# Automotive-Grade UFS and e.MMC Embedded Flash Drives

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# The Storage You Can Drive On

Designed for the connected and autonomous car market, Western Digital's automotive-grade iNAND® UFS and e.MMC Embedded Flash Drives (EFDs) deliver high-performance and high-reliability storage for a variety of demanding automotive applications. The devices address the evolving needs of traditional applications such as infotainment and vehicle navigation systems, and next generation applications such as Vehicle-to-Vehicle/Infrastructure communications, telematics gateways, digital cluster, drive recorders, and autonomous driving.

Smart partitioning, a sophisticated read refresh algorithm, power fail immunity, and an LDPC ECC engine are just a few of the features that make these some of the most advanced EFDs on the market. With additional industry-leading features including automotive-optimized 3D technology, iNAND SmartSLC™, and deep diagnostics, Western Digital iNAND automotive-grade e.MMC and UFS EFDs empower your data-driven applications.



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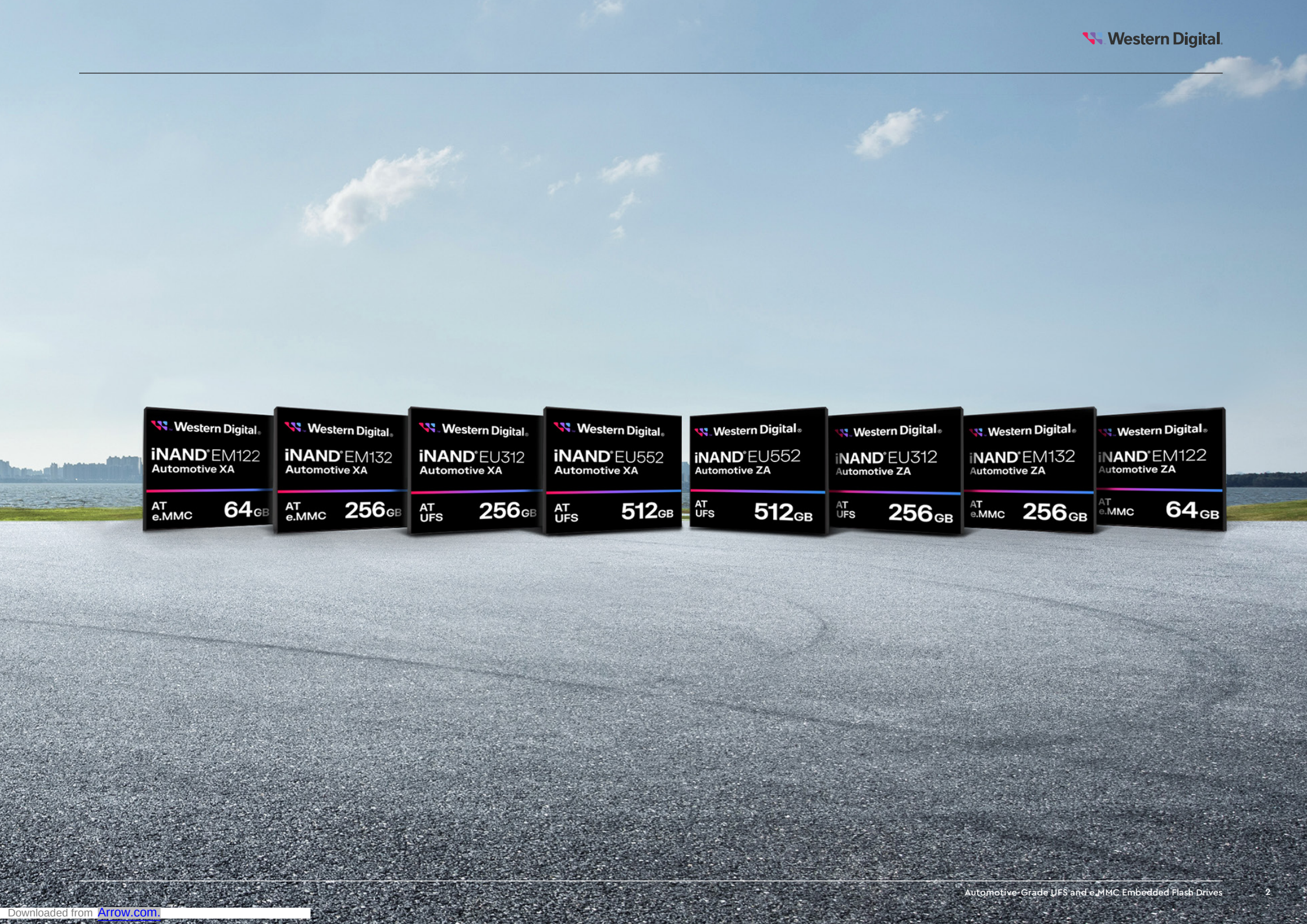




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# Advanced Features

## 3D Technology*

- Higher performance, lower cost and lower power consumption
- Larger effective cell size and less cell-to-cell interference
- Higher reliability margins when compared to 2D NAND with similar bit density

## SmartSLC™ & Write Booster*

Western Digital's automotive grade iNAND products feature industry-leading SmartSLC for e.MMC and UFS2.1 and Write Booster for UFS3.1, designed to boost host write performance and leverage the benefits of SLC to maximize device throughput and endurance.

Adaptive mechanisms ensure writes are routed through SLC blocks for superior write speeds and efficiently migrate data to TLC to ensure performance consistency.

### Advantages:

**Performance:**

- Boost sequential and random write performance to SLC level
- SLC-grade latency for better write-driven use cases
- Maintain high performance when media is fragmented
- Persistent performance even when media is full

**Endurance:**

- Reduce host writes to the TLC area
- Reduces Write Amplification Factor (WAF) to the TLC area
- Increase product endurance and longevity (TBW)

**Robustness:**

- Leverage SLC's higher resiliency to data corruption
- TLC/SLC redundancy increases power failure handling

*Note: SmartSLC applicable for AT EM132 and AT EU312, Write Booster applicable for AT EU552



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# Advanced Features

## Advanced Device Report

iNAND products offer a proprietary device report feature with detailed information and diagnostics on the firmware and device status at runtime. This information provides a deeper EFD status understanding, on top of the e.MMC and UFS JEDEC specs in an easy-to-use method including:

- Wear-leveling areas and device health
- Voltage droop and occurrences
- Power diagnostics
- WAF (Write Amplification Factor) value
- Lifetime prediction
- Firmware release and update
- Host read and write
- Error detection and correction
- Temperature
- Failures and recovery

## Smart Partitioning

iNAND automotive-grade e.MMC and UFS Smart Partitioning implementation creates dedicated, physically separated and individually managed memory areas. This protects specific partitions from the unwanted effects of overuse as well as preventing any impact to the data integrity caused by activities in other areas, thus helping to maximize endurance, data retention and separation.

**Separate areas may include:**

- TLC/MLC based User Area
- SLC based High Data Retention / Read Intensive / Secured area
- SLC based High Endurance area, tailored for write-intensive applications

## Auto/Manual Read Refresh

A sophisticated automatic read refresh algorithm is implemented in the iNAND automotive-grade e.MMC and UFS devices to offer better handling of data retention, read disturb and read refresh. It senses early signs of block degradation and automatically refreshes the data. The algorithm includes multiple types of scans designed to identify affected pages with high Bit Error Rate (BER).

In addition, the host can initiate Refresh via command, which is proprietary in iNAND automotive-grade e.MMC and according to JEDEC UFS3.0 in iNAND automotive-grade UFS.



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# Advanced Features

## Power Immunity

iNAND automotive-grade e.MMC and UFS devices implement advanced mechanisms for protecting the device and the user data from data loss, data corruption or device damage due to external power failures. This addresses the occurrence of both write abort and voltage droop.

## 100% Content Preloading and Integrity Post IR Reflow

iNAND automotive-grade e.MMC and UFS are designed to support 100% content preloading (via external programmer) pre-IR reflow and guarantee high data integrity post-IR reflow. This assures that the high temperature experienced during the IR-reflow process does not affect the data integrity of the preloaded data.

## Thermal Management

To prevent the damage to the NAND or controller while operating in high temperatures, the iNAND automotive-grade e.MMC and UFS implement a robust thermal management mechanism. This mechanism is activated by default and automatically adjusts the internal power mode to ensure protection from overheating. In addition, the iNAND automotive-grade UFS device supports Temperature Event Notification-a JEDEC UFS3.0 parameter.

## Suited for Automotive Applications

iNAND automotive-grade e.MMC and UFS devices undergo rigorous qualification and production testing, and comply with automotive standards such as AEC-Q100 and are qualified to meet and exceed the standard requirements.

## Fast Boot

iNAND automotive-grade e.MMC and UFS devices enable the host to boot from boot partitions/LUs of the device.
This feature allows the system to be functional at the proper time. For example, the console display and the remaining car system functionality are needed the moment the driver enters or activates the vehicle. In addition, this feature enables the replacement of SPI NOR for the inherent capability of the iNAND device, reducing BOM costs and board space.



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## Automotive iNAND® Embedded Flash Devices

| | iNAND AT EU552 Grade 2 | iNAND AT EU552 Grade 3 | iNAND AT EU312 Grade 2 | iNAND AT EU312 Grade 3 | iNAND AT EM132 Grade 2 | iNAND AT EM132 Grade 3 | iNAND AT EM122 Grade 2 | iNAND AT EM122 Grade 3 |
|---|---|---|---|---|---|---|---|---|
| | Western Digital. iNAND® EU552 Automotive ZA AT UFS 512GB | Western Digital. iNAND® EU552 Automotive XA AT UFS 512GB | Western Digital. iNAND® EU312 Automotive ZA AT UFS 256GB | Western Digital. iNAND® EU312 Automotive XA AT UFS 256GB | Western Digital. iNAND® EM132 Automotive ZA AT e.MMC 256GB | Western Digital. iNAND® EM132 Automotive XA AT e.MMC 256GB | Western Digital. iNAND® EM122 Automotive ZA AT e.MMC 64GB | Western Digital. iNAND® EM122 Automotive XA AT e.MMC 64GB |
| Capacity (GB) | 64GB – 512GB | | 16GB – 256GB | | 32GB – 256GB | | 8GB – 64GB | |
| Interface | UFS 3.1 | | UFS 2.1 | | e.MMC 5.1 HS400 | | e.MMC 5.1 HS400 | |
| Operating Temperature | –40°C to 105°C | –40°C to 85°C | –40°C to 105°C | –40°C to 85°C | –40°C to 105°C | –40°C to 85°C | –40°C to 105°C | –40°C to 85°C |
| Sequential R/W (MB/s)* | Up to 1600/1200 | | Up to 800/550 | | Up to 310/250 | | Up to 300/125 | |
| Random R/W (IOPS) | Up to 100K/95K | | Up to 45K/40K | | Up to 20K/12K | | Up to 22K/12K | |
| Enhanced Features | Advanced Health Report, Smart Partitioning, Auto and Manual Refresh, Thermal Management, UFS 3.0 automotive features included | | Advanced Health Report, Smart Partitioning, Auto and Manual Refresh, Thermal Management, UFS 3.0 automotive features included | | Advanced Health Report, Smart Partitioning, Auto and Manual Refresh, Thermal Management | | Advanced Health Report, Smart Partitioning, Auto and Manual Refresh, Thermal Management | |
| Package | 11.5 × 13 × 1.2mm | | 11.5 × 13 × 1.2mm | | 11.5 × 13 × 1.0mm, 11.5 × 13 × 1.2mm | | 11.5 × 13 × 0.8mm, 11.5 × 13 × 1.0mm, 11.5 × 13 × 1.2mm | |
| Ordering Information | SDINFDQ6-##G-ZA1 | SDINFDQ6-##G-XA1 | SDINDDH6-##G-ZA2 | SDINDDH6-##G-XA2 | SDINBDA6-##G-ZA1 | SDINBDA6-##G-XA1 | SDINBDG4-##G-ZA3 | SDINBDG4-##G-XA3 |

Note: One gigabyte (GB) is equal to one billion bytes. Actual user capacity may be less due to operating environment.
* 1 MB/s = 1 million bytes per second. Based on internal testing; performance may vary depending upon host device, usage conditions, drive capacity, and other factors.



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