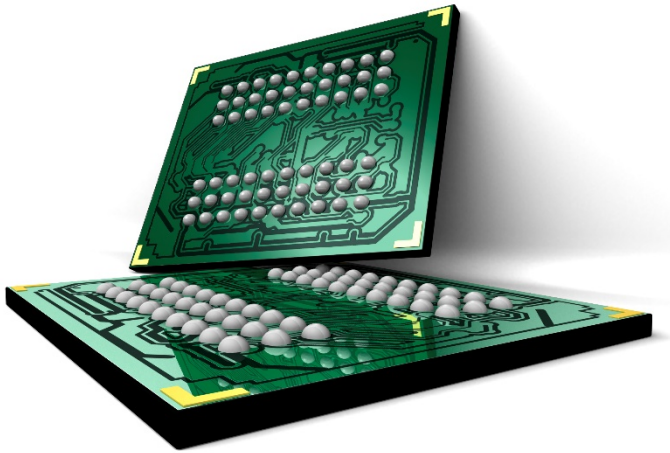
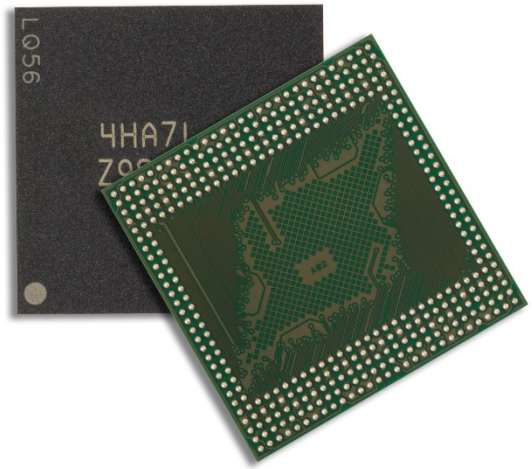
LPDRAM Product Overview



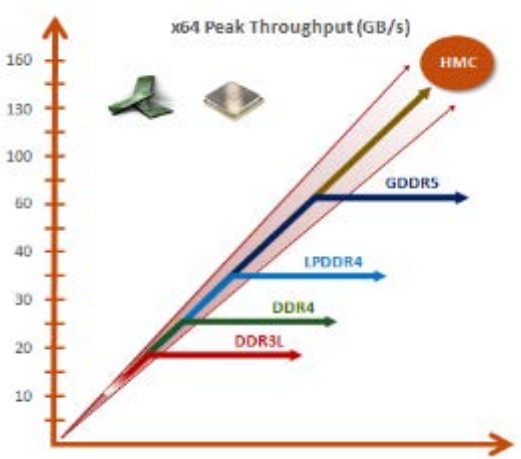


Standard DRAM & LPDRAM Trade Offs

General LP vs. DDR Comparison

	Standard DRAM	LPDRAM
Form Factor	Center bond pads for highest performance and lowest cost	Edge bond pads allow for stacked die for MCP and PoP packaging, enabling compact form factors
Performance	x4, x8, x16 is lower cost and supports higher density configurations	x32 allows system to support high bandwidth in point-to-point applications
DRAM power	IDD specifications are geared towards moderate stand-by power, providing the highest yields and lowest cost	Ultra low standby power enabled by on-die power management and long refresh rates
System power	Additional Delay Locked Loop (DLL) circuitry required for high performance which inhibits system power savings	Lack of DLL circuitry allows for improved system power management; System can enter/exit power-down modes as well as throttle or stop the clock
Key Takeaway	**Optimized for cost and performance;** ***cost is primary feature***	**Optimized for battery life and portability;** ***low power & smallest possible footprint are primary features***

LPDDR4 Specific Info



LPDDR4 is a higher bandwidth solution vs. DDR4

- **LPDDR4:** Peak BW 34GB/s (2 x32 package)
- **DDR4:** Peak BW 25.6GB/s (4 x16 packages)

LPDRAM offers additional value over standard DRAM

Automotive LPDRAM Overview

DRAM Application Adoption

May 18, 2017

Market Trends

Increasing LPDRAM Usage

- LPDRAM used in multiple applications
  - Instrument Cluster
  - Infotainment
  - ADAS
- Skipping LPDDR3 & moving to LPDDR4
- Increasing MCP adoption in communication modules

LPDRAM Requirements

Zero Defect Target Approach

- Burn in required to lower DPM rate
- Material selection for Auto grade devices

Extended Operating Temperatures

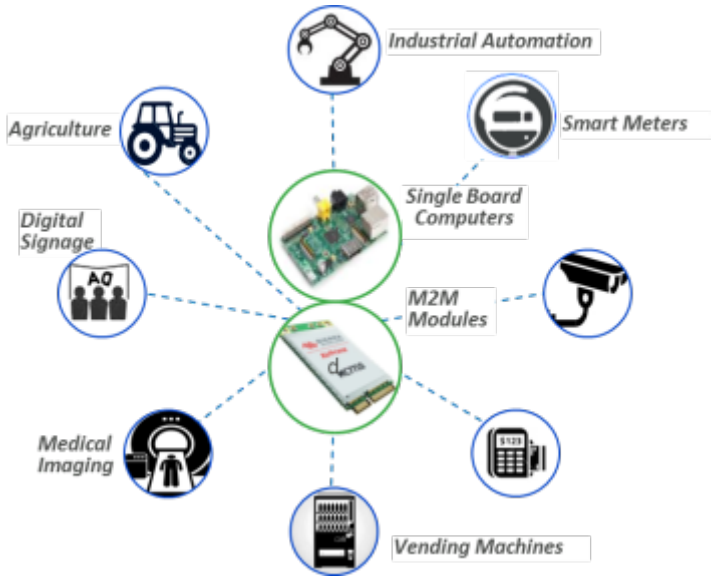
- From -40C up to 125C for next gen devices

Product Longevity

- Formal Product Longevity Program (PLP)
  - Support for 10 years & beyond
- Extended transition times for die shrinks
  - 1 year Last Time Buy + 1 year Last Time Ship

Industrial LPDRAM Overview

DRAM Application Adoption



Market Trends

Wide Mix of DRAM Technology

- Continued need for legacy support

Strong LPDRAM Adoption

- Driven by battery driven applications
- Minimal LPDDR3 adoption projected (follows Auto LPDRAM adoption trends)
  - LP3 adoption driven by mobile CSVs branching into adjacent IMM markets

LPDRAM Requirements

Product Longevity

- Formal Product Longevity Program (PLP)
  - Support for 10 years & beyond
- Proven record of long term support

Extended Operating Temperatures

- IT grade components enable systems to operate in harsh environments

Broad portfolio for many applications

- Lower density offerings (i.e. 4Gb LP3)
- Increasing MCP and PoP adoption

Micron's LPDRAM Advantages

Automotive

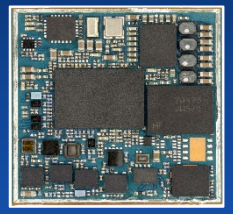
Zero Defect Target Approach
- Burn in to lower DPM rate
- True Auto grade devices

Extended Operating Temps
- -40C up to 125C

Product Longevity
- Product Longevity Program: PLP

Extended time for die shrinks
- 1 year Last Time Buy + 1 year Last Time Ship

Industrial & Other



Product Longevity
- Product Longevity Program: PLP
- Proven record of long term support

Extended Operating Temperatures
- IT grade components enable systems to operate in harsh environments

Broad portfolio/Many applications
- Lower density offerings
- Small footprint MCPs and PoPs

Consumer & Connected Home

Leading Edge Technology

Manufacturing Scale

Cost driven customer base
- Similar dynamic to mobile handset market

Differentiated Solutions for Cost Optimization and Innovation
- Solutions for small form factors
  - KGD
  - MCPs