

Technical Deep Dive: The GEEKOM Mini IT8 Series

Engineering and Performance Analysis

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The evolution of Small Form Factor (SFF) computing has transitioned from niche hobbyist hardware to enterprise-grade solutions capable of handling intensive computational workloads. At the forefront of this transition is the **GEEKOM Mini IT8** series, particularly the models powered by the **Intel Core i5-8259U** and the **i3-8109U**. This technical analysis explores the architectural nuances, thermal management systems, and practical implementation strategies for these units in modern IT environments.

1. Architectural Framework: Intel Coffee Lake-U Microarchitecture

The core of the GEEKOM Mini IT8 series lies in the 8th Generation Intel Coffee Lake-U microarchitecture. Unlike previous iterations that focused primarily on energy efficiency at the cost of raw throughput, the Coffee Lake-U chips utilized in the IT8 series (specifically the i5-8259U) introduced a higher **Thermal Design Power (TDP)** ceiling of 28W, compared to the standard 15W found in most ultrabooks of that era.

1.1. Core Configuration and Lithography

Both the i5-8259U and i3-8109U are manufactured on Intel's 14nm++ process. This refined lithography allows for higher clock speeds and better thermal characteristics. The i5-8259U features a **4-core, 8-thread** configuration, while the i3-8109U operates on a **2-core, 4-thread** layout. The inclusion of Intel Hyper-Threading Technology across both tiers ensures that even the entry-level SE (Special Edition) model can handle concurrent background processes without significant context-switching overhead.

1.2. The Impact of eDRAM and Iris Plus Graphics 655

One of the most significant technical differentiators for the IT8 series is the integration of **Intel Iris Plus Graphics 655**. Unlike standard UHD Graphics, the Iris Plus 655 includes **128MB of dedicated eDRAM**. This acts as a Level 4 cache, significantly reducing the latency between the GPU and the system memory. In a Mini PC environment where bandwidth is often a bottleneck, this eDRAM allows for superior performance in video transcoding (QuickSync) and 4K display output at 60Hz.

2. Memory and Storage Scalability

The GEEKOM Mini IT8 is designed with a high degree of modularity, a crucial factor for hardware longevity. The system supports **Dual-Channel DDR4-2400 SODIMM** memory. From a technical standpoint, the transition from single-channel to dual-channel configurations on this platform can yield up to a 30% increase in integrated graphics performance and a 15% improvement in multi-threaded CPU tasks due to the doubling of the memory bus width from 64-bit to 128-bit.

2.1. Storage Interface Protocols

The device supports a dual-drive configuration, which is rare for its size:

- **M.2 2280 Slot:** Supports both SATA and PCIe Gen 3 x4 NVMe protocols. Using an NVMe drive allows for sequential read speeds up to 3,500 MB/s, vastly outperforming standard SATA SSDs.
- **2.5-inch SATA Drive Bay:** Allows for the expansion of high-capacity HDD or SSD storage, making it an ideal

candidate for a localized media server or a network-attached storage (NAS) node.

3. Technical Specification Matrix

The following table provides a side-by-side comparison of the two primary configurations found in the GEEKOM Mini IT8 series.

Feature	Intel Core i5-8259U Model	Intel Core i3-8109U (SE) Model
Cores / Threads	4 Cores / 8 Threads	2 Cores / 4 Threads
Base / Turbo Frequency	2.30 GHz / 3.80 GHz	3.00 GHz / 3.60 GHz
Smart Cache	6 MB	4 MB
Integrated Graphics	Iris Plus 655 (300-1050 MHz)	Iris Plus 655 (300-1050 MHz)
eDRAM	128 MB	128 MB
Max TDP	28 W	28 W
OS Compatibility	Windows 11 Pro / Linux	Windows 11 Pro / Linux

4. Thermal Dynamics and Cooling Engineering

In a chassis measuring roughly 117 x 112 x 45.6 mm, heat dissipation is the primary engineering challenge. GEEKOM utilizes a high-efficiency **centrifugal fan** coupled with a copper heat pipe system. The airflow logic draws cool air from the side vents and exhausts hot air through the rear I/O shield.

4.1. Thermal Throttling Mechanisms

The system BIOS is tuned to manage the **PL1 (Power Level 1)** and **PL2 (Power Level 2)** states. Under sustained load, the i5-8259U can pull up to 50W (PL2) for short bursts (Tau) before settling down to its 28W (PL1) limit. This prevents the junction temperature (TjMax) from exceeding 100°C, ensuring system stability during long rendering tasks or complex data compilations.

5. Connectivity and I/O Protocol Analysis

The GEEKOM Mini IT8 series is equipped with a robust array of ports that utilize high-speed data protocols. Understanding the bandwidth limits of these ports is essential for professional deployment.

- **USB 3.2 Gen 2:** Provides up to 10 Gbps of throughput. This is critical for connecting external NVMe enclosures or high-speed RAID arrays.
- **HDMI 2.0:** Supports 4K resolution at 60Hz with HDR metadata. This is a significant upgrade over HDMI 1.4, which was limited to 30Hz at 4k.
- **Mini DisplayPort:** Offers an alternative 4K output, enabling dual-monitor setups which are essential for productivity workflows.
- **SD Card Reader:** Integrated UHS-I support for photographers and videographers needing quick ingest from camera media.

6. Practical Implementation: Step-by-Step Hardware Upgrade

For IT professionals and power users, upgrading the internal components of the GEEKOM Mini IT8 is a straightforward procedure. Follow this technical guide to ensure component integrity.

6.1. Accessing the Internal Chassis

1. **Safety First:** Ensure the device is powered down and the external power supply is disconnected. Discharge

static electricity by touching a grounded metal object.

2. Removing the Base Plate: Use a Phillips #1 screwdriver to loosen the four rubber-footed screws located at the corners of the bottom plate. Note that these screws are captive and will stay attached to the plate.

3. Lifting the Plate: Gently pry the plate upward. Be cautious of the SATA cable connecting the 2.5-inch drive bay to the motherboard.

6.2. Installing Memory (RAM)

1. Locate the two SO-DIMM slots. If installing two sticks, ensure they are of the same capacity and frequency to enable interleaved dual-channel mode.

2. Insert the RAM module at a 30-degree angle into the slot.

3. Press down until the side metal clips click into place.

7. Software Optimization and OS Integration

The GEEKOM Mini IT8 comes pre-installed with **Windows 11 Pro**. The "Pro" license is significant for business users as it enables **BitLocker Encryption**, **Remote Desktop (Host)**, and **Hyper-V** virtualization support.

7.1. Linux Compatibility and Kernel Support

For developers, the IT8 is highly compatible with modern Linux kernels (5.15+). Standard distributions like Ubuntu, Fedora, and Debian recognize the Iris Plus graphics and Intel Wireless-AC 7265 chipset out of the box. This makes it an excellent candidate for a **Docker host** or a lightweight **Kubernetes (k3s)** node.

7.2. BIOS Tuning for Performance

Accessing the BIOS (typically via the Del or F2 key during boot) allows for several technical adjustments:

- Fan Curve Profiles: Switch between "Quiet," "Normal," and "Performance" modes to balance acoustics with thermal headroom.
- Wake-on-LAN (WoL): Essential for remote management in office environments.
- Video Memory (VRAM) Allocation: Adjust the amount of system RAM dedicated to the integrated GPU.

8. Case Study: The IT8 as a Home Lab Edge Server

In a real-world scenario, a user deployed five GEEKOM Mini IT8 units as a high-availability Proxmox cluster. Each node featured an i5-8259U with 32GB of RAM. The cluster successfully managed 20 virtual machines, including pfSense for routing, Home Assistant for IoT, and several Plex Media Server instances utilizing **Intel QuickSync** for hardware-accelerated transcoding of 4K HEVC streams.

8.1. Energy Efficiency Metrics

During the case study, the idle power draw was measured at approximately 6-8W. Under full synthetic load (AIDA64 Stress Test), the power draw peaked at 42W. This results in a highly efficient performance-per-watt ratio, making it an economically viable solution for 24/7 operation compared to traditional rack-mount servers.

9. Troubleshooting Common Operational Challenges

Despite the robust engineering, users may encounter specific technical hurdles. Here are documented solutions for common failure modes:

9.1. Thermal Throttling or Unexpected Shutdowns

Cause: Dust accumulation in the heatsink fins or dried thermal interface material (TIM). **Solution:** Use compressed air to clear the intake vents. For advanced users, repasting the CPU with a high-conductivity thermal compound

(e.g., Thermal Grizzly Kryonaut) can reduce peak temperatures by 5-8°C.

9.2. Display Flickering at 4K/60Hz

Cause: Insufficient cable bandwidth or EMI interference. **Solution:** Ensure the use of **Premium High Speed HDMI** (Category 2) cables rated for 18Gbps. In the BIOS, ensure the primary display output is set to the correct version protocol.

10. Synthesis and Future Outlook

The GEEKOM Mini IT8, particularly in its Intel Core i5 configuration, remains a highly relevant piece of hardware in the current computing landscape. While newer generations of processors have since been released, the 28W TDP of the Coffee Lake-U series, combined with the 128MB eDRAM of the Iris Plus 655, provides a unique performance profile that excels in specific tasks like media encoding and multi-threaded office applications. Its ability to support Windows 11 Pro natively, combined with its dual-storage and dual-channel memory expandability, ensures that it fulfills the requirements of both the modern professional and the tech-savvy enthusiast looking for a reliable, compact, and powerful computing node.

As we move further into the era of edge computing and decentralized home offices, the Mini IT8 stands as a testament to the viability of SFF PCs as primary workstations. Its balance of I/O versatility, thermal stability, and computational density makes it a benchmark for what a sub-0.5-liter PC should achieve.

Baca Juga (Artikel Terkait)

- [Mastering High-Performance FPGA Design: A Technical Deep Dive into Optimization and Workflow Excellence](#)

URL: <http://123caramba.com/mastering-high-performance-fpga-design-optimization.pdf>

- [Comprehensive Engineering Guide to Artix-7 and Spartan-7 FPGA PCB Design: Optimization and Implementation](#)

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- [The Comprehensive Guide to AFUDOS Flash Utility: Technical Architecture, Implementation, and Advanced BIOS Maintenance](#)

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- [Technical Deep Dive: Architecture, Performance, and System Diagnostics of the GEEKOM Mini IT8 SE Ecosystem](#)

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