BiCS FLASH 3D Flash Memory Fabricated Using 64-Layer Stacking Process

Toshiba announced the world's first three-dimensional (3D) flash memory(*1) in 2007. In July 2016, we began shipping samples of the 64-layer 256 Gbit (32 Gbyte) 3-bit-per-cell (triple-level cell (TLC)) flash memory for the first time in the world(*2). The samples were developed in collaboration with SanDisk Corporation. Our leading-edge 64-layer stacking process realizes a 40% larger capacity per unit chip size than the preceding 48-layer stacking process, reduces the cost per bit, and increases the manufacturability of memory capacity per silicon wafer. Mass production started in the first half of 2017.

We also commenced the shipment of samples of a 512 Gbit (64 Gbyte) flash memory using the 64-layer stacking process in February 2017, with the start of mass production of the chip scheduled for the second half of 2017. This makes it possible to realize the industry's largest 1 Tbyte(*3) single-package implementation(*4) with a 16-die stacked architecture.

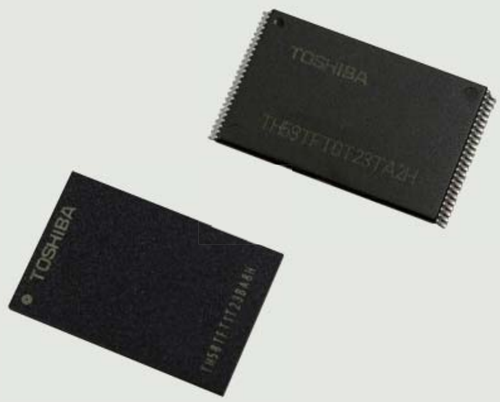
These new devices can meet stringent performance specifications and will be used in applications that include enterprise and consumer solid-state drives (SSDs), smartphones, tablets, and memory cards. Since announcing the world's first prototype 3D flash memory technology, we have continued to advance the development of 3D flash memory and are actively promoting BiCS FLASH to meet the demand for larger capacity with smaller size.

(*1) Toshiba presentation, June 12, 2007

(*2) As of July 2016 (as researched by Toshiba)

(*3) Definition of capacity: Toshiba defines a terabyte (Tbyte) as 10^{12} (1 000 000 000 000) bytes.

(*4) As of February 2017 (as researched by Toshiba)



BiCS FLASH 3D flash memory fabricated using 64-layer stacking process

3.5-Inch 8 Tbyte HDDs for NAS Applications

Toshiba released the MN Series of 3.5-inch(*1) hard disk drives (HDDs) for personal, home office, and small/medium business use that can be configured as network-attached storage (NAS) in February 2017. The new HDDs are optimized for the performance, reliability, endurance, and scalability required for NAS environments in which large amounts of data must be efficiently stored and accessed daily.

The MN Series achieves an enhanced recording density through several improvements including high-accuracy positioning due to the use of dual-stage actuator technology, a recording capacity of 8 Tbytes, and a data transfer speed of 230 MiB/s(*2). The MN Series is designed for 24/7 operation with a mean time to failure (MTTF) rating of 1 000 000 hours. In addition, the MN Series incorporates rotational vibration compensation technology that is used in nearline HDDs to achieve high reliability.

(*1) 3.5-inch means the form factor of HDDs. It does not indicate driver's physical size.

(*2) A mebibyte (MiB) is 2^{20} (1 048 576) bytes.

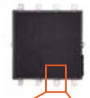
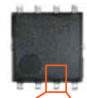
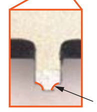
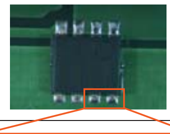
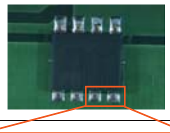
MN05ACA800 3.5-inch 8 Tbyte HDD for use as part of NAS device

Wettable Flank Packaging Technology for Small Automotive Surface Mount Devices

The automobile industry has been using an increasing number of automotive electronic control units (ECUs) in recent years to address the need for greater safety and environmental friendliness. Since only a limited space is available for the installation of these ECUs, there is a growing need for small surface mount packages. Lead terminals are therefore typically made short and flat to house a large chip in space-sensitive packages. However, lead-free solder compliant with the ELV Directive(*) has a higher melting point and causes reliability problems during the temperature cycle.

To solve these problems, Toshiba has developed a wettable flank technology that partially plates the tips of lead terminals to allow for a greater solder area. We are using this technology for our new-generation high-performance automotive metal-oxide-semiconductor field-effect transistors (MOSFETs) featuring low loss, low capacitance, and low noise.

(*) European Union (EU) Directive 2000/53/EC on end-of-life vehicles

Item	Small surface mount packages	
	Wettable flank package	Conventional package
Outer appearance		
Lead terminals (enlarged view)	 Plated surface	
Mounting example		
Soldered lead terminals (enlarged view)		

Comparison of lead terminal soldered states of conventional and wettable flank packages

TC35678FXG Ultralow-Power BLE Communication IC

Applications utilizing the Internet of Things (IoT) require long-term operation with small-sized lithium coin cell batteries. To meet this need, Toshiba released the TC35678FXG ultralow-power Bluetooth® Low Energy (BLE) communication integrated circuit (IC) featuring the world's lowest-class power consumption(*1) and compliant with version 4.2 of the BLE specification in July 2016.

The TC35678FXG has a receiver architecture suitable for low-current operation and incorporates a newly developed high-efficiency power supply system with low switching noise as well as low-current radio frequency (RF) circuits including a power amplifier. As a result, the TC35678FXG achieves an operating current consumption of 3.3 mA for receiving (RX) and transmitting (TX), a 50% reduction compared with the previous IC(*2). Nonetheless, the TC35678FXG exhibits improved radio performance with an RX sensitivity of −93 dBm and a TX output power of 0 dBm.

Furthermore, the integration of RF matching networks reduces the number of external components from 19 for the previous IC to seven, making it possible to further reduce the power consumption and size of IoT devices and thus expand IoT applications.

(*1) As of December 2016 (as researched by Toshiba)

(*2) In comparison with the TC35667FTG

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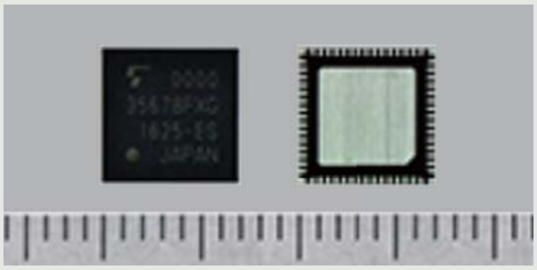
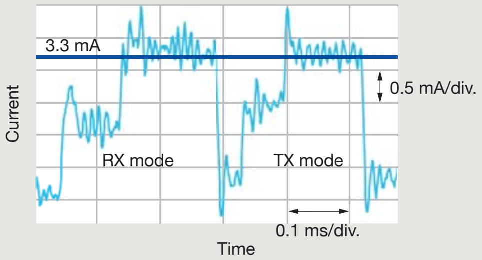


TC35678FXG ultralow-power BLE communication IC

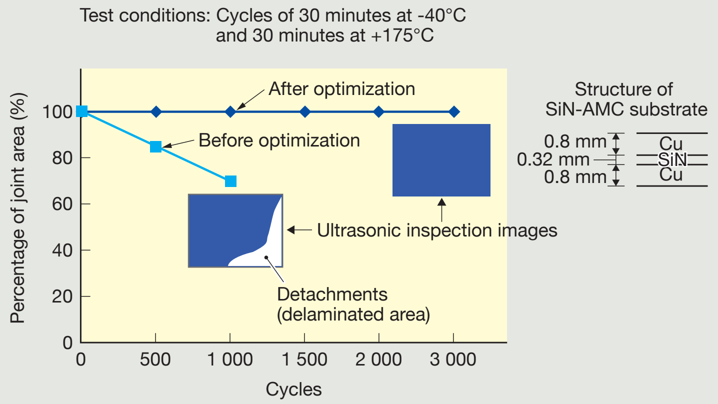


Example of current waveform during connection event

SiN-AMC Substrates with Excellent Heat Dissipation and Reliability

Silicon nitride active metal brazed copper (SiN-AMC) substrates are widely used for power module applications. However, demand has arisen for reduction of the size and improvement of the heat dissipation performance of SiN-AMC substrates. Although the size of power modules can be reduced by using baseless SiN substrates with a thicker copper circuit layer, it was known that baseless SiN substrates are highly susceptible to detachment of the copper layer in the early stage of cooling/heating cycles because the joint interface between the copper layer and the SiN substrate is subjected to more than three times higher stress.

In order to solve this problem, Toshiba Materials Co., Ltd. optimized the composition of the joining material and the cross-sectional shape of the copper circuit layer. As a result, we have successfully developed highly reliable SiN-AMC substrates that showed no detachment after 3 000 heat shocks in a thermal cycling test. We are planning to expand the applications of these SiN-AMC substrates in order to reduce the size of power modules, taking advantage of their excellent heat dissipation and reliability.



Results of thermal cycle tests to evaluate reliability of SiN-AMC substrates before and after optimization

59.6-Inch-Wide Thermal Print Head for Large-Format Printers

A thermal print head (TPH) prints characters and images on paper using heat. Toshiba Hokuto Electronics Corporation has mass-produced TPHs with an effective print width of up to 26 inches (approximately 660 mm). In addition, we have developed a larger TPH for large-format printers. We realized an effective print width of 59.6 inches (1 514 mm) by cutting multiple TPHs with high precision and connecting them together.

When our previous TPHs were used to achieve the same print width, photo printing suffered variations in color density where they were connected together. To realize 59.6-inch-wide photo-quality printing, we modified the shape of the interface where the TPHs are joined together.

We intend to develop a new market for large-format printers, taking advantage of the printing speed of TPHs.

59.6-inch-wide photoprint printed by thermal print head for large-format printers