ADVANTECH

*Enabling an Intelligent Planet*

# 2022 SQF SSD update


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**January 2022**

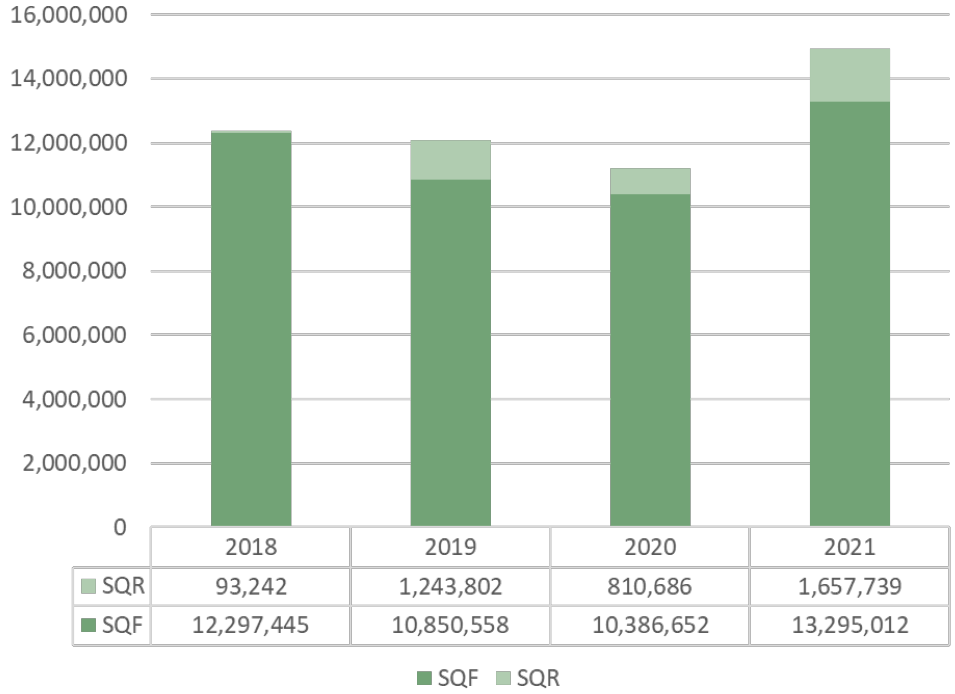
# Full-scale Expansion in New Sectors

## Cross sector collaboration to penetrate new opportunities

| Self service KIOSK | Green energy storage | Service robot | DRAM/NAND tester |
|---|---|---|---|
|  |  |  |  |

| 5G & Starlink | Autonomous system | Military & tactical | EV charger |
|---|---|---|---|
|  |  |  |  |

# SQF/SQR Revenue 2018 ~ 2021




| | 2018 | 2019 | 2020 | 2021 |
|---|---|---|---|---|
| SQR | 93,242 | 1,243,802 | 810,686 | 1,657,739 |
| SQF | 12,297,445 | 10,850,558 | 10,386,652 | 13,295,012 |

- From 2018~2021 G/R : 12% / CAGR : 4.3% [USD 15M in 2021]
- SQR revenue grew 1,678 % since 2018 / CAGR 161% [USD 1.6 Mil]
- 2020 slowed down due to Covid impact, but 2021 had fully recovered and back on track. ANA did even more **than expected 3 years CAGR.**

**Key success factors:**

- Securing MLC delivery and negotiated with customer on cost impact at earliest stage.
- Rapidly adopting new technology (BiCS4/sTLC) to ensure fulfillment problem can be relieved ASAP.
- PD's strong support and close communication and collaboration with ACL.

Industrial Reliability

## Commitment on Design and Supply

- Advantech design
- Quality control

## Design and material

- Toshiba Bin1 NAND, Phison controller
- Reliability first
- Firmware modification service

## Supplying & Warranty

- 3yrs Guaranteed Longevity and revision control
- 3yrs limited warranty

# Value Proposition of SQF

| | Advantech SQF | Micron, Intel, Samsung, Kingston, Sandisk … |
|---|---|---|
| **Product Longevity** | Minimum 3 years | 12 - 24 months |
| **Ext. Temperature** | support both 0-70 & -40 to 85 degree C selection | 0 - 70 degree C, very few ext. temp selection |
| **Long tail of legacy FF support** | Support all popular industrial form factor | 2.5", M.2, some mSATA |
| **NAND Selection** | SLC, uMLC, MLC, 3D TLC | most are 3D TLC, a little MLC left |
| **Power Failure Protection** | standard feature | selected models |
| **Firmware Modification Service** | common | not common |
| **Focus Market** | industrial, embedded | consumer, data center, some embedded |
| **Other Features** | H/W write protection, GPIO triggered quick erase | not common |

# A Long Tail of Legacy Support

| | Compact Flash | 2.5" | Full & H/S mSATA MO-300A | SATA slim MO-297 | M.2 2242 2280 | U.2 U.3 | CFAST | SD/uSD | USB |
|---|---|---|---|---|---|---|---|---|---|
| **PATA** | SLC/MLC | | | | | | | | |
| **SATA** | | SLC/MLC/TLC | MLC/ TLC | MLC/ TLC | MLC/ TLC | | TLC | | |
| **NVMe** | | | | | TLC | TLC | | | |
| **Others** | | | | | | | | MLC/TLC | MLC/TLC |

SQF provide both selection of 0-70C and -40 to 85 degree C operation temperature

# What is TBW ?

## Endurance

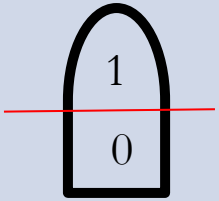
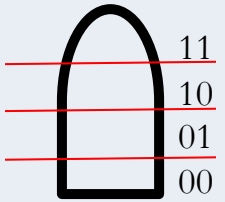
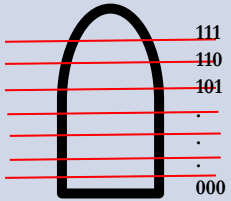
JEDEC defined an endurance rating TBW (TeraByte Written), following by the equation below, for indicating the number of terabytes a SSD can be written which is a measurement of SSDs' expected lifespan, represents the amount of data written to the device.

**TBW = [(NAND Endurance) x (SSD Capacity)] / WAF**

- **NAND Endurance**: Program / Erase cycle of a NAND flash.
  - SLC: 100,000 cycles
  - Ultra MLC: 30,000 cycles
  - MLC: 3,000 cycles
- **SSD Capacity**: SSD physical capacity in total of a SSD.
- **WAF**: Write Amplification Factor (WAF), as the equation shown below, is a numerical value representing the ratio between the amount of data that a SSD controller needs to write and the amount of data that the host's flash controller writes. A better WAF, which is near to 1, guarantees better endurance and lower frequency of data written to flash memory.

**WAF = (Lifetime write to flash) / (Lifetime write to host)**

# SQF provide SLC, MLC, uMLC and 3D TLC selection

| NAND Type | Program / Erase (P/E) cycle | |
|---|---|---|
| SLC single level cell 1bit | 100K times ✓ |   |
| MLC Multi level cell 2 bit<br><br>ultraMLC = MLC but store Only one bit of data | MLC ~ 3K times ✓<br>uMLC ~ 30K times ✓ |   |
| TLC triple level cell 3 bit<br>sTLC = TLC but only store 1 bit of data | 2D ~ 500 times X<br>32L 48L 3D ~ 1.5K X<br>64/96/112 L 3D ~ 2.5K<br>sTLC ~ 25K ✓ |   |

# NAND Revolving

| NAND | Definition | Longevity | Technology | Temerature | Price | Leadtime | TBW (write endurance) | Thermal Throttling | Data Retention |
|---|---|---|---|---|---|---|---|---|---|
| SLC | Legacy | end of 204 so far EOL low demand item | 2D | 0-70C '-40 - 85C | ~ 500% | 10 weeks made by order | 3000% | No | 10 yr (New) 1 yr (90% wear out) |
| MLC / uMLC | Legacy | end of 204 so far EOL low demand item | 2D | 0-70C '-40 - 85C | 100% | 10 weeks made by order | MLC : 100% uMLC : ~1000% | No | 10 yr (New) 1 yr (90% wear out) |
| BICS3 | Legacy | in EOL process | 3D 64 layer | 0-70C '-40 - 85C | ~ 50% | 10 weeks made by order | TLC : ~ 80% | YES | 10 yr (New) 1 yr (90% wear out) |
| BICS4 TLC/sTLC | Legacy, MP but no new spec in | end of 2024 | 3D 96 layer | 0-70C only | ~ 35% | 4-6 weeks | TLC : ~ 80% sTLC : ~ 800% | YES | 10 yr (New) 1 yr (90% wear out) |
| BICS5 TLC/sTLC | Main Stream Spec in | end of 2025 | 3D 112 layer | 0-70C '-40 - 85C | ~25% | 4-6 weeks | TLC : ~ 70% sTLC : ~ 700% | YES | 10 yr (New) 1 yr (90% wear out) |

# Performance SSD vs embedded SSD

| I/F | Series | Controller | Cache | Density | temp | Form Factor |
|---|---|---|---|---|---|---|
| SATA | 840 | S12, performance | DRAM | 240GB – 8TB | 0-70 C & -40 -85C | 2.5”, M.2 2280, mSATA |
| SATA | 650 | S17 embedded | NAND run in single bit mode | 32GB – 2TB | 0-70 C & -40 -85C | 2.5”, M.2 2280, 2242, mSATA F/S, mSATA H/S SATAslim, Cfast |
| NVMe | 920 | E12, performance | DRAM | 240GB – 8TB | 0-70 C & -40 -85C | U.2, U.3 M.2 2242, 2280 |
| NVMe | 720 | E13T embedded | NAND run in single bit mode | 32GB – 2TB | 0-70 C & -40 -85C | M.2 2242, 2280 |

# Security Design TCG OPAL and Flash Lock

- **Lock OS booting drive with corresponding platform**
  - AES-256 enabled SSD with TCG compliance self-encryption disk (SED)
  - Operated by a secured pre-boot zone, low design effort with high flexibility of customization to reach higher security standard.
  - Supported product line: SQF 830 / 710 / 920 series
  - Support secured erase
  - Implementation
    - SQFlash **Flash Lock** function – auto pair with motherboard
    - Generic user authentication – username and password before OS
    - 3rd party TCG-OPAL tool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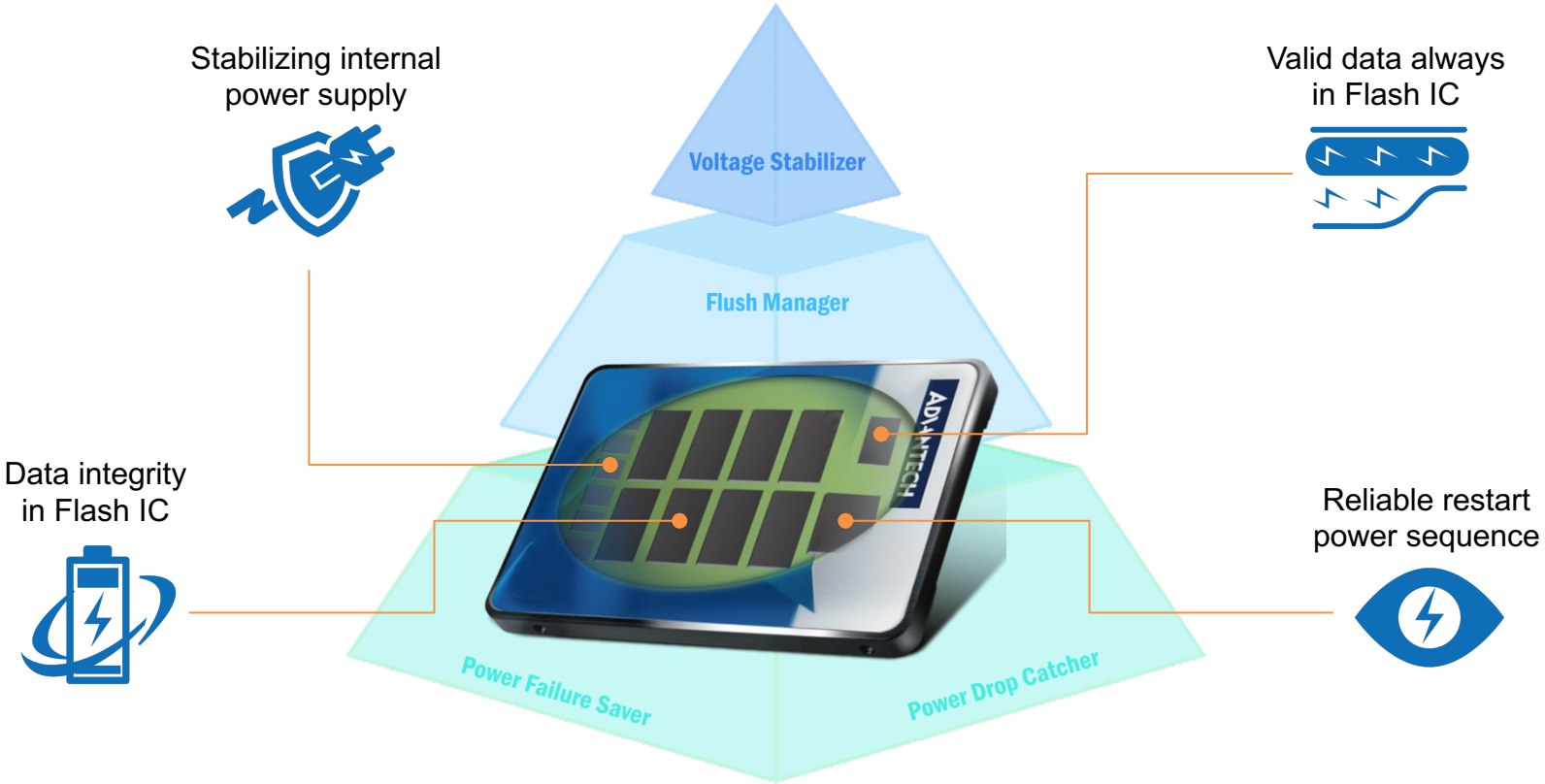
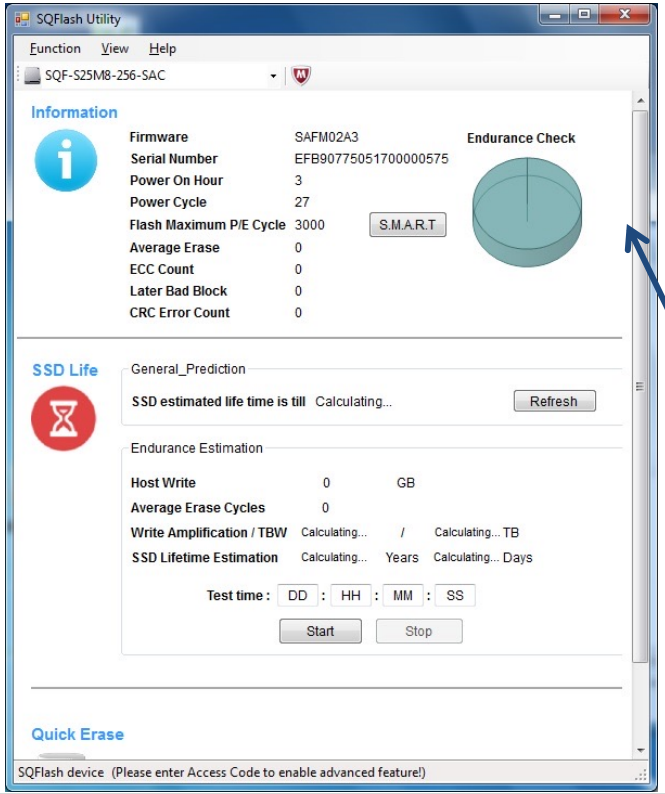
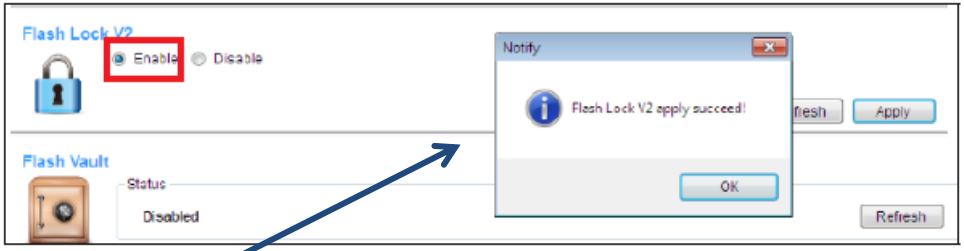
# Power Failure Protection



# Life Prediction and health monitoring Utility
# Flash Lock Utility




- "Flash Lock" is a pre-boot authentication utility. Once enabled the system and SQF will exchange unique ID then reboot. After that the specific SQF and the system are "paired" and "locked". (only OPAL SKU support Flash lock)
- Monitor SQFlash health status.
- Real time SSD remaining life prediction based on user behavior
- Quick erase

Reset AES key → format → write FF → rebuilt firmware table

# High-end security and government: FIPS 140-2 certified product


| Product Series | Capacity |
|---|---|
| 840S SATA 2.5” SSD | 120GB - 1920GB |
| 840S SATA M.2 2280 SSD | 120GB - 1920GB |
| 920S NVMe M.2 2280 SSD | 240GB - 1920GB |

- Line-by-line code review and certification (9+ months & >150K USD)
- Full Disk Encryption: AES-256 + FIPS mode OPAL secure boot
- Physical anti-temper coating on product

**Our strength**
Complete eco-system support

**Key to Win**
Selling channel build-up

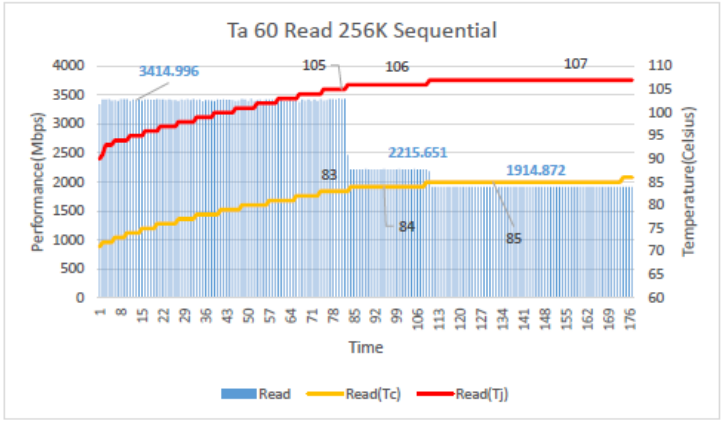
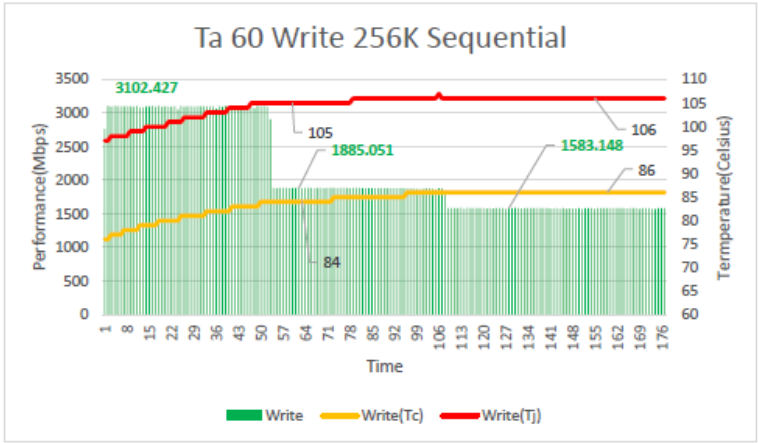
# What is Thermal Throttling of TLC NAND

TLC NAND is more sensitive to high temperature than MLC and SLC.
Definition of operation temperature of TLC SSD is the Tcase of NAND.  Not ambient temperature.
Operation temperature = SSD throughput at full speed
SSD will keep going at lower speed when Tcase is > operation temperature

| T ambient | SMART (sensor) | Tcase CTL | Tcase NAND | Read/write (MB/s) | Thermal Throttling |
|---|---|---|---|---|---|
| 55C | 72C | 85C | 69C | 524/478 | No TT |
| 70C | 84C | 95C | 80C | 407/373 | Trig TT1 |
| 80C | 95C | 105C | 90C | 349/319 | Trig TT2 |

0- 70C SKU — TT1 trigger @ 67C, TT2 trigger @ 70C per SMART
-40 to 85C SKU — TT1 trigger @ 82C, TT2 trigger @ 85C per SMART

- **Benchmark Result with Ta 60 Celsius**

| Results | |
|---|---|
| Read |  |
| Write |  |



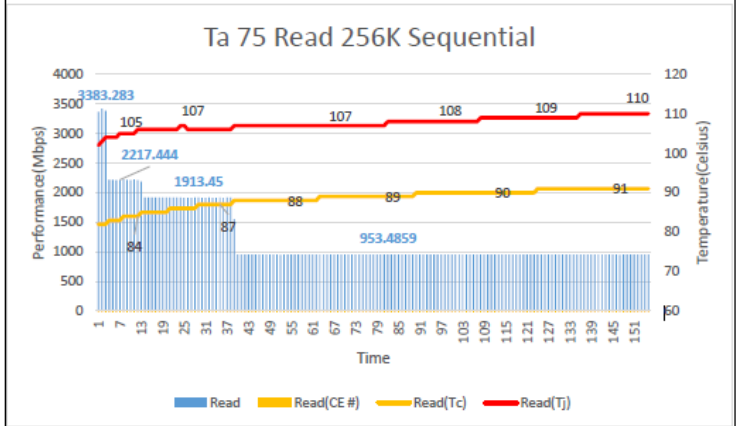


**Yellow line : Tcase of NAND read by on-board sensor**
**Red line : Tjunction of SSD controller**
**Blue : Sequential read speed in MB/s.**

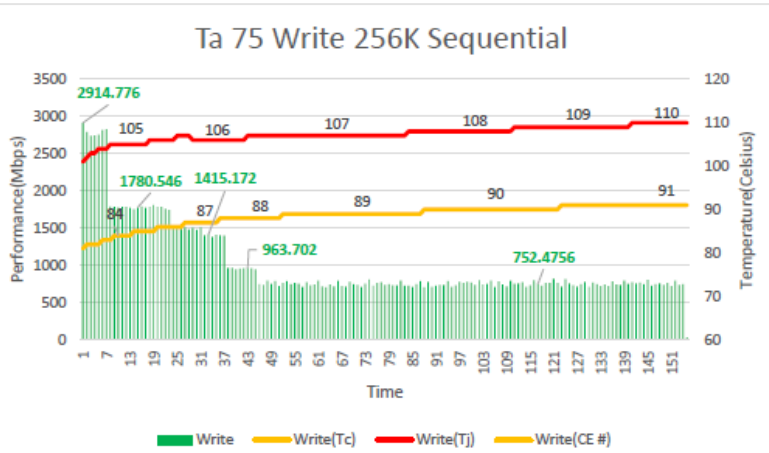
Test unit : SQF-CM8V4-1K9GDECE (-40 to 85C)

**Yellow line : Tcase of NAND read by on-board sensor**
**Red line : Tjunction of SSD controller**
**Blue : Sequential write speed in MB/s.**

- **Benchmark Result with Ta 75 Celsius**

| Results | |
|---|---|
| Read |  |



| | |
|---|---|
| Write |  |



**Yellow line : Tcase of NAND read by on-board sensor**
**Red line : Tjunction of SSD controller**
**Blue : Sequential read speed in MB/s.**

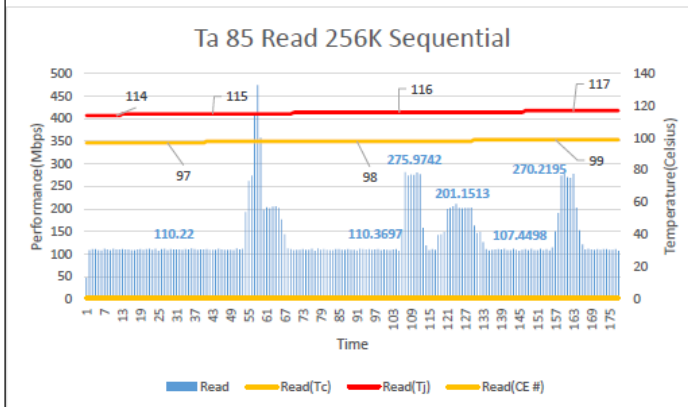
Test unit : SQF-CM8V4-1K9GDECE (-40 to 85C)

**Yellow line : Tcase of NAND read by on-board sensor**
**Red line : Tjunction of SSD controller**
**Blue : Sequential write speed in MB/s.**

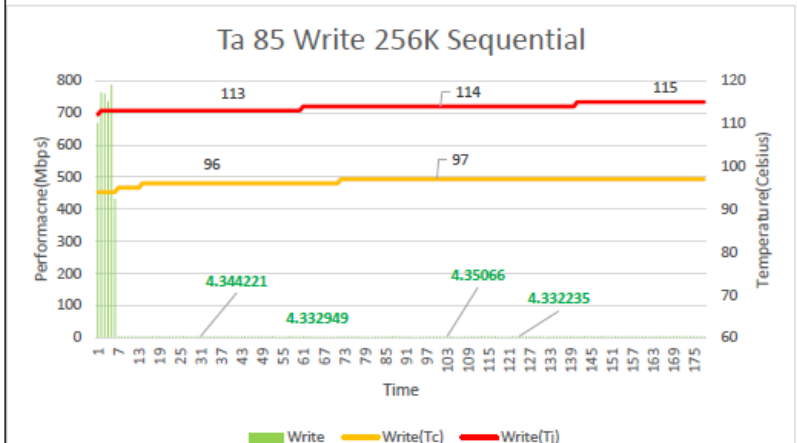
- **Benchmark Result with Ta 85 Celsius**

**Results**

Read




Write

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Test unit : SQF-CM8V4-1K9GDECE (-40 to 85C)

**Yellow line : Tcase of NAND read by on-board sensor**
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**Blue : Sequential write speed in MB/s.**

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# Price book

**SSD**

- **Main stream P/N and price will be released in price book & SAP.**
- **Price of legacy item will only update price in SAP**

**DRAM**

- **Suggest to use “focus items”.  Those are pe-selected product with better price, longevity and availability.**