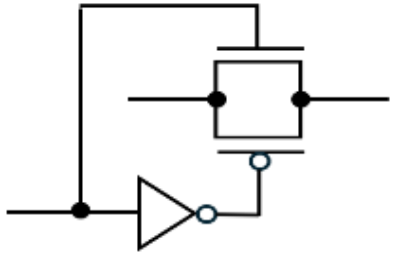
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1. Bus Switches and Usage Examples in Memory System

Basic Description of the Bus Switch

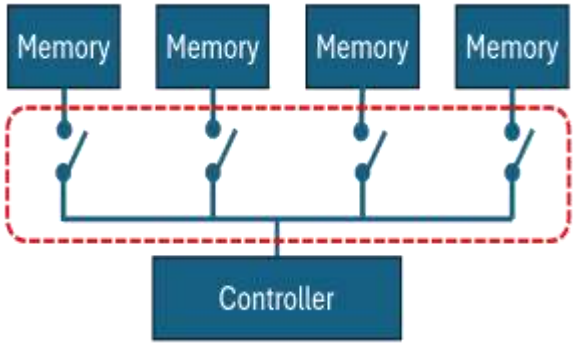
■ What is a Bus Switch ?

- A switch for high-speed and low-loss switching of signal lines
- The basic elements of the Bus Switch are MOSFETs
- Used in a variety fields, including embedded devices, PCs, and servers



■ Usage Examples in Memory System

- Because multiple memory modules for increased capacity are connected to the controller, the load increases.
- A Bus Switch may be used to address signal quality degradation and increased power consumption caused by an increase in load capacity.
- It seems Bus Switches were sometimes used in the DDR systems (DDR2,DDR3,DDR4).
- It is difficult to use Bus Switches with higher-speed signals, because the Bus Switch's capacitance begins to affect signal quality.



- With the evolution of 2.5D/3D IC technology, it may be possible to reuse Bus Switches even for higher-speed signals.

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2. IBIS Model of Basic Bus Switches

Description of Bus Switch's IBIS Model

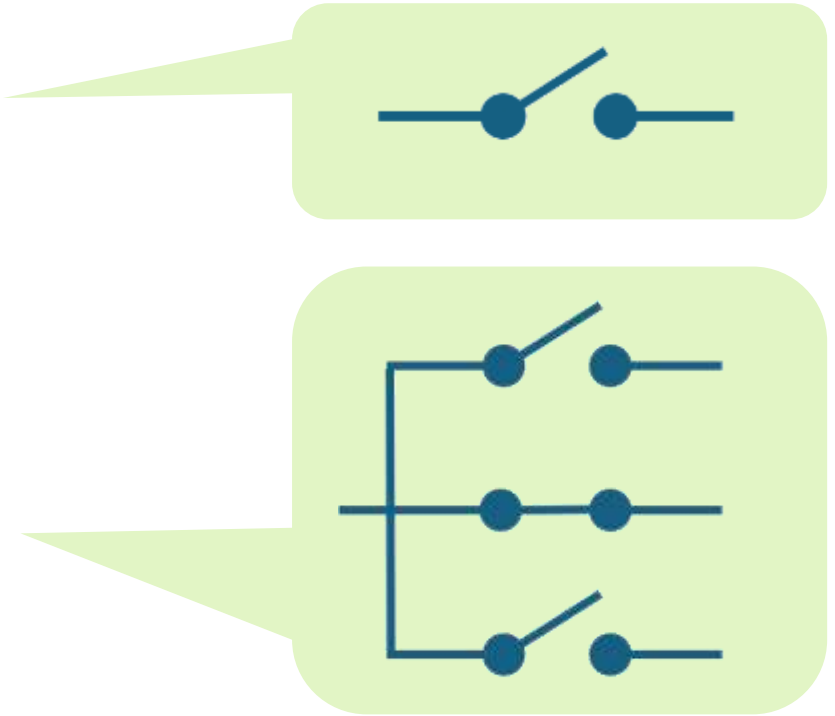
■ IBIS Modeling

- The characteristics of a single switch that makes up Bus Switches are represented by **[Model].**
- Bus Switch configurations and combinations are represented in **[Component].**

■ Keywords defined in [Model]

[Model]　Model_type：Series_switch

- [On]
- [Off]
- [Series Current]
- [Series MOSFET]



■ Keywords defined in [Component]

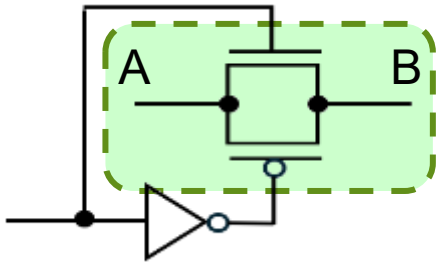
[Component]

- [Series Pin Mapping]
- [Series Switch Groups]

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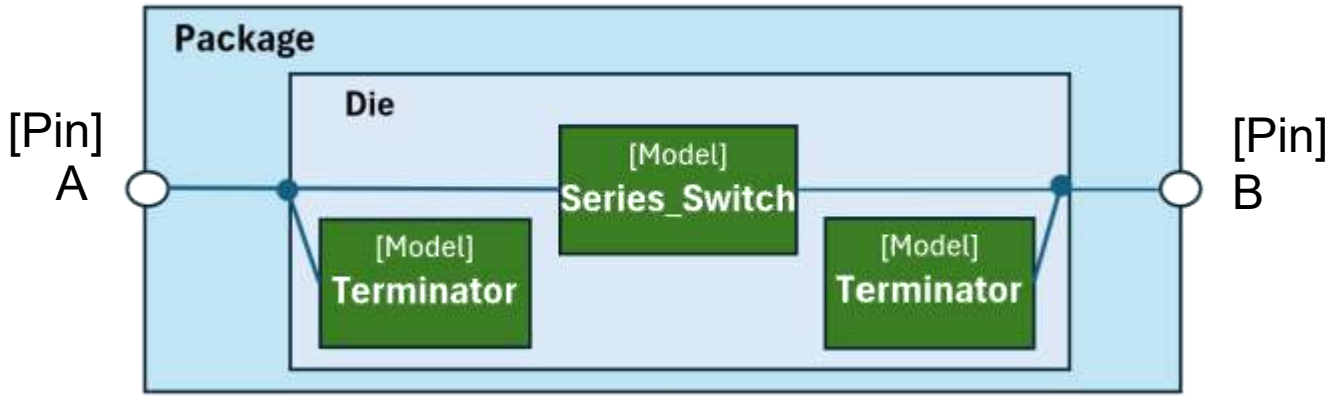
Description Example of [Model]

Introduce the IBIS shown in the circuit diagram on the right,
as an example of a single switch



■ Features

- Composed of 3 [Model]s ： “**Terminator**”(Normally) ×2、“**Series_switch**” ×1
- Although 3 models are used, the pins are consolidated into two located on the input/output paths.
  (The selection signal does not define [Pin])
- Model_type “Series_switch” defines the characteristics for both the On and Off states.




```
[Component] BSWITCH
[Package]
|          typ      min      max
R_pkg  0.030   0.025   0.035
       :
[Pin] signal_name model_name R_pin L_pin C_pin
A   SIG1    TERMA
B   SIG1    TERMB
|*************************************************************
[Model] TERMA
Model_type Terminator
       :
[Model] TERMB
Model_type Terminator
       :
[Model] SIGSW
Model_type  Series_switch
       :
```


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Description Example of [Component]

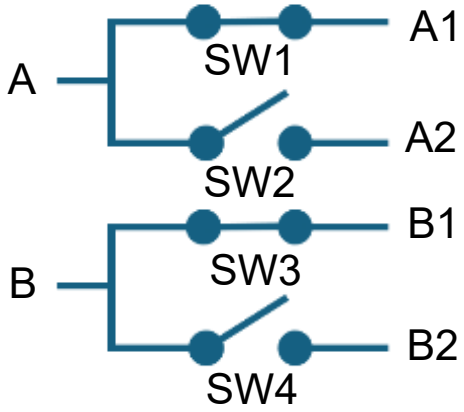
Define the switch signal selection using the following 2 keywords under [Component]

■ [Series Pin Mapping]

- Associate two pins joined by a Switch and set a name to associate switch that are switched.
- Set a name to associate those sets of Series_switch pins that are switched together.

■ [Series Switch Groups]

- A state line will start with “On” or “Off” and define allowable switching combinations of series switches.
- A line “On” is described by the set of the on-state group names. （the undefined states are “Off”）
- A line “Off” is described by the set of the off-state group names. （the undefined states are “On”）




```
[Component]   BSWITCH
   :
|*****************************************************************
[Series Pin Mapping] pin_2 model_name function_table_group
A   A1  SIGSW  SW1
A   A2  SIGSW  SW2
B   B1  SIGSW  SW3
B   B2  SIGSW  SW4
|*****************************************************************
[Series Switch Groups]
On  SW1 SW3/
On  SW2 SW4/
|*****************************************************************
```

The first line defines the default state of the set of series switches.

＜Example of a Model using two 1:2 Bus Switches＞

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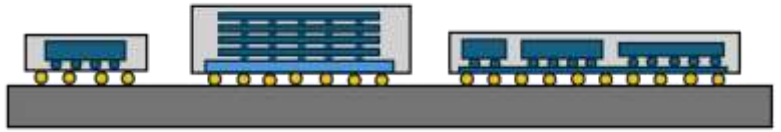
3. New Opportunities for Bus Switches

Opportunities for Using Bus Switches by Technology Evolves

■ The evolution of 2.5D/3D IC packaging technology

- Low-capacity implementation of connections between multiple devices has become a reality.

➡ It is now also possible to assemble packages that integrated multiple devices, including Bus Switches.



■ The evolution of IBIS models

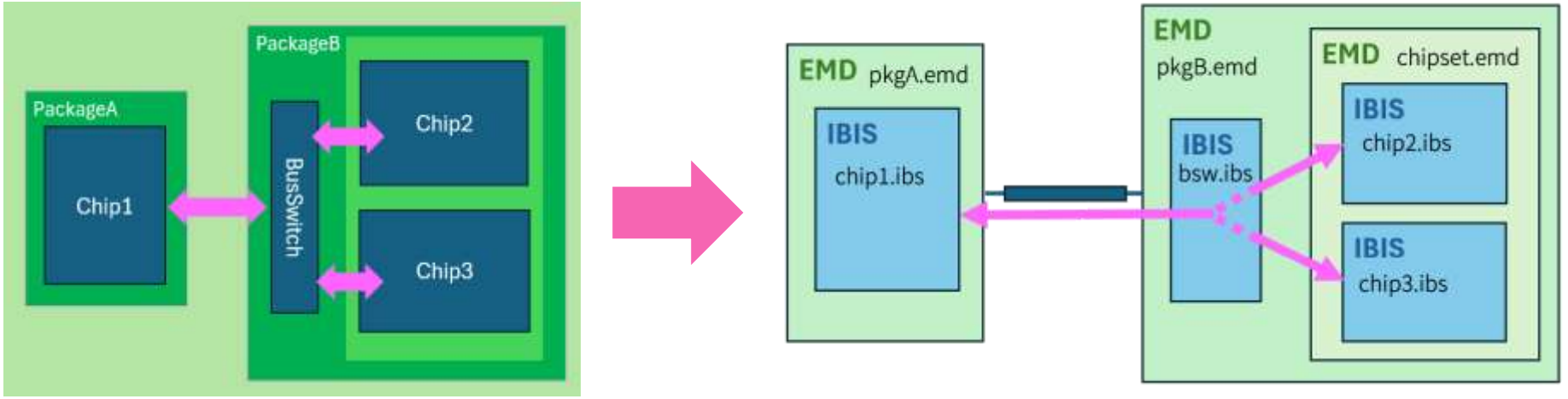
- EMD specifications have been added in IBIS 7.1 and later.
- It is possible to create IBIS models of complex connections between devices.

Advances in packaging and modeling technologies may make it possible to implement high-speed signal transmission using Bus Switches.

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An Example of analysis models that include Bus Switches in the Package

- **Circuit and model diagrams for packages that integrates Bus Switches and other devices.**



- **We could create this configuration model and confirmed that it could be analyzed using certain EDA tools.**
  - *Depending on the EDA tool, we may need to be aware of the following.*
    - ✓*Using EMD models as packaging models*
    - ✓*Analysis of Routes Passing Through Bus Switches*
    - ✓*How to Set the Bus Switch to ”On” or “Off”*
- **Even if the number of complex devices increases in the future, it seems we'll be able to create compatible models thanks to IBIS EMD.**

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4.Summary

Summary

- In some cases, Bus Switches are used in memory systems as a measure to reduce power consumption.
- As memory signal speeds have increased, the Bus Switch has become difficult to use due to the impact of its own capacitance.
- Introduced the basic Bus Switch circuit and IBIS model.
- Evolution in packaging technology and IBIS models have expanded the potential usage of Bus Switches.
- Introduced an example of analysis models that include Bus Switches in the package.
- We confirmed that SI analysis of complex devices is possible by the evolution of IBIS model and the expansion of EDA tools.

We would like to thank IBIS Open Forum for its ongoing technical development, and we look forward to your continued development efforts.

Some major EDA tools do not yet support some IBIS specification version 7.X or later. We look forward to support them.

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