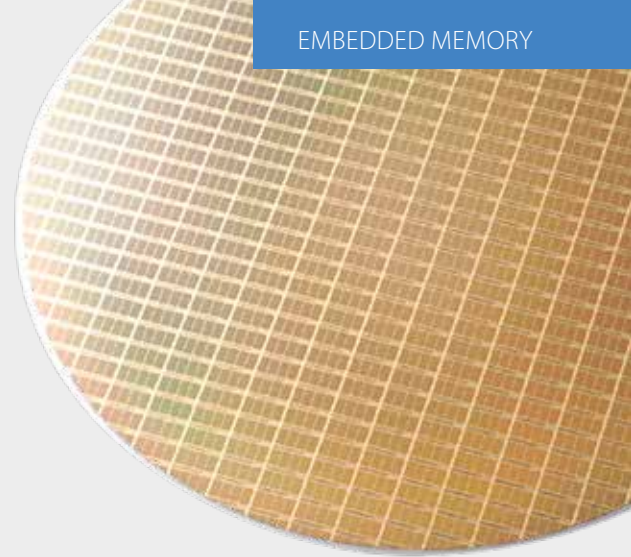


Inventor of Flash Memory



Silica wafers are formed from highly pure, nearly defect-free single crystalline material: the starting point for any integrated circuits.

INNOVATION IS OUR TRADITION

In 1984 Toshiba developed a new type of semiconductor memory called flash memory. Later in 1987, NAND flash memory was developed that raised electronic equipment to the next level. The NAND flash market has grown rapidly, with flash memory becoming an internationally standardised memory device. Toshiba, the inventor of flash memory, has thus carved out a path to a new era in which innovations are increased by the opportunities of NAND flash.

SPEED UP DIGITAL PROCESSES

Storing and processing data has always been an important aspect of all digital processes. But in the last years it increased to one of the key technologies for industry 4.0, smart mobility, cloud technology and artificial intelligence, because smart ideas and innovations have to be ready for markets right away – with the highest reliability of storage components.

With our embedded memory solutions, Toshiba is the partner for all smart markets and fast moving industries. Toshiba, the inventor of flash memory in 1984, provides a highly grade of innovation combined with highly reliable security – now and in the future.

PARTNERSHIP IS OUR PASSION

Our success is based on our strong customer focus: Your metrics are our metrics. The result is a broad range of industry-leading flash-based storage solutions. Our products are designed to meet your specific engineering demands.

TOSHIBA EMBEDDED MEMORY – THE KEY TO A SMART FUTURE



Embedded memory connects us with the things that surround and serve us – for more efficiency, comfort and sustainability.

Toshiba's Milestones



World's first
flash memory

1984

1987

Invention of the
world's first NAND
flash memory



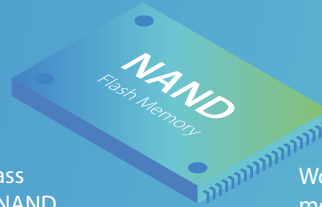
World's
first

World's first mass
production of NAND
flash memory

1991

1999

Key milestones for
investment and
development of
Toshiba Flash
Technology



World's first 3D flash
memory technology
announced

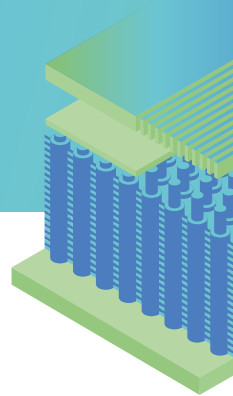
2007

2011

World's first
24nm SLC NAND
flash memory

2014

World's first 15nm
128 Gbit NAND
flash memory



From the invention of flash memory in 1984 to today's breakthrough BiCS FLASH™ 3D technology (BiCS stands for "Bit Column Stacked"), Toshiba continues to move the industry forward. Whatever the digital future demands, we will keep developing the right solutions for our customers.

Demanding change

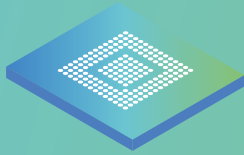
The economy's digital transformation is resulting in a massive increase of data processing, storage and traffic.

48
Layer

64
Layer

96
Layer

World's first
48-layer 3D BiCS
FLASH™



Mass production of
96-layer BiCS FLASH™

By 2020, 60% of all
enterprises will have
organisation-wide digital
transformation platform
strategies

2015

2017

2018

2019

2020

2021

2022

Mass production of
64-layer BiCS FLASH™

By the end of 2019, digital
transformation spending is
expected to reach \$1.7T, up
42% from 2017

By 2021, at least 50% of global
GDP will be digitised with
growth driven by digitally
enhanced offerings, operations
and relationships

BiCS FLASH™

165
ZB

1 zettabyte (ZB) = 10²¹ bytes = 1 billion terabytes (TB)

15
ZB

2016

2017

2018

2019

2020

2021

2022

EMBEDDED FLASH MEMORY

SLC NAND
 BENAND
 Serial NAND
 e-MMC
 UFS

Toshiba offers a wide range of advanced Flash Memory technology for all kind of applications like consumer electronics, mobile technology and industrial applications such as robotics.

NAND Flash Memory requires an appropriate management, which has to cover tasks like Bad Block Management, Wear Leveling, Garbage Collection and ECC Error Correction. Either these functions are supported by the host system in combination with raw NAND Memory, or it is covered instantly inside a managed NAND by utilizing an integrated memory controller.

The selection between these basic different approaches to control a NAND memory defines the individual host requirements and interface options. For managed NAND there are JEDEC specified Standard-Interfaces supported, enabling the developer to easily design the required memory solution.

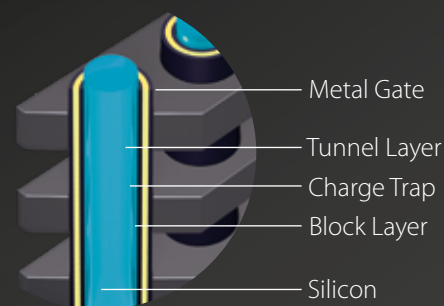
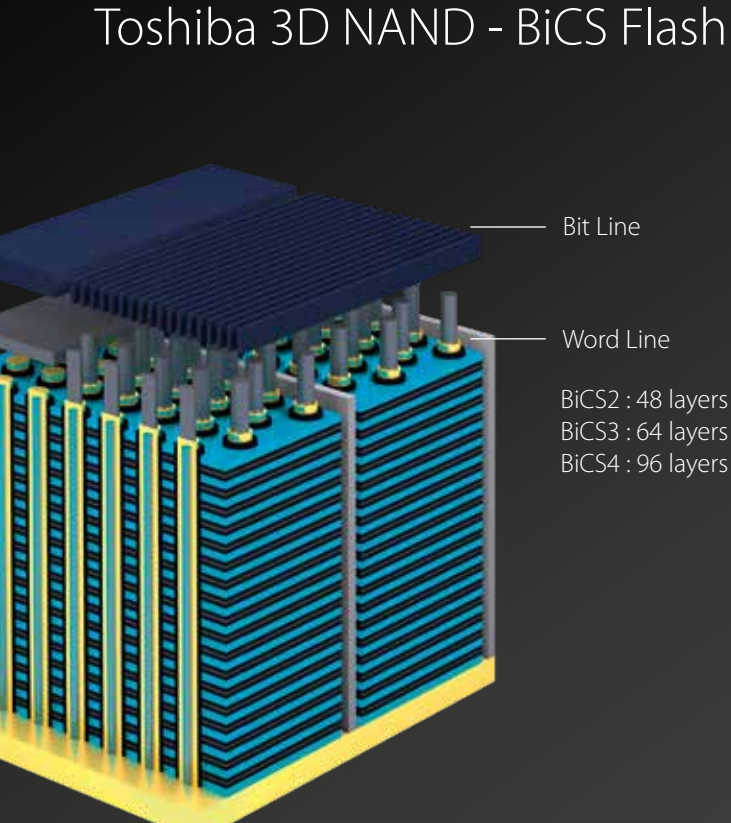
RAW NAND

With raw NANDs like SLC NAND, BENAND™ and Serial NAND we provide best in class endurance and data retention for sensitive or frequently used data.

MANAGED NAND

For applications that demand high-speed performance and power efficiency like mobile and automotive uses our managed NANDs e-MMC and UFS support reliable processes at the highest standards. They provide higher capacity and faster programming.

Toshiba 3D NAND - BiCS Flash



Our cutting-edge 3D BiCS FLASH technology with 64- and 96-layer stacking make a powerful memory solutions possible. It gives BiCS FLASH far higher die area density compared to 2D NAND. BiCS FLASH reduces the chip size by optimizing both circuit technology and the manufacturing process.



BiCS FLASH™



UFS

High Performance Mass Storage

Toshiba's flash memories with an integrated controller provide error correction, wear levelling, bad-block management, etc. They have an interface compliant with JEDEC/UFS Version 2.1 / 3.0, eliminating the need for users to perform NAND-specific control. The new full-duplex serial high-speed interface offers superior performance.

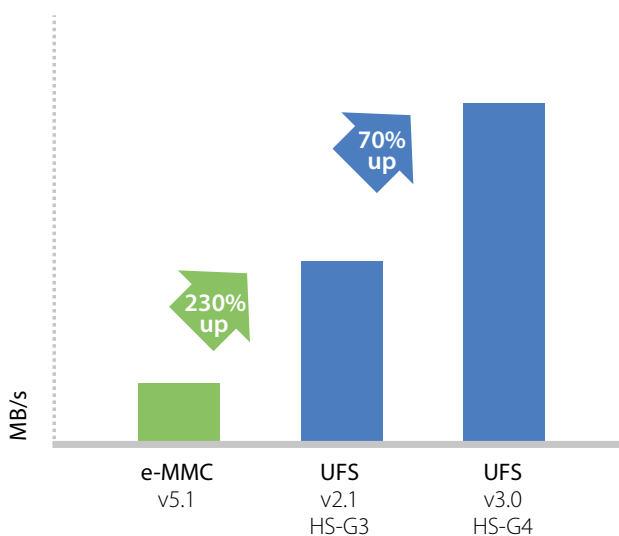
SPECIFICATIONS

FEATURES	UFS – UNIVERSAL FLASH STORAGE
Density	32 GB – 512 GB
Technology	BiCS 3D NAND
JEDEC Version	2.1 / 3.0
Temperature	-25 °C to 85 °C
Package	153 ball FBGA (11.5 x 13 mm ²)

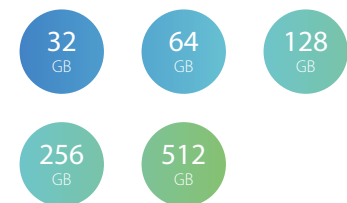
COMPARING THE PERFORMANCE:

■ e-MMC ■ UFS

Sequential Read



CAPACITIES:



KEY FEATURES:

- 32 GB – 512 GB
- BiCS Flash™ Technology (3D NAND)
- Conforms to JEDEC Version 2.1 / 3.0
- Integrated memory management:
 - Error correction code
 - Bad block management
 - Wear-levelling
 - Garbage collection
- Standard temperature range
- 153 ball BGA FBGA package
- High Speed Serial interface

ADVANTAGES

- High speeds up to 1160 MB/sec / 2320 MB/sec
- Managed memory
- Package, interface, features, commands, etc. are standard
- Utilises high quality Toshiba BiCS Flash™ memory in combination with a Toshiba origin developed controller
- Produced in the world's largest, leading edge technology flash factory

APPLICATIONS:

- Consumer Electronics
- Multimedia Applications
- Industrial Applications
- Smart Applications