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### What is "[Embedded - Microcontrollers](#)"?

"[Embedded - Microcontrollers](#)" refer to small, integrated circuits designed to perform specific tasks within larger systems. These microcontrollers are essentially compact computers on a single chip, containing a processor core, memory, and programmable input/output peripherals. They are called "embedded" because they are embedded within electronic devices to control various functions, rather than serving as standalone computers. Microcontrollers are crucial in modern electronics, providing the intelligence and control needed for a wide range of applications.

### Applications of "[Embedded - Microcontrollers](#)"

#### Details

|                            |                                                                                                                                                                           |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Product Status             | Obsolete                                                                                                                                                                  |
| Core Processor             | ARM® Cortex®-M3                                                                                                                                                           |
| Core Size                  | 32-Bit Single-Core                                                                                                                                                        |
| Speed                      | 144MHz                                                                                                                                                                    |
| Connectivity               | CANbus, CSIO, EBI/EMI, Ethernet, I <sup>2</sup> C, LINbus, SD, UART/USART, USB                                                                                            |
| Peripherals                | DMA, LVD, POR, PWM, WDT                                                                                                                                                   |
| Number of I/O              | 154                                                                                                                                                                       |
| Program Memory Size        | 1MB (1M x 8)                                                                                                                                                              |
| Program Memory Type        | FLASH                                                                                                                                                                     |
| EEPROM Size                | -                                                                                                                                                                         |
| RAM Size                   | 128K x 8                                                                                                                                                                  |
| Voltage - Supply (Vcc/Vdd) | 2.7V ~ 5.5V                                                                                                                                                               |
| Data Converters            | A/D 32x12b                                                                                                                                                                |
| Oscillator Type            | Internal                                                                                                                                                                  |
| Operating Temperature      | -40°C ~ 85°C (TA)                                                                                                                                                         |
| Mounting Type              | Surface Mount                                                                                                                                                             |
| Package / Case             | 176-LQFP                                                                                                                                                                  |
| Supplier Device Package    | 176-LQFP (24x24)                                                                                                                                                          |
| Purchase URL               | <a href="https://www.e-xfl.com/product-detail/infineon-technologies/mb9bfd18tpmc-gk7e1">https://www.e-xfl.com/product-detail/infineon-technologies/mb9bfd18tpmc-gk7e1</a> |

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| Module             | Pin name | Function                                | Pin No   |          |         |
|--------------------|----------|-----------------------------------------|----------|----------|---------|
|                    |          |                                         | LQFP-176 | LQFP-144 | BGA-192 |
| External Interrupt | INT00_0  | External interrupt request 00 input pin | 13       | 13       | E5      |
|                    | INT00_1  |                                         | 8        | 8        | D3      |
|                    | INT00_2  |                                         | 165      | 135      | C6      |
|                    | INT01_0  | External interrupt request 01 input pin | 14       | 14       | F1      |
|                    | INT01_1  |                                         | 9        | 9        | D4      |
|                    | INT01_2  |                                         | 123      | 99       | E11     |
|                    | INT02_0  | External interrupt request 02 input pin | 15       | 15       | F2      |
|                    | INT02_1  |                                         | 91       | 75       | M12     |
|                    | INT02_2  |                                         | 120      | 96       | F12     |
|                    | INT03_0  | External interrupt request 03 input pin | 6        | 6        | D2      |
|                    | INT03_1  |                                         | 94       | 78       | L11     |
|                    | INT03_2  |                                         | 28       | -        | H3      |
|                    | INT04_0  | External interrupt request 04 input pin | 31       | -        | H6      |
|                    | INT04_1  |                                         | 97       | 81       | K14     |
|                    | INT04_2  |                                         | 29       | -        | H4      |
|                    | INT05_0  | External interrupt request 05 input pin | 127      | 103      | D13     |
|                    | INT05_1  |                                         | 100      | 84       | J12     |
|                    | INT05_2  |                                         | 30       | -        | H5      |
|                    | INT06_0  | External interrupt request 06 input pin | 170      | -        | B4      |
|                    | INT06_1  |                                         | 126      | 102      | D12     |
|                    | INT06_2  |                                         | 64       | 56       | K6      |
|                    | INT07_0  | External interrupt request 07 input pin | 171      | -        | C4      |
|                    | INT07_1  |                                         | 70       | 62       | P8      |
|                    | INT07_2  |                                         | 16       | 16       | F3      |
|                    | INT08_0  | External interrupt request 08 input pin | 172      | 140      | B3      |
|                    | INT08_1  |                                         | 33       | -        | J4      |
|                    | INT08_2  |                                         | 19       | 19       | F6      |
|                    | INT09_0  | External interrupt request 09 input pin | 119      | 95       | F11     |
|                    | INT09_1  |                                         | 34       | 26       | J3      |
|                    | INT09_2  |                                         | 22       | 22       | G4      |
|                    | INT10_0  | External interrupt request 10 input pin | 76       | -        | K9      |
|                    | INT10_1  |                                         | 35       | 27       | J2      |
|                    | INT10_2  |                                         | 7        | 7        | D1      |
|                    | INT11_0  | External interrupt request 11 input pin | 77       | -        | P10     |
|                    | INT11_1  |                                         | 36       | 28       | K1      |
|                    | INT11_2  |                                         | 71       | 63       | J8      |
|                    | INT12_0  | External interrupt request 12 input pin | 78       | -        | N10     |
|                    | INT12_1  |                                         | 46       | 38       | N2      |
|                    | INT12_2  |                                         | 72       | 64       | P9      |
|                    | INT13_0  | External interrupt request 13 input pin | 81       | -        | M10     |
|                    | INT13_1  |                                         | 47       | 39       | N3      |
|                    | INT13_2  |                                         | 66       | 58       | N8      |
|                    | INT14_0  | External interrupt request 14 input pin | 82       | -        | N11     |
|                    | INT14_1  |                                         | 58       | 50       | M5      |
|                    | INT14_2  |                                         | 67       | 59       | M8      |

| Module | Pin name | Function                   | Pin No   |          |         |
|--------|----------|----------------------------|----------|----------|---------|
|        |          |                            | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO   | P60      | General-purpose I/O port 6 | 169      | 139      | C5      |
|        | P61      |                            | 168      | 138      | B5      |
|        | P62      |                            | 167      | 137      | E6      |
|        | P70      | General-purpose I/O port 7 | 65       | 57       | J6      |
|        | P71      |                            | 66       | 58       | N8      |
|        | P72      |                            | 67       | 59       | M8      |
|        | P73      |                            | 68       | 60       | L8      |
|        | P74      |                            | 69       | 61       | K8      |
|        | P75      |                            | 70       | 62       | P8      |
|        | P76      |                            | 71       | 63       | J8      |
|        | P77      |                            | 72       | 64       | P9      |
|        | P78      |                            | 73       | 65       | N9      |
|        | P79      |                            | 74       | 66       | M9      |
|        | P7A      |                            | 75       | 67       | L9      |
|        | P7B      |                            | 76       | -        | K9      |
|        | P7C      |                            | 77       | -        | P10     |
|        | P7D      |                            | 78       | -        | N10     |
|        | P7E      |                            | 79       | -        | L10     |
|        | P7F      |                            | 80       | -        | K10     |
|        | P80      | General-purpose I/O port 8 | 174      | 142      | A3      |
|        | P81      |                            | 175      | 143      | A2      |
|        | P82      |                            | 130      | 106      | D14     |
|        | P83      |                            | 131      | 107      | C14     |
|        | P90      | General-purpose I/O port 9 | 139      | -        | C11     |
|        | P91      |                            | 140      | -        | D11     |
|        | P92      |                            | 141      | -        | B10     |
|        | P93      |                            | 142      | -        | C10     |
|        | P94      |                            | 143      | -        | D10     |
|        | P95      |                            | 144      | -        | B9      |
|        | PA0      | General-purpose I/O port A | 2        | 2        | B2      |
|        | PA1      |                            | 3        | 3        | C2      |
|        | PA2      |                            | 4        | 4        | C3      |
|        | PA3      |                            | 5        | 5        | D5      |
|        | PA4      |                            | 6        | 6        | D2      |
|        | PA5      |                            | 7        | 7        | D1      |
|        | PB0      | General-purpose I/O port B | 110      | -        | H13     |
|        | PB1      |                            | 111      | -        | H12     |
|        | PB2      |                            | 112      | -        | H11     |
|        | PB3      |                            | 113      | -        | G13     |
|        | PB4      |                            | 114      | -        | G12     |
|        | PB5      |                            | 115      | -        | G11     |
|        | PB6      |                            | 116      | -        | G10     |
|        | PB7      |                            | 117      | -        | G9      |

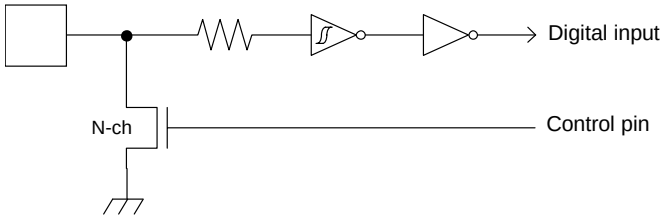
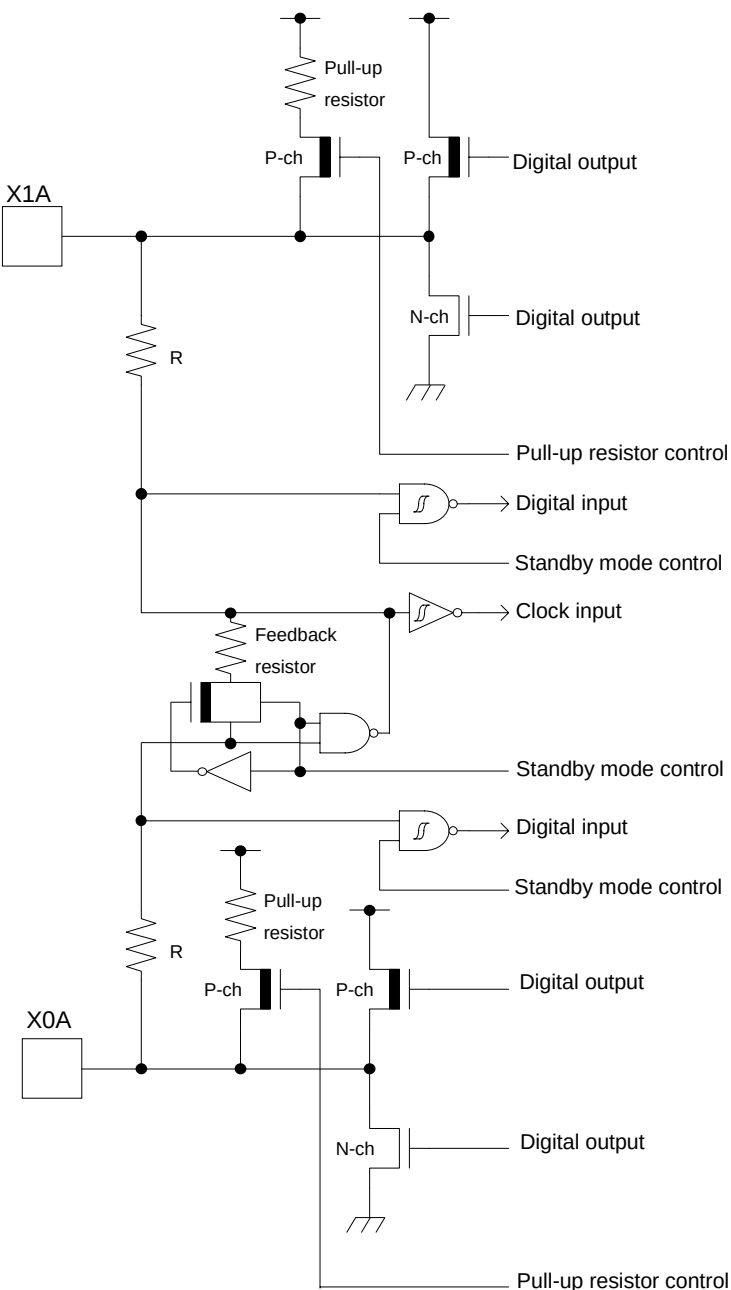
| Module | Pin name | Function                                  | Pin no   |          |         |
|--------|----------|-------------------------------------------|----------|----------|---------|
|        |          |                                           | LQFP-176 | LQFP-144 | BGA-192 |
| GPIO   | PC0      | General-purpose I/O port C                | 145      | 115      | C9      |
|        | PC1      |                                           | 146      | 116      | B8      |
|        | PC2      |                                           | 147      | 117      | D9      |
|        | PC3      |                                           | 148      | 118      | E9      |
|        | PC4      |                                           | 149      | 119      | F9      |
|        | PC5      |                                           | 150      | 120      | C8      |
|        | PC6      |                                           | 151      | 121      | D8      |
|        | PC7      |                                           | 152      | 122      | E8      |
|        | PC8      |                                           | 153      | 123      | A10     |
|        | PC9      |                                           | 154      | 124      | F8      |
|        | PCA      |                                           | 155      | 125      | B7      |
|        | PCB      |                                           | 158      | 128      | A7      |
|        | PCC      |                                           | 159      | 129      | C7      |
|        | PCD      |                                           | 160      | 130      | A6      |
|        | PCE      |                                           | 161      | 131      | D7      |
|        | PCF      |                                           | 162      | 132      | E7      |
|        | PD0      | General-purpose I/O port D                | 163      | 133      | F7      |
|        | PD1      |                                           | 164      | 134      | B6      |
|        | PD2      |                                           | 165      | 135      | C6      |
|        | PD3      |                                           | 166      | 136      | D6      |
|        | PE0      | General-purpose I/O port E                | 84       | 68       | N13     |
|        | PE2      |                                           | 86       | 70       | P12     |
|        | PE3      |                                           | 87       | 71       | P13     |
|        | PF0      | General-purpose I/O port F <sup>[1]</sup> | 81       | -        | M10     |
|        | PF1      |                                           | 82       | -        | N11     |
|        | PF2      |                                           | 83       | -        | M11     |
|        | PF3      |                                           | 170      | -        | B4      |
|        | PF4      |                                           | 171      | -        | C4      |
|        | PF5      |                                           | 172      | 140      | B3      |
|        | PF6      |                                           | 128      | 104      | C13     |

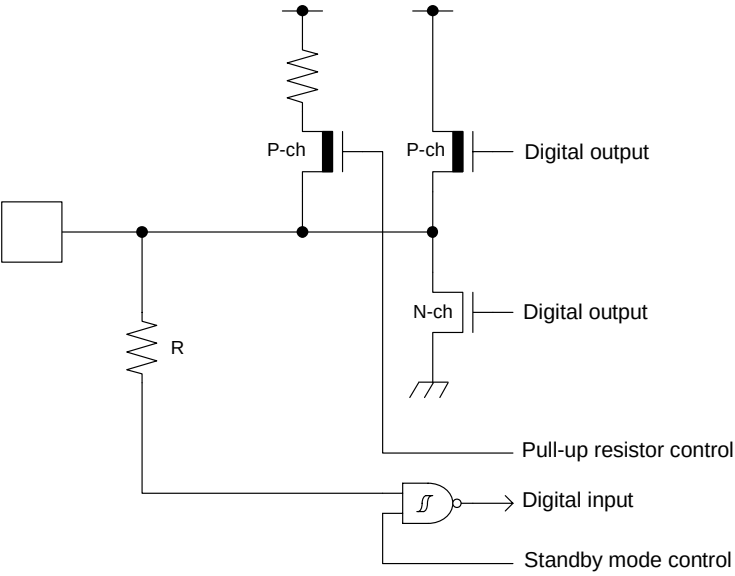
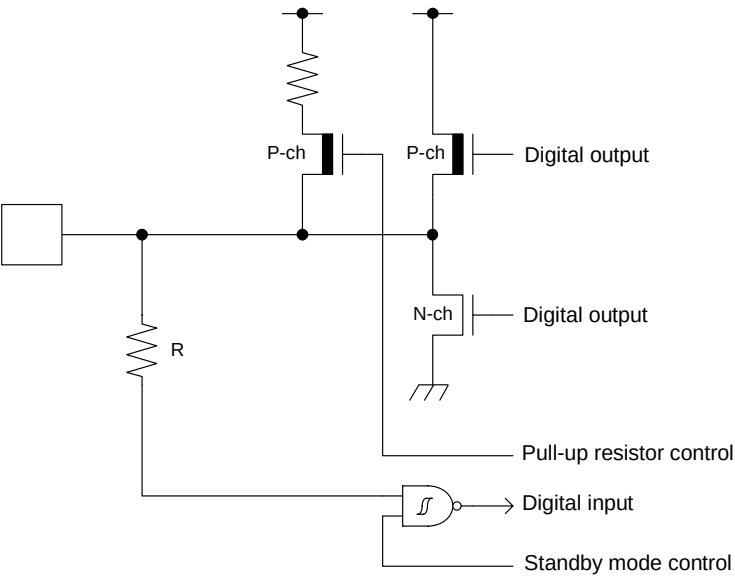
| Module                  | Pin name        | Function                                                                                                                                                                                                         | Pin No   |          |         |
|-------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------|---------|
|                         |                 |                                                                                                                                                                                                                  | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-function Serial 6 | SIN6_0          | Multi-function serial interface ch.6 input pin                                                                                                                                                                   | 16       | 16       | F3      |
|                         | SIN6_1          |                                                                                                                                                                                                                  | 31       | -        | H6      |
|                         | SIN6_2          |                                                                                                                                                                                                                  | 170      | -        | B4      |
|                         | SOT6_0 (SDA6_0) | Multi-function serial interface ch.6 output pin.<br>This pin operates as SOT6 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA6 when it is used in an I <sup>2</sup> C (operation mode 4). | 17       | 17       | F4      |
|                         | SOT6_1 (SDA6_1) |                                                                                                                                                                                                                  | 30       | -        | H5      |
|                         | SOT6_2 (SDA6_2) |                                                                                                                                                                                                                  | 171      | -        | C4      |
|                         | SCK6_0 (SCL6_0) | Multi-function serial interface ch.6 clock I/O pin.<br>This pin operates as SCK6 when it is used in a CSIO (operation mode 2) and as SCL6 when it is used in an I <sup>2</sup> C (operation mode 4).             | 18       | 18       | F5      |
|                         | SCK6_1 (SCL6_1) |                                                                                                                                                                                                                  | 29       | -        | H4      |
|                         | SCK6_2 (SCL6_2) |                                                                                                                                                                                                                  | 172      | 140      | B3      |
| Multi-function Serial 7 | SIN7_0          | Multi-function serial interface ch.7 input pin                                                                                                                                                                   | 22       | 22       | G4      |
|                         | SIN7_1          |                                                                                                                                                                                                                  | 64       | 56       | K6      |
|                         | SIN7_2          |                                                                                                                                                                                                                  | 110      | -        | H13     |
|                         | SOT7_0 (SDA7_0) | Multi-function serial interface ch.7 output pin.<br>This pin operates as SOT7 when it is used in a UART/CSIO/LIN (operation modes 0 to 3) and as SDA7 when it is used in an I <sup>2</sup> C (operation mode 4). | 23       | 23       | G5      |
|                         | SOT7_1 (SDA7_1) |                                                                                                                                                                                                                  | 63       | 55       | L6      |
|                         | SOT7_2 (SDA7_2) |                                                                                                                                                                                                                  | 111      | -        | H12     |
|                         | SCK7_0 (SCL7_0) | Multi-function serial interface ch.7 clock I/O pin.<br>This pin operates as SCK7 when it is used in a CSIO (operation mode 2) and as SCL7 when it is used in an I <sup>2</sup> C (operation mode 4).             | 24       | 24       | G6      |
|                         | SCK7_1 (SCL7_1) |                                                                                                                                                                                                                  | 62       | 54       | M6      |
|                         | SCK7_2 (SCL7_2) |                                                                                                                                                                                                                  | 112      | -        | H11     |

| Module                 | Pin name             | Function                                                                                          | Pin No   |          |         |
|------------------------|----------------------|---------------------------------------------------------------------------------------------------|----------|----------|---------|
|                        |                      |                                                                                                   | LQFP-176 | LQFP-144 | BGA-192 |
| Multi-function Timer 1 | DTT11X_0             | Input signal controlling wave form generator outputs RTO10 to RTO15 of multi-function timer 1.    | 19       | 19       | F6      |
|                        | DTT11X_1             |                                                                                                   | 58       | 50       | M5      |
|                        | FRCK1_0              | 16-bit free-run timer ch.1 external clock input pin                                               | 2        | 2        | B2      |
|                        | FRCK1_1              |                                                                                                   | 63       | 55       | L6      |
|                        | IC10_0               | 16-bit input capture ch.1 input pin of multi-function timer 1.<br>(ICxx describes channel number) | 3        | 3        | C2      |
|                        | IC10_1               |                                                                                                   | 59       | 51       | L5      |
|                        | IC11_0               |                                                                                                   | 4        | 4        | C3      |
|                        | IC11_1               |                                                                                                   | 60       | 52       | K5      |
|                        | IC12_0               |                                                                                                   | 5        | 5        | D5      |
|                        | IC12_1               |                                                                                                   | 61       | 53       | N6      |
|                        | IC13_0               |                                                                                                   | 6        | 6        | D2      |
|                        | IC13_1               |                                                                                                   | 62       | 54       | M6      |
|                        | RTO10_0<br>(PPG10_0) | Wave form generator output pin of multi-function timer 1.                                         | 13       | 13       | E5      |
|                        | RTO10_1<br>(PPG10_1) | This pin operates as PPG10 when it is used in PPG1 output modes.                                  | 46       | 38       | N2      |
|                        | RTO11_0<br>(PPG10_0) | Wave form generator output pin of multi-function timer 1.                                         | 14       | 14       | F1      |
|                        | RTO11_1<br>(PPG10_1) | This pin operates as PPG10 when it is used in PPG1 output modes.                                  | 47       | 39       | N3      |
|                        | RTO12_0<br>(PPG12_0) | Wave form generator output pin of multi-function timer 1.                                         | 15       | 15       | F2      |
|                        | RTO12_1<br>(PPG12_1) | This pin operates as PPG12 when it is used in PPG1 output modes.                                  | 48       | 40       | M3      |
|                        | RTO13_0<br>(PPG12_0) | Wave form generator output pin of multi-function timer 1.                                         | 16       | 16       | F3      |
|                        | RTO13_1<br>(PPG12_1) | This pin operates as PPG12 when it is used in PPG1 output modes.                                  | 49       | 41       | L4      |
|                        | RTO14_0<br>(PPG14_0) | Wave form generator output pin of multi-function timer 1.                                         | 17       | 17       | F4      |
|                        | RTO14_1<br>(PPG14_1) | This pin operates as PPG14 when it is used in PPG1 output modes.                                  | 50       | 42       | M4      |
|                        | RTO15_0<br>(PPG14_0) | Wave form generator output pin of multi-function timer 1.                                         | 18       | 18       | F5      |
|                        | RTO15_1<br>(PPG14_1) | This pin operates as PPG14 when it is used in PPG1 output modes.                                  | 51       | 43       | N4      |

| Module                                    | Pin name | Function                                      | Pin No   |          |         |
|-------------------------------------------|----------|-----------------------------------------------|----------|----------|---------|
|                                           |          |                                               | LQFP-176 | LQFP-144 | BGA-192 |
| Quadrature Position/ Revolution Counter 0 | AIN0_0   | QPRC ch.0 AIN input pin                       | 28       | -        | H3      |
|                                           | AIN0_1   |                                               | 59       | 51       | L5      |
|                                           | AIN0_2   |                                               | 13       | 13       | E5      |
|                                           | BIN0_0   | QPRC ch.0 BIN input pin                       | 29       | -        | H4      |
|                                           | BIN0_1   |                                               | 60       | 52       | K5      |
|                                           | BIN0_2   |                                               | 14       | 14       | F1      |
|                                           | ZIN0_0   | QPRC ch.0 ZIN input pin                       | 30       | -        | H5      |
|                                           | ZIN0_1   |                                               | 61       | 53       | N6      |
|                                           | ZIN0_2   |                                               | 15       | 15       | F2      |
| Quadrature Position/ Revolution Counter 1 | AIN1_0   | QPRC ch.1 AIN input pin                       | 73       | 65       | N9      |
|                                           | AIN1_1   |                                               | 127      | 103      | D13     |
|                                           | AIN1_2   |                                               | 62       | 54       | M6      |
|                                           | BIN1_0   | QPRC ch.1 BIN input pin                       | 74       | 66       | M9      |
|                                           | BIN1_1   |                                               | 126      | 102      | D12     |
|                                           | BIN1_2   |                                               | 63       | 55       | L6      |
|                                           | ZIN1_0   | QPRC ch.1 ZIN input pin                       | 75       | 67       | L9      |
|                                           | ZIN1_1   |                                               | 125      | 101      | E13     |
|                                           | ZIN1_2   |                                               | 64       | 56       | K6      |
| Quadrature Position/ Revolution Counter 2 | AIN2_0   | QPRC ch.2 AIN input pin                       | 67       | 59       | M8      |
|                                           | AIN2_1   |                                               | 170      | -        | B4      |
|                                           | AIN2_2   |                                               | 115      | -        | G11     |
|                                           | BIN2_0   | QPRC ch.2 BIN input pin                       | 68       | 60       | L8      |
|                                           | BIN2_1   |                                               | 171      | -        | C4      |
|                                           | BIN2_2   |                                               | 116      | -        | G10     |
|                                           | ZIN2_0   | QPRC ch.2 ZIN input pin                       | 69       | 61       | K8      |
|                                           | ZIN2_1   |                                               | 172      | 140      | B3      |
|                                           | ZIN2_2   |                                               | 117      | -        | G9      |
| USB0                                      | UDM0     | USB ch.0 function/host D – pin                | 174      | 142      | A3      |
|                                           | UDP0     | USB ch.0 function/host D + pin                | 175      | 143      | A2      |
|                                           | UHCONX0  | USB ch.0.<br>USB external pull-up control pin | 168      | 138      | B5      |
| USB1                                      | UDM1     | USB ch.1 function/host D – pin                | 130      | 106      | D14     |
|                                           | UDP1     | USB ch.1 function/host D + pin                | 131      | 107      | C14     |
|                                           | UHCONX1  | USB ch.1.<br>USB external pull-up control pin | 127      | 103      | D13     |



| Type | Circuit                                                                            | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|------|------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| C    |   | <ul style="list-style-type: none"> <li>■ Open drain output</li> <li>■ CMOS level hysteresis input</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| D    |  | <p>It is possible to select the sub oscillation / GPIO function</p> <p>When the sub oscillation is selected.</p> <ul style="list-style-type: none"> <li>■ Oscillation feedback resistor : Approximately 5 MΩ</li> <li>■ With Standby mode control</li> </ul> <p>When the GPIO is selected.</p> <ul style="list-style-type: none"> <li>■ CMOS level output.</li> <li>■ CMOS level hysteresis input</li> <li>■ With pull-up resistor control</li> <li>■ With standby mode control</li> <li>■ Pull-up resistor : Approximately 50 kΩ</li> <li>■ <math>I_{OH} = -4 \text{ mA}</math>, <math>I_{OL} = 4 \text{ mA}</math></li> </ul> |

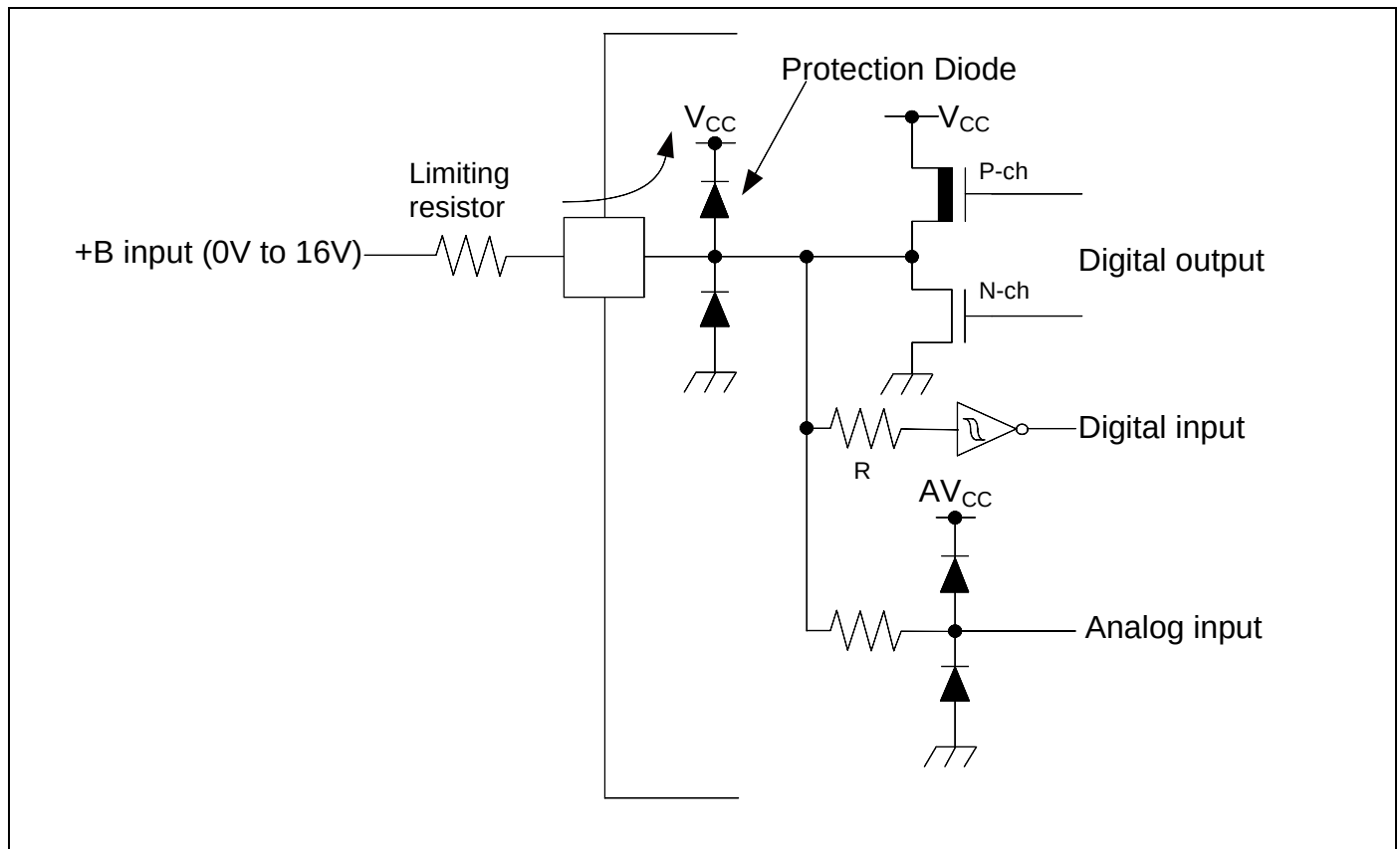
| Type | Circuit                                                                            | Remarks                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------|------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| K    |   | <ul style="list-style-type: none"> <li>■ CMOS level output</li> <li>■ TTL level hysteresis input</li> <li>■ With pull-up resistor control</li> <li>■ With standby mode control</li> <li>■ Pull-up resistor : Approximately 50 kΩ</li> <li>■ <math>I_{OH} = -4 \text{ mA}</math>, <math>I_{OL} = 4 \text{ mA}</math></li> </ul>                                                                                                                                               |
| L    |  | <ul style="list-style-type: none"> <li>■ CMOS level output</li> <li>■ CMOS level hysteresis input</li> <li>■ With pull-up resistor control</li> <li>■ With standby mode control</li> <li>■ Pull-up resistor : Approximately 50 kΩ</li> <li>■ <math>I_{OH} = -8 \text{ mA}</math>, <math>I_{OL} = 8 \text{ mA}</math></li> <li>■ When this pin is used as an I<sup>2</sup>C pin, the digital output P-ch transistor is always off</li> <li>■ +B input is available</li> </ul> |

[7]: The average output is the average current for a single pin over a period of 100 ms.

[8]: The total average output current is the average current for all pins over a period of 100 ms.

[9]:

- See "4. List of Pin Functions" and "5. I/O Circuit Type" about +B input available pin.
- Use within recommended operating conditions.
- Use at DC voltage (current) the +B input.
- The +B signal should always be applied a limiting resistance placed between the +B signal and the device.
- The value of the limiting resistance should be set so that when the +B signal is applied the input current to the device pin does not exceed rated values, either instantaneously or for prolonged periods.
- Note that when the device drive current is low, such as in the low-power consumption modes, the +B input potential may pass through the protective diode and increase the potential at the VCC and AVCC pin, and this may affect other devices.
- Note that if a +B signal is input when the device power supply is off (not fixed at 0 V), the power supply is provided from the pins, so that incomplete operation may result.
- The following is a recommended circuit example (I/O equivalent circuit).



### WARNING:

Semiconductor devices can be permanently damaged by application of stress (voltage, current, temperature, etc.) in excess of absolute maximum ratings. Do not exceed these ratings.

### 12.4.8 External Bus Timing

#### External bus clock output characteristics

( $V_{CC} = 2.7\text{ V to } 5.5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -40^\circ\text{C to } +85^\circ\text{C}$ )

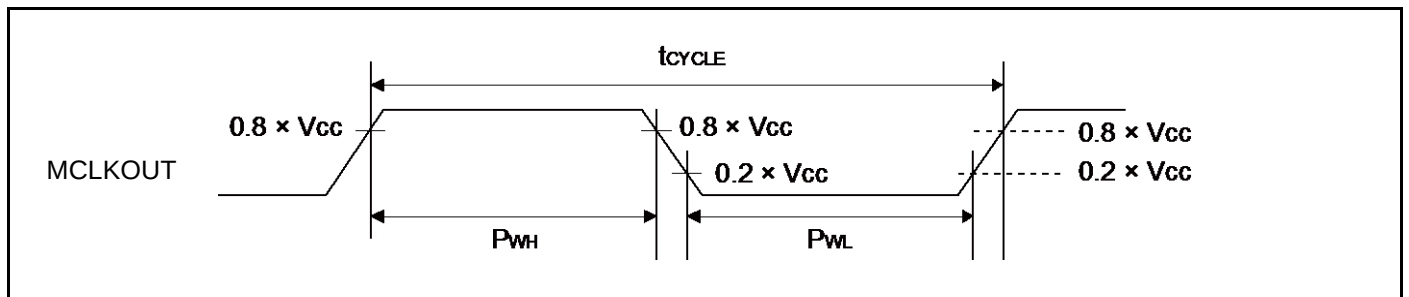
| Parameter        | Symbol             | Pin name               | Conditions                 | Value |                   | Unit |
|------------------|--------------------|------------------------|----------------------------|-------|-------------------|------|
|                  |                    |                        |                            | Min   | Max               |      |
| Output frequency | $t_{\text{CYCLE}}$ | MCLKOUT <sup>[1]</sup> | $V_{CC} \geq 4.5\text{ V}$ | -     | 50 <sup>[2]</sup> | MHz  |
|                  |                    |                        | $V_{CC} < 4.5\text{ V}$    | -     | 32 <sup>[3]</sup> | MHz  |

[1]: External bus clock (MCLKOUT) is divided clock of HCLK.

For more information about setting of clock divider, see "Chapter 12: External Bus Interface" in "FM3 Family Peripheral Manual".  
When external bus clock is not output, this characteristic does not give any effect on external bus operation.

[2]: When AHB bus clock frequency is more than 100 MHz, the divider setting for MCLKOUT must be more than 4.

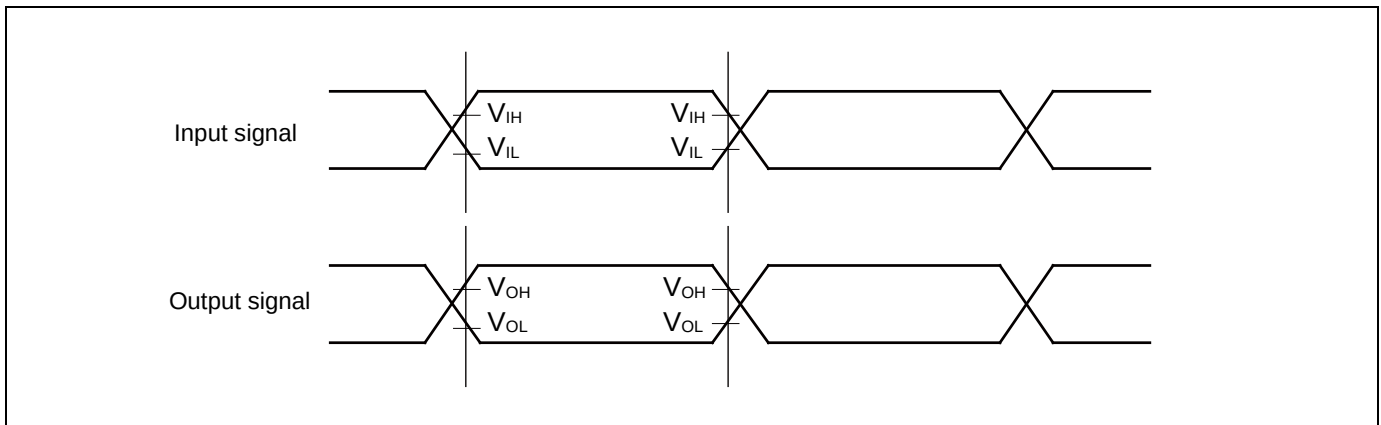
[3]: When AHB bus clock frequency is more than 64 MHz, the divider setting for MCLKOUT must be more than 4.



#### External bus signal input/output characteristics

( $V_{CC} = 2.7\text{ V to } 5.5\text{ V}$ ,  $V_{SS} = 0\text{ V}$ ,  $T_a = -40^\circ\text{C to } +85^\circ\text{C}$ )

| Parameter                     | Symbol   | Conditions | Value               | Unit | Remarks |
|-------------------------------|----------|------------|---------------------|------|---------|
| Signal input characteristics  | $V_{IH}$ | -          | $0.8 \times V_{CC}$ | V    |         |
|                               | $V_{IL}$ |            | $0.2 \times V_{CC}$ | V    |         |
| Signal output characteristics | $V_{OH}$ | -          | $0.8 \times V_{CC}$ | V    |         |
|                               | $V_{OL}$ |            | $0.2 \times V_{CC}$ | V    |         |



## Separate bus access asynchronous SRAM mode

(Vcc = 2.7 V to 5.5 V, Vss = 0 V, Ta = - 40°C to + 85°C)

| Parameter                             | Symbol                   | Pin name                | Conditions                 | Value                 |                       | Unit |
|---------------------------------------|--------------------------|-------------------------|----------------------------|-----------------------|-----------------------|------|
|                                       |                          |                         |                            | Min                   | Max                   |      |
| MOEX<br>Min pulse width               | t <sub>OEW</sub>         | MOEX                    | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×n-3              | -                     | ns   |
| MCSX ↓ → Address output<br>delay time | t <sub>CSL - AV</sub>    | MCSX[7:0],<br>MAD[24:0] | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | -9<br>-12             | +9<br>+12             | ns   |
| MOEX ↑ →<br>Address hold time         | t <sub>OEH - AX</sub>    | MOEX,<br>MAD[24:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |
| MCSX ↓ →<br>MOEX ↓ delay time         | t <sub>CSL - OEL</sub>   | MOEX,<br>MCSX[7:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×m-9<br>MCLK×m-12 | MCLK×m+9<br>MCLK×m+12 | ns   |
| MOEX ↑ →<br>MCSX ↑ time               | t <sub>OEH - CSH</sub>   |                         | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |
| MCSX ↓ →<br>MDQM ↓ delay time         | t <sub>CSL - RDQML</sub> | MCSX,<br>MDQM[1:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×m-9<br>MCLK×m-12 | MCLK×m+9<br>MCLK×m+12 | ns   |
| Data set up →<br>MOEX ↑ time          | t <sub>DS - OE</sub>     | MOEX,<br>MADATA[15:0]   | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 20<br>38              | -<br>-                | ns   |
| MOEX ↑ →<br>Data hold time            | t <sub>DH - OE</sub>     | MOEX,<br>MADATA[15:0]   | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | -                     | ns   |
| MWEX<br>Min pulse width               | t <sub>WEW</sub>         | MWEX                    | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×n-3              | -                     | ns   |
| MWEX ↑ → Address output<br>delay time | t <sub>WEH - AX</sub>    | MWEX,<br>MAD[24:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |
| MCSX ↓ →<br>MWEX ↓ delay time         | t <sub>CSL - WEL</sub>   | MWEX,<br>MCSX[7:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×n-9<br>MCLK×n-12 | MCLK×n+9<br>MCLK×n+12 | ns   |
| MWEX ↑ →<br>MCSX ↑ delay time         | t <sub>WEH - CSH</sub>   |                         | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |
| MCSX ↓ →<br>MDQM ↓ delay time         | t <sub>CSL - WDQML</sub> | MCSX,<br>MDQM[1:0]      | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK×n-9<br>MCLK×n-12 | MCLK×n+9<br>MCLK×n+12 | ns   |
| MCSX ↓ →<br>Data output time          | t <sub>CSL - DV</sub>    | MCSX,<br>MADATA[15:0]   | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | MCLK-9<br>MCLK-12     | MCLK+9<br>MCLK+12     | ns   |
| MWEX ↑ →<br>Data hold time            | t <sub>WEH - DX</sub>    | MWEX,<br>MADATA[15:0]   | Vcc ≥ 4.5 V<br>Vcc < 4.5 V | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |

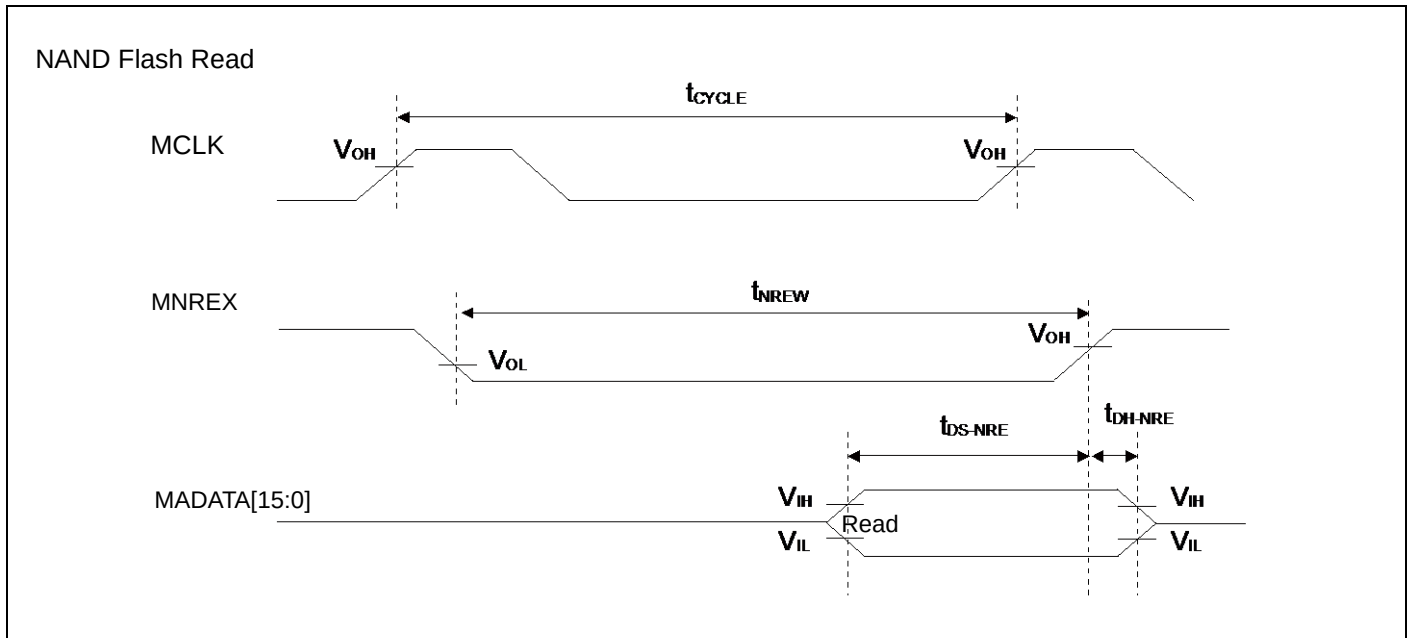
**Note:** When the external load capacitance = 30 pF. (m = 0 to 15, n = 1 to 16)

**NAND flash mode**

(Vcc = 2.7 V to 5.5 V, Vss = 0 V, Ta = - 40°C to + 85°C)

| Parameter                   | Symbol          | Pin name               | Conditions                                              | Value                 |                       | Unit |
|-----------------------------|-----------------|------------------------|---------------------------------------------------------|-----------------------|-----------------------|------|
|                             |                 |                        |                                                         | Min                   | Max                   |      |
| MNREX<br>Min pulse width    | $t_{NREW}$      | MNREX                  | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | MCLK×n-3              | -                     | ns   |
| Data setup →<br>MNREX↑time  | $t_{DS-NRE}$    | MNREX,<br>MADATA[15:0] | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | 20<br>38              | -                     | ns   |
| MNREX↑→<br>Data hold time   | $t_{DH-NRE}$    | MNREX,<br>MADATA[15:0] | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | 0                     | -                     | ns   |
| MNALE↑→<br>MNWEX delay time | $t_{ALEH-NWEL}$ | MNALE,<br>MNWEX        | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | MCLK×m-9<br>MCLK×m-12 | MCLK×m+9<br>MCLK×m+12 | ns   |
| MNALE↓→<br>MNWEX delay time | $t_{ALEL-NWEL}$ | MNALE,<br>MNWEX        | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | MCLK×m-9<br>MCLK×m-12 | MCLK×m+9<br>MCLK×m+12 | ns   |
| MNCLE↑→<br>MNWEX delay time | $t_{CLEH-NWEL}$ | MNCLE,<br>MNWEX        | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | MCLK×m-9<br>MCLK×m-12 | MCLK×m+9<br>MCLK×m+12 | ns   |
| MNWEX↑→<br>MNCLE delay time | $t_{NWEH-CLEL}$ | MNCLE,<br>MNWEX        | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |
| MNWEX<br>Min pulse width    | $t_{NWEW}$      | MNWEX                  | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | MCLK×n-3              | -                     | ns   |
| MNWEX↓→<br>Data output time | $t_{NWEL-DV}$   | MNWEX,<br>MADATA[15:0] | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | -9<br>-12             | +9<br>+12             | ns   |
| MNWEX↑→<br>Data hold time   | $t_{NWEH-DX}$   | MNWEX,<br>MADATA[15:0] | $V_{cc} \geq 4.5 \text{ V}$<br>$V_{cc} < 4.5 \text{ V}$ | 0                     | MCLK×m+9<br>MCLK×m+12 | ns   |

**Note:** When the external load capacitance = 30 pF. (m=0 to 15, n=1 to 16)



## CSIO (SPI = 1, SCINV = 0)

(V<sub>CC</sub> = 2.7 V to 5.5 V, V<sub>SS</sub> = 0 V, T<sub>a</sub> = - 40°C to + 85°C)

| Parameter                    | Symbol             | Pin name   | Conditions  | V <sub>CC</sub> < 4.5 V |      | V <sub>CC</sub> ≥ 4.5 V |      | Unit |
|------------------------------|--------------------|------------|-------------|-------------------------|------|-------------------------|------|------|
|                              |                    |            |             | Min                     | Max  | Min                     | Max  |      |
| Serial clock cycle time      | t <sub>SCYC</sub>  | SCKx       | Master mode | 4t <sub>CYCP</sub>      | -    | 4t <sub>CYCP</sub>      | -    | ns   |
| SCK ↑ → SOT delay time       | t <sub>SHOVI</sub> | SCKx, SOTx |             | - 30                    | + 30 | - 20                    | + 20 | ns   |
| SIN → SCK ↓ setup time       | t <sub>IVSLI</sub> | SCKx, SINx |             | 50                      | -    | 30                      | -    | ns   |
| SCK ↓ → SIN hold time        | t <sub>SLIXI</sub> | SCKx, SINx |             | 0                       | -    | 0                       | -    | ns   |
| SOT → SCK ↓ delay time       | t <sub>SOVLI</sub> | SCKx, SOTx |             | 2t <sub>CYCP</sub> - 30 | -    | 2t <sub>CYCP</sub> - 30 | -    | ns   |
| Serial clock "L" pulse width | t <sub>SLSH</sub>  | SCKx       | Slave mode  | 2t <sub>CYCP</sub> - 10 | -    | 2t <sub>CYCP</sub> - 10 | -    | ns   |
| Serial clock "H" pulse width | t <sub>SHSL</sub>  | SCKx       |             | t <sub>CYCP</sub> + 10  | -    | t <sub>CYCP</sub> + 10  | -    | ns   |
| SCK ↑ → SOT delay time       | t <sub>SHOVE</sub> | SCKx, SOTx |             | -                       | 50   | -                       | 30   | ns   |
| SIN → SCK ↓ setup time       | t <sub>IVSLE</sub> | SCKx, SINx |             | 10                      | -    | 10                      | -    | ns   |
| SCK ↓ → SIN hold time        | t <sub>SLIXE</sub> | SCKx, SINx |             | 20                      | -    | 20                      | -    | ns   |
| SCK fall time                | t <sub>F</sub>     | SCKx       |             | -                       | 5    | -                       | 5    | ns   |
| SCK rise time                | t <sub>R</sub>     | SCKx       |             | -                       | 5    | -                       | 5    | ns   |

### Notes:

- The above characteristics apply to CLK synchronous mode.
- t<sub>CYCP</sub> indicates the APB bus clock cycle time.  
About the APB bus number which Multi-function Serial is connected to, see "8. Block Diagram" in this datasheet.
- These characteristics only guarantee the same relocate port number.  
For example, the combination of SCKx\_0 and SOTx\_1 is not guaranteed.
- When the external load capacitance = 30 pF.

## 12.4.16 Ethernet-MAC Timing

### RMII transmission (100 Mbps/10 Mbps)

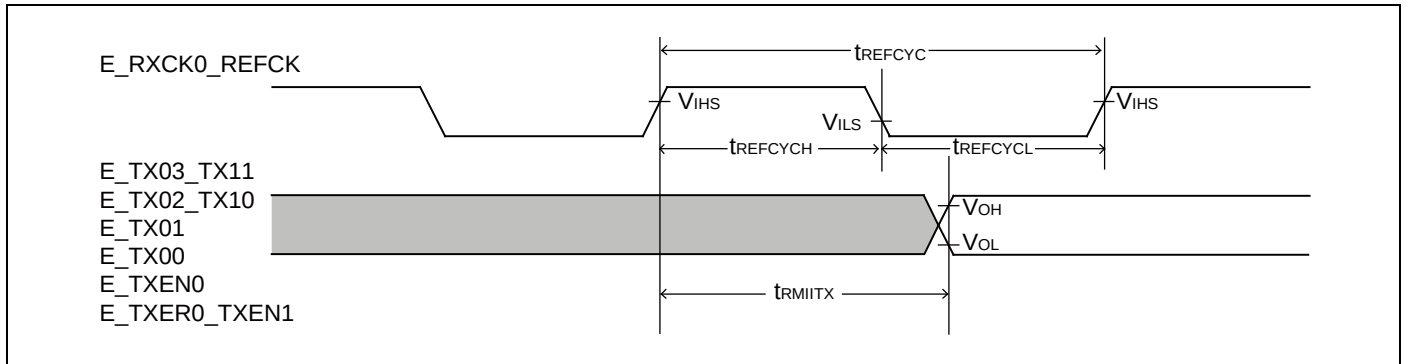
(ETHV<sub>CC</sub> = 3.0 V to 3.6 V, 4.5 V to 5.5 V<sup>[1]</sup>)

(V<sub>SS</sub> = 0 V, T<sub>a</sub> = - 40°C to + 85°C, C<sub>L</sub>=25 pF)

| Parameter                                       | Symbol               | Pin name                                      | Conditions                                    | Value |     | Unit |
|-------------------------------------------------|----------------------|-----------------------------------------------|-----------------------------------------------|-------|-----|------|
|                                                 |                      |                                               |                                               | Min   | Max |      |
| Reference Clock<br>Cycle time <sup>[2]</sup>    | t <sub>REFCYC</sub>  | E_RXCK0_REFCK                                 | 20 ns (typical)                               | -     | -   | ns   |
| Reference Clock<br>High pulse width duty        | t <sub>REFCYCH</sub> | E_RXCK0_REFCK                                 | t <sub>REFCYCH</sub> /<br>t <sub>REFCYC</sub> | 35    | 65  | %    |
| Reference Clock<br>Low pulse width duty         | t <sub>REFCYCL</sub> | E_RXCK0_REFCK                                 | t <sub>REFCYCL</sub> /<br>t <sub>REFCYC</sub> | 35    | 65  | %    |
| REFCK ↑ → Transmitted data<br>Delay time (ch.0) | t <sub>RMITX</sub>   | E_TX01,<br>E_TX00,<br>E_TXEN0                 | -                                             | -     | 12  | ns   |
| REFCK ↑ → Transmitted data<br>Delay time (ch.1) |                      | E_TX03_TX11,<br>E_TX02_TX10,<br>E_TXER0_TXEN1 |                                               |       |     |      |

[1]: When ETHV = 4.5 V to 5.5 V, it is recommended to add a series resistor at the output pin to suppress the output current.

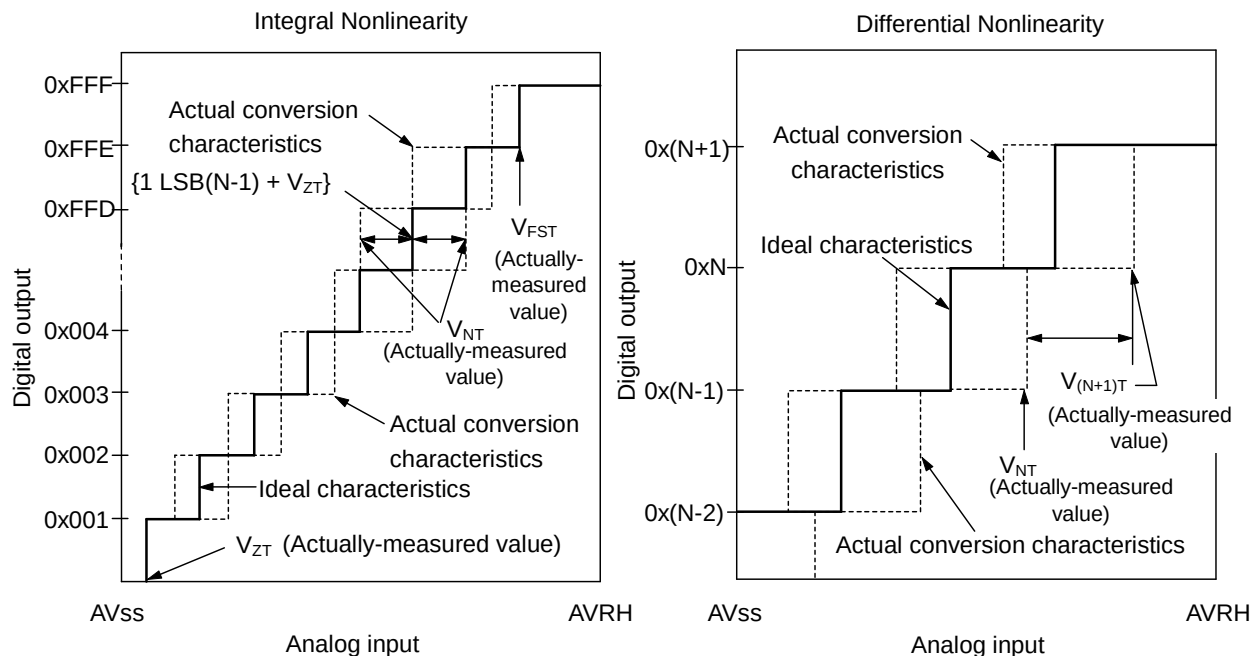
[2]: The reference clock is fixed to 50 MHz in the RMII specifications. The clock accuracy should meet the PHY-device specifications.





## Definition of 12-bit A/D converter terms

- Resolution : Analog variation that is recognized by an A/D converter.
- Integral Nonlinearity : Deviation of the line between the zero-transition point (0b000000000000 ↔ 0b000000000001) and the full-scale transition point (0b111111111110 ↔ 0b111111111111) from the actual conversion characteristics.
- Differential Nonlinearity : Deviation from the ideal value of the input voltage that is required to change the output code by 1 LSB.



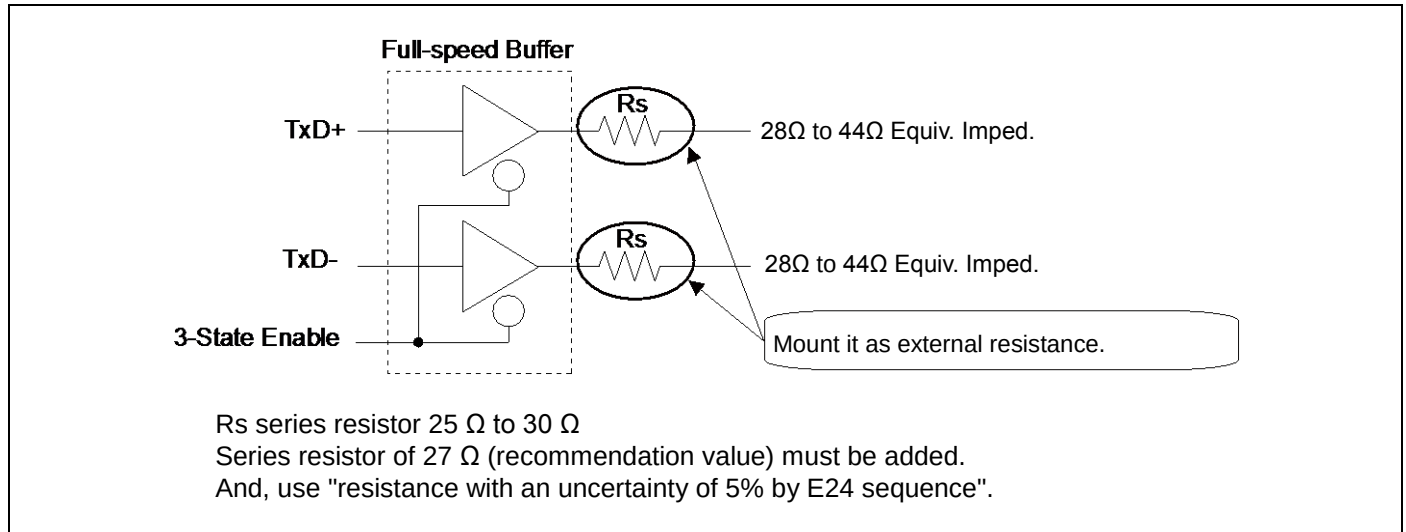
$$\text{Integral Nonlinearity of digital output } N = \frac{V_{NT} - \{1\text{LSB} \times (N - 1) + V_{ZT}\}}{1\text{LSB}} \quad [\text{LSB}]$$

$$\text{Differential Nonlinearity of digital output } N = \frac{V_{(N+1)T} - V_{NT}}{1\text{LSB}} - 1 \quad [\text{LSB}]$$

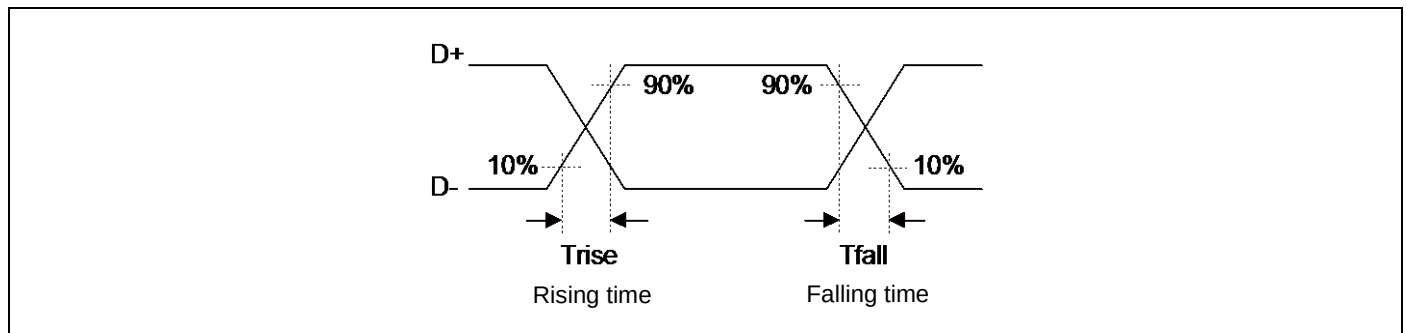
$$1\text{LSB} = \frac{V_{FST} - V_{ZT}}{4094}$$

- N : A/D converter digital output value.
- $V_{ZT}$  : Voltage at which the digital output changes from 0x000 to 0x001.
- $V_{FST}$  : Voltage at which the digital output changes from 0xFFE to 0xFFFF.
- $V_{NT}$  : Voltage at which the digital output changes from 0x(N - 1) to 0xN.

[6]: USB Full-speed connection is performed via twist pair cable shield with  $90\ \Omega \pm 15\%$  characteristic impedance (Differential Mode). USB standard defines that output impedance of USB driver must be in range from  $28\ \Omega$  to  $44\ \Omega$ . So, discrete series resistor ( $R_s$ ) addition is defined in order to satisfy the above definition and keep balance. When using this USB I/O, use it with  $25\ \Omega$  to  $30\ \Omega$  (recommendation value  $27\ \Omega$ ) series resistor  $R_s$ .

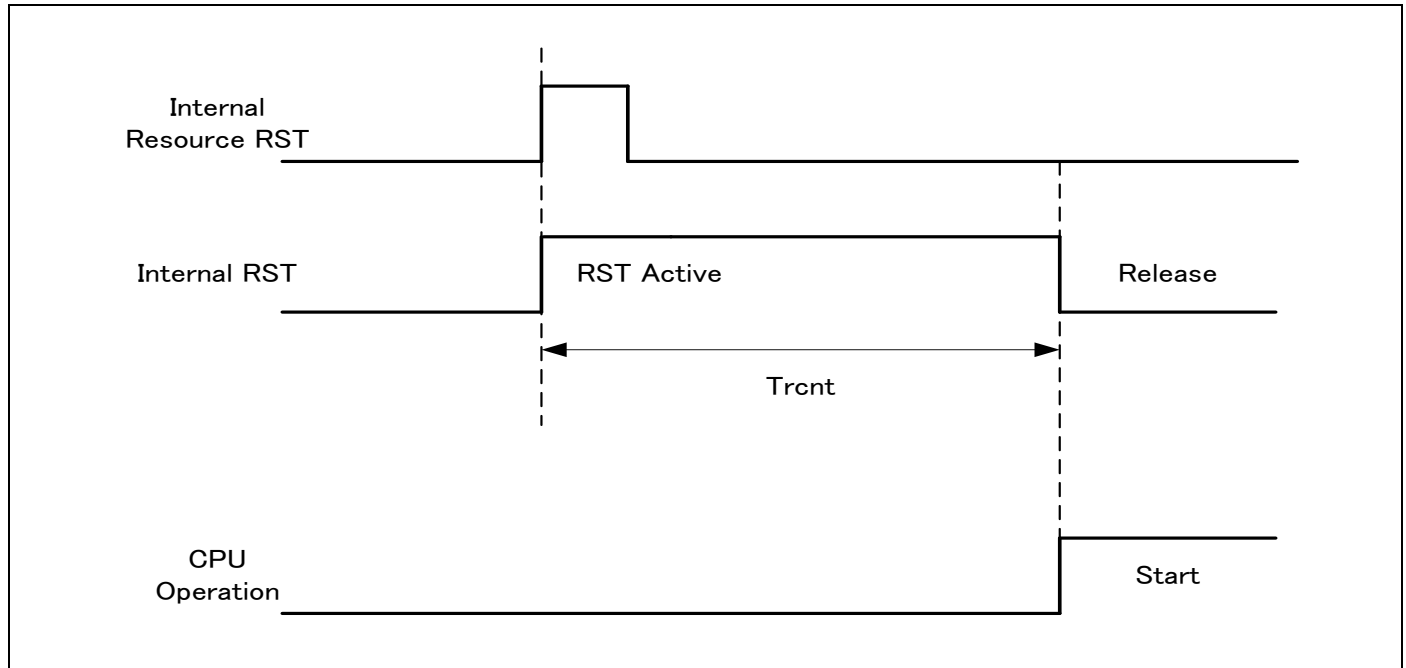


[7]: They indicate rise time ( $T_{rise}$ ) and fall time ( $T_{fall}$ ) of the low-speed differential data signal. They are defined by the time between 10% and 90% of the output signal voltage.



See Figure "Low-speed load (compliance load)" for conditions of external load.

**Operation example of return from low power consumption mode (by internal resource reset<sup>[1]</sup>)**



[1]: Internal resource reset is not included in return factor by the kind of Low-Power consumption mode.

**Notes:**

- The return factor is different in each Low-Power consumption modes.  
See "Chapter 6: Low Power Consumption Mode" and "Operations of Standby Modes" in FM3 Family Peripheral Manual.
- When interrupt recoveries, the operation mode that CPU recoveries depend on the state before the Low-Power consumption mode transition. See "Chapter 6: Low Power Consumption Mode" in "FM3 Family Peripheral Manual"
- The time during the power-on reset/low-voltage detection reset is excluded. See "12.4.7. Power-on Reset Timing in 12.4. AC Characteristics 12. Electrical Characteristics" for the detail on the time during the power-on reset/low -voltage detection reset
- When in recovery from reset, CPU changes to the high-speed CR run mode. When using the main clock or the PLL clock, it is necessary to add the main clock oscillation stabilization wait time or the main PLL clock stabilization wait time
- The internal resource reset means the watchdog reset and the CSV reset.

### 13. Ordering Information

| Part number      | On-chip Flash memory | On-chip SRAM | Package                                                   | Packing |
|------------------|----------------------|--------------|-----------------------------------------------------------|---------|
| MB9BFD16SPMC-GE1 | 512 KB               | 64 KB        | Plastic · LQFP 144-pin<br>(0.5 mm pitch), (FPT-144P-M08)  | Tray    |
| MB9BFD17SPMC-GE1 | 768 KB               | 96 KB        |                                                           |         |
| MB9BFD18SPMC-GE1 | 1 MB                 | 128 KB       |                                                           |         |
| MB9BFD16TPMC-GE1 | 512 KB               | 64 KB        | Plastic · LQFP 176-pin<br>(0.5 mm pitch), (FPT-176P-M07)  |         |
| MB9BFD17TPMC-GE1 | 768 KB               | 96 KB        |                                                           |         |
| MB9BFD18TPMC-GE1 | 1 MB                 | 128 KB       |                                                           |         |
| MB9BFD16TBGL-GE1 | 512 KB               | 64 KB        | Plastic · PFBGA 192-pin<br>(0.8 mm pitch), (BGA-192P-M06) |         |
| MB9BFD17TBGL-GE1 | 768 KB               | 96 KB        |                                                           |         |
| MB9BFD18TBGL-GE1 | 1 MB                 | 128 KB       |                                                           |         |

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### Technical Support

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