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Integrated Interposer and Voltage Regulator Module

ABSTRACT

This disclosure describes techniques for providing voltage management functionality in a silicon interposer included in an integrated circuit (chip) package. Per techniques of this disclosure, the silicon interposer is utilized for voltage regulation, in addition to providing electrical routing to the package. The interposer includes a voltage regulator module (VRM) that can convert the supply voltage to other voltage levels that can be utilized by different chips in the integrated circuit (IC) package. Switching logic is included within the interposer. Since many packages have similar power specifications, the interposer designs can be reused across different chip designs. A lower impedance can be attained since the distance between the VRM sensor and load is reduced, thereby enabling faster response times. The described techniques can enable fewer power pads and a lower power requirement, providing better efficiency and thermal performance. Unused rails can be powered down for additional power savings.

KEYWORDS

- Silicon interposer
- Voltage regulator module (VRM)
- Through Silicon Via (TSV)
- Power management
- Voltage rail
- Voltage line
- Multi-chip module (MCM)
- Pin impedance

BACKGROUND

Computing devices increasingly utilize large size integrated circuits (IC) that include multiple dies. Routing of electrical power between the dies is enabled by the use of interposers. Interposers provide electrical interface routing between connections and enable rerouting of electrical connections across the integrated circuit.

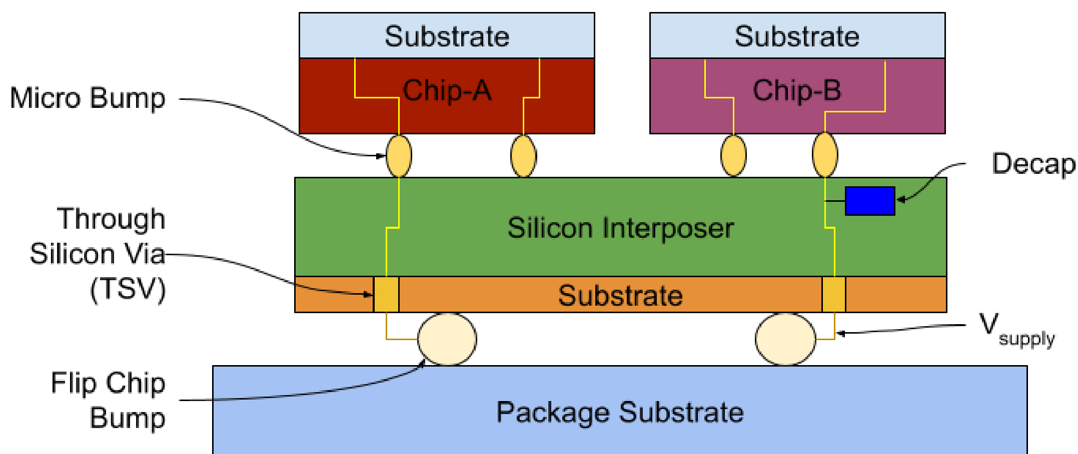

Fig. 1: Interposers are utilized to enable electrical interface routing

Fig. 1 depicts an example integrated circuit package that includes a silicon interposer. As shown in Fig. 1, the silicon interposer provides an electrical connection between the package substrate and the chips (Chip-A and Chip-B) included in the package.

DESCRIPTION

High performance chips commonly use multiple lower levels of voltage ($V_{nom)}$ to improve performance. It is common for printed circuit boards (PCBs) to include up to four voltage lines, and a corresponding set of pins. At the lower levels of voltage, pin impedance can be an important parameter to maximize efficiency. Utilization of the silicon interposer for additional functionality on the package can boost overall performance of the package.

This disclosure describes techniques to provide additional voltage management functionality with a silicon interposer included in an integrated circuit (chip) package. Per techniques of this disclosure, the silicon interposer is utilized for voltage regulation, in addition to providing electrical routing to the package. A single voltage line can be routed to the interposer, which can include one or more voltage regulators to generate multiple voltage lines.

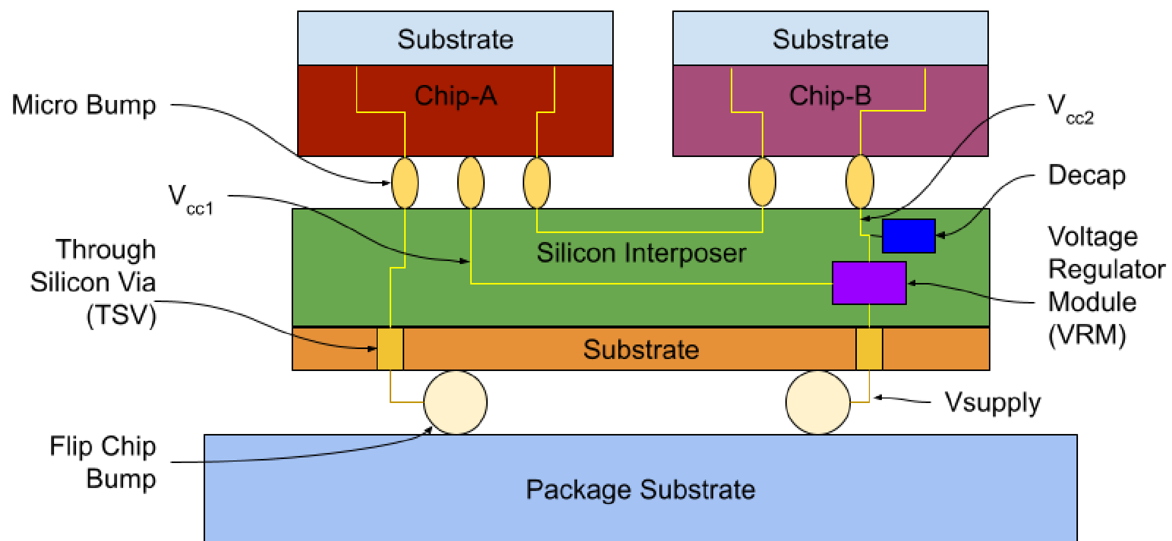

Fig. 2: Silicon interposer provides additional power regulation functionality

Fig. 2 depicts an example silicon interposer that provides additional power regulation functionality, per techniques of this disclosure. As shown in Fig. 2, the interposer includes a voltage regulator module (VRM) that can convert the supply voltage (V_{supply}) to other voltage levels (e.g., V_{cc1} and V_{cc2}) that can be utilized by different chips on the IC package.

In this illustrative example, V_{cc1} is routed to Chip-A and V_{cc2} is routed to Chip-B. In some implementations, a switch can be provided to match the chips with corresponding voltage circuits (lines).

Techniques of this disclosure can enable a reduced number of power (voltage) regulators, e.g., on the die or motherboard, by providing some of the functionality using the interposer. For

example, the pins can operate at a single supply voltage, e.g., 2.5V, 3.3V, etc. which is converted to different voltages across multiple rails on the package.

In some implementations, switching logic can be included within the interposer. Since many packages have similar power specifications, the interposer design can be shared across different chip designs, provided they have the same required voltage and thermal design power (TDP) per rail.

In some implementations, bulk capacitance on a package can be replaced with inductance, and multiple phases utilized to improve the stability of the rail under load. A lower impedance can be attained since the distance between the VRM sensor and load is reduced, thereby enabling faster response time (assuming more phases and or higher frequency, or a shunt reservoir for critical events). The described techniques can enable fewer power pads and a lower power requirement, providing better efficiency and thermal performance. Unused rails or phases in the package can be powered down for additional power savings.

CONCLUSION

This disclosure describes techniques for providing voltage management functionality in a silicon interposer included in an integrated circuit (chip) package. Per techniques of this disclosure, the silicon interposer is utilized for voltage regulation, in addition to providing electrical routing to the package. The interposer includes a voltage regulator module (VRM) that can convert the supply voltage to other voltage levels that can be utilized by different chips in the integrated circuit (IC) package. Switching logic is included within the interposer. Since many packages have similar power specifications, the interposer designs can be reused across different chip designs. A lower impedance can be attained since the distance between the VRM sensor and load is reduced, thereby enabling faster response times. The described techniques can enable

fewer power pads and a lower power requirement, providing better efficiency and thermal performance. Unused rails can be powered down for additional power savings.

REFERENCES

1. Song, Taigon, Noah Sturcken, Krit Athikulwongse, Kenneth Shepard, and Sung Kyu Lim. "Thermal analysis and optimization of 2.5-D integrated voltage regulator." In *2012 IEEE 21st Conference on Electrical Performance of Electronic Packaging and Systems*, pp. 25-28. IEEE, 2012, https://gtcad.gatech.edu/www/papers/06457835.pdf, accessed on 18 July 2023.