TOSHIBA

Leading Innovation

Microcontrollers

Toshiba Microcontrollers with LCD Controller

~ Functions and Features ~

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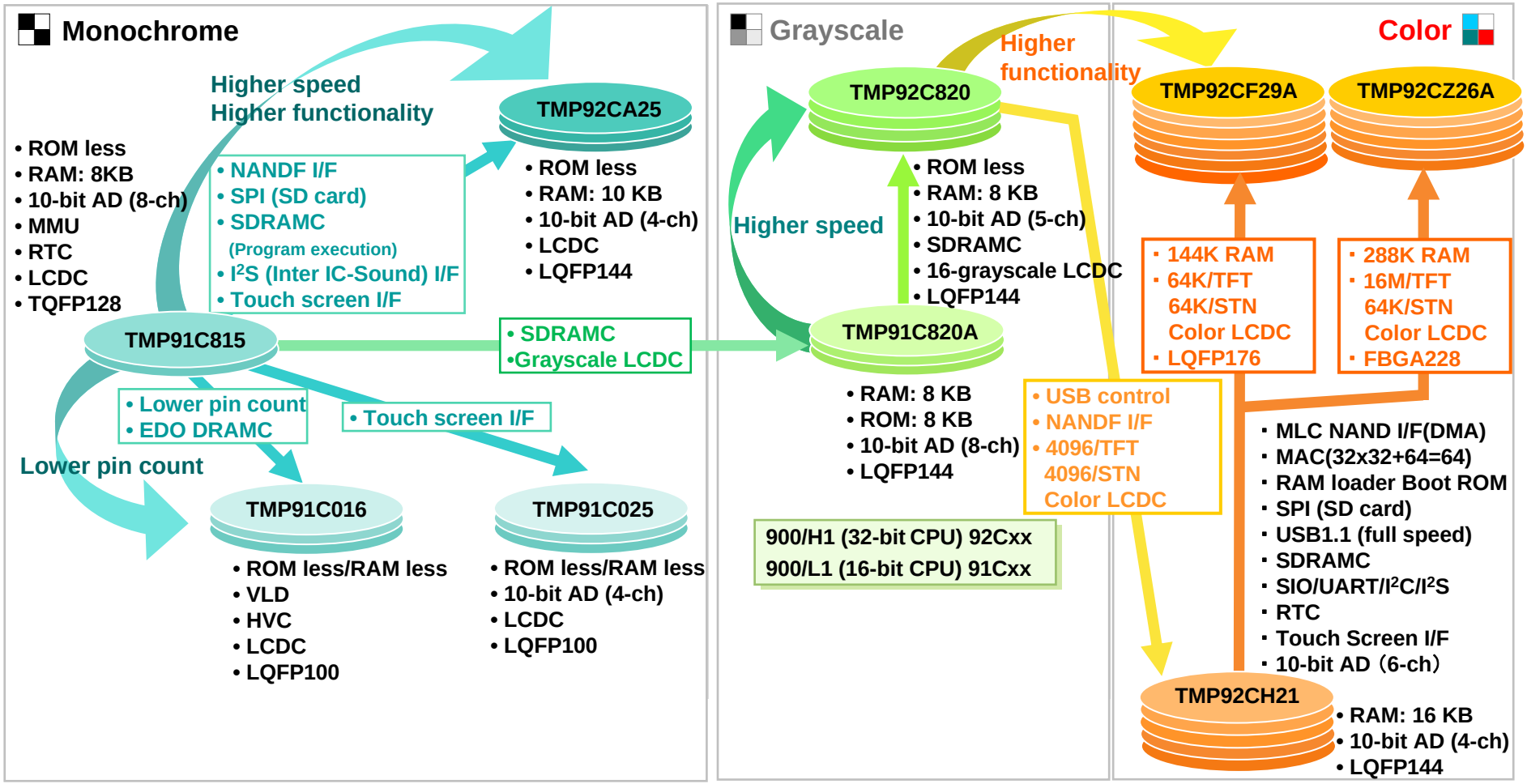
TOSHIBA CORPORATION
Semiconductor Company

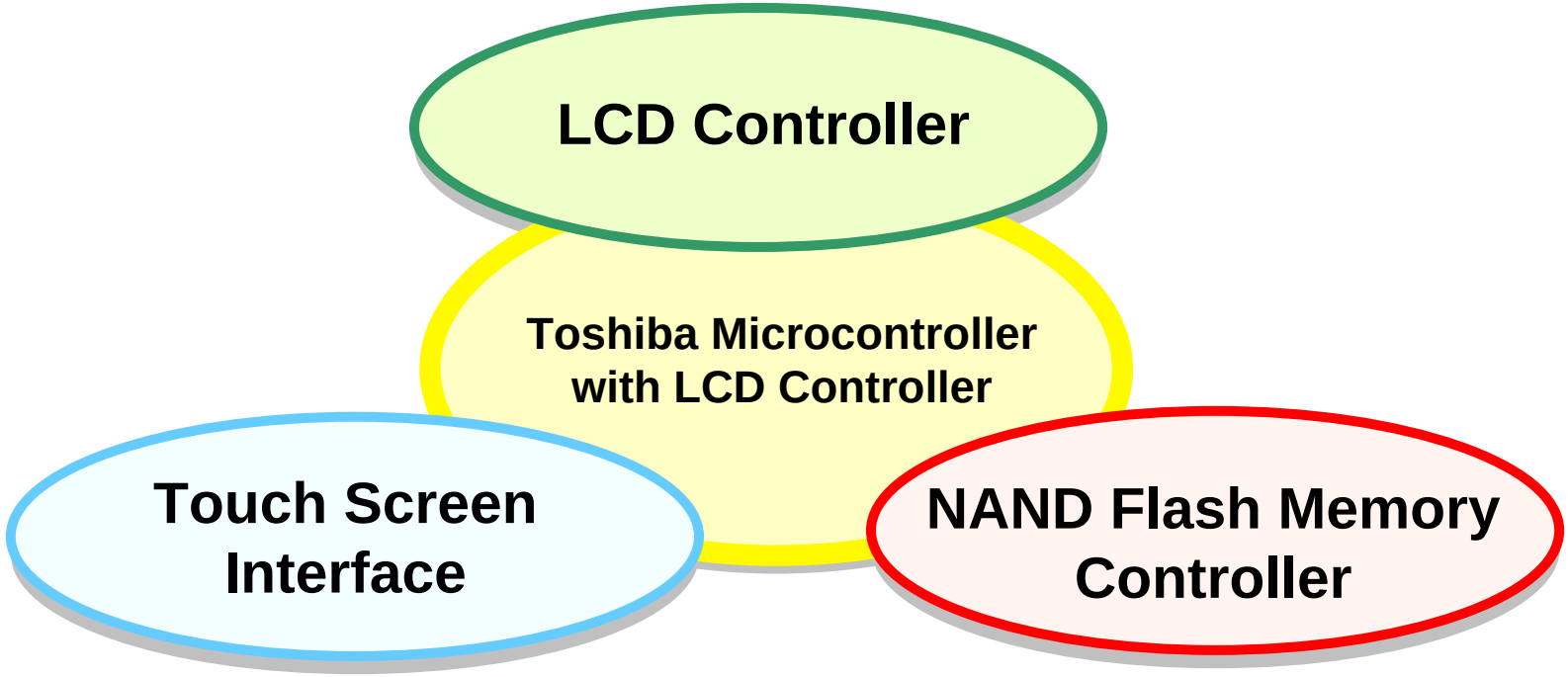
Line-Up of Microcontrollers with LCD Controller

Toshiba offers an extensive line-up of microcontrollers with LCD controller, all containing a clock function (RTC), a memory management unit (MMU), a communications function (UART), a keyboard interface, and a melody function as basic functions.



Optimum Peripheral Functions

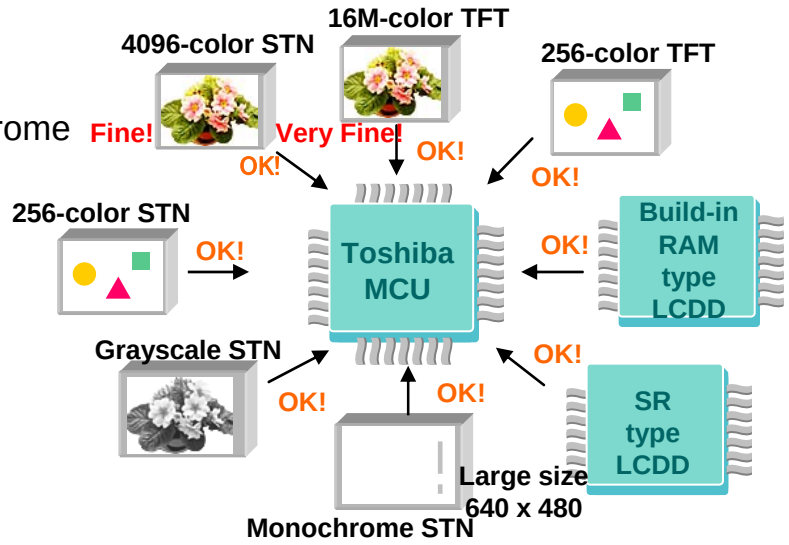
Toshiba microcontrollers with LCD controller contain various peripheral functions to meet the needs of customers.
This presentation focuses on the following three key functions.



LCD Controller - Features and Functions -

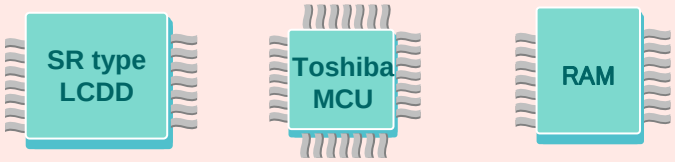
The LCD controller contained in a Toshiba microcontroller has the following features to support various needs.

- LCD panel type : STN, TFT
- LCD driver type : Built-in RAM type, shift register type
- Display color mode: 16M-/256K-/64K-/4096-/256-color
  64-/16-/8-/4-level grayscale, monochrome
- Display size : Up to 640 x 480
- Display RAM : Built-in RAM, SRAM, SDRAM
- Refresh rate adjustment function
- Pan function (memory: SDRAM)
- Frame split function



● **System Configuration**

Simple! **Low cost!** **Easy!**



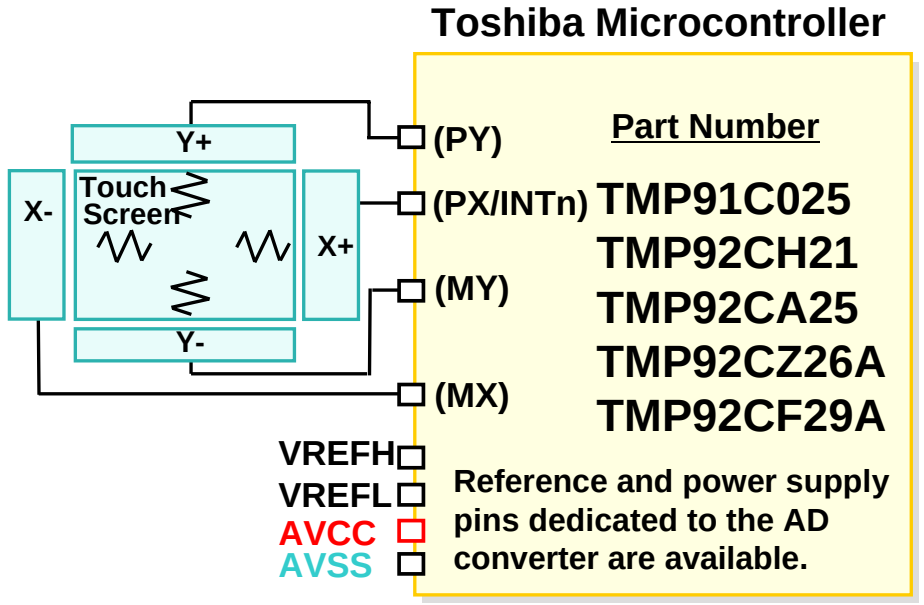
Toshiba is dedicated to offering smaller, lighter microcontrollers that consume less power to help customers reduce part count.

Touch Panel Interface - Features and Functions -

Toshiba microcontrollers offer the following benefits to customers:

- **Reduced external part count**
- **Easy connection**
- **Simplified control**

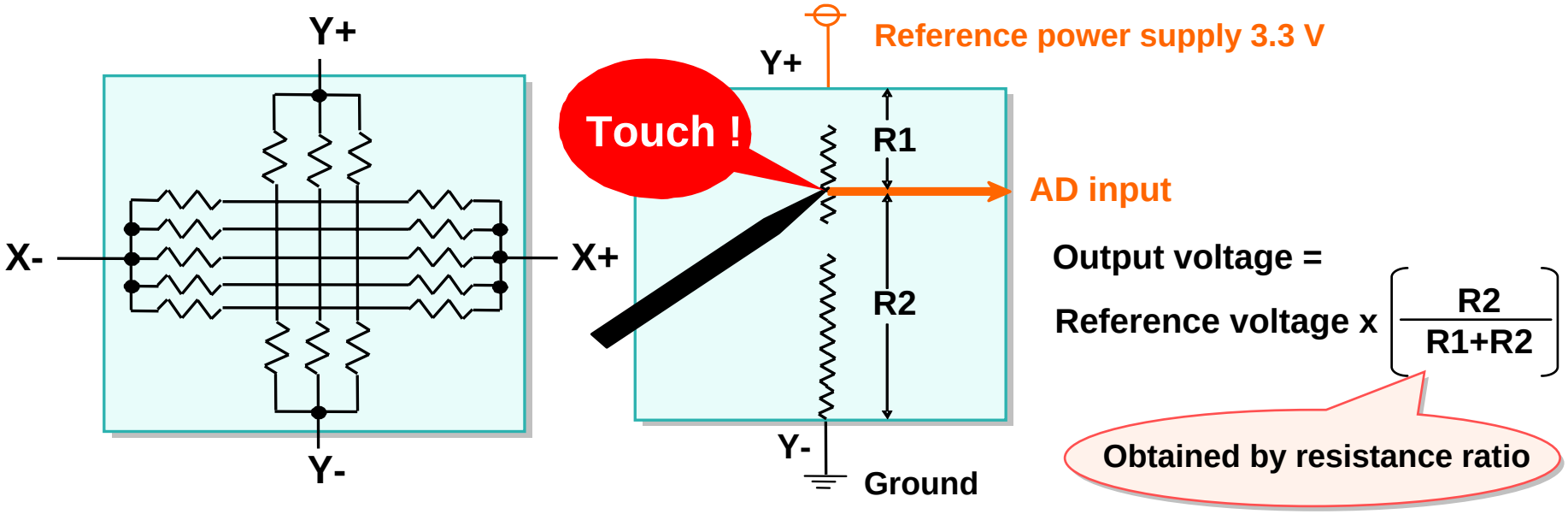
Toshiba Microcontroller Built-in Functions
1. Screen touch interrupt
2. Horizontal (X coordinate)/vertical (Y coordinate) measurement switching
3. 10-bit AD conversion



Touch Panel Interface - Position Measurement Method -

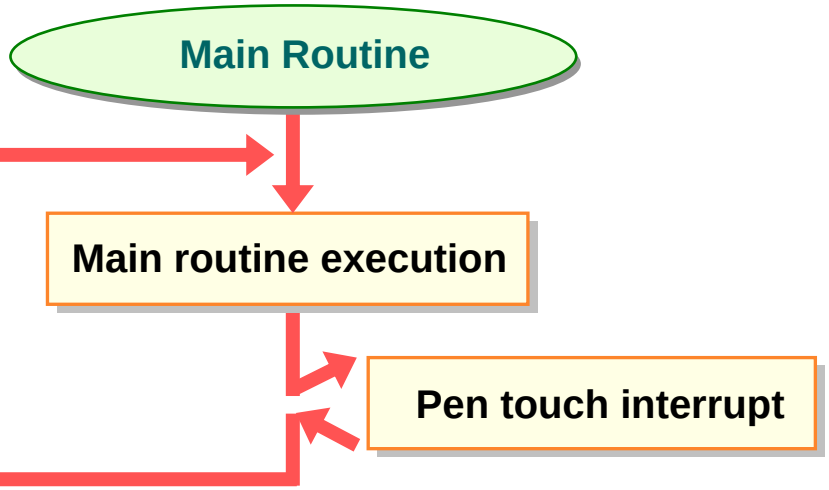
Coordinate Position Measurement Using a Resistance Division Method

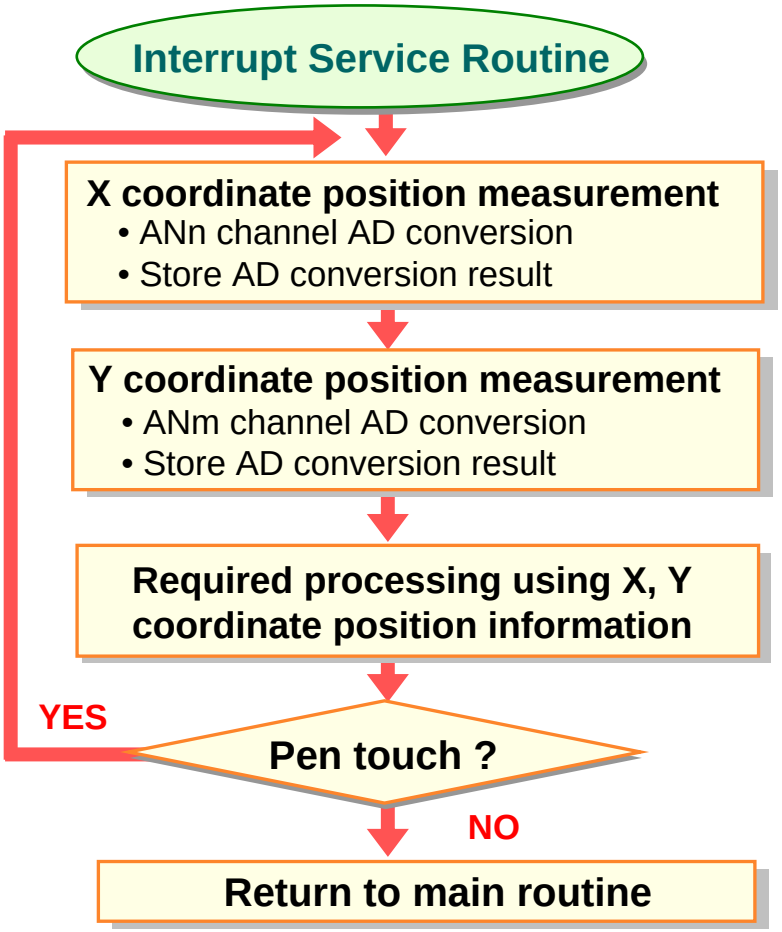
To measure the vertical coordinate, the reference voltage is applied to the Y+ and Y- pins. When a screen touch occurs, a voltage divided by resistance at the contact point is output and fed into the AD converter. The result of AD conversion is output as a digital value.



Touch Panel Interface - Coordinate Position Measurement Flow -

[Example of coordinate position measurement flow]



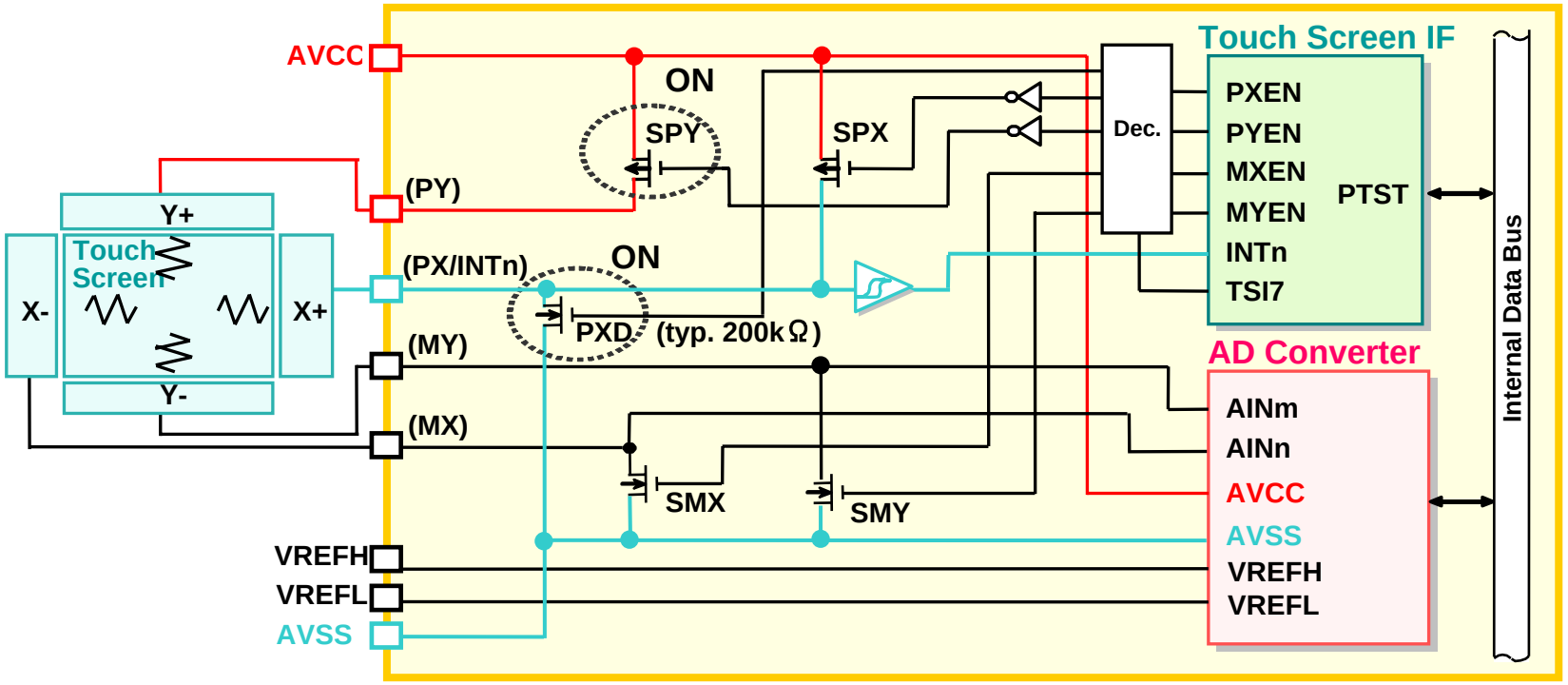


- When there is no pen touch on the screen, the main routine is executed.
- When a pen touch is sensed, the contact point is immediately analyzed to determine the X coordinate and Y coordinate positions. Then, required processing is performed.
- After the required processing is completed, whether or not the screen is being touched is checked. If there is no pen touch, control returns to the main routine.

Touch Panel Interface - Normal Processing in a Non-Touch State -

Main Routine (when there is no pen touch)

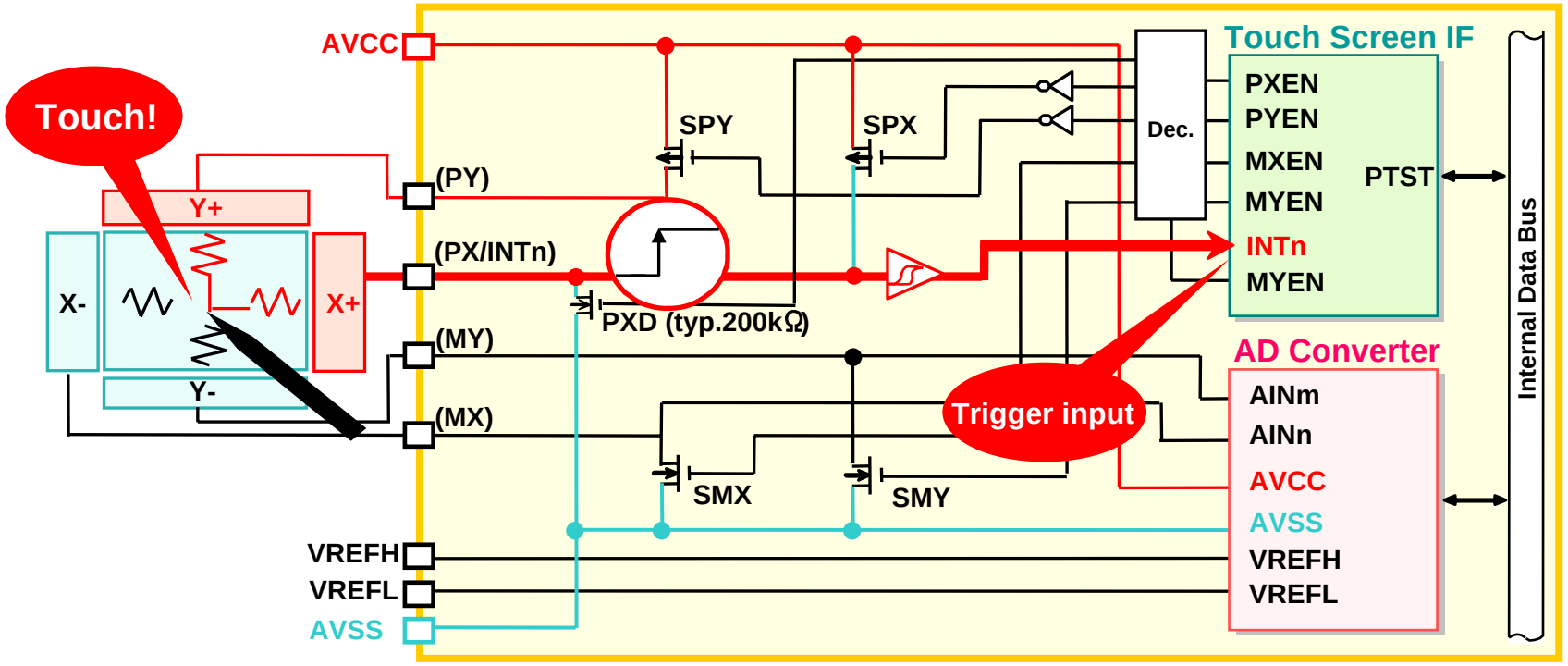
- A voltage at AVCC level is applied to the Y+ pin only. (Only SPY = ON)
- PXD (the INTn pin's pull-down resistor) is ON.



Touch Panel Interface - Starting Coordinate Position Measurement -

When the screen is touched,

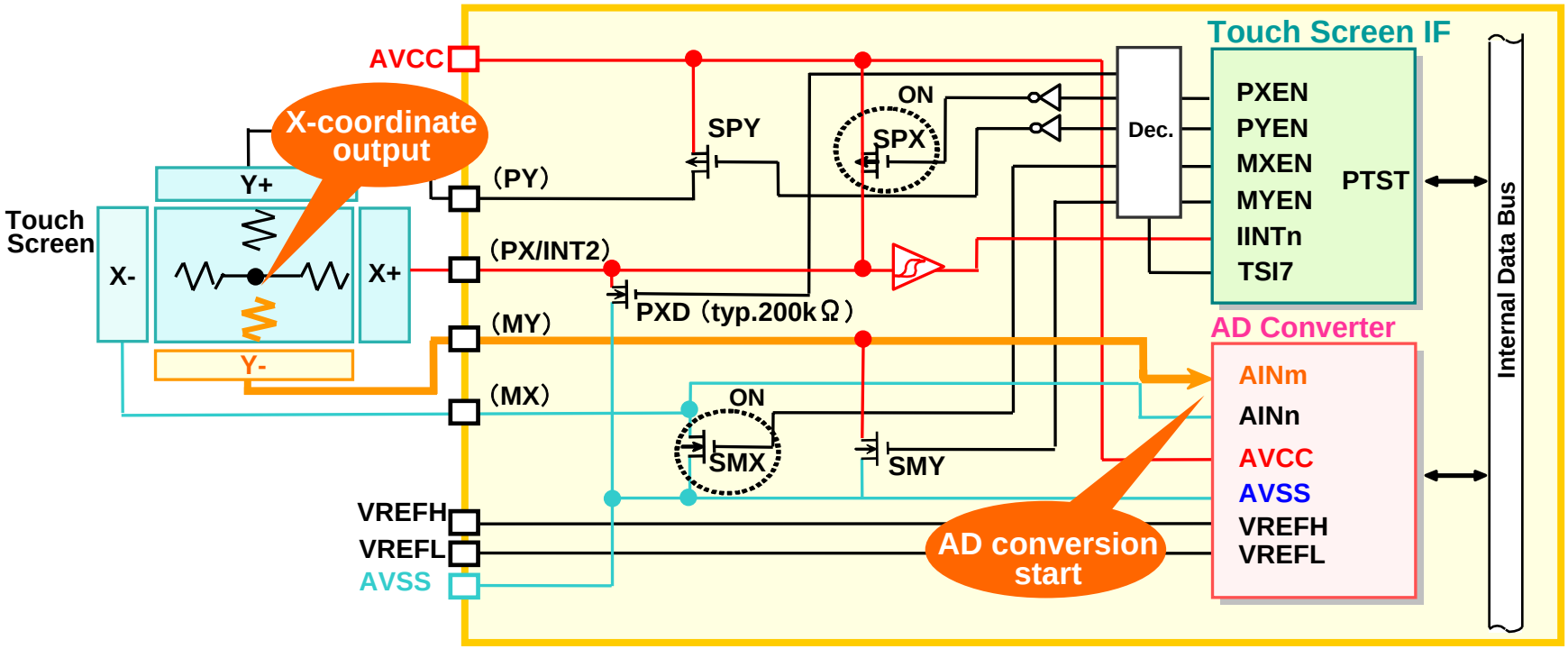
PY and PX are connected and a rising edge signal is input to INTn (edge interrupt).



Touch Panel Interface - Measuring the X Coordinate Position -

Interrupt Routine (1) X coordinate position measurement

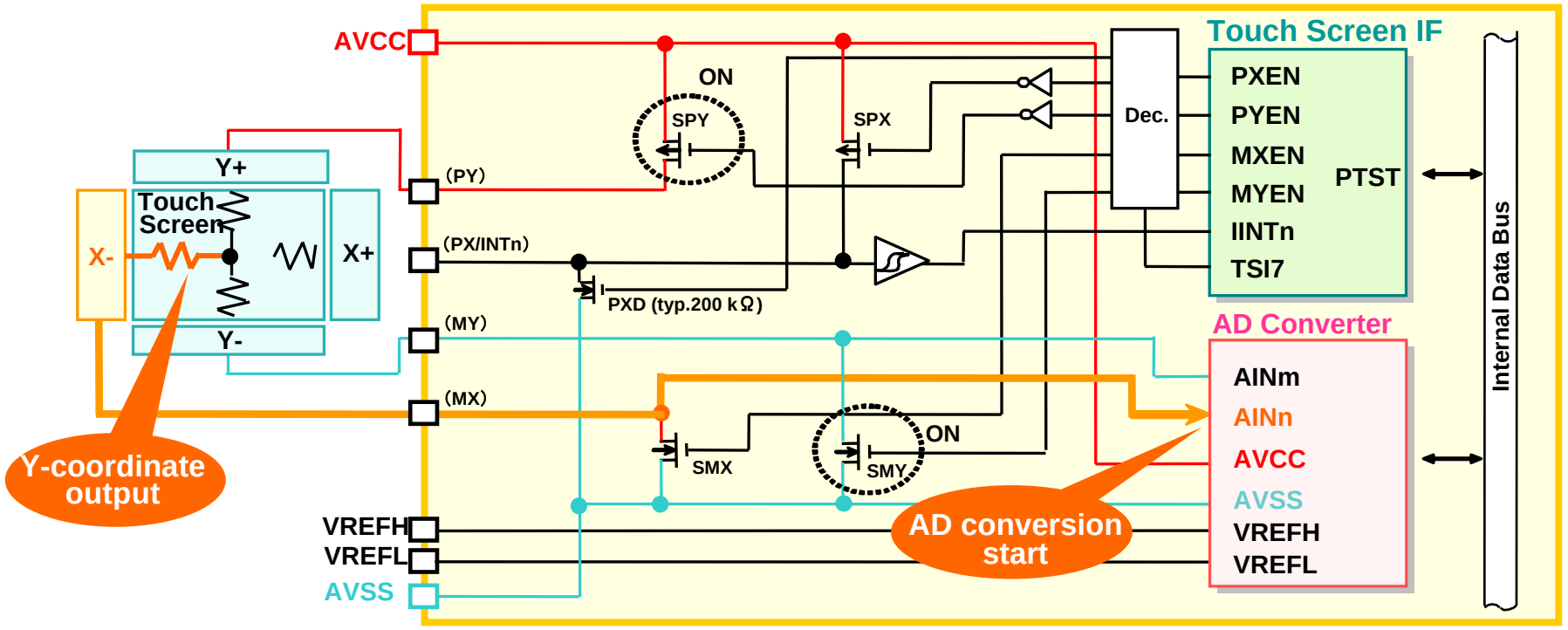
- A voltage at AVCC level is applied to the X+ pin, and a voltage at AVSS level is applied to X- pin. (SPX, SMX = ON)
- The output voltage is fed into AINm to start AD conversion.



Touch Panel Interface - Measuring the Y Coordinate Position -

Interrupt Routine (2) Y coordinate position measurement

- A voltage at AVCC level is applied to the Y+ pin, and a voltage at AVSS level is applied to the Y- pin. (SPY, SMY = ON)
- The output voltage is fed into AINn to start AD conversion.



NAND Flash Memory Controller - Features -

NAND Flash memory* has the following features:

- Low-cost, large-capacity nonvolatile memory
- High speed programming/erase
- High-speed access (excluding random access)
- A dedicated interface is required.
- An ECC (Error Correction Code) circuit is required.

* Flash memory technology developed by Toshiba in 1987. In NAND Flash memory, memory cells are connected in series with bit lines.

Toshiba microcontrollers with NAND Flash controller

- **TMP92CF29A**
- **TMP92CZ26A**
- **TMP92CA25**
- **TMP92CH21**

NAND Flash Memory Controller - Error Correction Method -

In storage devices handling large volumes of data, such as NAND Flash memory and HDD, ECC (Error Correction Code) is used for error correction.

NAND Flash Write

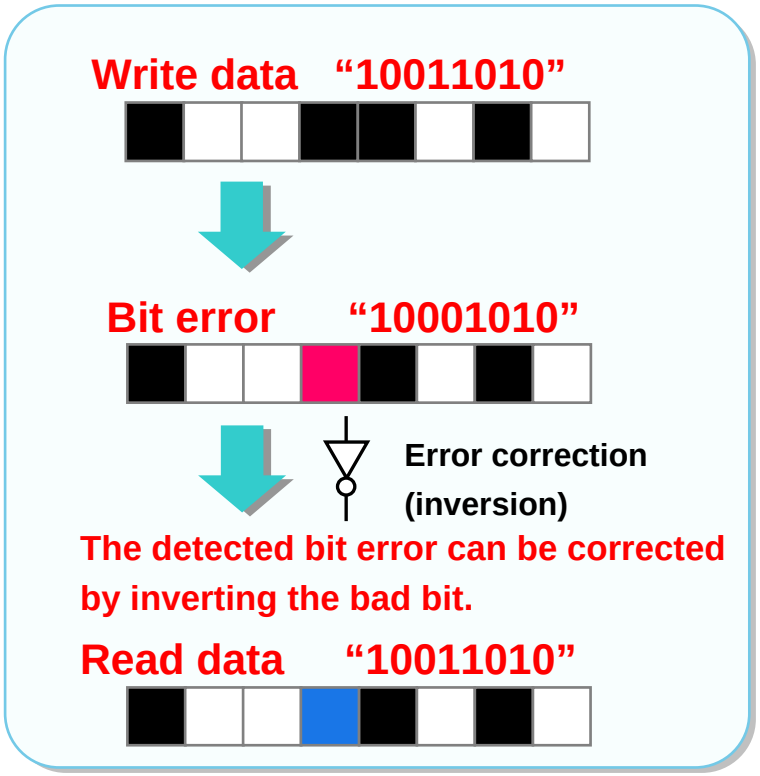
↓

Bit Error

↓

Bit Error Correction

In NAND Flash, Hamming codes are used for error correction.
(Two-state: Based on SmartMedia specs)



NAND Flash Memory Controller - ECC (Error Correction Code) -

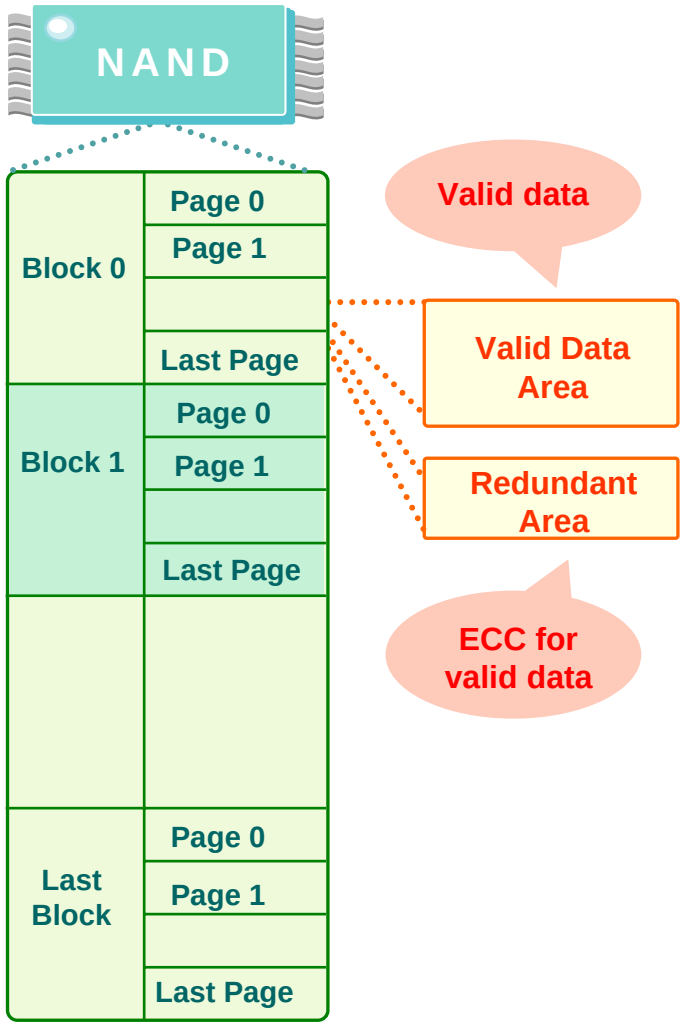
How ECC Works in NAND Flash

- **Memory Write**

1. When valid data is written to NAND Flash, Code 1 is generated for the written data.
2. Apart from the valid data, Code 1 is stored in the redundant area in NAND Flash.

- **Memory Read**

3. When the valid data is requested for reading, Code 2 is generated for the valid data.
4. Code1 stored in the redundant area and Code 2 are compared to check for a bit error. If a bit error is detected, the address and bit position of the bad bit are identified and the bad bit is then corrected.



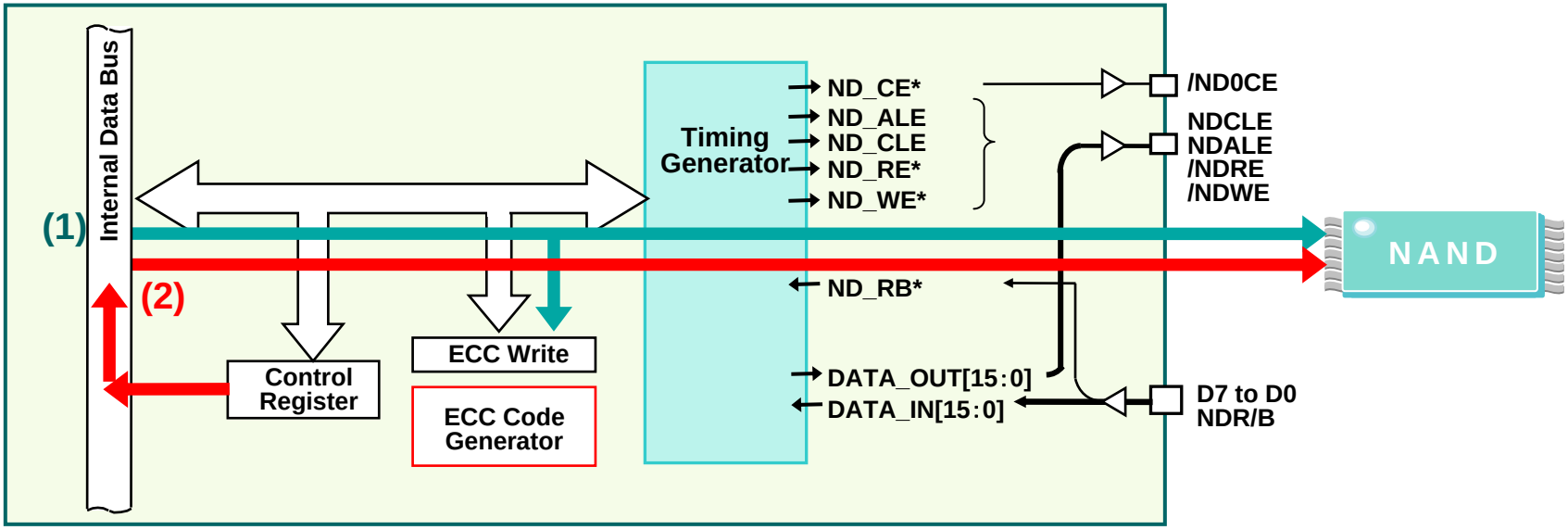
NAND Flash Memory Controller - ECC Mechanism (1) -

The following shows how ECC is implemented in the NAND Flash controller contained in a Toshiba microcontroller.

- **Memory Write**

  (1) When valid data is written to NAND Flash, Code 1 is generated for the written data.

  (2) Apart from the valid data, Code 1 is stored in the redundant area in NAND Flash.

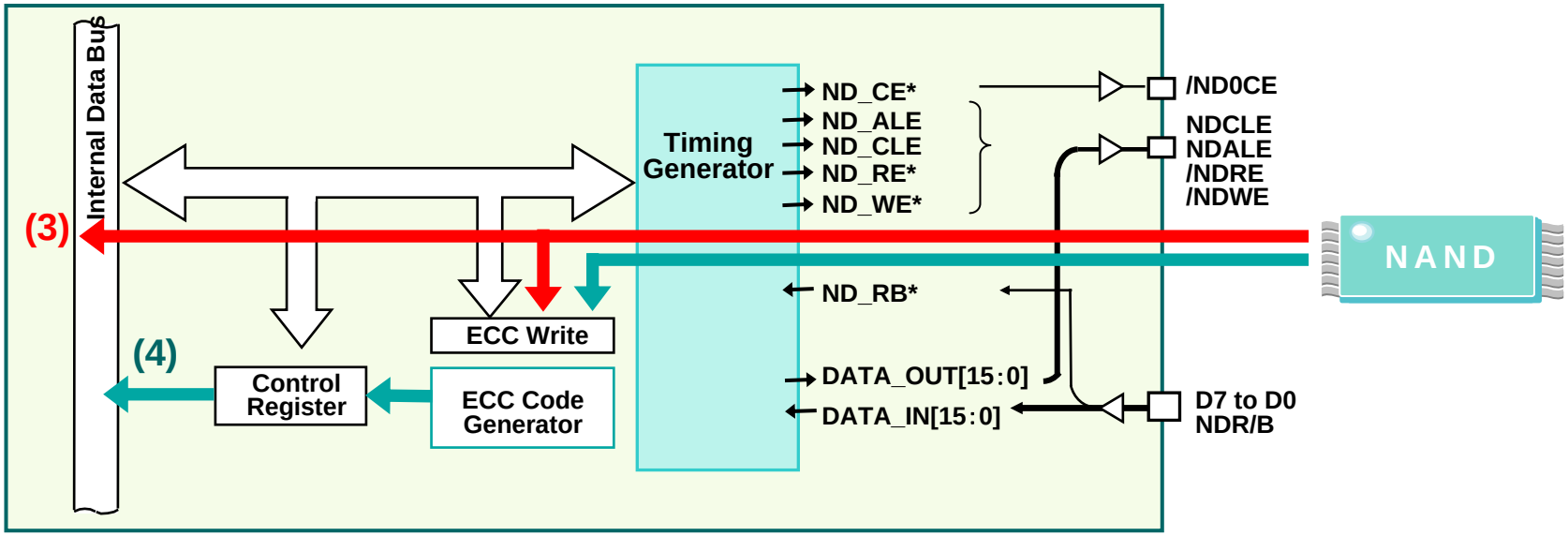


NAND Flash Memory Controller - ECC Mechanism (2) -

Memory Read

(3) When the valid data is requested for reading, Code 2 is generated for the valid data.

(4) Code 1 stored in the redundant area and Code 2 are compared to check for a bit error. If a bit error is detected, the address and bit position of the bad bit are identified and the bad bit is then corrected.



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