Driven by the demand for ever-increasing design complexity and device gate density, the adoption of Process, Voltage and Temperature (PVT) monitoring is critical to achieve reliable operation and optimum performance of advanced node (FinFET, Gate-All-Around (GAA)) semiconductor devices. Increasing transistor density, multi-die ICs and pushing silicon performance boundaries is making monitoring of PVT parameters throughout the silicon lifecycle a necessity. Based on the output of these monitors actions can be taken to optimize silicon health.

The Synopsys SLM PVT IP portfolio includes process detector, voltage monitor, temperature sensor, distributed temperature sensor, catastrophic temperature sensor and thermal diode. The monitors are available from 28nm down to 3nm (Including N3E, N3P, N3AE, Intel 18A, N4P, N5, N5A, N6, N7, N7Auto, 12FFC and 16FFC). The IP allows for life-cycle analytics, increased performance optimization and enhanced reliability for applications such as data center, AI, automotive, 5G and consumer in both commercial and automotive grade.

For GAA process nodes the monitors will leverage digitally assisted analog (DAA) architecture providing smaller size and ease of integration.

PVT CONTROLLER

AMBA APB
Interface
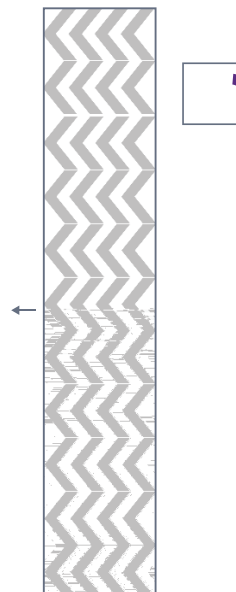
Once integrated, the SLM PVT Monitor IP provides visibility of process, supply and thermal conditions that are accessible via standard interfaces. Through chip assessment and by accurately measuring dynamically changing conditions, the SLM PVT Monitor IP will support device screening and power/performance optimization schemes. The localized, low latency monitoring solution enables an enhanced opportunity for power reduction, increased data throughput and extended device lifetime at both chip and system level. Features include:

- Real-time thermal mapping across the die
- Localized supply voltage analysis
- Silicon assessment for enhanced device screening and increased performance
- Energy and power optimization scheme support (DVFS, AVS)
- Extended reliability and support for predictive maintenance and failure

Easy to integrate, the embedded monitoring subsystem includes the following key components:

Process Detector (PD) - Assessment of silicon for device screening, age monitoring and tracking of real-time circuit speed performance.

Voltage Monitor (VM) - High accuracy supply measurement and IR drop analysis during bring-up, production test and in-field device operation.

Temperature Sensor (TS and DTS) - Distributed, low-latency thermal mapping across the die allowing for real-time analysis device activity.

Catastrophic Temperature Sensor (CTS) - Monitors and provides alert on thermal runaway

Thermal Diode (TD) - Monitors die temperature using external current source

The comprehensive solution consists of a range of monitors communicating to a PVT Controller. Configurable by application, the PVT controller is easily integrated into the design-flow and architecture of the chip.

As a major contributor to the Silicon Lifecycle Management Family platform, the flexible solution accommodates the evolving landscape of PVT monitoring and analytics solutions designed to measure in-chip conditions continuously throughout a silicon chip's lifetime, from fabrication to end-of-life. The PVT controller features include:

- Standard interfacing, including AMBA APB and iJTAG test access support
- Flexible configuration when implementing the SMH and register map
- Supports of multiple monitor IP instances
- Auto-polling and configurable monitor duty cycling
- Low system overhead, relieves system control of monitor management tasks
- Alerts, alarms and trigger conditions for safer, more reliable chip operation
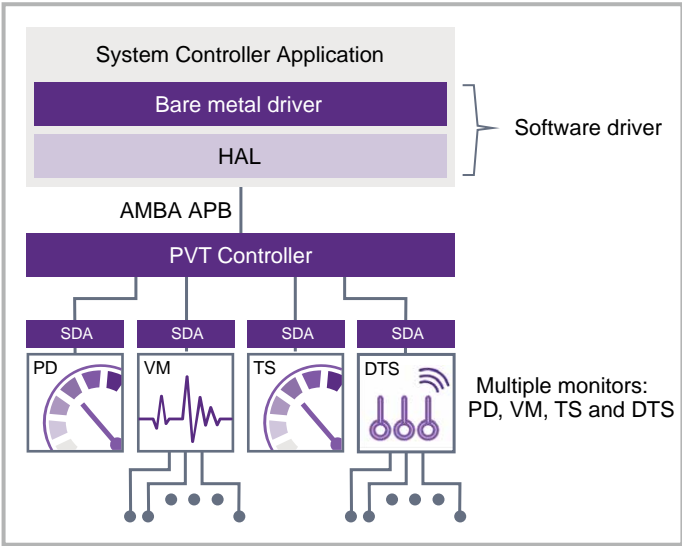
The Synopsys SLM family is designed to improve silicon health and operational metrics at every phase of the device lifecycle. SLM is built on a foundation of PVT monitor IP, data analytics and design automation. Environmental, structural and functional monitors enable deep insights from SoC manufacturing to in-field systems. Meaningful data is gathered at every opportunity for continuous analysis and actionable feedback.

1 In-Chip Monitors
2 Collect
3 Analyze
4 Act