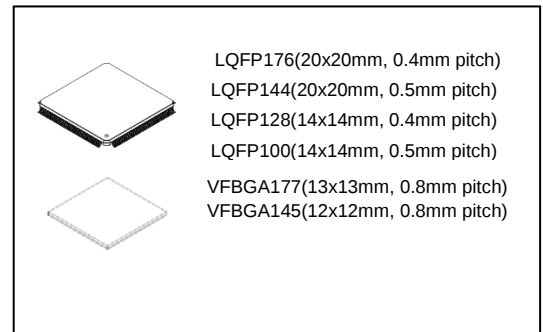


CMOS Digital Integrated Circuit Silicon Monolithic

## TMPM4G Group(1)

### General Description

- Arm® Cortex®-M4( with FPU)
- Frequency: 1 to 160 MHz, Operation voltage: 2.7 to 3.6 V
- Code Flash: 512 KB to 1536 KB. Data Flash: 32KB
- Built-in High speed 12-bit AD converter and plenty of timers/serial channels



### Applications

TMPM4G group(1) integrates widely used for the equipment in which high speed data procedure is required, such as OA/digital products, industrial equipment, and others.

### Features

- Arm Cortex-M4( with FPU)
  - Operation frequency: 1 to 160 MHz
  - Memory Protection Unit (MPU)
- Supply voltage and power consumption
  - Operation voltage: 2.7 to 3.6 V
  - Low-power consumption operation: IDLE, STOP1, and STOP2
- Operation temperature:
  - 40 to +85°C@operation frequency 1 to 120 MHz
  - 40 to +70°C@operation frequency 1 to 160 MHz
- Internal memory
  - Code Flash: 512 KB to 1536 KB, rewritable up to 10,000 times
  - Data Flash: 32 KB, rewritable up to 100,000 times
  - Data Flash is rewritable during instruction execution
  - RAM: 128 KB to 192 KB and Backup RAM: 2 KB (all products)
- Clock
  - External high speed oscillator: 8 MHz to 20 MHz (Ceramic and Crystal)
  - External high speed clock input: 8 to 20 MHz
  - Internal high speed oscillator1 (IHOSC1):10MHz, user trimming function
  - Internal high speed oscillator2 (IHOSC2):10MHz
  - PLL: 160 MHz output
  - External low speed oscillator: 32.768 kHz
- Oscillation Frequency Detector (OFD): Abnormal system clock detection
- Voltage Detection (LVD): 7 levels. selection between interrupts and reset outputs
- Interrupt
  - External: 12 to 16 factors. Integrate digital noise filters (DNF).
  - Internal: 91 to 124 factors
- I/O ports: 87 to 155 (Input: 4, Output: 1)
  - Enable to select Pull-up/Pull-down resistor, Open-drain
  - 5V tolerant, 3V tolerant
- On-chip debug (JTAG/SW) and NBDIF (RAM monitor)
- Trigger Selector (TRGSEL)
  - Expand trigger requests for DMA Controller, Timer counter, and others.
- DMA Controller: 3 units
  - MDMAC: 1 unit,  
DMA requests: 30 to 32 factors, internal/external triggers
  - HDMAC: 2 units,  
DMA requests: 13 to 15 factors, internal/external triggers
- External bus interface(EBIF)
  - Expandable to 64MB(Program/data)
  - External data bus(separate bug/multiplexed bun): 8/16 bit width
  - Chip select controller: 4 channels
- Asynchronous serial communication
  - UART: 3 to 6 channels, 5.0 Mbps (Max). FIFO (Transmission 8 stage and Reception 8 stage)
  - FUART: 1 or 2 channels, 2.5Mbps (Max). FIFO (Transmission 32 stage and Reception 32 stage) and IrDA 115.2Kbps (Max).
- Serial Peripheral Interface (TSPI): 5 to 9 channels
  - SIO/SPI mode, 25 Mbps (Max)
  - FIFO (Transmission 16bit x 8 stage and Reception 16bit x 8 stage)
- I<sup>2</sup>C Interface (I<sup>2</sup>C): 3 to 5 channels  
Multi master, standard mode/fast mode available
- Serial Memory Interface (SMIF): 1 channel
  - Connectable to two SPI FLASH

Start of commercial production  
2019-2

- Consumer Electronics Control Circuit (CEC): 1 channel
- 8-bit DA converter (DAC): 2 channels
- 12-bit AD converter (ADC): 16 to 24 channel inputs
  - Sample and hold circuit
  - Conversion time:  $1.0\ \mu\text{s}$  @  $f_{\text{ADCLK}} = 60\ \text{MHz}$
- Advanced Programmable Motor Control Circuit (A-PMD): 1 channel
  - 3 phase PWM output, Synchronized with 12-bit ADC
  - Emergency stop function by external inputs (EMG0 pin and OVV0 pin)
- 32-bit Timer Event Counter (T32A)
  - 28 channels as 16-bit Timers: 14 channels as 32-bit Timers
  - Interval Timer, event counter, input capture, phase difference input, PPG output, Sync Start, Trigger Start
- Interval Sensor Detection circuit (ISD): 3 units
  - 4 inputs per unit
  - Sampling 12 inputs at maximum simultaneously in Unit synchronous mode
  - Low speed oscillator (32.768 kHz) and 32-bit timer output can be used as sampling clock
- Long Term Timer (LTTMR): 1 channel
  - Interval time of  $0.1\ \mu\text{s}$  to  $6553.5\ \mu\text{s}$  can be set
- Real-time Clock (RTC): 1 channel
- Clock Selective Watchdog Timer (SIWDT): 1 channel
  - Clocks other than the system clock can be selected.
  - Clear window, interrupts and reset outputs
- Remote Control Signal Preprocessor (RMC): 1 to 2 channels
- Supports boundary scan(BSC)

## Products Lists Categorized by Functions

The product under development is contained in this table.  
For the newest status of each product, Please contact your sales representative.

**Table 1 TMPM4G9 (1)**

| Built-in Functions                      |                      | TMPM4G9F15FG                                     | TMPM4G9F10FG                                     | TMPM4G9FEFG                                      | TMPM4G9FDFG                                      |
|-----------------------------------------|----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)      | 1536                                             | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)      | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)             | 192                                              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)      | 2                                                | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)           | 155                                              | 155                                              | 155                                              | 155                                              |
| External interrupt                      | INT                  | 16                                               | 16                                               | 16                                               | 16                                               |
| External bus                            | EBIF                 | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)           | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | HDMAC (ch)           | 15                                               | 15                                               | 15                                               | 15                                               |
| Timer function                          | T32A (ch)            | 14                                               | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)           | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART(ch)             | 6                                                | 6                                                | 6                                                | 6                                                |
|                                         | FUART(ch)            | 2                                                | 2                                                | 2                                                | 2                                                |
|                                         | I <sup>2</sup> C(ch) | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | TSPI(ch)             | 9                                                | 9                                                | 9                                                | 9                                                |
|                                         | SMIF(ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | CEC (ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC (ch)      | 24                                               | 24                                               | 24                                               | 24                                               |
|                                         | 8-bit DAC (ch)       | 2                                                | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD (ch)           | 1                                                | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC (ch)             | 2                                                | 2                                                | 2                                                | 2                                                |
| Interval Sensor Detection peripherals   | ISD (unit)           | 3                                                | 3                                                | 3                                                | 3                                                |
| System function                         | LVD(ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT(ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | OFD(ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | POR                  | 1                                                | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type         | LQFP176<br>(20 mm x 20 mm, 0.4 mm pitch)         |                                                  |                                                  |                                                  |

**Table 2 TMPM4G9 (2)**

| Built-in Functions                      |                       | TMPM4G9F15XBG                                    | TMPM4G9F10XBG                                    | TMPM4G9FEXBG                                     | TMPM4G9FDXBG                                     |
|-----------------------------------------|-----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)       | 1536                                             | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)       | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)              | 192                                              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)       | 2                                                | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)            | 155                                              | 155                                              | 155                                              | 155                                              |
| External interrupt                      | INT                   | 16                                               | 16                                               | 16                                               | 16                                               |
| External bus                            | EBIF                  | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)            | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | HDMAC (ch)            | 15                                               | 15                                               | 15                                               | 15                                               |
| Timer function                          | T32A (ch)             | 14                                               | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART (ch)             | 6                                                | 6                                                | 6                                                | 6                                                |
|                                         | FUART (ch)            | 2                                                | 2                                                | 2                                                | 2                                                |
|                                         | I <sup>2</sup> C (ch) | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | TSPI (ch)             | 9                                                | 9                                                | 9                                                | 9                                                |
|                                         | SMIF (ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | CEC (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC (ch)       | 24                                               | 24                                               | 24                                               | 24                                               |
|                                         | 8-bit DAC (ch)        | 2                                                | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC (ch)              | 2                                                | 2                                                | 2                                                | 2                                                |
| Interval Sensor Detection peripherals   | ISD (unit)            | 3                                                | 3                                                | 3                                                | 3                                                |
| System function                         | LVD (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | OFD (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | POR                   | 1                                                | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                 | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type          | VFBGA177<br>(13 mm x 13 mm, 0.8 mm pitch)        |                                                  |                                                  |                                                  |

Table 3 TMPM4G8 (1)

| Built-in Functions                      |                      | TMPM4G8F15FG                                     | TMPM4G8F10FG                                     | TMPM4G8FEFG                                      | TMPM4G8FDFG                                      |
|-----------------------------------------|----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)      | 1536                                             | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)      | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)             | 192                                              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)      | 2                                                | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)           | 127                                              | 127                                              | 127                                              | 127                                              |
| External interrupt                      | INT                  | 16                                               | 16                                               | 16                                               | 16                                               |
| External bus                            | EBIF                 | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)           | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | HDMAC (ch)           | 15                                               | 15                                               | 15                                               | 15                                               |
| Timer function                          | T32A (ch)            | 14                                               | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)           | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART(ch)             | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | FUART(ch)            | 2                                                | 2                                                | 2                                                | 2                                                |
|                                         | I <sup>2</sup> C(ch) | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | TSPI(ch)             | 8                                                | 8                                                | 8                                                | 8                                                |
|                                         | SMIF(ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | CEC(ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC(ch)       | 24                                               | 24                                               | 24                                               | 24                                               |
|                                         | 8-bit DAC(ch)        | 2                                                | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD(ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC(ch)              | 2                                                | 2                                                | 2                                                | 2                                                |
| Interval Sensor Detection peripherals   | ISD(unit)            | 2                                                | 2                                                | 2                                                | 2                                                |
| System function                         | LVD(ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT(ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | OFD(ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | POR                  | 1                                                | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type         | LQFP144<br>(20 mm x 20 mm, 0.5 mm pitch)         |                                                  |                                                  |                                                  |

Table 4 TMPM4G8 (2)

| Built-in Functions                      |                       | TMPM4G8F15XBG                                    | TMPM4G8F10XBG                                    | TMPM4G8FEXBG                                     | TMPM4G8FDXBG                                     |
|-----------------------------------------|-----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)       | 1536                                             | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)       | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)              | 192                                              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)       | 2                                                | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)            | 127                                              | 127                                              | 127                                              | 127                                              |
| External interrupt                      | INT                   | 16                                               | 16                                               | 16                                               | 16                                               |
| External bus                            | EBIF                  | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)            | 32                                               | 32                                               | 32                                               | 32                                               |
|                                         | HDMAC (ch)            | 15                                               | 15                                               | 15                                               | 15                                               |
| Timer function                          | T32A (ch)             | 14                                               | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART (ch)             | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | FUART (ch)            | 2                                                | 2                                                | 2                                                | 2                                                |
|                                         | I <sup>2</sup> C (ch) | 5                                                | 5                                                | 5                                                | 5                                                |
|                                         | TSPI (ch)             | 8                                                | 8                                                | 8                                                | 8                                                |
|                                         | SMIF (ch)             | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | CEC (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC (ch)       | 24                                               | 24                                               | 24                                               | 24                                               |
|                                         | 8-bit DAC (ch)        | 2                                                | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC (ch)              | 2                                                | 2                                                | 2                                                | 2                                                |
| Interval Sensor Detection peripherals   | ISD (unit)            | 2                                                | 2                                                | 2                                                | 2                                                |
| System function                         | LVD (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT (ch)            | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | OFD (ch)              | 1                                                | 1                                                | 1                                                | 1                                                |
|                                         | POR                   | 1                                                | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                 | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type          | VFPGA145<br>(12 mm x 12 mm, 0.8 mm pitch)        |                                                  |                                                  |                                                  |

Table 5 TMPM4G7

| Built-in Functions                      |                       | TMPM4G7F10FG                                     | TMPM4G7FEFG                                      | TMPM4G7FDFG                                      |
|-----------------------------------------|-----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)       | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)       | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)       | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)            | 111                                              | 111                                              | 111                                              |
| External interrupt                      | INT                   | 14                                               | 14                                               | 14                                               |
| External bus                            | EBIF                  | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)            | 30                                               | 30                                               | 30                                               |
|                                         | HDMAC (ch)            | 15                                               | 15                                               | 15                                               |
| Timer function                          | T32A (ch)             | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)            | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)              | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART(ch)              | 4                                                | 4                                                | 4                                                |
|                                         | FUART(ch)             | 1                                                | 1                                                | 1                                                |
|                                         | I <sup>2</sup> C (ch) | 3                                                | 3                                                | 3                                                |
|                                         | TSPI (ch)             | 6                                                | 6                                                | 6                                                |
|                                         | SMIF (ch)             | 1                                                | 1                                                | 1                                                |
|                                         | CEC (ch)              | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC (ch)       | 20                                               | 20                                               | 20                                               |
|                                         | 8-bit DAC (ch)        | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD(ch)             | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC(ch)               | 2                                                | 2                                                | 2                                                |
| Interval Sensor Detection peripherals   | ISD(unit)             | 2                                                | 2                                                | 2                                                |
| System function                         | LVD(ch)               | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT(ch)             | 1                                                | 1                                                | 1                                                |
|                                         | OFD(ch)               | 1                                                | 1                                                | 1                                                |
|                                         | POR                   | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                 | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type          | LQFP128<br>(14 mm x 14 mm, 0.4 mm pitch)         |                                                  |                                                  |

**Table 6 TMPM4G6**

| Built-in Functions                      |                       | TMPM4G6F10FG                                     | TMPM4G6FEFG                                      | TMPM4G6FDFG                                      |
|-----------------------------------------|-----------------------|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| Memory                                  | Code Flash (KB)       | 1024                                             | 768                                              | 512                                              |
|                                         | Data Flash (KB)       | 32                                               | 32                                               | 32                                               |
|                                         | RAM (KB)              | 192                                              | 128                                              | 128                                              |
|                                         | Backup RAM (KB)       | 2                                                | 2                                                | 2                                                |
| I/O port                                | PORT (pin)            | 91                                               | 91                                               | 91                                               |
| External interrupt                      | INT                   | 12                                               | 12                                               | 12                                               |
| External bus                            | EBIF                  | Sep./Mul.                                        | Sep./Mul.                                        | Sep./Mul.                                        |
| DMAC                                    | MDMAC (ch)            | 30                                               | 30                                               | 30                                               |
|                                         | HDMAC (ch)            | 13                                               | 13                                               | 13                                               |
| Timer function                          | T32A (ch)             | 14                                               | 14                                               | 14                                               |
|                                         | LTTMR (ch)            | 1                                                | 1                                                | 1                                                |
|                                         | RTC (ch)              | 1                                                | 1                                                | 1                                                |
| Serial communication function           | UART (ch)             | 3                                                | 3                                                | 3                                                |
|                                         | FUART (ch)            | 1                                                | 1                                                | 1                                                |
|                                         | I <sup>2</sup> C (ch) | 3                                                | 3                                                | 3                                                |
|                                         | TSPI (ch)             | 5                                                | 5                                                | 5                                                |
|                                         | SMIF (ch)             | 1                                                | 1                                                | 1                                                |
|                                         | CEC (ch)              | 1                                                | 1                                                | 1                                                |
| Analog function                         | 12-bit ADC (ch)       | 16                                               | 16                                               | 16                                               |
|                                         | 8-bit DAC (ch)        | 2                                                | 2                                                | 2                                                |
| Motor control function                  | A-PMD (ch)            | 1                                                | 1                                                | 1                                                |
| Remote Control preprocessor peripherals | RMC (ch)              | 1                                                | 1                                                | 1                                                |
| Interval Sensor Detection peripherals   | ISD(unit)             | 1                                                | 1                                                | 1                                                |
| System function                         | LVD (ch)              | 1                                                | 1                                                | 1                                                |
|                                         | SIWDT (ch)            | 1                                                | 1                                                | 1                                                |
|                                         | OFD (ch)              | 1                                                | 1                                                | 1                                                |
|                                         | POR                   | 1                                                | 1                                                | 1                                                |
| Debug interface                         | Debug                 | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF | On-chip debug (JTAG/SW)<br>TRACE(4bits)<br>NBDIF |
| Package                                 | Package type          | LQFP100<br>(14 mm x 14 mm, 0.5 mm pitch)         |                                                  |                                                  |

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## Preface

### Conventions

- Numeric formats follow the rules as shown below:  
 Hexadecimal: 0xABC  
 Decimal: 123 or 0d123 – Only when it needs to be explicitly shown that they are decimal numbers.  
 Binary: 0b111 – It is possible to omit the “0b” when the number of bit can be distinctly understood from a sentence.
- “\_N” is added to the end of signal names to indicate low active signals.
- It is called “assert” that a signal moves to its active level, “deassert” to its inactive level.
- When two or more signal names are referred, they are described like as [m: n].  
 Example: S[3: 0] shows four signal names S3, S2, S1 and S0 together.
- The characters surrounded by [ ] defines the register.  
 Example: [ABCD]
- “n” substitutes suffix number of two or more same kind of registers, fields, and bit names.  
 Example: [XYZ1], [XYZ2], [XYZ3] → [XYZn]
- “x” substitutes suffix number or character of units and channels in the Register List.  
 In case of unit, “x” means A, B, and C . . .  
 Example: [ADACR0], [ADBCR0], [ADCCR0] → [ADxCR0]  
 In case of channel, “x” means 0, 1, and 2 . . .  
 Example: [T32A0RUNA], [T32A1RUNA], [T32A2RUNA] → [T32AxRUNA]
- The bit range of a register is written like as [m: n].  
 Example: Bit[3: 0] expresses the range of bit 3 to 0.
- The configuration value of a register is expressed by either the hexadecimal number or the binary number.  
 Example: [ABCD]<EFG> = 0x01 (hexadecimal), [XYZn]<VW> = 1 (binary)
- Word and Byte represent the following bit length.  
 Byte: 8 bits  
 Half word: 16 bits  
 Word: 32 bits  
 Double word: 64 bits
- Properties of each bit in a register are expressed as follows:  
 R: Read only  
 W: Write only  
 R/W: Read and Write are possible
- Unless otherwise specified, register access supports only word access.
- The register defined as reserved must not be rewritten. Moreover, do not use the read value.
- The value read from the bit having default value of “-” is unknown.
- When a register containing both of writable bits and read-only bits is written, read-only bits should be written with their default value. In the cases that default is “-”, follow the definition of each register.
- Reserved bits of the Write-only register should be written with their default value. In the cases that default is “-”, follow the definition of each register.
- Do not use read-modified-write processing to the register of a definition which is different by writing and read out.

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**Terms and Abbreviations**

The following words are terms or abbreviations mainly used in this datasheet.

|                  |                                                  |
|------------------|--------------------------------------------------|
| ADC              | Analog to Digital Converter                      |
| A-PMD            | Advanced Programmable Motor Control Circuit      |
| BSC              | Boundary Scan                                    |
| CEC              | Consumer Electronics Control                     |
| DAC              | Digital to Analog Converter                      |
| DNF              | Digital Noise Filter                             |
| EBIF             | External Bus Interface                           |
| EHOSC            | External High Speed Oscillator                   |
| ELOSC            | External Low Speed Oscillator                    |
| FUART            | Full Universal Asynchronous Receiver Transmitter |
| HDMAC            | High Speed DMAC                                  |
| IHOSC            | Internal High Speed Oscillator                   |
| INT              | Interrupt                                        |
| I <sup>2</sup> C | Inter-Integrated Circuit                         |
| ISD              | Interval Sensor Detection Circuit                |
| LTMR             | Long Term Timer                                  |
| LVD              | Voltage Detection Circuit                        |
| MDMAC            | Multi-Function DMA Controller                    |
| NBDIF            | Non Break Debug Interface                        |
| NMI              | Non-Maskable Interrupt                           |
| OFD              | Oscillation Frequency Detector                   |
| POR              | Power On Reset Circuit                           |
| RMC              | Remote Control Signal Preprocessor               |
| RTC              | Real Time Clock                                  |
| SMIF             | Serial Memory Interface                          |
| SIWDT            | Clock Selective Watchdog Timer                   |
| TRGSEL           | Trigger Selection circuit                        |
| TRM              | Trimming Circuit                                 |
| TSPI             | Toshiba Serial Peripheral Interface              |
| T32A             | 32-bit Timer Event Counter                       |
| UART             | Universal Asynchronous Receiver Transmitter      |

## 1. Block Diagram

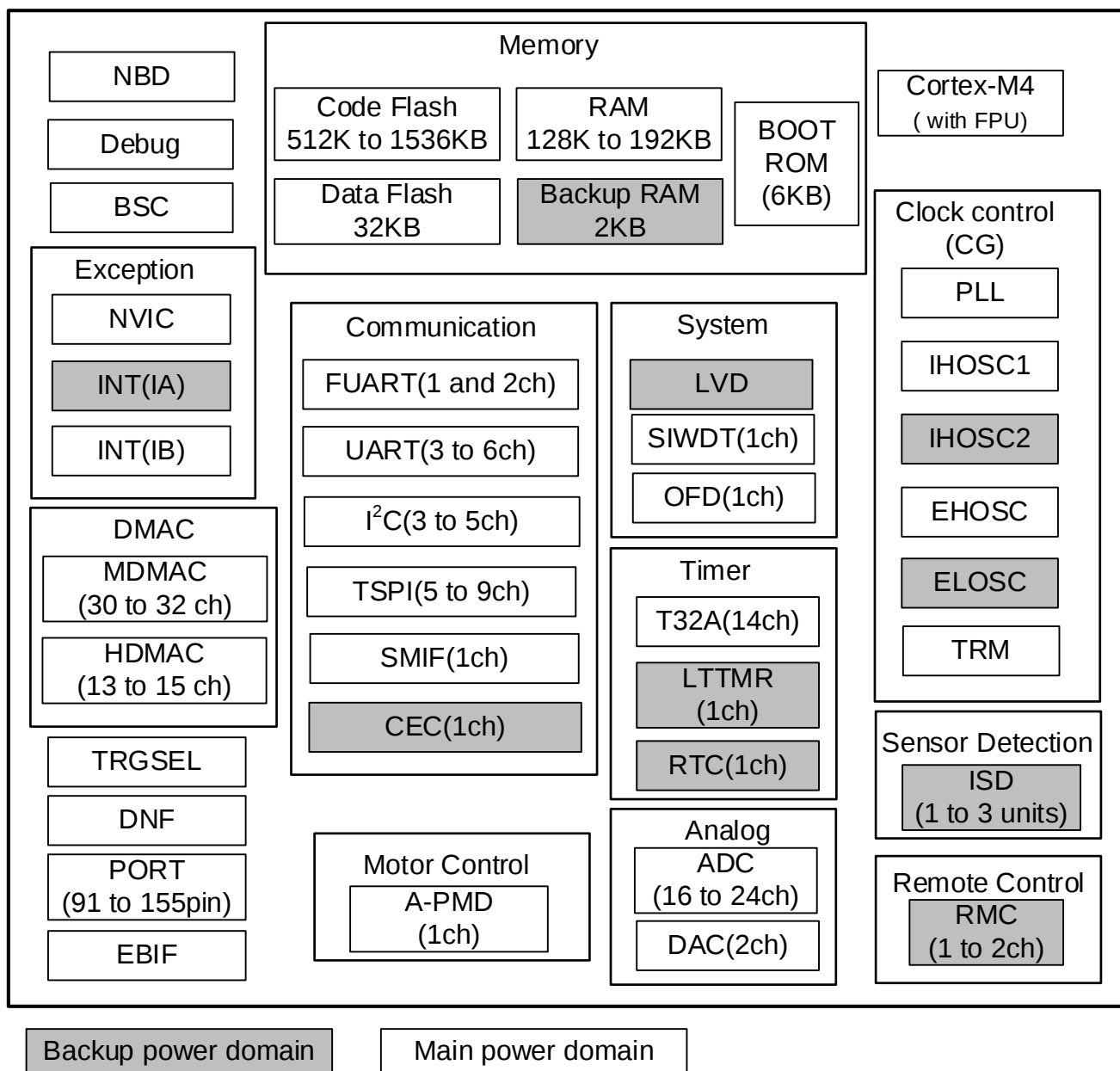


Figure 1.1 Block diagram of the TMPM4G Group(1)

## 2.1. LQFP176

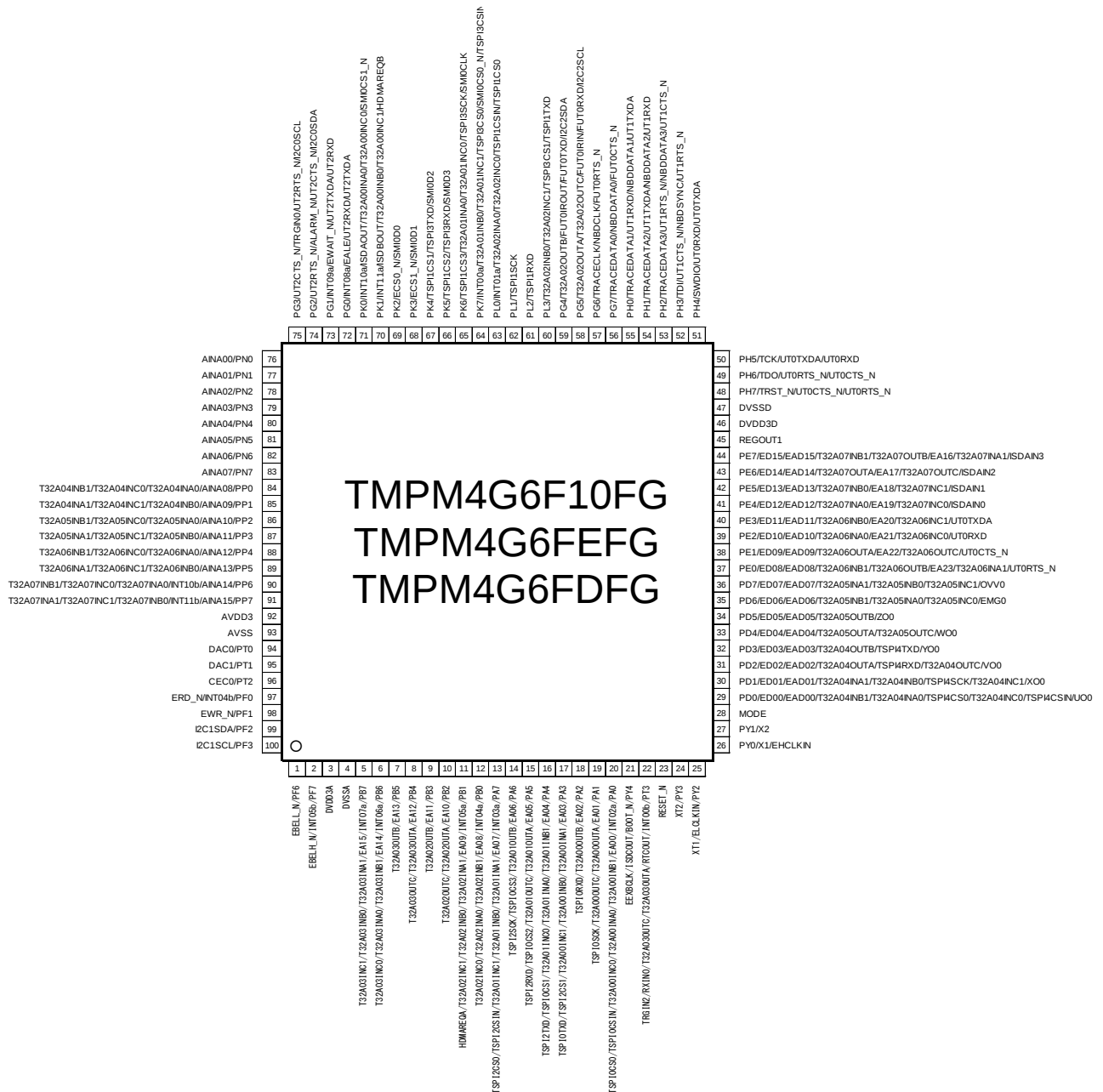
TMPM4G9F15FG  
TMPM4G9F10FG  
TMPM4G9FEFG  
TMPM4G9FDFG



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## 2.4. LQFP100



## 2.5. VFBGA177

### TPM4G9F15XBG/TPM4G9F10XBG/TPM4G9FEXBG/TPM4G9FDXBG

|   | 1       | 2      | 3      | 4      | 5      | 6     | 7     | 8   | 9   | 10      | 11  | 12     | 13     | 14  | 15  | 16    |
|---|---------|--------|--------|--------|--------|-------|-------|-----|-----|---------|-----|--------|--------|-----|-----|-------|
| A | DVDD3A  | PF4    | PF3    | PF1    | PT1    | PT0   | AVDD3 | PR4 | PR3 | PP7     | PP3 | PN7    | PN5    | PN3 | PN1 | DVSSF |
| B | PF7     | PF6    | PF5    | PF2    | PJ0    | PJ1   | AVSS  | PR5 | PR2 | PP6     | PP2 | PN6    | PN4    | PN2 | PN0 | PG3   |
| C | PC4     | PC5    | —      | —      | —      | —     | —     | —   | —   | —       | —   | —      | —      | —   | PG2 | PG1   |
| D | PC2     | PC3    | —      | PC7    | PF0    | PJ2   | PJ3   | PR7 | PR1 | PP5     | PP1 | PP0    | DVSSE  | —   | PG0 | PL4   |
| E | PB4     | PB5    | —      | PC6    | DVSSH  | PT2   | PL6   | PL7 | PR6 | PR0     | PP4 | DVSSD  | PM3    | —   | PL5 | PM0   |
| F | PB2     | PB3    | —      | PC0    | PC1    | DVSSG | —     | —   | —   | —       | —   | PV0    | PT4    | —   | PM1 | PM2   |
| G | PB0     | PB1    | —      | PB6    | PB7    | —     | —     | —   | —   | —       | —   | PV2    | PV1    | —   | PW4 | PW5   |
| H | PA6     | PA7    | —      | PU0    | PT3    | —     | —     | —   | —   | —       | —   | PK0    | PV3    | —   | PW6 | PW7   |
| J | PA4     | PA5    | —      | PU1    | PU2    | —     | —     | —   | —   | —       | —   | PK1    | PK2    | —   | PK4 | PK6   |
| K | PA2     | PA3    | —      | PU3    | PU4    | —     | —     | —   | —   | —       | —   | PK7    | PK3    | —   | PK5 | PL1   |
| L | PA0     | PA1    | —      | PU6    | PU5    | —     | —     | —   | —   | —       | —   | PG4    | PL0    | —   | PL2 | PL3   |
| M | DVSSA   | PY4    | —      | PU7    | DVDD3G | PD1   | PD3   | PD5 | PD7 | PW2     | PW0 | DVDD3D | PG5    | —   | PG7 | PG6   |
| N | PY3/XT2 | DVSSB  | —      | DVDD3H | PD0    | PD2   | PD4   | PD6 | PJ7 | PW3     | PW1 | PM4    | DVDD3E | —   | PH1 | PH0   |
| P | PY2/XT1 | DVSSC  | —      | —      | —      | —     | —     | —   | —   | —       | —   | —      | —      | —   | PH3 | PH2   |
| R | RESET_N | DVDD3B | DVDD3C | PE0    | PE1    | PE4   | PE5   | PJ6 | PJ5 | PT5     | PV7 | PV4    | PM6    | PH7 | PH6 | PH4   |
| T | MODE    | PY0/X1 | PY1/X2 | DVDD3F | PE2    | PE3   | PE6   | PE7 | PJ4 | REGOUT1 | PV6 | PV5    | PM7    | PM5 | PH5 | BSC   |

## 2.6. VFBGA145

### TMPM4G8F15XBG/TMPM4G8F10XBG/TMPM4G8FEXBG/TMPM4G8FDXBG

|   | 1       | 2      | 3      | 4      | 5                | 6              | 7   | 8       | 9   | 10               | 11  | 12  | 13  | 14    |
|---|---------|--------|--------|--------|------------------|----------------|-----|---------|-----|------------------|-----|-----|-----|-------|
| A | DVDD3A  | PF4    | PF3    | PT1    | PT0              | AVDD3          | PR3 | PP7     | PP3 | PN7              | PN5 | PN3 | PN1 | DVSSF |
| B | PF7     | PF6    | PF5    | PF2    | PF1              | AVSS           | PR2 | PP6     | PP2 | PN6              | PN4 | PN2 | PN0 | PG3   |
| C | PC4     | PC5    | —      | —      | —                | —              | —   | —       | —   | —                | —   | —   | PG2 | PG1   |
| D | PC2     | PC3    | —      | PC7    | PF0              | PR7            | PR4 | PR0     | PP4 | PP1              | PP0 | —   | PG0 | PM0   |
| E | PB4     | PB5    | —      | PC6    | PT2              | PR6            | PR5 | PR1     | PP5 | DVSSD<br>DVSSE   | PT4 | —   | PM1 | PM2   |
| F | PB2     | PB3    | —      | PC0    | PC1              | DVSSG<br>DVSSH | —   | —       | —   | PV0              | PV1 | —   | PM3 | PK2   |
| G | PA5     | PA6    | —      | PB6    | PB7              | —              | —   | —       | —   | PV3              | PV2 | —   | PK3 | PK4   |
| H | PA3     | PA4    | —      | PB0    | PB1              | —              | —   | —       | —   | PK0              | PK1 | —   | PK5 | PK6   |
| J | PA1     | PA2    | —      | PA0    | PA7              | —              | —   | —       | —   | PK7              | PL0 | —   | PL2 | PL1   |
| K | DVSSA   | PY4    | —      | PT3    | DVDD3G<br>DVDD3H | PD2            | PD5 | PD6     | PT5 | DVDD3D<br>DVDD3E | PG5 | —   | PG4 | PL3   |
| L | PY3/XT2 | DVSSB  | —      | PD0    | PD1              | PD3            | PD4 | PD7     | PV7 | PM4              | PH0 | —   | PG7 | PG6   |
| M | PY2/XT1 | DVSSC  | —      | —      | —                | —              | —   | —       | —   | —                | —   | —   | PH1 | PH2   |
| N | RESET_N | DVDD3B | DVDD3C | PE0    | PE1              | PE3            | PE6 | PE7     | PV6 | PV4              | PM6 | PH7 | PH3 | PH4   |
| P | MODE    | PY0/X1 | PY1/X2 | DVDD3F | PE2              | PE4            | PE5 | REGOUT1 | PV5 | PM7              | PM5 | PH6 | PH5 | BSC   |

## 3. Memory Map

|            |                                    |
|------------|------------------------------------|
| 0xFFFFFFFF | Vendor-Specific                    |
| 0xE0100000 | CPU Register Region                |
| 0xE0000000 | Fault                              |
| 0xA8000000 | Reserved                           |
| 0xA1000000 | Serial Memory Interface Area       |
| 0xA0000000 | Fault                              |
| 0x80000000 | Reserved                           |
| 0x64000000 | External bus Interface Area        |
| 0x60000000 | Fault                              |
| 0x5E180000 | Flash for code<br>(Mirror 1636KB)  |
| 0x5E000000 | Flash (SFR)                        |
| 0x5DFF0000 | Fault                              |
| 0x44000000 | Bit Band Alias<br>(SFR)            |
| 0x42000000 | Fault                              |
| 0x40100000 | SFR                                |
| 0x4003E000 | Fault                              |
| 0x400D0000 | SFR                                |
| 0x400C0000 | Fault                              |
| 0x40002000 | SFR                                |
| 0x40000000 | Fault                              |
| 0x30008000 | Data Flash<br>(32 KB)              |
| 0x30000000 | Fault                              |
| 0x22610000 | Bit Band Alias<br>(RAM/Backup RAM) |
| 0x22000000 | Fault                              |
| 0x20030800 | Backup RAM (2KB)                   |
| 0x20030000 | RAM3 (32KB)                        |
| 0x20028000 | RAM2 (32KB)                        |
| 0x20020000 | RAM1 (64KB)                        |
| 0x20010000 | RAM0 (64KB)                        |
| 0x20000000 | Fault                              |
| 0x00180000 | Code Flash<br>(1536 KB)            |
| 0x00000000 |                                    |

**Figure 3.1** Example of the memory map of TMPM4G9F15

Note: “Fault” and “Reserved” areas should not be accessed.

## 3.1. List of Memory Sizes

Table 3.1 Memory sizes and addresses

| Products          |                     |          | TMPM4G9F15FG<br>TMPM4G9F15XBG<br>TMPM4G8F15FG<br>TMPM4G8F15XBG | TMPM4G9F10FG<br>TMPM4G9F10XBG<br>TMPM4G8F10FG<br>TMPM4G8F10XBG<br>TMPM4G7F10FG<br>TMPM4G6F10FG | TMPM4G9FEFG<br>TMPM4G9FEXBG<br>TMPM4G8FEFG<br>TMPM4G8FEXBG<br>TMPM4G7FEFG<br>TMPM4G6FEFG | TMPM4G9FDFG<br>TMPM4G9FDXBG<br>TMPM4G8FDFG<br>TMPM4G8FDXBG<br>TMPM4G7FDFG<br>TMPM4G6FDFG |
|-------------------|---------------------|----------|----------------------------------------------------------------|------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Peripheral region | Code Flash (Mirror) | START    | 0x5E000000                                                     | 0x5E000000                                                                                     | 0x5E000000                                                                               | 0x5E000000                                                                               |
|                   |                     | END      | 0x5E17FFFF                                                     | 0x5E0FFFFF                                                                                     | 0x5E0BFFFF                                                                               | 0x5E07FFFF                                                                               |
| SRAM region       | Data Flash          | Size     | 32 KB                                                          |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | START    | 0x30000000                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | END      | 0x30007FFF                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   | Backup RAM          | Size     | 2 KB                                                           |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | START    | 0x20030000                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | END      | 0x200307FF                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   | RAM                 | Size     | 192 KB                                                         |                                                                                                | 128 KB                                                                                   |                                                                                          |
|                   |                     | START(0) | 0x20000000                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | END(0)   | 0x2000FFFF                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | START(1) | 0x20010000                                                     |                                                                                                | 0x20010000                                                                               |                                                                                          |
|                   |                     | END(1)   | 0x2001FFFF                                                     |                                                                                                | 0x20017FFF                                                                               |                                                                                          |
|                   |                     | START(2) | 0x20020000                                                     |                                                                                                | -                                                                                        |                                                                                          |
|                   |                     | END(2)   | 0x20027FFF                                                     |                                                                                                | -                                                                                        |                                                                                          |
|                   |                     | START(3) | 0x20028000                                                     |                                                                                                |                                                                                          |                                                                                          |
|                   |                     | END(3)   | 0x2002FFFF                                                     |                                                                                                |                                                                                          |                                                                                          |
| Code region       | Code Flash          | Size     | 1536 KB                                                        | 1024 KB                                                                                        | 768 KB                                                                                   | 512 KB                                                                                   |
|                   |                     | START    | 0x00000000                                                     | 0x00000000                                                                                     | 0x00000000                                                                               | 0x00000000                                                                               |
|                   |                     | END      | 0x0017FFFF                                                     | 0x000FFFFF                                                                                     | 0x000BFFFF                                                                               | 0x0007FFFF                                                                               |

## 4. Pin Description

### 4.1. Functional Pin Name and Function

#### 4.1.1. Peripheral Function Pins

**Table 4.1 Pin names and functions of peripheral pins**

| Peripheral function                | Pin name  | Input or Output | Function                                                                                                 |
|------------------------------------|-----------|-----------------|----------------------------------------------------------------------------------------------------------|
| Interrupt control                  | INTx      | Input           | External interrupt input pin<br>External input pin provides the noise filter (filter width: typ. 30 ns). |
| 32-bit Timer event counter (T32A)  | T32AxINA0 | Input           | 16-bit timer-A input capture input pin 0                                                                 |
|                                    | T32AxINA1 | Input           | 16-bit timer-A input capture input pin 1                                                                 |
|                                    | T32AxOUTA | Output          | 16-bit timer A output pin                                                                                |
|                                    | T32AxINB0 | Input           | 16-bit timer B input capture input pin 0                                                                 |
|                                    | T32AxINB1 | Input           | 16-bit timer B input capture input pin 1                                                                 |
|                                    | T32AxOUTB | Output          | 16-bit timer B output pin                                                                                |
|                                    | T32AxINC0 | Input           | 32-bit timer C input capture input pin 0                                                                 |
|                                    | T32AxINC1 | Input           | 32-bit timer C input capture input pin 1                                                                 |
|                                    | T32AxOUTC | Output          | 32-bit timer C output pin                                                                                |
| Serial peripheral interface (TSPI) | TSPIxRXD  | Input           | Data input pin                                                                                           |
|                                    | TSPIxTXD  | Output          | Data output pin                                                                                          |
|                                    | TSPIxSCK  | I/O             | Clock input/output pin                                                                                   |
|                                    | TSPIxCS0  | Output          | Chip select output pin 0                                                                                 |
|                                    | TSPIxCS1  | Output          | Chip select output pin 1                                                                                 |
|                                    | TSPIxCS2  | Output          | Chip select output pin 2                                                                                 |
|                                    | TSPIxCS3  | Output          | Chip select output pin 3                                                                                 |
|                                    | TSPIxCSIN | Input           | Chip select input pin                                                                                    |
| Serial Memory Interface (SMIF)     | SMIXCLK   | Output          | Clock output pin                                                                                         |
|                                    | SMIXD0    | I/O             | Data input/output pin 0                                                                                  |
|                                    | SMIXD1    | I/O             | Data input/output pin 1                                                                                  |
|                                    | SMIXD2    | I/O             | Data input/output pin 2                                                                                  |
|                                    | SMIXD3    | I/O             | Data input/output pin 3                                                                                  |
|                                    | SMIXCSx_N | Output          | Chip select output pin                                                                                   |

|                                                                  |           |        |                                 |
|------------------------------------------------------------------|-----------|--------|---------------------------------|
| Asynchronous serial communication circuit (UART)                 | UTxTXDA   | Output | Data output pin A               |
|                                                                  | UTxRXD    | Input  | Data input pin                  |
|                                                                  | UTxCTS_N  | Input  | Clear to send signal pin        |
|                                                                  | UTxRTS_N  | Output | Request to send signal pin      |
| Full Universal Asynchronous Receiver Transmitter circuit (FUART) | FUTxTXD   | Output | Data output pin                 |
|                                                                  | FUTxRXD   | Input  | Data input pin                  |
|                                                                  | FUTxCTS_N | Input  | Transmission control input pin  |
|                                                                  | FUTxRTS_N | Output | Transmission request output pin |
|                                                                  | FUTxIROUT | Output | IrDA 1.0 Data output pin        |
|                                                                  | FUTxIRIN  | Input  | IrDA 1.0 Data input pin         |
| I <sup>2</sup> C interface (I <sup>2</sup> C)                    | I2CxSDA   | I/O    | Data input/output pin           |
|                                                                  | I2CxSCL   | I/O    | Clock input/output pin          |
| High speed DMA Controller (HDMAC)                                | HDMAREQx  | Input  | HDMA request input pin          |
| Interval Sensor Detection (ISD)                                  | ISDxIN0   | Input  | Data input pin 0                |
|                                                                  | ISDxIN1   | Input  | Data input pin 1                |
|                                                                  | ISDxIN2   | Input  | Data input pin 2                |
|                                                                  | ISDxIN3   | Input  | Data input pin 3                |
|                                                                  | ISDxOUT   | Output | Data output pin                 |
| Consumer Electronics Control Circuit (CEC)                       | CECx      | I/O    | Data input/output pin           |
| External bus interface (EBIF)                                    | EAx       | Output | Address bus output pin          |
|                                                                  | EDx       | I/O    | Data bus input/output pin       |
|                                                                  | ERD_N     | Output | Read strobe output pin          |
|                                                                  | EWR_N     | Output | Write strobe output pin         |
|                                                                  | ECSx_N    | Output | Chip select output pin          |
|                                                                  | EBELL_N   | Output | Byte enable output pin          |
|                                                                  | EBELH_N   | Output | Byte enable output pin          |
|                                                                  | EALE      | Output | Address latch enable output pin |
|                                                                  | EWAIT_N   | Input  | Wait input pin                  |
|                                                                  | EEXBCLK   | Output | Clock output pin                |

|                                                     |         |        |                                        |
|-----------------------------------------------------|---------|--------|----------------------------------------|
| Advanced Programmable Motor control circuit (A-PMD) | XOx     | Output | X-phase output pin                     |
|                                                     | YOx     | Output | Y-phase output pin                     |
|                                                     | ZOx     | Output | Z-phase output pin                     |
|                                                     | UOx     | Output | U-phase output pin                     |
|                                                     | VOx     | Output | V-phase output pin                     |
|                                                     | WOx     | Output | W-phase output pin                     |
|                                                     | EMGx    | Input  | Emergency state detection input pin    |
|                                                     | OVVx    | Input  | Overvoltage detection input pin        |
| Trigger input (TRGSEL)                              | TRGINx  | Input  | External trigger input pin (MDMAC/ADC) |
| Analog to digital converter (ADC)                   | AINAx   | Input  | Analog input pin                       |
| Digital to analog converter (DAC)                   | DACx    | Output | DAC output pin                         |
| Remote Control Signal Preprocessor (RMC)            | RXINx   | Input  | Remote Signaling Data input pin        |
| Real Time Clock (RTC)                               | ALARM_N | Output | Alarm output pin                       |
|                                                     | RTCOUT  | Output | 1Hz clock output pin                   |

Note: “x” means channel number or unit number or interrupt number.

## 4.1.2. Debug Pins

There are the special pins which output internal information using TRACE and NBDIF as well as basic debug pins of JTAG/SWD.

**Table 4.2 Debug pin names and functions**

| Debug Function | Pin name   | Input or Output | Function                                                                                         |
|----------------|------------|-----------------|--------------------------------------------------------------------------------------------------|
| JTAG           | TMS        | Input           | JTAG test mode selection input pin                                                               |
|                | TCK        | Input           | JTAG serial clock input pin                                                                      |
|                | TDO        | Output          | JTAG serial data output pin                                                                      |
|                | TDI        | Input           | JTAG serial data input pin                                                                       |
|                | TRST_N     | Input           | JTAG test reset input pin<br>JTAG test reset input pin have noise filter(filter width: typ.30ns) |
| SW             | SWDIO      | I/O             | Serial wire data input/output pin                                                                |
|                | SWCLK      | Input           | Serial wire clock input pin                                                                      |
|                | SWV        | Output          | Serial wire viewer output pin                                                                    |
| TRACE          | TRACECLK   | Output          | Trace clock output pin                                                                           |
|                | TRACEDATA0 | Output          | Trace data output pin 0                                                                          |
|                | TRACEDATA1 | Output          | Trace data output pin 1                                                                          |
|                | TRACEDATA2 | Output          | Trace data output pin 2                                                                          |
|                | TRACEDATA3 | Output          | Trace data output pin 3                                                                          |
| NBDIF          | NBDSYNC    | Input           | Non-break debug synchronous input pin                                                            |
|                | NBDCLK     | Input           | Non-break debug clock input pin                                                                  |
|                | NBDDATA0   | I/O             | Non-break debug data input/output pin 0                                                          |
|                | NBDDATA1   | I/O             | Non-break debug data input/output pin 1                                                          |
|                | NBDDATA2   | I/O             | Non-break debug data input/output pin 2                                                          |
|                | NBDDATA3   | I/O             | Non-break debug data input/output pin 3                                                          |

## 4.1.3. Control Pins

**Table 4.3 Control pin names and functions**

|             | Pin name | Input or Output | Function                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------|-----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Control pin | X1       | Input           | High speed oscillator connection pin, External clock input pin                                                                                                                                                                                                                                                                                                                                        |
|             | X2       | Output          | High speed oscillator connection pin                                                                                                                                                                                                                                                                                                                                                                  |
|             | XT1      | Input           | Low speed oscillator connection pin, Low clock input pin                                                                                                                                                                                                                                                                                                                                              |
|             | XT2      | Output          | Low speed oscillator connection pin                                                                                                                                                                                                                                                                                                                                                                   |
|             | MODE     | Input           | Mode pin<br>This pin must be fixed to "Low" level.                                                                                                                                                                                                                                                                                                                                                    |
|             | RESET_N  | Input           | Reset signal input pin<br>Reset signal input pin has noise filter(filter width: typ.30ns)                                                                                                                                                                                                                                                                                                             |
|             | BOOT_N   | Input           | BOOT mode control pin<br>The BOOT mode control pin is sampled at the rising edge of the RESET_N pin input or the rising edge of POR, whichever is delayed.<br>It's not sampled by internal Reset factor.<br>If the BOOT mode control pin is "Low" level, the MCU enters single boot mode. If it is "High", the MCU enters single chip mode.<br>For details, refer to "Flash Memory" reference manual. |
|             | BSC      | Input           | Boundary-scan mode control pin                                                                                                                                                                                                                                                                                                                                                                        |

## 4.1.4. Power Supply Pins

Table 4.4 Power supply pin names and functions

| Power Supply | Pin name                                                                                                                                     | Function                                                                                                                                                                                           |
|--------------|----------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Power        | DVDD3A (Note1)<br>DVDD3B (Note1)<br>DVDD3C (Note1)<br>DVDD3D (Note1)<br>DVDD3E (Note1)<br>DVDD3F (Note1)<br>DVDD3G (Note1)<br>DVDD3H (Note1) | Power supply pin for digital<br>DVDD3A/B/C/D/E/F/G/H supplies the power to the following pins:<br>PA to PH, PJ to PM, PT(PT2 to PT5), PU to PW, PY, X1, X2, XT1, XT2, MODE,<br>RESET_N, BOOT_N,BSC |
|              | DVSSA (Note2)<br>DVSSB (Note2)<br>DVSSC (Note2)<br>DVSSD (Note2)<br>DVSSE (Note2)<br>DVSSF (Note2)<br>DVSSG (Note2)<br>DVSSH (Note2)         | GND pin for digital                                                                                                                                                                                |
|              | REGOUT1 (Note3)                                                                                                                              | Capacitor for a regulator connection pin (Note4)                                                                                                                                                   |
|              | AVDD3                                                                                                                                        | Power supply pin and Reference power pin (VREFH) for analog circuits<br>A AVDD3 supplies the power to the following pins:<br>PN, PP, PR, PT(PT0, PT1)                                              |
|              | AVSS                                                                                                                                         | GND pin and Reference GND (VREFL)pin for analog circuits                                                                                                                                           |
|              |                                                                                                                                              |                                                                                                                                                                                                    |
|              |                                                                                                                                              |                                                                                                                                                                                                    |
|              |                                                                                                                                              |                                                                                                                                                                                                    |
|              |                                                                                                                                              |                                                                                                                                                                                                    |
|              |                                                                                                                                              |                                                                                                                                                                                                    |

Note1: Apply the voltage to DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, and DVDD3H at the same potential except the case that the pins are not provided.

Note2: Apply the external voltage to DVSSA, DVSSB, DVSSC, DVSSD, DVSSE, DVSSF, DVSSG, and DVSSH at the same potential except the case that the pins are not provided.

Note3: For REGOUT1, do not cause a short circuit with DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H, DVSSA, DVSSB, DVSSC, DVSSD, DVSSE, DVSSF, DVSSG, or DVSSH

Note4: For the capacitor value, refer to the “Electrical Characteristics”

## 4.2. Functional Pin and Port Assignment (Pin Number)

Following table shows a pin number of the port assignment and each product which were seen from the functional pin.

“-” means that does not have a pin or there is no assignment of a function.

**Table 4.5 List of signal connections (1/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| UT0RXD                          | PE2       | 60             | 52             | 48             | 39             | T5            | P5            |
|                                 | PH4       | 89             | 73             | 65             | 51             | R16           | N14           |
|                                 | PH5       | 88             | 72             | 64             | 50             | T15           | P13           |
| UT0TXDA                         | PE3       | 61             | 53             | 49             | 40             | T6            | N6            |
|                                 | PH5       | 88             | 72             | 64             | 50             | T15           | P13           |
|                                 | PH4       | 89             | 73             | 65             | 51             | R16           | N14           |
| UT0CTS_N                        | PE1       | 59             | 51             | 47             | 38             | R5            | N5            |
|                                 | PH7       | 86             | 70             | 62             | 48             | R14           | N12           |
|                                 | PH6       | 87             | 71             | 63             | 49             | R15           | P12           |
| UT0RTS_N                        | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |
|                                 | PH6       | 87             | 71             | 63             | 49             | R15           | P12           |
|                                 | PH7       | 86             | 70             | 62             | 48             | R14           | N12           |
| UT1RXD                          | PH0       | 93             | 77             | 69             | 55             | N16           | L11           |
|                                 | PH1       | 92             | 76             | 68             | 54             | N15           | M13           |
|                                 | PV4       | 81             | 65             | 61             | -              | R12           | N10           |
| UT1TXDA                         | PH1       | 92             | 76             | 68             | 54             | N15           | M13           |
|                                 | PH0       | 93             | 77             | 69             | 55             | N16           | L11           |
|                                 | PV5       | 80             | 64             | 60             | -              | T12           | P9            |
| UT1CTS_N                        | PH3       | 90             | 74             | 66             | 52             | P15           | N13           |
|                                 | PH2       | 91             | 75             | 67             | 53             | P16           | M14           |
|                                 | PV6       | 79             | 63             | 59             | -              | T11           | N9            |
| UT1RTS_N                        | PH2       | 91             | 75             | 67             | 53             | P16           | M14           |
|                                 | PH3       | 90             | 74             | 66             | 52             | P15           | N13           |
|                                 | PV7       | 78             | 62             | 58             | -              | R11           | L9            |

Table 4.6 List of signal connections (2/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| UT2RXD                          | PG0       | 129            | 105            | 93             | 72             | D15           | D13           |
|                                 | PG1       | 130            | 106            | 94             | 73             | C16           | C14           |
| UT2TXDA                         | PG1       | 130            | 106            | 94             | 73             | C16           | C14           |
|                                 | PG0       | 129            | 105            | 93             | 72             | D15           | D13           |
| UT2CTS_N                        | PG3       | 132            | 108            | 96             | 75             | B16           | B14           |
|                                 | PG2       | 131            | 107            | 95             | 74             | C15           | C13           |
| UT2RTS_N                        | PG2       | 131            | 107            | 95             | 74             | C15           | C13           |
|                                 | PG3       | 132            | 108            | 96             | 75             | B16           | B14           |
| UT3RXD                          | PU6       | 40             | -              | -              | -              | L4            | -             |
|                                 | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
|                                 | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
| UT3TXDA                         | PU7       | 41             | -              | -              | -              | M4            | -             |
|                                 | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
|                                 | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
| UT3CTS_N                        | PU5       | 39             | -              | -              | -              | L5            | -             |
|                                 | PV3       | 112            | 94             | 86             | -              | H13           | G10           |
|                                 | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
| UT3RTS_N                        | PU4       | 38             | -              | -              | -              | K5            | -             |
|                                 | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
|                                 | PV3       | 112            | 94             | 86             | -              | H13           | G10           |
| UT4RXD                          | PM0       | 124            | 102            | -              | -              | E16           | D14           |
|                                 | PM1       | 123            | 101            | -              | -              | F15           | E13           |
|                                 | PU1       | 35             | -              | -              | -              | J4            | -             |
| UT4TXDA                         | PM1       | 123            | 101            | -              | -              | F15           | E13           |
|                                 | PM0       | 124            | 102            | -              | -              | E16           | D14           |
|                                 | PU0       | 34             | -              | -              | -              | H4            | -             |
| UT4CTS_N                        | PM3       | 121            | 99             | -              | -              | E13           | F13           |
|                                 | PM2       | 122            | 100            | -              | -              | F16           | E14           |
|                                 | PU2       | 36             | -              | -              | -              | J5            | -             |
| UT4RTS_N                        | PM2       | 122            | 100            | -              | -              | F16           | E14           |
|                                 | PM3       | 121            | 99             | -              | -              | E13           | F13           |
|                                 | PU3       | 37             | -              | -              | -              | K4            | -             |

Table 4.7 List of signal connections (3/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| UT5RXD                          | PJ0       | 168            | -              | -              | -              | B5            | -             |
|                                 | PJ1       | 167            | -              | -              | -              | B6            | -             |
| UT5TXDA                         | PJ1       | 167            | -              | -              | -              | B6            | -             |
|                                 | PJ0       | 168            | -              | -              | -              | B5            | -             |
| UT5CTS_N                        | PJ3       | 165            | -              | -              | -              | D7            | -             |
|                                 | PJ2       | 166            | -              | -              | -              | D6            | -             |
| UT5RTS_N                        | PJ2       | 166            | -              | -              | -              | D6            | -             |
|                                 | PJ3       | 165            | -              | -              | -              | D7            | -             |
| FUT0RXD                         | PG5       | 96             | 80             | 72             | 58             | M13           | K11           |
|                                 | PJ5       | 68             | -              | -              | -              | R9            | -             |
| FUT0TXD                         | PG4       | 97             | 81             | 73             | 59             | L12           | K13           |
|                                 | PJ4       | 69             | -              | -              | -              | T9            | -             |
| FUT0CTS_N                       | PG7       | 94             | 78             | 70             | 56             | M15           | L13           |
| FUT0RTS_N                       | PG6       | 95             | 79             | 71             | 57             | M16           | L14           |
| FUT0IROUT                       | PG4       | 97             | 81             | 73             | 59             | L12           | K13           |
| FUT0IRIN                        | PG5       | 96             | 80             | 72             | 58             | M13           | K11           |
| FUT1RXD                         | PJ7       | 66             | -              | -              | -              | N9            | -             |
|                                 | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| FUT1TXD                         | PJ6       | 67             | -              | -              | -              | R8            | -             |
|                                 | PM7       | 82             | 66             | -              | -              | T13           | P10           |
| FUT1CTS_N                       | PM4       | 85             | 69             | -              | -              | N12           | L10           |
| FUT1RTS_N                       | PM5       | 84             | 68             | -              | -              | T14           | P11           |
| FUT1IROUT                       | PM7       | 82             | 66             | -              | -              | T13           | P10           |
| FUT1IRIN                        | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| I2C0SDA                         | PG2       | 131            | 107            | 95             | 74             | C15           | C13           |
| I2C0SCL                         | PG3       | 132            | 108            | 96             | 75             | B16           | B14           |
| I2C1SDA                         | PF2       | 174            | 142            | 126            | 99             | B4            | B4            |
| I2C1SCL                         | PF3       | 175            | 143            | 127            | 100            | A3            | A3            |
| I2C2SDA                         | PG4       | 97             | 81             | 73             | 59             | L12           | K13           |
|                                 | PV5       | 80             | 64             | 60             | -              | T12           | P9            |
| I2C2SCL                         | PG5       | 96             | 80             | 72             | 58             | M13           | K11           |
|                                 | PV4       | 81             | 65             | 61             | -              | R12           | N10           |

**Table 4.8 List of signal connections (4/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| I2C3SDA                         | PJ6       | 67             | -              | -              | -              | R8            | -             |
|                                 | PM0       | 124            | 102            | -              | -              | E16           | D14           |
| I2C3SCL                         | PJ7       | 66             | -              | -              | -              | N9            | -             |
|                                 | PM1       | 123            | 101            | -              | -              | F15           | E13           |
| I2C4SDA                         | PJ3       | 165            | -              | -              | -              | D7            | -             |
|                                 | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| I2C4SCL                         | PJ2       | 166            | -              | -              | -              | D6            | -             |
|                                 | PM7       | 82             | 66             | -              | -              | T13           | P10           |
| ISDAIN0                         | PE4       | 62             | 54             | 50             | 41             | R6            | P6            |
| ISDAIN1                         | PE5       | 63             | 55             | 51             | 42             | R7            | P7            |
| ISDAIN2                         | PE6       | 64             | 56             | 52             | 43             | T7            | N7            |
| ISDAIN3                         | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
| ISDAOUT                         | PK0       | 111            | 93             | 85             | 71             | H12           | H10           |
| ISDBIN0                         | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
| ISDBIN1                         | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
| ISDBIN2                         | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
| ISDBIN3                         | PV3       | 112            | 94             | 86             | -              | H13           | G10           |
| ISDBOUT                         | PK1       | 110            | 92             | 84             | 70             | J12           | H11           |
| ISDCIN0                         | PW4       | 120            | -              | -              | -              | G15           | -             |
| ISDCIN1                         | PW5       | 119            | -              | -              | -              | G16           | -             |
| ISDCIN2                         | PW6       | 118            | -              | -              | -              | H15           | -             |
| ISDCIN3                         | PW7       | 117            | -              | -              | -              | H16           | -             |
| ISDCOUT                         | PY4       | 30             | 30             | 26             | 21             | M2            | K2            |
| TSPI0CSIN                       | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
| TSPI0CS0                        | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
| TSPI0CS1                        | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
| TSPI0CS2                        | PA5       | 24             | 24             | 20             | 15             | J2            | G1            |
| TSPI0CS3                        | PA6       | 23             | 23             | 19             | 14             | H1            | G2            |
| TSPI0RXD                        | PA2       | 27             | 27             | 23             | 18             | K1            | J2            |
| TSPI0TXD                        | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
| TSPI0SCK                        | PA1       | 28             | 28             | 24             | 19             | L2            | J1            |

**Table 4.9 List of signal connections (5/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| TSPI1CSIN                       | PL0       | 103            | 85             | 77             | 63             | L13           | J11           |
| TSPI1CS0                        | PL0       | 103            | 85             | 77             | 63             | L13           | J11           |
| TSPI1CS1                        | PK4       | 107            | 89             | 81             | 67             | J15           | G14           |
| TSPI1CS2                        | PK5       | 106            | 88             | 80             | 66             | K15           | H13           |
| TSPI1CS3                        | PK6       | 105            | 87             | 79             | 65             | J16           | H14           |
| TSPI1RXD                        | PL2       | 101            | 83             | 75             | 61             | L15           | J13           |
| TSPI1TXD                        | PL3       | 100            | 82             | 74             | 60             | L16           | K14           |
| TSPI1SCK                        | PL1       | 102            | 84             | 76             | 62             | K16           | J14           |
| TSPI2CSIN                       | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
| TSPI2CS0                        | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
| TSPI2CS1                        | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
| TSPI2RXD                        | PA5       | 24             | 24             | 20             | 15             | J2            | G1            |
| TSPI2TXD                        | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
| TSPI2SCK                        | PA6       | 23             | 23             | 19             | 14             | H1            | G2            |
| TSPI3CSIN                       | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| TSPI3CS0                        | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| TSPI3CS1                        | PL3       | 100            | 82             | 74             | 60             | L16           | K14           |
| TSPI3RXD                        | PK5       | 106            | 88             | 80             | 66             | K15           | H13           |
| TSPI3TXD                        | PK4       | 107            | 89             | 81             | 67             | J15           | G14           |
| TSPI3SCK                        | PK6       | 105            | 87             | 79             | 65             | J16           | H14           |
| TSPI4CSIN                       | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
| TSPI4CS0                        | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
| TSPI4RXD                        | PD2       | 50             | 42             | 38             | 31             | N6            | K6            |
| TSPI4TXD                        | PD3       | 51             | 43             | 39             | 32             | M7            | L6            |
| TSPI4SCK                        | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
| TSPI5CSIN                       | PV7       | 78             | 62             | 58             | -              | R11           | L9            |
| TSPI5CS0                        | PV7       | 78             | 62             | 58             | -              | R11           | L9            |
| TSPI5RXD                        | PV4       | 81             | 65             | 61             | -              | R12           | N10           |
| TSPI5TXD                        | PV5       | 80             | 64             | 60             | -              | T12           | P9            |
| TSPI5SCK                        | PV6       | 79             | 63             | 59             | -              | T11           | N9            |
| TSPI6CSIN                       | PM3       | 121            | 99             | -              | -              | E13           | F13           |
| TSPI6CS0                        | PM3       | 121            | 99             | -              | -              | E13           | F13           |
| TSPI6RXD                        | PM1       | 123            | 101            | -              | -              | F15           | E13           |
| TSPI6TXD                        | PM0       | 124            | 102            | -              | -              | E16           | D14           |
| TSPI6SCK                        | PM2       | 122            | 100            | -              | -              | F16           | E14           |

**Table 4.10 List of signal connections (6/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| TSPI7CSIN                       | PM4       | 85             | 69             | -              | -              | N12           | L10           |
| TSPI7CS0                        | PM4       | 85             | 69             | -              | -              | N12           | L10           |
| TSPI7RXD                        | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| TSPI7TXD                        | PM7       | 82             | 66             | -              | -              | T13           | P10           |
| TSPI7SCK                        | PM5       | 84             | 68             | -              | -              | T14           | P11           |
| TSPI8CSIN                       | PW0       | 77             | -              | -              | -              | M11           | -             |
| TSPI8CS0                        | PW0       | 77             | -              | -              | -              | M11           | -             |
| TSPI8RXD                        | PW2       | 75             | -              | -              | -              | M10           | -             |
| TSPI8TXD                        | PW3       | 74             | -              | -              | -              | N10           | -             |
| TSPI8SCK                        | PW1       | 76             | -              | -              | -              | N11           | -             |
| SMI0CS1_N                       | PK0       | 111            | 93             | 85             | 71             | H12           | H10           |
| SMI0D0                          | PK2       | 109            | 91             | 83             | 69             | J13           | F14           |
| SMI0D1                          | PK3       | 108            | 90             | 82             | 68             | K13           | G13           |
| SMI0D2                          | PK4       | 107            | 89             | 81             | 67             | J15           | G14           |
| SMI0D3                          | PK5       | 106            | 88             | 80             | 66             | K15           | H13           |
| SMI0CLK                         | PK6       | 105            | 87             | 79             | 65             | J16           | H14           |
| SMI0CS0_N                       | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| T32A00INA0                      | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
|                                 | PK0       | 111            | 93             | 85             | 71             | H12           | H10           |
| T32A00INA1                      | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
| T32A00OUTA                      | PA1       | 28             | 28             | 24             | 19             | L2            | J1            |
|                                 | PW1       | 76             | -              | -              | -              | N11           | -             |
| T32A00INB0                      | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
|                                 | PK1       | 110            | 92             | 84             | 70             | J12           | H11           |
| T32A00INB1                      | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
| T32A00OUTB                      | PA2       | 27             | 27             | 23             | 18             | K1            | J2            |
|                                 | PW0       | 77             | -              | -              | -              | M11           | -             |
| T32A00INC0                      | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
|                                 | PK0       | 111            | 93             | 85             | 71             | H12           | H10           |
| T32A00INC1                      | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
|                                 | PK1       | 110            | 92             | 84             | 70             | J12           | H11           |
| T32A00OUTC                      | PA1       | 28             | 28             | 24             | 19             | L2            | J1            |
|                                 | PW1       | 76             | -              | -              | -              | N11           | -             |

**Table 4.11 List of signal connections (7/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A01INA0                      | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
|                                 | PK6       | 105            | 87             | 79             | 65             | J16           | H14           |
| T32A01INA1                      | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
| T32A01OUTA                      | PA5       | 24             | 24             | 20             | 15             | J2            | G1            |
|                                 | PW2       | 75             | -              | -              | -              | M10           | -             |
| T32A01INB0                      | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
|                                 | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| T32A01INB1                      | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
| T32A01OUTB                      | PA6       | 23             | 23             | 19             | 14             | H1            | G2            |
|                                 | PW3       | 74             | -              | -              | -              | N10           | -             |
| T32A01INC0                      | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
|                                 | PK6       | 105            | 87             | 79             | 65             | J16           | H14           |
| T32A01INC1                      | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
|                                 | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| T32A01OUTC                      | PA5       | 24             | 24             | 20             | 15             | J2            | G1            |
|                                 | PW2       | 75             | -              | -              | -              | M10           | -             |
| T32A02INA0                      | PB0       | 21             | 21             | 17             | 12             | G1            | H4            |
|                                 | PL0       | 103            | 85             | 77             | 63             | L13           | J11           |
| T32A02INA1                      | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
| T32A02OUTA                      | PB2       | 19             | 19             | 15             | 10             | F1            | F1            |
|                                 | PG5       | 96             | 80             | 72             | 58             | M13           | K11           |
| T32A02INB0                      | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
|                                 | PL3       | 100            | 82             | 74             | 60             | L16           | K14           |
| T32A02INB1                      | PB0       | 21             | 21             | 17             | 12             | G1            | H4            |
| T32A02OUTB                      | PB3       | 18             | 18             | 14             | 9              | F2            | F2            |
|                                 | PG4       | 97             | 81             | 73             | 59             | L12           | K13           |
| T32A02INC0                      | PB0       | 21             | 21             | 17             | 12             | G1            | H4            |
|                                 | PL0       | 103            | 85             | 77             | 63             | L13           | J11           |
| T32A02INC1                      | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
|                                 | PL3       | 100            | 82             | 74             | 60             | L16           | K14           |
| T32A02OUTC                      | PB2       | 19             | 19             | 15             | 10             | F1            | F1            |
|                                 | PG5       | 96             | 80             | 72             | 58             | M13           | K11           |

Table 4.12 List of signal connections (8/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A03INA0                      | PB6       | 15             | 15             | 11             | 6              | G4            | G4            |
|                                 | PJ4       | 69             | -              | -              | -              | T9            | -             |
| T32A03INA1                      | PB7       | 14             | 14             | 10             | 5              | G5            | G5            |
| T32A03OUTA                      | PB4       | 17             | 17             | 13             | 8              | E1            | E1            |
|                                 | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| T32A03INB0                      | PB7       | 14             | 14             | 10             | 5              | G5            | G5            |
|                                 | PJ5       | 68             | -              | -              | -              | R9            | -             |
| T32A03INB1                      | PB6       | 15             | 15             | 11             | 6              | G4            | G4            |
| T32A03OUTB                      | PB5       | 16             | 16             | 12             | 7              | E2            | E2            |
|                                 | PT5       | 73             | 61             | 57             | -              | R10           | K9            |
| T32A03INC0                      | PB6       | 15             | 15             | 11             | 6              | G4            | G4            |
|                                 | PJ4       | 69             | -              | -              | -              | T9            | -             |
| T32A03INC1                      | PB7       | 14             | 14             | 10             | 5              | G5            | G5            |
|                                 | PJ5       | 68             | -              | -              | -              | R9            | -             |
| T32A03OUTC                      | PB4       | 17             | 17             | 13             | 8              | E1            | E1            |
|                                 | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| T32A04INA0                      | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
|                                 | PP0       | 141            | 117            | 105            | 84             | D12           | D11           |
| T32A04INA1                      | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
|                                 | PP1       | 142            | 118            | 106            | 85             | D11           | D10           |
| T32A04OUTA                      | PD2       | 50             | 42             | 38             | 31             | N6            | K6            |
|                                 | PV5       | 80             | 64             | 60             | -              | T12           | P9            |
| T32A04INB0                      | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
|                                 | PP1       | 142            | 118            | 106            | 85             | D11           | D10           |
| T32A04INB1                      | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
|                                 | PP0       | 141            | 117            | 105            | 84             | D12           | D11           |
| T32A04OUTB                      | PD3       | 51             | 43             | 39             | 32             | M7            | L6            |
|                                 | PV4       | 81             | 65             | 61             | -              | R12           | N10           |
| T32A04INC0                      | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
|                                 | PP0       | 141            | 117            | 105            | 84             | D12           | D11           |
| T32A04INC1                      | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
|                                 | PP1       | 142            | 118            | 106            | 85             | D11           | D10           |
| T32A04OUTC                      | PD2       | 50             | 42             | 38             | 31             | N6            | K6            |
|                                 | PV5       | 80             | 64             | 60             | -              | T12           | P9            |

Table 4.13 List of signal connections (9/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A05INA0                      | PD6       | 54             | 46             | 42             | 35             | N8            | K8            |
|                                 | PP2       | 143            | 119            | 107            | 86             | B11           | B9            |
| T32A05INA1                      | PD7       | 55             | 47             | 43             | 36             | M9            | L8            |
|                                 | PP3       | 144            | 120            | 108            | 87             | A11           | A9            |
| T32A05OUTA                      | PD4       | 52             | 44             | 40             | 33             | N7            | L7            |
|                                 | PV6       | 79             | 63             | 59             | -              | T11           | N9            |
| T32A05INB0                      | PD7       | 55             | 47             | 43             | 36             | M9            | L8            |
|                                 | PP3       | 144            | 120            | 108            | 87             | A11           | A9            |
| T32A05INB1                      | PD6       | 54             | 46             | 42             | 35             | N8            | K8            |
|                                 | PP2       | 143            | 119            | 107            | 86             | B11           | B9            |
| T32A05OUTB                      | PD5       | 53             | 45             | 41             | 34             | M8            | K7            |
|                                 | PV7       | 78             | 62             | 58             | -              | R11           | L9            |
| T32A05INC0                      | PD6       | 54             | 46             | 42             | 35             | N8            | K8            |
|                                 | PP2       | 143            | 119            | 107            | 86             | B11           | B9            |
| T32A05INC1                      | PD7       | 55             | 47             | 43             | 36             | M9            | L8            |
|                                 | PP3       | 144            | 120            | 108            | 87             | A11           | A9            |
| T32A05OUTC                      | PD4       | 52             | 44             | 40             | 33             | N7            | L7            |
|                                 | PV6       | 79             | 63             | 59             | -              | T11           | N9            |
| T32A06INA0                      | PE2       | 60             | 52             | 48             | 39             | T5            | P5            |
|                                 | PP4       | 145            | 121            | 109            | 88             | E11           | D9            |
| T32A06INA1                      | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |
|                                 | PP5       | 146            | 122            | 110            | 89             | D10           | E9            |
| T32A06OUTA                      | PE1       | 59             | 51             | 47             | 38             | R5            | N5            |
|                                 | PM5       | 84             | 68             | -              | -              | T14           | P11           |
| T32A06INB0                      | PE3       | 61             | 53             | 49             | 40             | T6            | N6            |
|                                 | PP5       | 146            | 122            | 110            | 89             | D10           | E9            |
| T32A06INB1                      | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |
|                                 | PP4       | 145            | 121            | 109            | 88             | E11           | D9            |
| T32A06OUTB                      | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |
|                                 | PM4       | 85             | 69             | -              | -              | N12           | L10           |
| T32A06INC0                      | PE2       | 60             | 52             | 48             | 39             | T5            | P5            |
|                                 | PP4       | 145            | 121            | 109            | 88             | E11           | D9            |
| T32A06INC1                      | PE3       | 61             | 53             | 49             | 40             | T6            | N6            |
|                                 | PP5       | 146            | 122            | 110            | 89             | D10           | E9            |
| T32A06OUTC                      | PE1       | 59             | 51             | 47             | 38             | R5            | N5            |
|                                 | PM5       | 84             | 68             | -              | -              | T14           | P11           |

**Table 4.14 List of signal connections (10/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A07INA0                      | PE4       | 62             | 54             | 50             | 41             | R6            | P6            |
|                                 | PP6       | 147            | 123            | 111            | 90             | B10           | B8            |
| T32A07INA1                      | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
|                                 | PP7       | 148            | 124            | 112            | 91             | A10           | A8            |
| T32A07OUTA                      | PE6       | 64             | 56             | 52             | 43             | T7            | N7            |
|                                 | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| T32A07INB0                      | PE5       | 63             | 55             | 51             | 42             | R7            | P7            |
|                                 | PP7       | 148            | 124            | 112            | 91             | A10           | A8            |
| T32A07INB1                      | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
|                                 | PP6       | 147            | 123            | 111            | 90             | B10           | B8            |
| T32A07OUTB                      | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
|                                 | PM7       | 82             | 66             | -              | -              | T13           | P10           |
| T32A07INC0                      | PE4       | 62             | 54             | 50             | 41             | R6            | P6            |
|                                 | PP6       | 147            | 123            | 111            | 90             | B10           | B8            |
| T32A07INC1                      | PE5       | 63             | 55             | 51             | 42             | R7            | P7            |
|                                 | PP7       | 148            | 124            | 112            | 91             | A10           | A8            |
| T32A07OUTC                      | PE6       | 64             | 56             | 52             | 43             | T7            | N7            |
|                                 | PM6       | 83             | 67             | -              | -              | R13           | N11           |
| T32A08INA0                      | PC0       | 11             | 11             | 7              | -              | F4            | F4            |
|                                 | PR0       | 149            | 125            | 113            | -              | E10           | D8            |
| T32A08OUTA                      | PC2       | 9              | 9              | 5              | -              | D1            | D1            |
|                                 | PL4       | 126            | -              | -              | -              | D16           | -             |
| T32A08INB0                      | PC1       | 10             | 10             | 6              | -              | F5            | F5            |
|                                 | PR1       | 150            | 126            | 114            | -              | D9            | E8            |
| T32A08OUTB                      | PC3       | 8              | 8              | 4              | -              | D2            | D2            |
|                                 | PL5       | 125            | -              | -              | -              | E15           | -             |
| T32A08INC0                      | PC0       | 11             | 11             | 7              | -              | F4            | F4            |
|                                 | PR0       | 149            | 125            | 113            | -              | E10           | D8            |
| T32A08INC1                      | PC1       | 10             | 10             | 6              | -              | F5            | F5            |
|                                 | PR1       | 150            | 126            | 114            | -              | D9            | E8            |
| T32A08OUTC                      | PC2       | 9              | 9              | 5              | -              | D1            | D1            |
|                                 | PL4       | 126            | -              | -              | -              | D16           | -             |

**Table 4.15 List of signal connections (11/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A09INA0                      | PR2       | 151            | 127            | 115            | -              | B9            | B7            |
|                                 | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
| T32A09OUTA                      | PL6       | 164            | -              | -              | -              | E7            | -             |
|                                 | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
| T32A09INB0                      | PR3       | 152            | 128            | 116            | -              | A9            | A7            |
|                                 | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
| T32A09OUTB                      | PL7       | 163            | -              | -              | -              | E8            | -             |
|                                 | PV3       | 112            | 94             | 86             | -              | H13           | G10           |
| T32A09INC0                      | PR2       | 151            | 127            | 115            | -              | B9            | B7            |
|                                 | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
| T32A09INC1                      | PR3       | 152            | 128            | 116            | -              | A9            | A7            |
|                                 | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
| T32A09OUTC                      | PL6       | 164            | -              | -              | -              | E7            | -             |
|                                 | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
| T32A10INA0                      | PR4       | 153            | 129            | -              | -              | A8            | D7            |
|                                 | PW4       | 120            | -              | -              | -              | G15           | -             |
| T32A10INA1                      | PW7       | 117            | -              | -              | -              | H16           | -             |
| T32A10OUTA                      | PC4       | 7              | 7              | -              | -              | C1            | C1            |
|                                 | PW5       | 119            | -              | -              | -              | G16           | -             |
| T32A10INB0                      | PR5       | 154            | 130            | -              | -              | B8            | E7            |
| T32A10OUTB                      | PC5       | 6              | 6              | -              | -              | C2            | C2            |
|                                 | PW4       | 120            | -              | -              | -              | G15           | -             |
| T32A10INC0                      | PR4       | 153            | 129            | -              | -              | A8            | D7            |
| T32A10INC1                      | PR5       | 154            | 130            | -              | -              | B8            | E7            |
| T32A10OUTC                      | PC4       | 7              | 7              | -              | -              | C1            | C1            |
|                                 | PW5       | 119            | -              | -              | -              | G16           | -             |

**Table 4.16 List of signal connections (12/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| T32A11INA0                      | PR6       | 155            | 131            | -              | -              | E9            | E6            |
|                                 | PW7       | 117            | -              | -              | -              | H16           | -             |
| T32A11INA1                      | PW4       | 120            | -              | -              | -              | G15           | -             |
| T32A11OUTA                      | PM2       | 122            | 100            | -              | -              | F16           | E14           |
|                                 | PW6       | 118            | -              | -              | -              | H15           | -             |
| T32A11INB0                      | PR7       | 156            | 132            | -              | -              | D8            | D6            |
| T32A11OUTB                      | PM3       | 121            | 99             | -              | -              | E13           | F13           |
|                                 | PW7       | 117            | -              | -              | -              | H16           | -             |
| T32A11INC0                      | PR6       | 155            | 131            | -              | -              | E9            | E6            |
| T32A11INC1                      | PR7       | 156            | 132            | -              | -              | D8            | D6            |
| T32A11OUTC                      | PM2       | 122            | 100            | -              | -              | F16           | E14           |
|                                 | PW6       | 118            | -              | -              | -              | H15           | -             |
| T32A12INA0                      | PU2       | 36             | -              | -              | -              | J5            | -             |
| T32A12OUTA                      | PU0       | 34             | -              | -              | -              | H4            | -             |
| T32A12INB0                      | PU3       | 37             | -              | -              | -              | K4            | -             |
| T32A12OUTB                      | PU1       | 35             | -              | -              | -              | J4            | -             |
| T32A12INC0                      | PU2       | 36             | -              | -              | -              | J5            | -             |
| T32A12INC1                      | PU3       | 37             | -              | -              | -              | K4            | -             |
| T32A12OUTC                      | PU0       | 34             | -              | -              | -              | H4            | -             |
| T32A13INA0                      | PU5       | 39             | -              | -              | -              | L5            | -             |
| T32A13OUTA                      | PU6       | 40             | -              | -              | -              | L4            | -             |
| T32A13INB0                      | PU4       | 38             | -              | -              | -              | K5            | -             |
| T32A13OUTB                      | PU7       | 41             | -              | -              | -              | M4            | -             |
| T32A13INC0                      | PU5       | 39             | -              | -              | -              | L5            | -             |
| T32A13INC1                      | PU4       | 38             | -              | -              | -              | K5            | -             |
| T32A13OUTC                      | PU6       | 40             | -              | -              | -              | L4            | -             |

**Table 4.17 List of signal connections (13/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| EA00                            | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
| EA01                            | PA1       | 28             | 28             | 24             | 19             | L2            | J1            |
| EA02                            | PA2       | 27             | 27             | 23             | 18             | K1            | J2            |
| EA03                            | PA3       | 26             | 26             | 22             | 17             | K2            | H1            |
| EA04                            | PA4       | 25             | 25             | 21             | 16             | J1            | H2            |
| EA05                            | PA5       | 24             | 24             | 20             | 15             | J2            | G1            |
| EA06                            | PA6       | 23             | 23             | 19             | 14             | H1            | G2            |
| EA07                            | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
| EA08                            | PB0       | 21             | 21             | 17             | 12             | G1            | H4            |
| EA09                            | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
| EA10                            | PB2       | 19             | 19             | 15             | 10             | F1            | F1            |
| EA11                            | PB3       | 18             | 18             | 14             | 9              | F2            | F2            |
| EA12                            | PB4       | 17             | 17             | 13             | 8              | E1            | E1            |
| EA13                            | PB5       | 16             | 16             | 12             | 7              | E2            | E2            |
| EA14                            | PB6       | 15             | 15             | 11             | 6              | G4            | G4            |
| EA15                            | PB7       | 14             | 14             | 10             | 5              | G5            | G5            |
| EA16                            | PC0       | 11             | 11             | 7              | -              | F4            | F4            |
|                                 | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
| EA17                            | PC1       | 10             | 10             | 6              | -              | F5            | F5            |
|                                 | PE6       | 64             | 56             | 52             | 43             | T7            | N7            |
| EA18                            | PC2       | 9              | 9              | 5              | -              | D1            | D1            |
|                                 | PE5       | 63             | 55             | 51             | 42             | R7            | P7            |
| EA19                            | PC3       | 8              | 8              | 4              | -              | D2            | D2            |
|                                 | PE4       | 62             | 54             | 50             | 41             | R6            | P6            |
| EA20                            | PC4       | 7              | 7              | -              | -              | C1            | C1            |
|                                 | PE3       | 61             | 53             | 49             | 40             | T6            | N6            |
| EA21                            | PC5       | 6              | 6              | -              | -              | C2            | C2            |
|                                 | PE2       | 60             | 52             | 48             | 39             | T5            | P5            |
| EA22                            | PC6       | 5              | 5              | -              | -              | E4            | E4            |
|                                 | PE1       | 59             | 51             | 47             | 38             | R5            | N5            |
| EA23                            | PC7       | 4              | 4              | -              | -              | D4            | D4            |
|                                 | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |

**Table 4.18 List of signal connections (14/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| ED00/EAD00                      | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
| ED01/EAD01                      | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
| ED02/EAD02                      | PD2       | 50             | 42             | 38             | 31             | N6            | K6            |
| ED03/EAD03                      | PD3       | 51             | 43             | 39             | 32             | M7            | L6            |
| ED04/EAD04                      | PD4       | 52             | 44             | 40             | 33             | N7            | L7            |
| ED05/EAD05                      | PD5       | 53             | 45             | 41             | 34             | M8            | K7            |
| ED06/EAD06                      | PD6       | 54             | 46             | 42             | 35             | N8            | K8            |
| ED07/EAD07                      | PD7       | 55             | 47             | 43             | 36             | M9            | L8            |
| ED08/EAD08                      | PE0       | 58             | 50             | 46             | 37             | R4            | N4            |
| ED09/EAD09                      | PE1       | 59             | 51             | 47             | 38             | R5            | N5            |
| ED10/EAD10                      | PE2       | 60             | 52             | 48             | 39             | T5            | P5            |
| ED11/EAD11                      | PE3       | 61             | 53             | 49             | 40             | T6            | N6            |
| ED12/EAD12                      | PE4       | 62             | 54             | 50             | 41             | R6            | P6            |
| ED13/EAD13                      | PE5       | 63             | 55             | 51             | 42             | R7            | P7            |
| ED14/EAD14                      | PE6       | 64             | 56             | 52             | 43             | T7            | N7            |
| ED15/EAD15                      | PE7       | 65             | 57             | 53             | 44             | T8            | N8            |
| ERD_N                           | PF0       | 172            | 140            | 124            | 97             | D5            | D5            |
| EWR_N                           | PF1       | 173            | 141            | 125            | 98             | A4            | B5            |
| ECS0_N                          | PK2       | 109            | 91             | 83             | 69             | J13           | F14           |
| ECS1_N                          | PK3       | 108            | 90             | 82             | 68             | K13           | G13           |
| ECS2_N                          | PF4       | 176            | 144            | 128            | -              | A2            | A2            |
| ECS3_N                          | PF5       | 1              | 1              | 1              | -              | B3            | B3            |
| EBELL_N                         | PF6       | 2              | 2              | 2              | 1              | B2            | B2            |
| EBELH_N                         | PF7       | 3              | 3              | 3              | 2              | B1            | B1            |
| EALE                            | PG0       | 129            | 105            | 93             | 72             | D15           | D13           |
| EWAIT_N                         | PG1       | 130            | 106            | 94             | 73             | C16           | C14           |
| EEXBCLK                         | PY4       | 30             | 30             | 26             | 21             | M2            | K2            |
| NBDCLK                          | PG6       | 95             | 79             | 71             | 57             | M16           | L14           |
| NBDDATA0                        | PG7       | 94             | 78             | 70             | 56             | M15           | L13           |
| NBDDATA1                        | PH0       | 93             | 77             | 69             | 55             | N16           | L11           |
| NBDDATA2                        | PH1       | 92             | 76             | 68             | 54             | N15           | M13           |
| NBDDATA3                        | PH2       | 91             | 75             | 67             | 53             | P16           | M14           |
| NBDSYNC                         | PH3       | 90             | 74             | 66             | 52             | P15           | N13           |

**Table 4.19 List of signal connections (15/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| AINA00                          | PN0       | 133            | 109            | 97             | 76             | B15           | B13           |
| AINA01                          | PN1       | 134            | 110            | 98             | 77             | A15           | A13           |
| AINA02                          | PN2       | 135            | 111            | 99             | 78             | B14           | B12           |
| AINA03                          | PN3       | 136            | 112            | 100            | 79             | A14           | A12           |
| AINA04                          | PN4       | 137            | 113            | 101            | 80             | B13           | B11           |
| AINA05                          | PN5       | 138            | 114            | 102            | 81             | A13           | A11           |
| AINA06                          | PN6       | 139            | 115            | 103            | 82             | B12           | B10           |
| AINA07                          | PN7       | 140            | 116            | 104            | 83             | A12           | A10           |
| AINA08                          | PP0       | 141            | 117            | 105            | 84             | D12           | D11           |
| AINA09                          | PP1       | 142            | 118            | 106            | 85             | D11           | D10           |
| AINA10                          | PP2       | 143            | 119            | 107            | 86             | B11           | B9            |
| AINA11                          | PP3       | 144            | 120            | 108            | 87             | A11           | A9            |
| AINA12                          | PP4       | 145            | 121            | 109            | 88             | E11           | D9            |
| AINA13                          | PP5       | 146            | 122            | 110            | 89             | D10           | E9            |
| AINA14                          | PP6       | 147            | 123            | 111            | 90             | B10           | B8            |
| AINA15                          | PP7       | 148            | 124            | 112            | 91             | A10           | A8            |
| AINA16                          | PR0       | 149            | 125            | 113            | -              | E10           | D8            |
| AINA17                          | PR1       | 150            | 126            | 114            | -              | D9            | E8            |
| AINA18                          | PR2       | 151            | 127            | 115            | -              | B9            | B7            |
| AINA19                          | PR3       | 152            | 128            | 116            | -              | A9            | A7            |
| AINA20                          | PR4       | 153            | 129            | -              | -              | A8            | D7            |
| AINA21                          | PR5       | 154            | 130            | -              | -              | B8            | E7            |
| AINA22                          | PR6       | 155            | 131            | -              | -              | E9            | E6            |
| AINA23                          | PR7       | 156            | 132            | -              | -              | D8            | D6            |
| TRGIN0                          | PG3       | 132            | 108            | 96             | 75             | B16           | B14           |
| TRGIN1                          | PL7       | 163            | -              | -              | -              | E8            | -             |
| DAC0                            | PT0       | 159            | 135            | 119            | 94             | A6            | A5            |
| DAC1                            | PT1       | 160            | 136            | 120            | 95             | A5            | A4            |

Table 4.20 List of signal connections (16/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| INT00a                          | PK7       | 104            | 86             | 78             | 64             | K12           | J10           |
| INT00b                          | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| INT01a                          | PL0       | 103            | 85             | 77             | 63             | L13           | J11           |
| INT01b                          | PT4       | 116            | 98             | 90             | -              | F13           | E11           |
| INT02a                          | PA0       | 29             | 29             | 25             | 20             | L1            | J4            |
| INT02b                          | PT5       | 73             | 61             | 57             | -              | R10           | K9            |
| INT03a                          | PA7       | 22             | 22             | 18             | 13             | H2            | J5            |
| INT03b                          | PL6       | 164            | -              | -              | -              | E7            | -             |
| INT04a                          | PB0       | 21             | 21             | 17             | 12             | G1            | H4            |
| INT04b                          | PF0       | 172            | 140            | 124            | 97             | D5            | D5            |
| INT05a                          | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
| INT05b                          | PF7       | 3              | 3              | 3              | 2              | B1            | B1            |
| INT06a                          | PB6       | 15             | 15             | 11             | 6              | G4            | G4            |
| INT06b                          | PU2       | 36             | -              | -              | -              | J5            | -             |
| INT07a                          | PB7       | 14             | 14             | 10             | 5              | G5            | G5            |
| INT07b                          | PU3       | 37             | -              | -              | -              | K4            | -             |
| INT08a                          | PG0       | 129            | 105            | 93             | 72             | D15           | D13           |
| INT08b                          | PU4       | 38             | -              | -              | -              | K5            | -             |
| INT09a                          | PG1       | 130            | 106            | 94             | 73             | C16           | C14           |
| INT09b                          | PU5       | 39             | -              | -              | -              | L5            | -             |
| INT10a                          | PK0       | 111            | 93             | 85             | 71             | H12           | H10           |
| INT10b                          | PP6       | 147            | 123            | 111            | 90             | B10           | B8            |
| INT11a                          | PK1       | 110            | 92             | 84             | 70             | J12           | H11           |
| INT11b                          | PP7       | 148            | 124            | 112            | 91             | A10           | A8            |
| INT12a                          | PC0       | 11             | 11             | 7              | -              | F4            | F4            |
| INT12b                          | PL4       | 126            | -              | -              | -              | D16           | -             |
| INT13a                          | PC1       | 10             | 10             | 6              | -              | F5            | F5            |
| INT13b                          | PL5       | 125            | -              | -              | -              | E15           | -             |
| INT14a                          | PC6       | 5              | 5              | -              | -              | E4            | E4            |
| INT14b                          | PM3       | 121            | 99             | -              | -              | E13           | F13           |
| INT15a                          | PC7       | 4              | 4              | -              | -              | D4            | D4            |
| INT15b                          | PM4       | 85             | 69             | -              | -              | N12           | L10           |

**Table 4.21 List of signal connections (17/18)**

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| EMG0                            | PD6       | 54             | 46             | 42             | 35             | N8            | K8            |
|                                 | PV6       | 79             | 63             | 59             | -              | T11           | N9            |
| OVV0                            | PD7       | 55             | 47             | 43             | 36             | M9            | L8            |
|                                 | PV7       | 78             | 62             | 58             | -              | R11           | L9            |
| UO0                             | PD0       | 48             | 40             | 36             | 29             | N5            | L4            |
|                                 | PV0       | 115            | 97             | 89             | -              | F12           | F10           |
| VO0                             | PD2       | 50             | 42             | 38             | 31             | N6            | K6            |
|                                 | PV2       | 113            | 95             | 87             | -              | G12           | G11           |
| WO0                             | PD4       | 52             | 44             | 40             | 33             | N7            | L7            |
|                                 | PV4       | 81             | 65             | 61             | -              | R12           | N10           |
| XO0                             | PD1       | 49             | 41             | 37             | 30             | M6            | L5            |
|                                 | PV1       | 114            | 96             | 88             | -              | G13           | F11           |
| YO0                             | PD3       | 51             | 43             | 39             | 32             | M7            | L6            |
|                                 | PV3       | 112            | 94             | 86             | -              | H13           | G10           |
| ZO0                             | PD5       | 53             | 45             | 41             | 34             | M8            | K7            |
|                                 | PV5       | 80             | 64             | 60             | -              | T12           | P9            |
| CEC0                            | PT2       | 171            | 139            | 123            | 96             | E6            | E5            |
| ALARM_N                         | PG2       | 131            | 107            | 95             | 74             | C15           | C13           |
| RTCOUT                          | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| RXIN0                           | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| RXIN1                           | PT4       | 116            | 98             | 90             | -              | F13           | E11           |
| TRGIN2                          | PT3       | 31             | 31             | 27             | 22             | H5            | K4            |
| HDMAREQA                        | PB1       | 20             | 20             | 16             | 11             | G2            | H5            |
| HDMAREQB                        | PK1       | 110            | 92             | 84             | 70             | J12           | H11           |
| TMS                             | PH4       | 89             | 73             | 65             | 51             | R16           | N14           |
| TCK                             | PH5       | 88             | 72             | 64             | 50             | T15           | P13           |
| TDO                             | PH6       | 87             | 71             | 63             | 49             | R15           | P12           |
| TDI                             | PH3       | 90             | 74             | 66             | 52             | P15           | N13           |
| TRST_N                          | PH7       | 86             | 70             | 62             | 48             | R14           | N12           |
| SWDIO                           | PH4       | 89             | 73             | 65             | 51             | R16           | N14           |
| SWCLK                           | PH5       | 88             | 72             | 64             | 50             | T15           | P13           |
| SWV                             | PH6       | 87             | 71             | 63             | 49             | R15           | P12           |
| TRACECLK                        | PG6       | 95             | 79             | 71             | 57             | M16           | L14           |
| TRACEDATA0                      | PG7       | 94             | 78             | 70             | 56             | M15           | L13           |
| TRACEDATA1                      | PH0       | 93             | 77             | 69             | 55             | N16           | L11           |
| TRACEDATA2                      | PH1       | 92             | 76             | 68             | 54             | N15           | M13           |
| TRACEDATA3                      | PH2       | 91             | 75             | 67             | 53             | P16           | M14           |

Table 4.22 List of signal connections (18/18)

| Combination functional pin name | Port name | M4G9 (LQFP176) | M4G8 (LQFP144) | M4G7 (LQFP128) | M4G6 (LQFP100) | M4G9 (BGA177) | M4G8 (BGA145) |
|---------------------------------|-----------|----------------|----------------|----------------|----------------|---------------|---------------|
| X1                              | PY0       | 45             | 37             | 33             | 26             | T2            | P2            |
| X2                              | PY1       | 46             | 38             | 34             | 27             | T3            | P3            |
| XT1                             | PY2       | 44             | 36             | 32             | 25             | P1            | M1            |
| XT2                             | PY3       | 43             | 35             | 31             | 24             | N1            | L1            |
| BOOT_N                          | PY4       | 30             | 30             | 26             | 21             | M2            | K2            |
| EHCLKIN                         | PY0       | 45             | 37             | 33             | 26             | T2            | P2            |
| ELCLKIN                         | PY2       | 44             | 36             | 32             | 25             | P1            | M1            |
| RESET_N                         |           | 42             | 34             | 30             | 23             | R1            | N1            |
| MODE                            |           | 47             | 39             | 35             | 28             | T1            | P1            |
| BSC                             |           | -              | -              | -              | -              | T16           | P14           |
| DVDD3A                          |           | 12             | 12             | 8              | 3              | A1            | A1            |
| DVDD3B                          |           | 32             | 32             | 28             | -              | R2            | N2            |
| DVDD3C                          |           | 56             | 48             | 44             | -              | R3            | N3            |
| DVDD3D                          |           | 72             | 59             | 55             | 46             | M12           | K10           |
| DVDD3E                          |           | 98             | -              | -              | -              | N13           | K10           |
| DVDD3F                          |           | 127            | 103            | 91             | -              | T4            | P4            |
| DVDD3G                          |           | 161            | 137            | 121            | -              | M5            | K5            |
| DVDD3H                          |           | 169            | -              | -              | -              | N4            | K5            |
| DVSSA                           |           | 13             | 13             | 9              | 4              | M1            | K1            |
| DVSSB                           |           | 33             | 33             | 29             | -              | N2            | L2            |
| DVSSC                           |           | 57             | 49             | 45             | -              | P2            | M2            |
| DVSSD                           |           | 72             | 60             | 56             | 47             | E12           | E10           |
| DVSSE                           |           | 99             | -              | -              | -              | D13           | E10           |
| DVSSF                           |           | 128            | 104            | 92             | -              | A16           | A14           |
| DVSSG                           |           | 162            | 138            | 122            | -              | F6            | F6            |
| DVSSH                           |           | 170            | -              | -              | -              | E5            | F6            |
| REGOUT1                         |           | 70             | 58             | 54             | 45             | T10           | P8            |
| AVDD3                           |           | 157            | 133            | 117            | 92             | A7            | A6            |
| AVSS                            |           | 158            | 134            | 118            | 93             | B7            | B6            |

### 4.3. Ports

The symbols of each table of port have the following meanings.

- Input/Output: Input or/and Output of Port  
Input: Input port  
Output: Output port  
I/O: Input/output port
- PU/PD: Programmable pull-up/pull-down  
PU: Programmable pull-up is selectable  
PD: Programmable pull-down is selectable
- OD: Programmable open-drain output  
YES: Support  
NO: Non support
- 5VT/3VT: Tolerant  
5VT: 5V-tolerant  
3VT: 3V-tolerant  
N/A: Not available
- SMT/CMOS: Input gate  
SMT: Schmitt trigger input  
CMOS: CMOS input
- Under Reset: Port state under Reset  
Hi-z: High impedance  
PU: Pull-up  
PD: Pull-down
- After Reset: Port state after Reset  
Hi-z: High impedance  
PU: Pull-up  
PD: Pull-down

### 4.3.1. Port Specifications Table

**Table 4.23 Port names, and specifications of Port A, B, C, D**

| Port Name | Input/Output | PU/PD | OD  | 5V/3VT | SMT/CMOS | Under Reset | After Reset |
|-----------|--------------|-------|-----|--------|----------|-------------|-------------|
| PA0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PA1       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PA2       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PA3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PA4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PA5       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PA6       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PA7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PB7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PC7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PD0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PD1       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PD2       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PD3       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PD4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PD5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PD6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PD7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |

**Table 4.24 Port names, and specifications of Port E, F, G, H**

| Port Name | Input/Output | PU/PD | OD  | 5V/3VT | SMT/CMOS | Under Reset | After Reset |
|-----------|--------------|-------|-----|--------|----------|-------------|-------------|
| PE0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PE7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF2       | I/O          | PU/PD | YES | 5VT    | SMT      | Hi-z        | Hi-z        |
| PF3       | I/O          | PU/PD | YES | 5VT    | SMT      | Hi-z        | Hi-z        |
| PF4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PF7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG2       | I/O          | PU/PD | YES | 5VT    | SMT      | Hi-z        | Hi-z        |
| PG3       | I/O          | PU/PD | YES | 5VT    | SMT      | Hi-z        | Hi-z        |
| PG4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PG7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PH0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PH1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PH2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PH3       | I/O          | PU/PD | YES | N/A    | SMT      | PU          | PU          |
| PH4       | I/O          | PU/PD | YES | N/A    | SMT      | PU          | PU          |
| PH5       | I/O          | PU/PD | YES | N/A    | SMT      | PD          | PD          |
| PH6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PH7       | I/O          | PU/PD | YES | N/A    | SMT      | PU          | PU          |

Table 4.25 Port names, and specifications of Port J, K, L, M

| Port Name | Input/Output | PU/PD | OD  | 5V/3VT | SMT/CMOS | Under Reset | After Reset |
|-----------|--------------|-------|-----|--------|----------|-------------|-------------|
| PJ0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PJ7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PK0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PK1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PK2       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PK3       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PK4       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PK5       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PK6       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PK7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL1       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PL2       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PL3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PL7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PM0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PM1       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PM2       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PM3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PM4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PM5       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PM6       | I/O          | PU/PD | YES | N/A    | CMOS     | Hi-z        | Hi-z        |
| PM7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |

**Table 4.26 Port names, and specifications of Port N, P, R, T**

| Port Name | Input/Output | PU/PD | OD  | 5V/3VT | SMT/CMOS | Under Reset | After Reset |
|-----------|--------------|-------|-----|--------|----------|-------------|-------------|
| PN0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PN7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PP7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PR7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PT0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PT1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PT2       | I/O          | PU/PD | YES | 3VT    | SMT      | Hi-z        | Hi-z        |
| PT3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PT4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PT5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |

**Table 4.27 Port names, and specifications of Port U, V, W, Y**

| Port Name | Input/Output | PU/PD | OD  | 5V/3VT | SMT/CMOS | Under Reset | After Reset |
|-----------|--------------|-------|-----|--------|----------|-------------|-------------|
| PU0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PU7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PV7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW0       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW1       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW2       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW3       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW4       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW5       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW6       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PW7       | I/O          | PU/PD | YES | N/A    | SMT      | Hi-z        | Hi-z        |
| PY0       | Input        | PU/PD | N/A | N/A    | SMT      | Hi-z        | Hi-z        |
| PY1       | Input        | PU/PD | N/A | N/A    | SMT      | Hi-z        | Hi-z        |
| PY2       | Input        | PU/PD | N/A | N/A    | SMT      | Hi-z        | Hi-z        |
| PY3       | Input        | PU/PD | N/A | N/A    | SMT      | Hi-z        | Hi-z        |
| PY4       | Output       | PU/PD | YES | N/A    | SMT      | Hi-z(Note)  | Hi-z        |

Note: This pin is shared by BOOT\_N pin. When RESET\_N pin is "0", PU (Pull-up resistor connection) is active. If RESET\_N =1 and the internal reset is asserted, this pin is in Hi-z state.

## 5. Functional Description and Operation Description

For the details of the functions, refer to Reference manuals.

### 5.1. Reference Manuals

For more information on product of TMPM4G Group (1), please refer to Reference Manuals below;

**Table 5.1 Reference Manuals for TMPM4G Group (1)**

| Reference Manual                                                     | IP Symbol      | Category   |
|----------------------------------------------------------------------|----------------|------------|
| Input/Output Ports (TMPM4G Group(1))                                 | PORT-M4G(1)    | System     |
| Memory Map (TMPM4G Group(1))                                         | MMAP-M4G(1)    | System     |
| Exception (TMPM4G Group(1))                                          | EXCEPT-M4G(1)  | System     |
| Clock Control and Operation Mode (TMPM4G Group(1))                   | CG-M4G(1)-C    | System     |
| Product Information (TMPM4G Group(1))                                | PINFO-M4G(1)   | System     |
| Power Supply and Reset Operation (TMPM4G Group(1))                   | RESET-M4G(1)   | System     |
| Flash Memory<br>(Code Flash 1.5MB/1.0MB/768KB/512KB Data Flash 32KB) | FLASH15MHD32-A | Peripheral |
| Trimming Circuit                                                     | TRM-A          | Peripheral |
| Oscillation Frequency Detector                                       | OFD-A          | Peripheral |
| Voltage Detection Circuit                                            | LVD-C          | Peripheral |
| Digital Noise Filter Circuit                                         | DNF-A          | Peripheral |
| Debug Interface                                                      | DEBUG-A        | Peripheral |
| Non Break Debug Interface                                            | NBDIF-A        | Peripheral |
| Interval Sensor Detection Circuit                                    | ISD-A          | Peripheral |
| Multi-Function DMA Controller                                        | MDMAC-A        | Peripheral |
| High Speed DMA Controller                                            | HDMAC-A        | Peripheral |
| External Bus Interface                                               | EBIF-A         | Peripheral |
| Serial Memory Interface                                              | SMIF-A         | Peripheral |
| Asynchronous Serial Communication Circuit                            | UART-C         | Peripheral |
| Full Universal Asynchronous Receiver Transmitter Circuit             | FUART-B        | Peripheral |
| Serial Peripheral Interface                                          | TSPI-C         | Peripheral |
| I <sup>2</sup> C Interface                                           | I2C-B          | Peripheral |
| Consumer Electronics Control Circuit                                 | CEC-A          | Peripheral |
| 12-bit Analog to Digital Converter                                   | ADC-C          | Peripheral |
| 8-bit Digital to Analog Converter                                    | DAC-A          | Peripheral |
| Advanced Programmable Motor Control Circuit                          | A-PMD-C        | Peripheral |
| 32-bit Timer Event Counter                                           | T32A-B         | Peripheral |
| Long Term Timer                                                      | LTTMR-A        | Peripheral |
| Real Time Clock                                                      | RTC-A          | Peripheral |
| Clock Selective Watchdog Timer                                       | SIWDT-A        | Peripheral |
| Remote Control Signal Preprocessor                                   | RMC-B          | Peripheral |
| Boundary Scan                                                        | BSC-A          | Peripheral |

## 5.2. Processor Core

TMPM4G group(1) incorporates a high-performance 32-bit processor core (Arm Cortex-M4 (with FPU)).

For the operation of the processor core, refer to the Arm documentation set of the Arm "Cortex-M" series processors. This section explains the product-specific information.

### 5.2.1. Core Information

The Cortex-M4( with FPU) core revision used in TMPM4G group(1) is shown as below:

For details of the CPU core and the architecture, refer to the Arm documentation in the following URL:

<http://infocenter.arm.com/help/index.jsp>

**Table 5.2 Core revision**

| Group name | Core revision |
|------------|---------------|
| TMPM4G(1)  | r0p1          |

### 5.2.2. Configurable Options

In the Cortex-M4(with FPU) core, some blocks can be selected to implement. The following table shows the configurations of TMPM4G group(1).

**Table 5.3 Configurable options and their implementations**

| Configurable option            | Implementation                                     |
|--------------------------------|----------------------------------------------------|
| FWB                            | Literal comparator: 2<br>Instruction comparator: 6 |
| DWT                            | Comparator: 4                                      |
| ITM                            | Available                                          |
| MPU                            | Available                                          |
| ETM                            | Available                                          |
| AHB-AP                         | Available                                          |
| AHB trace macro cell interface | Not available                                      |
| TPIU                           | Available                                          |
| WIC                            | Not available                                      |
| Debug port                     | JTAG/Serial wire                                   |
| Bit band                       | Available                                          |
| Sequential control of AHB      | Not available                                      |

### 5.3. Clock Control and Operation Mode (CG)

The CG selects a clock gear ratio and the prescaler clock, or warm up time of the oscillator.

There are NORMAL mode and low power consumption mode as operation modes. Power consumption can be reduced by mode transition.

The system clock consists of “High speed system clock” and “Middle speed system clock”. The former is a high speed oscillation clock and the latter is generated by dividing High speed system clock.

The outline of the clock control circuit is as follows:

- Internal high speed oscillation circuit 1: 10MHz
- Internal high speed oscillation circuit 2: 10MHz
- Selectable from the external high speed oscillation circuit or internal high speed oscillation circuit.
- PLL (Clock Multiplication Circuit):  
Capable of 160 MHz output by changing the multiplication ratio according to the frequency of the high speed oscillation circuit
- Clock gear:  
The high speed clock can be divided by 1/1, 1/2, 1/4, 1/8, or 1/16 and the clock is used as the system clock (fsys).
- Low power consumption mode:  
IDLE: Only the CPU is stopped in this mode. Each peripheral circuit can enable or disable operation in the IDLE mode.  
STOP1: Except some peripheral circuits, all the internal circuits including the internal oscillator are brought to a stop in STOP1 mode. The low frequency oscillator can be supplied to RTC, RMC CEC and ISD by the corresponding setting. LTTMR can be worked by enabling of IHOSC2.  
STOP2: This mode halts voltage supply, retaining some peripheral circuits operation. The low frequency clock can be supplied to RTC, RMC, CEC and ISD by the corresponding setting. LTTMR can be worked by enabling of IHOSC2.

### 5.4. Flash Memory (Code FLASH, Data FLASH)

The code flash stores instruction code, and CPU reads instruction code and executes.

The code flash and data flash store data, and even if a power supply is off, data can be kept.

It has the dual mode that possible to write and erase a data flash while executing an order by a code flash, and it's also possible to continue executing an application program during writing or erasing data flash.

While saving the data to the data flash, it can continue running the application program on the code flash.

It has protection function which prohibits write or erase by the block unit and it has the security function which prohibits the reading of the program code by the 3rd person.

## 5.5. Oscillation Circuit

External High Speed Oscillator (EHOSC): Connect crystal resonator or ceramic resonator to terminals. Use clock source for System clock.

External Low Speed Oscillator (ELOSC): Connect crystal resonator (32.768 kHz) to terminals. Use clock source for Real Time Clock or Power consumption mode.

Internal High Speed Oscillator 1(IHOSC1): Oscillation frequency is 10MHz. Use clock source for System clock.

Internal High Speed Oscillator 2(IHOSC2): Oscillation frequency is 10MHz. Use clock source for OFD, SIWDT and LTTMR.

The built-in oscillators in TMPM4G group(1) are shown in the following table.

**Table 5.4 Built-in Oscillator**

|        | M4G9 | M4G8 | M4G7 | M4G6 |
|--------|------|------|------|------|
| EHOSC  | ✓    | ✓    | ✓    | ✓    |
| ELOSC  | ✓    | ✓    | ✓    | ✓    |
| IHOSC1 | ✓    | ✓    | ✓    | ✓    |
| IHOSC2 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.6. Trimming Circuit (TRM)

The trimming function can adjust frequency of the internal high speed oscillator1 (IHOSC1).

The built-in trimming circuit is integrated in TMPM4G group(1) as shown in the following table.

**Table 5.5 Built-in TRM**

|     | M4G9 | M4G8 | M4G7 | M4G6 |
|-----|------|------|------|------|
| TRM | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.7. Oscillation Frequency Detector (OFD)

The oscillation frequency detection circuit (OFD) is a function that detects an abnormal state of the clock. It measures the external high speed oscillation ( $f_{EHOSC}$ ) or high speed clock ( $f_c$ ) based on the internal reference clock ( $f_{IHOSC2}$ ). If an oscillation or clock frequency is out of the specified range, a reset signal occurs.

The upper limit and the lower limit of detection frequency ranges can be specified respectively.

**Table 5.6 Built-in OFD**

|     | M4G9 | M4G8 | M4G7 | M4G6 |
|-----|------|------|------|------|
| OFD | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.8. Voltage Detection Circuit (LVD)

The LVD is a peripheral function that detects whether a power supply voltage is lower or higher than the preset voltage. When a low voltage or higher voltage than the preset voltage is detected, the LVD generates an interrupt request or reset the MCU.

Setting voltage can be chosen from seven kinds. LVD is set to enable from the Reset state at the Power-on.

**Table 5.7 Built-in LVD**

|     | M4G9 | M4G8 | M4G7 | M4G6 |
|-----|------|------|------|------|
| LVD | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.9. Digital Noise Filter Circuit (DNF)

The digital noise canceler circuit can eliminate noise of input signals from external interrupt pins at the certain range. The noise of the High level / Low level input of the external interrupt signal INTx is removed. The noise rejection of width can be selected from among 0.0875 to 5.6  $\mu$ s ( $f_c=160$ MHz) for each interrupt input pin independently.

TMPM4G group(1) can have 17 to 32 external interrupt input pins.

**Table 5.8 Number of External interrupt pins (Built-in DNF)**

|                         | M4G9 | M4G8 | M4G7 | M4G6 |
|-------------------------|------|------|------|------|
| External interrupt pins | 32   | 25   | 21   | 17   |

## 5.10. Debug Interface (DEBUG)

TMPM4G Group (1) contain Interface for connect debug tool, which is the Serial Wire Debug Port (SWCLK, SWDIO) and the JTAG Debug Port (TDI, TDO, TMS, TCK, TRST\_N). These are connected with the Debug tool and used for program development. And also it contain the trace clock (TRACECLK) and data output (TRACEDATA0to3) to reduce the Debug Process.

TMPM4G group(1) supports Serial Wire Debug Port, JTAG Debug Port and Trace outputs.

**Table 5.9 Built-in Debug Interface**

|            | Port | M4G9 | M4G8 | M4G7 | M4G6 |
|------------|------|------|------|------|------|
| TMS/SWDIO  | PH4  | ✓    | ✓    | ✓    | ✓    |
| TCK/SWCLK  | PH5  | ✓    | ✓    | ✓    | ✓    |
| TDO/SWV    | PH6  | ✓    | ✓    | ✓    | ✓    |
| TDI        | PH3  | ✓    | ✓    | ✓    | ✓    |
| TRST_N     | PH7  | ✓    | ✓    | ✓    | ✓    |
| TRACECLK   | PG6  | ✓    | ✓    | ✓    | ✓    |
| TRACEDATA0 | PG7  | ✓    | ✓    | ✓    | ✓    |
| TRACEDATA1 | PH0  | ✓    | ✓    | ✓    | ✓    |
| TRACEDATA2 | PH1  | ✓    | ✓    | ✓    | ✓    |
| TRACEDATA3 | PH2  | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.11. Non Break Debug Interface(NBDIF)

Connecting debug tools supporting NBD interface can provide RAM monitor function.

**Table 5.10 Built-in NBDIF**

|          | M4G9 | M4G8 | M4G7 | M4G6 |
|----------|------|------|------|------|
| NBDSYNC  | ✓    | ✓    | ✓    | ✓    |
| NBDCLK   | ✓    | ✓    | ✓    | ✓    |
| NBDDATA0 | ✓    | ✓    | ✓    | ✓    |
| NBDDATA1 | ✓    | ✓    | ✓    | ✓    |
| NBDDATA2 | ✓    | ✓    | ✓    | ✓    |
| NBDDATA3 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.12. Interval Sensor Detection Circuit(ISD)

ISD can generate an interrupt when the value of the sensor input changes (High level, Low level, High to Low transition, and Low to High transition). And the low power consumption mode can be released by the input signal detection interrupt.

**Table 5.11 Built-in ISD**

| UNIT   | M4G9 | M4G8 | M4G7 | M4G6 |
|--------|------|------|------|------|
| unit A | ✓    | ✓    | ✓    | ✓    |
| unit B | ✓    | ✓    | ✓    | -    |
| unit C | ✓    | -    | -    | -    |

Note: ✓: Available, -: N/A

## 5.13. DMA Controller

### 5.13.1. Multi-Function DMA Controller (MDMAC)

MDMAC transfers data from peripheral function to memory, from memory to peripheral function and between memories. These operations are performed separately from the CPU control. The CPU load can be greatly reduced by using it. The transfer count can be set infinitely by using chain transfer.

TMPM4G group(1) has one unit of MDMAC. There are 32 channel requests per unit. The inputs of channels 0 to 31 can be startup factors which is assigned to TSPI, UART, FUART, I<sup>2</sup>C, T32A, ADC, A-PMD, external trigger input via the trigger selector (TRGSEL).

**Table 5.12 Built-in MDMAC**

| UNIT   | M4G9 | M4G8 | M4G7 | M4G6 |
|--------|------|------|------|------|
| unit A | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

### 5.13.2. High Speed DMA Controller (HDMAC)

HDMAC transfers data from peripheral function to memory, from memory to peripheral function and between memories. High speed transfer of up to 4095 counts is possible. These operations are performed separately from the CPU control. The CPU load can be greatly reduced by using it.

TMPM4G group(1) has two units of HDMAC. SMIF, TSPI, External trigger pin can be startup factors of HDMAC.

**Table 5.13 Built-in HDMAC**

| UNIT   | M4G9 | M4G8 | M4G7 | M4G6 |
|--------|------|------|------|------|
| unit A | ✓    | ✓    | ✓    | ✓    |
| unit B | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.14. External Bus Interface (EBIF)

EBIF (External bus interface) connects external memories, external I/O's, and others.

Two modes (Separate bus mode and Multiplex bus mode) are available and EBIF supports 64 MB access space (16 MB × 4 channels) at maximum. The data bus width can be set to 8 bits or 16 bits per channel.

**Table 5.14 Built-in EBIF**

|      | M4G9 | M4G8 | M4G7 | M4G6 |
|------|------|------|------|------|
| EBIF | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.15. Serial Memory Interface (SMIF)

SMIF is communication function that can be high speed serial transfer with external devices such as SPI Flash. Up to 2 devices can be connected to one channel. A direct access and a register access are supported. The Single I/O, Dual I/O read and Quad I/O read are supported by communication interface of SPI(Mode 0).

**Table 5.15 Built-in SMIF**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.16. Asynchronous Serial Communication Circuit

### 5.16.1. Asynchronous Serial Communication Circuit (UART)

The UART is asynchronous serial communication function. It can choose the data length of 7, 8 or 9bits, parity existence, and a STOP bit length function. Moreover, selection of the MSB first / LSB first and reversal of data polarity can be performed and Terminal exchanged of TXD/RXD can be performed in a Port setting.

The FIFO buffer supports data communication on 8 stage at transmission; and on 8 stage at reception.

The telecommunication control by CTS/RTS are supported.

**Table 5.16 Built-in UART**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |
| Channel 1 | ✓    | ✓    | ✓    | ✓    |
| Channel 2 | ✓    | ✓    | ✓    | ✓    |
| Channel 3 | ✓    | ✓    | ✓    | -    |
| Channel 4 | ✓    | ✓    | -    | -    |
| Channel 5 | ✓    | -    | -    | -    |

Note1: ✓: Available, -: N/A

Note2: External pin are not same by product. Please refer to section “2 Pin Assignment”.

### 5.16.2. Full Universal Asynchronous Receiver Transmitter Circuit (FUART)

FUART is asynchronous serial communication function. It can choose a data length of 5, 6, 7, or 8 bits, parity existence, and a STOP bit length.

The FIFO buffer contains data communication on 32 stage at transmission and on 32 stage at reception. The communication control by CTS/RTS, IrDA 1.0 function, and DMA are supported.

**Table 5.17 Built-in FUART**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |
| Channel 1 | ✓    | ✓    | -    | -    |

Note1: ✓: Available, -: N/A

Note2: External pin are not same by product. Please refer to section “2 Pin Assignment”.

## 5.17. Serial Peripheral Interface (TSPI)

The TSPI supports two communication methods and enables to perform serial communication between other devices at high speed. The SPI bus type, which uses a CS (Chip Select) signal at communications, and SIO bus type, which does not use a CS signal at communications can be selected.

The data length can be changed from 7 bits (with a parity bit) to 32 bits (without a parity bit) in the unit of one bit. There are an 8 stage 16-bit FIFO for reception and transmission, each. The TSPI supports the master and slave communications.

**Table 5.18 Built-in TSPI**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |
| Channel 1 | ✓    | ✓    | ✓    | ✓    |
| Channel 2 | ✓    | ✓    | ✓    | ✓    |
| Channel 3 | ✓    | ✓    | ✓    | ✓    |
| Channel 4 | ✓    | ✓    | ✓    | ✓    |
| Channel 5 | ✓    | ✓    | ✓    | -    |
| Channel 6 | ✓    | ✓    | -    | -    |
| Channel 7 | ✓    | ✓    | -    | -    |
| Channel 8 | ✓    | -    | -    | -    |

Note1: ✓: Available, -: N/A

Note2: External pin are not same by product. Please refer to section “2 Pin Assignment”.

## 5.18. I<sup>2</sup>C Interface (I<sup>2</sup>C)

I<sup>2</sup>C is two-wire bi-directional serial communications between Master and Slave device. The mode in which two or more masters can exist on the same bus called a multi-master is supported. It supports Standard mode (Max 100kbps), Fast mode (Max 400kbps).

**Table 5.19 Built-in I<sup>2</sup>C**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |
| Channel 1 | ✓    | ✓    | ✓    | ✓    |
| Channel 2 | ✓    | ✓    | ✓    | ✓    |
| Channel 3 | ✓    | ✓    | -    | -    |
| Channel 4 | ✓    | ✓    | -    | -    |

Note: ✓: Available, -: N/A

## 5.19. Consumer Electronics Control Circuit (CEC)

CEC (Consumer Electronics Control) transfers data compliant with HDMI standard Version 1.3a.

**Table 5.20 Built-in CEC**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.20. 8-bit Digital to Analog Converter (DAC)

The DAC is an R-2R type 8-bit digital to analog converter that can output the specified voltage. A buffer amplifier is not incorporated.

**Table 5.21 Built-in DAC**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |
| Channel 1 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.21. 12-bit Analog to Digital Converter (ADC)

The ADC is a successive-approximation analog to digital converter. It supports maximum 24 analog inputs. The combination of conversion result register and analog input can be programmed for each AD conversion start factor, and it can be selected the highest startup factor / general purpose startup factor or sampling period. A startup trigger for ADC can be selected from software or peripheral functions (timer/event counter outputs, port inputs).

The monitor function is also available and it can generate an interrupt request when the compare conditions are matched.

**Table 5.22 Built-in ADC**

| UNIT   | M4G9 | M4G8 | M4G7 | M4G6 |
|--------|------|------|------|------|
| unit A | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

**Table 5.23 Number of analog inputs for ADC**

|                         | M4G9 | M4G8 | M4G7 | M4G6 |
|-------------------------|------|------|------|------|
| Analog inputs pin count | 24   | 24   | 20   | 16   |

## 5.22. Advanced Programmable Motor Control Circuit (A-PMD)

The Advanced Programmable Motor control circuit (A-PMD) can control motors easily. It incorporates a three-phase pulse modulation circuit and a dead-time circuit, and easily generates waveforms for motor control.

**Table 5.24 Built-in A-PMD**

| Channel   | M4G9 | M4G8 | M4G7 | M4G6 |
|-----------|------|------|------|------|
| Channel 0 | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.23. 32-bit Timer Event Counter (T32A)

The T32A is a timer event counter that can operate as a 32-bit timer or two 16-bit timers. 16-bit Timer or 32-bit Timer can be selected. In 16-bit Timer, the T32A is comprised of Timer A and Timer B incorporating a 16-bit counter respectively. In 32-bit Timer, the T32A operates as Timer C incorporating a 32-bit counter.

The T32A have an interval timer, event counter, input capture, 2-phase counter input, PPG output, Synchronous Start, and Trigger start/stop functions.

**Table 5.25 Built-in T32A**

| Channel    | M4G9 | M4G8 | M4G7 | M4G6 |
|------------|------|------|------|------|
| Channel 0  | ✓    | ✓    | ✓    | ✓    |
| Channel 1  | ✓    | ✓    | ✓    | ✓    |
| Channel 2  | ✓    | ✓    | ✓    | ✓    |
| Channel 3  | ✓    | ✓    | ✓    | ✓    |
| Channel 4  | ✓    | ✓    | ✓    | ✓    |
| Channel 5  | ✓    | ✓    | ✓    | ✓    |
| Channel 6  | ✓    | ✓    | ✓    | ✓    |
| Channel 7  | ✓    | ✓    | ✓    | ✓    |
| Channel 8  | ✓    | ✓    | ✓    | ✓    |
| Channel 9  | ✓    | ✓    | ✓    | ✓    |
| Channel 10 | ✓    | ✓    | ✓    | ✓    |
| Channel 11 | ✓    | ✓    | ✓    | ✓    |
| Channel 12 | ✓    | ✓    | ✓    | ✓    |
| Channel 13 | ✓    | ✓    | ✓    | ✓    |

Note1: ✓: Available, -: N/A

Note2: External pin are not same by product. Please refer to section “2 Pin Assignment”.

## 5.24. Long Term Timer (LTTMR)

The long term timer (LTTMR) notifies an interrupt request at a constant period. The period is generated based on the frequency of the internal oscillator 2 (IHOSC2). The interrupt cycle can be generated in the range of 0.1  $\mu$ s to 6553.5  $\mu$ s. The output of LTTMR can be used as the source clock of RMC and CEC.

**Table 5.26 Built-in LTTMR**

| Channel | M4G9 | M4G8 | M4G7 | M4G6 |
|---------|------|------|------|------|
| LTTMR   | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.25. Real Time Clock (RTC)

The RTC is a peripheral function that has a second counter, clock function, and leap year calendar function. It also has the alarm function that generates an interrupt on a specified time and date.

Since the RTC operates on a low speed external oscillation clock, it can operate in low power consumption mode such as IDLE, STOP1 or STOP2 mode. In addition, the MCU can be returned from low power consumption mode by an interrupt request of the RTC.

The RTC easily corrects a gain/loss of the clock caused by an error of low speed oscillation frequency using the clock correction function.

**Table 5.27 Built-in RTC**

|     | M4G9 | M4G8 | M4G7 | M4G6 |
|-----|------|------|------|------|
| RTC | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.26. Clock Selective Watchdog Timer (SIWDT)

The SIWDT is a peripheral function that detects an overflow of the binary counter and generates an interrupt request or resets the MCU. This state occurs when a binary counter cannot be cleared within the preset detection time.

The count clock can be selected from three clocks: system clock ( $f_{sys}/4$ ), internal high speed oscillator 1 ( $f_{IHOSC1}$ ), or internal high speed oscillator 2 ( $f_{IHOSC2}$ ).

It also provides the count-clear window function that can clear the count only for the specified period.

Moreover, change of a register can be forbidden by setting to protected mode.(the count-clear function is possible)

**Table 5.28 Built-in SIWDT**

|       | M4G9 | M4G8 | M4G7 | M4G6 |
|-------|------|------|------|------|
| SIWDT | ✓    | ✓    | ✓    | ✓    |

Note: ✓: Available, -: N/A

## 5.27. Remote Control Signal Preprocessor (RMC)

The RMC is a peripheral function that receives signals excluding carrier signal from remote control reception signals. The RMC detects a leader signal to receive 72 bits data in a collective manner. Two data formats can be received: synchronous format and fixed-synchronous phase format.

In addition, it contains a digital noise canceller to avoid external noise. The interval of the leader signals can be also measured using the timer event counter.

Since the RMC operates on a low speed clock, it can operate in low power consumption mode, such as IDLE mode, STOP1 mode or STOP2 mode according to the setting. The MCU can also be returned from low power consumption mode by an interrupt request of the RMC.

**Table 5.29 Built-in RMC**

| Channel  | M4G9 | M4G8 | M4G7 | M4G6 |
|----------|------|------|------|------|
| Channel0 | ✓    | ✓    | ✓    | ✓    |
| Channel1 | ✓    | ✓    | ✓    | -    |

Note: ✓: Available, -: N/A

## 5.28. Boundary Scan (BSC)

A boundary-scan support the on-board Test. The TMPM4G group (1) provides a boundary-scan interface that is compatible with Joint Test Action Group (JTAG) specifications and uses the industry-standard JTAG protocol (IEEE Standard 1149.1•1990 <Includes IEEE Standard 1449.1a•1993>).

**Table 5.30 Built-in BSC**

|               | M4G9 | M4G8 | M4G7 | M4G6 |
|---------------|------|------|------|------|
| Boundary-scan | ✓    | ✓    | -    | -    |

Note1: ✓: Available, -: N/A

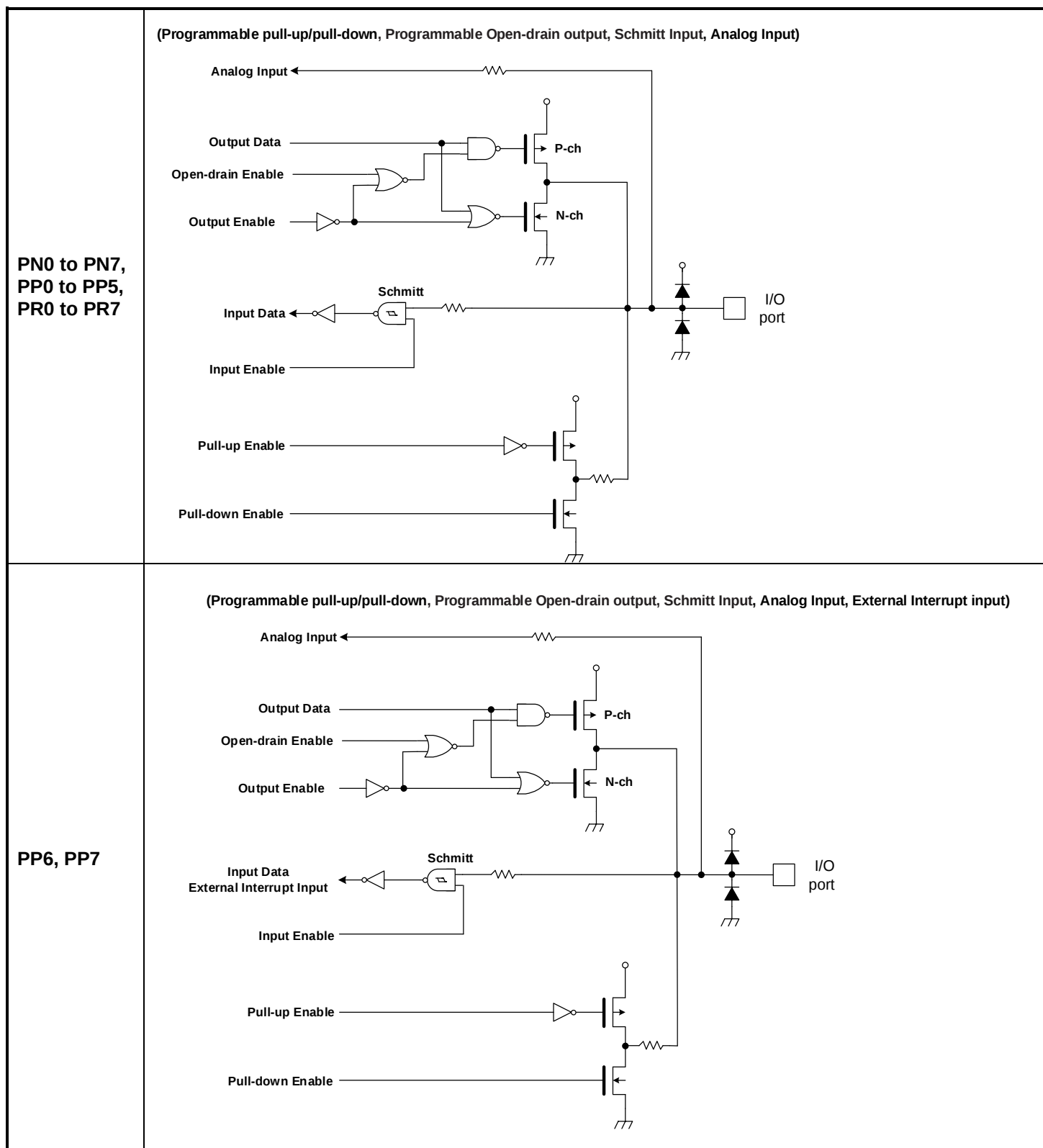
Note2: It is implemented only VFBGA177 and VFBGA145

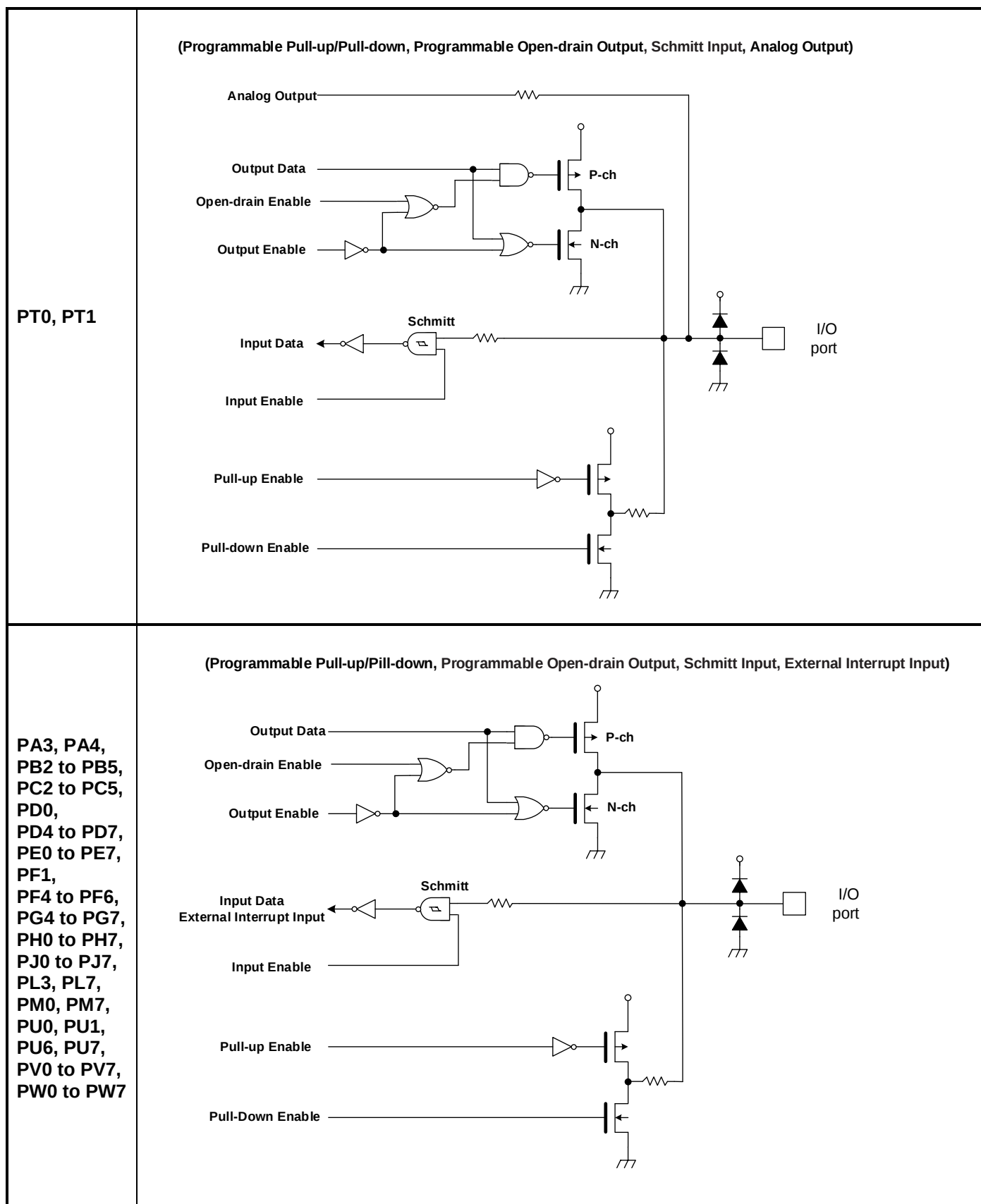
## 6. Equivalent Circuit

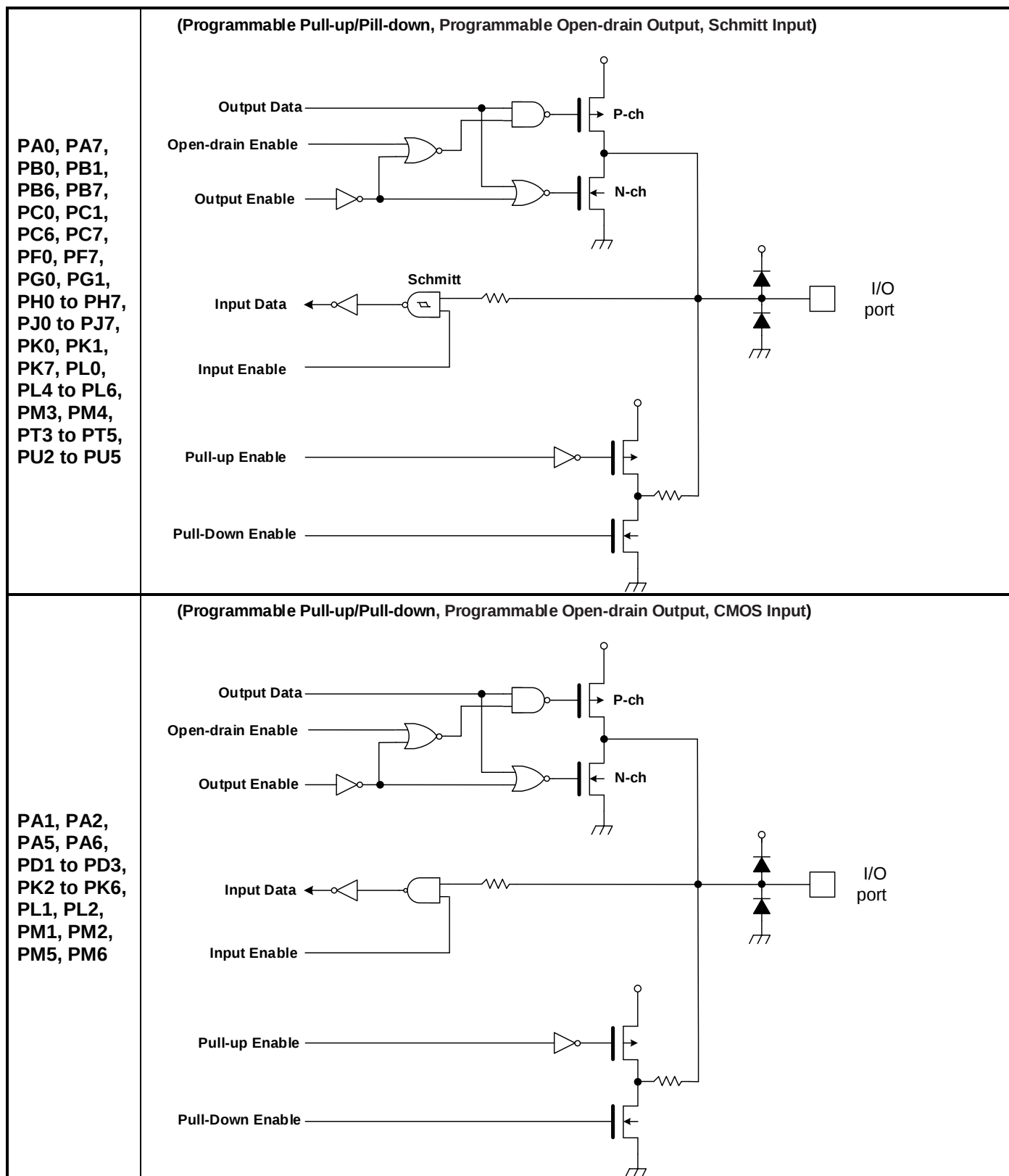
Basically, the gate symbols written are the same as those used for the standard CMOS logic IC [74HCXX] series.  
The input protection resistance ranges from several tens of  $\Omega$  to several hundred  $\Omega$ . Feedback resistor and Damping resistor are shown with a typical value.

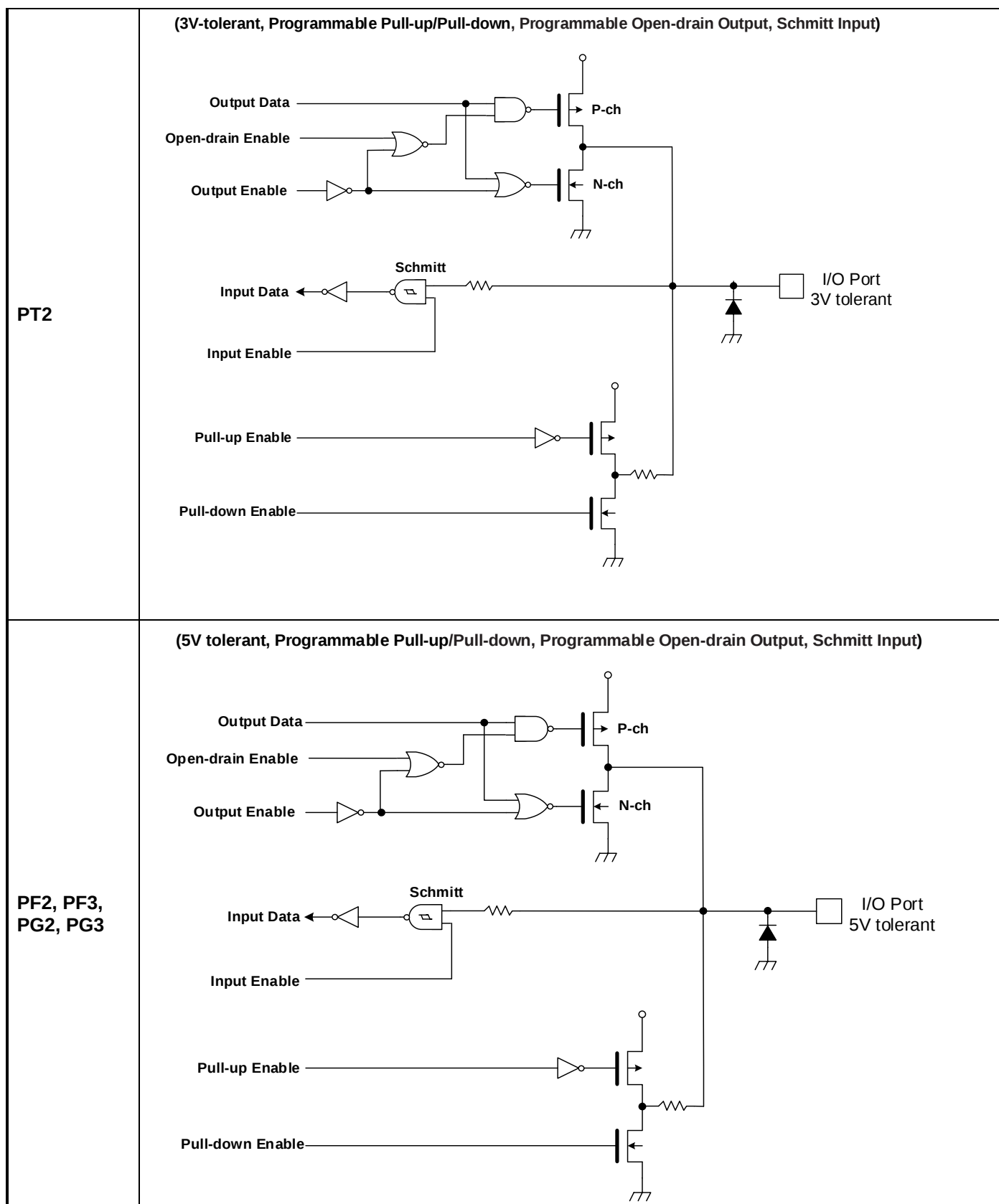
Note: The resistance without the statement of the numerical value in the figure shows input protection resistance.

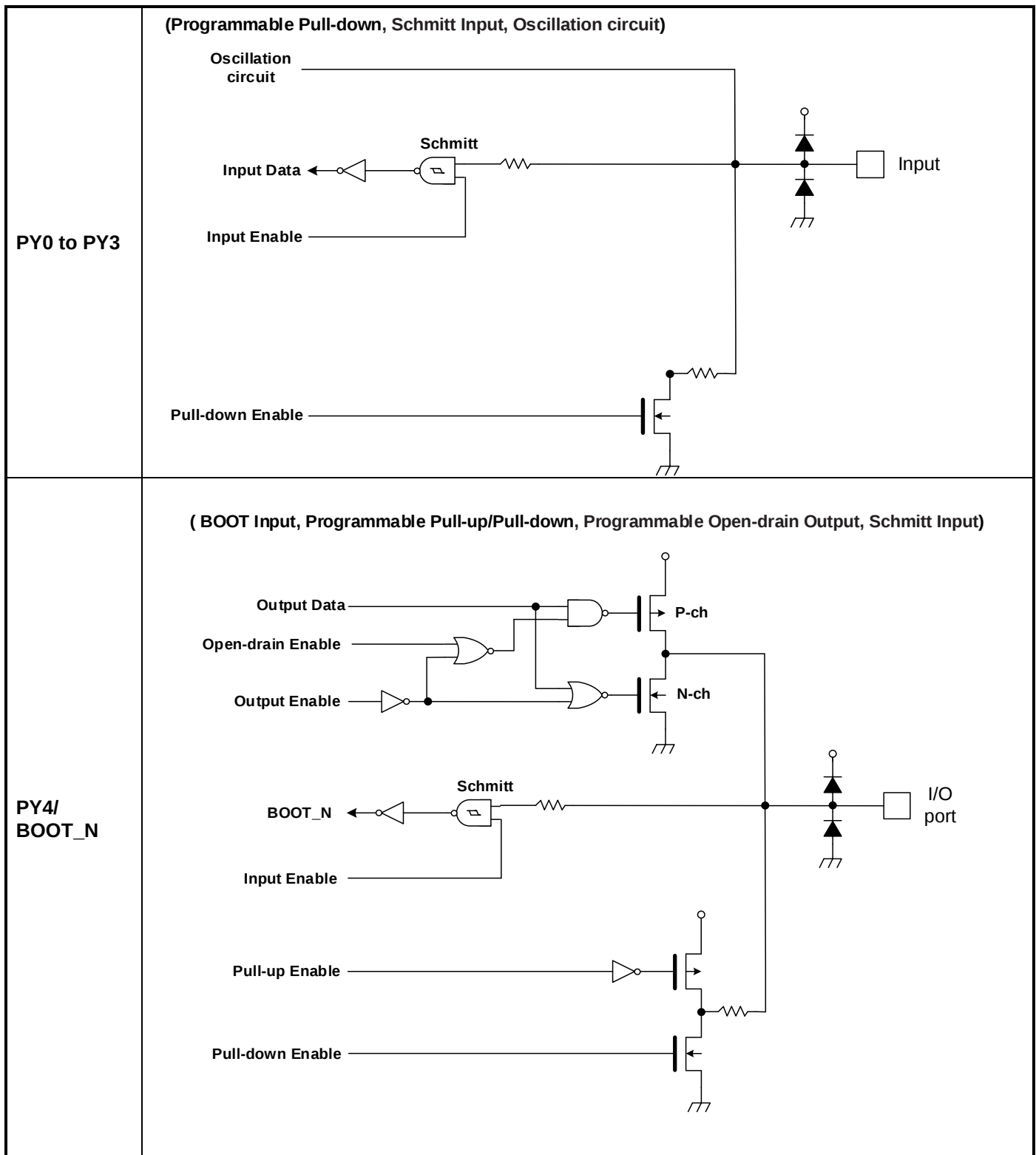
### 6.1. Port





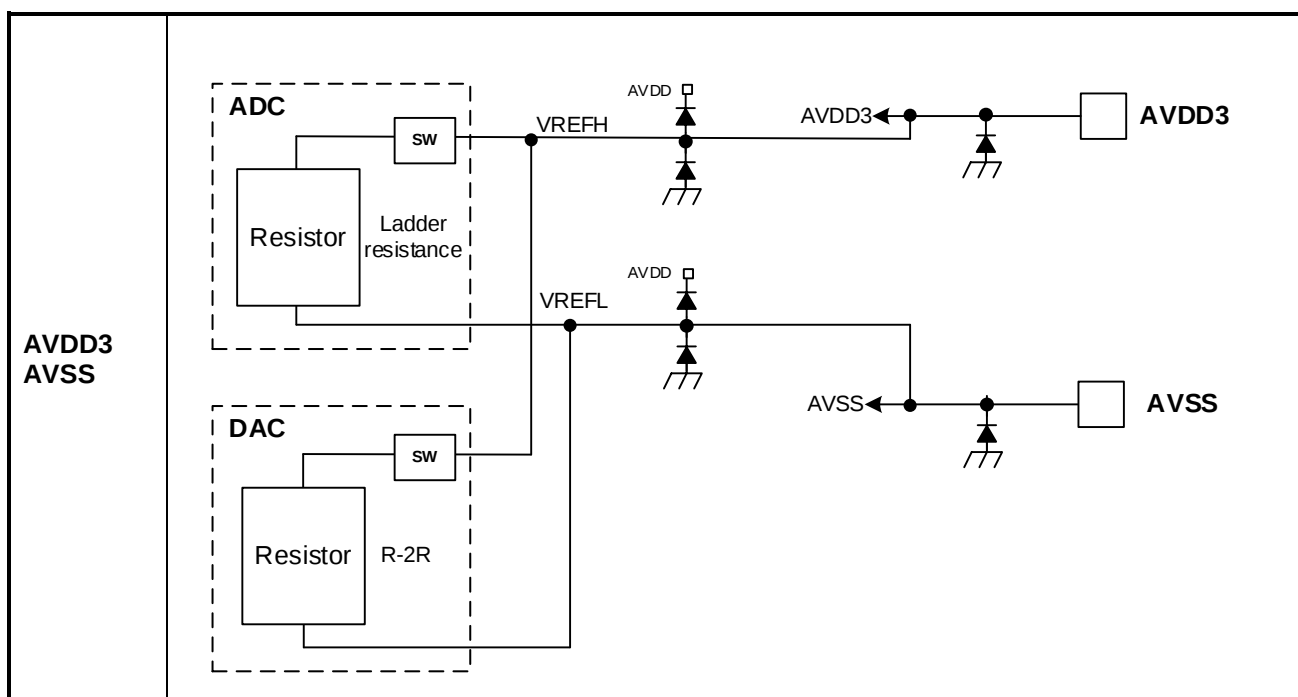






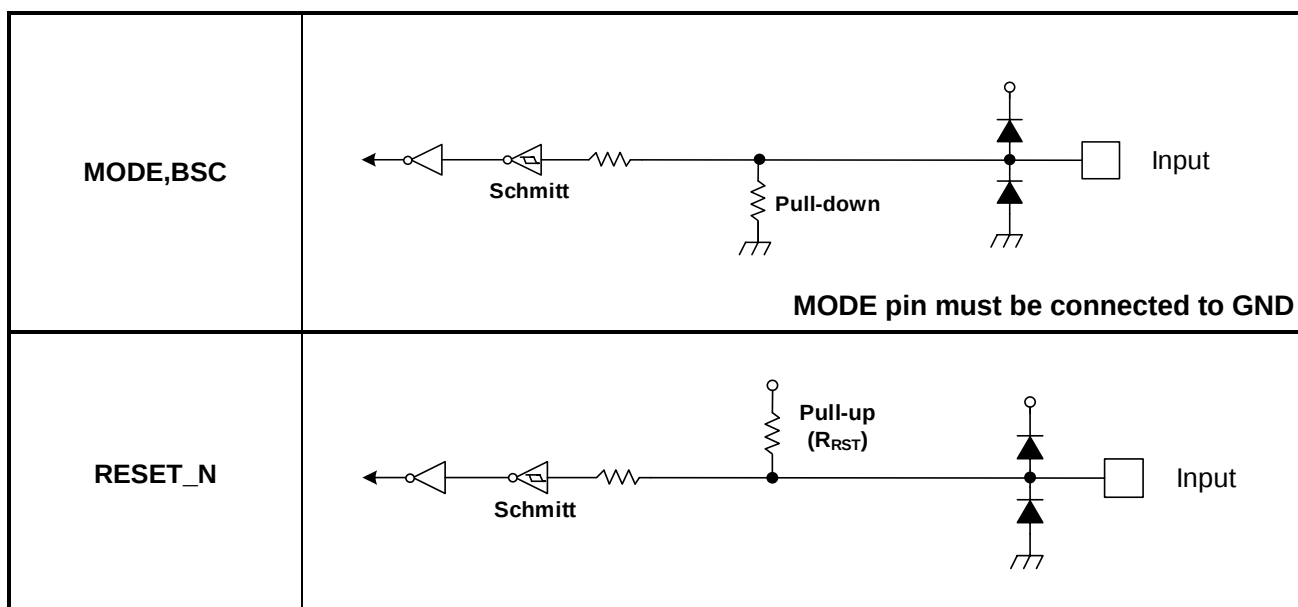
Note: Although, this port is input during pin reset period and POR period, it can be used for output port when use as port.

## 6.2. Analog Power pin



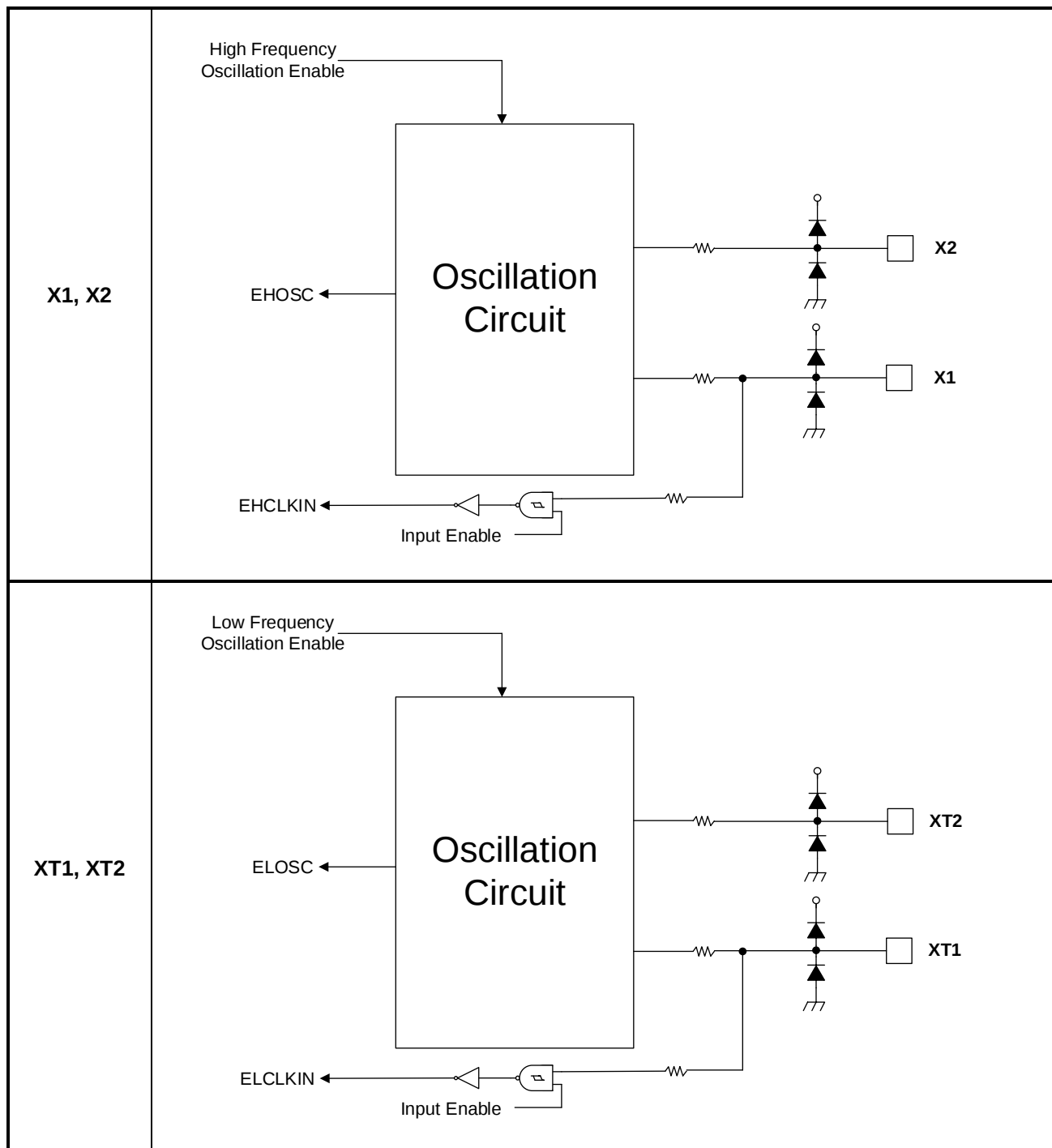
Note: SW: ON/OFF Switch Circuit

## 6.3. Control Pin



MODE pin must be connected to GND

## 6.4. Clock control



## 7. Electrical Characteristics

### 7.1. Absolute Maximum Ratings

**Table 7.1 Absolute maximum ratings**

| Parameter                    |                                                                                                                                                                                                                                                             | Symbol              | Rating                                                                    | Unit |
|------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|---------------------------------------------------------------------------|------|
| Power supply voltage         |                                                                                                                                                                                                                                                             | DVDD3A to DVDD3H    | -0.3 to 3.9                                                               | V    |
|                              |                                                                                                                                                                                                                                                             | AVDD3               | -0.3 to 3.9                                                               |      |
| Input voltage                | PA0 to PA7, PB0 to PB7, PC0 to PC7, PD0 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG4 to PG7, PH0 to PH7, PJ0 to PJ7, PK0 to PK7, PL0 to PL7, PM0 to PM7, PT3 to PT5, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY0 to PY3, MODE, RESET_N, BOOT_N, BSC  | V <sub>IN1</sub>    | -0.3 to DVDD3+0.3(≤ 3.9V)<br>(DVDD3 is generic name for DVDD3A to DVDD3H) | V    |
|                              | PN0 to PN7, PP0 to PP7, PR0 to PR7, PT0, PT1                                                                                                                                                                                                                | V <sub>IN2</sub>    | -0.3 to AVDD3+0.3(≤ 3.9V)                                                 |      |
|                              | PF2, PF3, PG2, PG3                                                                                                                                                                                                                                          | V <sub>IN3</sub>    | -0.3 to 5.5                                                               |      |
|                              | PT2                                                                                                                                                                                                                                                         | V <sub>IN4</sub>    | -0.3 to 3.9                                                               |      |
| Low level output current     | PA0 to PA7, PB0 to PB7, PC0 to PC7, PD0 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG4 to PG7, PH0 to PH7, PJ0 to PJ7, PK0 to PK7, PL0 to PL7, PN0 to PN7, PM0 to PM7, PP0 to PP7, PR0 to PR7, PT0 to PT5, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY4 | I <sub>OL1</sub>    | 5                                                                         | mA   |
|                              | PF2, PF3, PG2, PG3                                                                                                                                                                                                                                          | I <sub>OL2</sub>    | 25                                                                        |      |
|                              | Total                                                                                                                                                                                                                                                       | ΣI <sub>OL</sub>    | 50                                                                        |      |
| High level output current    | PA0 to PA7, PB0 to PB7, PC0 to PC7, PD0 to PD7, PE0 to PE7, PF0 to PF7, PG0 to PG7, PH0 to PH7, PJ0 to PJ7, PK0 to PK7, PL0 to PL7, PN0 to PN7, PM0 to PM7, PP0 to PP7, PR0 to PR7, PT0 to PT5, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY4                     | I <sub>OH1</sub>    | -5                                                                        |      |
|                              | Total                                                                                                                                                                                                                                                       | ΣI <sub>OH</sub>    | -50                                                                       |      |
| Power consumption (Ta= 85°C) |                                                                                                                                                                                                                                                             | PD                  | 600                                                                       | mW   |
| Soldering temperature        |                                                                                                                                                                                                                                                             | T <sub>SOLDER</sub> | 260                                                                       | °C   |
| Storage temperature          |                                                                                                                                                                                                                                                             | T <sub>STG</sub>    | -55 to 125                                                                | °C   |
| Operational temperature      | f <sub>sys</sub> ≤ 120MHz                                                                                                                                                                                                                                   | T <sub>OPR1</sub>   | -40 to 85                                                                 | °C   |
|                              | f <sub>sys</sub> ≤ 160MHz                                                                                                                                                                                                                                   | T <sub>OPR2</sub>   | -40 to 70                                                                 |      |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Absolute maximum ratings are limiting values of operating and environmental conditions which should not be exceeded under the worst possible conditions. The equipment manufacturer should design so that no Absolute maximum rating value is exceeded with respect to current, voltage, power consumption, temperature, etc. Exposure to conditions beyond those listed above may cause permanent damage to the device or affect device reliability, which could increase potential risks of personal injury due to IC blow up and/or burning.

## 7.2. DC Electrical Characteristics (1/2)

DVDD3 = AVDD3 = 2.7V to 3.6V

DVSS = AVSS = 0V

Ta = -40 to 85°C

| Parameter                | Symbol                                                                                                                                                                                                                                                                                    | Conditions                                                                                                                                                                          | Min        | Typ. | Max        | Unit |
|--------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|------|------------|------|
| Power supply voltage     | VDD                                                                                                                                                                                                                                                                                       | $f_{osc} = 8 \text{ to } 20\text{MHz}$<br>$f_{sys} = 1 \text{ to } 160\text{MHz}$<br>(Ta = -40 to 70°C)<br>1 to 120MHz<br>(Ta = -40 to 85°C)<br>$f_s = 30 \text{ to } 34\text{kHz}$ | 2.7        | -    | 3.6        | V    |
| Low level Input voltage  | PA1, PA2, PA5, PA6, PD1 to PD3, PK2 to PK6, PL1, PL2, PM1, PM2, PM5, PM6                                                                                                                                                                                                                  | V <sub>IL1</sub>                                                                                                                                                                    | -0.3       | -    | DVDD3×0.3  | V    |
|                          | PA0, PA3 to PA4, PA7, PB0 to PB7, PC0 to PC7, PD0, PD4 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG4 to PG7, PH0 to PH7, PJ0 to PJ7, PK0, PK1, PK7, PL0, PL3 to PL7, PM0, PM3, PM4, PM7, PT3 to PT5, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY0 to PY3, MODE, RESET_N, BOOT_N, BSC | V <sub>IL2</sub>                                                                                                                                                                    |            |      | DVDD3×0.25 |      |
|                          | PN0 to PN7, PP0 to PP7, PR0 to PR7, PT0, PT1                                                                                                                                                                                                                                              | V <sub>IL3</sub>                                                                                                                                                                    |            |      | AVDD3×0.25 |      |
|                          | PF2, PF3, PG2, PG3, PT2                                                                                                                                                                                                                                                                   | V <sub>IL4</sub>                                                                                                                                                                    |            |      | DVDD3×0.3  |      |
|                          | PA1, PA2, PA5, PA6, PD1 to PD3, PK2 to PK6, PL1, PL2, PM1, PM2, PM5, PM6                                                                                                                                                                                                                  | V <sub>IH1</sub>                                                                                                                                                                    | DVDD3×0.7  |      | DVDD3+0.3  |      |
| High level Input voltage | PA0, PA3, PA4, PA7, PB0 to PB7, PC0 to PC7, PD0, PD4 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG4 to PG7, PH0 to PH7, PJ0 to PJ7, PK0, PK1, PK7, PL0, PL3 to PL7, PM0, PM3, PM4, PM7, PT3 to PT5, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY0 to PY3, MODE, RESET_N, BOOT_N, BSC   | V <sub>IH2</sub>                                                                                                                                                                    | DVDD3×0.75 | -    | DVDD3+0.3  | V    |
|                          | PN0 to PN7, PP0 to PP7, PR0 to PR7, PT0, PT1                                                                                                                                                                                                                                              | V <sub>IH3</sub>                                                                                                                                                                    | AVDD3×0.75 |      | AVDD3+0.3  |      |
|                          | PF2, PF3, PG2, PG3, PT2                                                                                                                                                                                                                                                                   | V <sub>IH4</sub>                                                                                                                                                                    | DVDD3×0.7  |      | DVDD3+0.3  |      |
|                          |                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                     |            |      |            |      |

DVDD3 = AVDD3 = 2.7V to 3.6V

DVSS = AVSS = 0V

Ta = -40 to 85°C

| Parameter                 | Symbol             | Conditions                                                                                                                                                                                                                                                     | Min                    | Typ. | Max | Unit |
|---------------------------|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|------|-----|------|
| Low level output voltage  |                    | PA0 to PA7, PB0 to PB7, PC0 to PC7, PD0 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG6, PG7, PH0 to PH7, PJ0 to PJ7, PK0 to PK7, PL0 to PL7, PM0 to PM7, PN0 to PN7, PP0 to PP7, PR0 to PR7, PT0 to PT2, PT4, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY4 |                        |      |     | V    |
|                           | V <sub>OL1</sub>   | DVDD3=AVDD3=2.7V<br>I <sub>OL</sub> = 1.6mA                                                                                                                                                                                                                    | -                      | -    | 0.4 |      |
|                           | PG4, PG5, PT3, PT5 | DVDD3=2.7V<br>I <sub>OL</sub> =8mA                                                                                                                                                                                                                             | -                      | -    | 0.4 |      |
|                           | PF2, PF3, PG2, PG3 | DVDD3=2.7V<br>I <sub>OL</sub> =12mA                                                                                                                                                                                                                            | -                      | -    | 1.0 |      |
| High level output voltage |                    | PA0 to PA7, PB0 to PB7, PC0 to PC7, PD0 to PD7, PE0 to PE7, PF0, PF1, PF4 to PF7, PG0, PG1, PG6, PG7, PH0 to PH7, PJ0 to PJ7, PK0 to PK7, PL0 to PL7, PM0 to PM7, PN0 to PN7, PP0 to PP7, PR0 to PR7, PT0 to PT2, PT4, PU0 to PU7, PV0 to PV7, PW0 to PW7, PY4 |                        |      |     | V    |
|                           | V <sub>OH1</sub>   | DVDD3=AVDD3=2.7V<br>I <sub>OH</sub> = -1.6mA                                                                                                                                                                                                                   | DVDD3-0.4<br>AVDD3-0.4 | -    | -   |      |
|                           | PG4, PG5, PT3, PT5 | DVDD3=2.7V<br>I <sub>OH</sub> = -8mA                                                                                                                                                                                                                           | DVDD3-0.4              | -    | -   |      |
|                           | PF2, PF3, PG2, PG3 | DVDD3=2.7V<br>I <sub>OH</sub> = -1.0mA                                                                                                                                                                                                                         | DVDD3-0.4              | -    | 1.0 |      |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Typ. value is in Ta = 25 °C, DVDD3 = AVDD3 = 3.3V, unless otherwise noted.

Note3: Apply same voltage to DVDD3 and AVDD3.

DVDD3=AVDD3= 2.7V to 3.6V  
DVSS=AVSS=0V  
Ta= -40 to 85°C

| Parameter                               |                                                                                                                                                                                                                                                                                    | Symbol            | Conditions                                     | Min | Typ. | Max | Unit |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|------------------------------------------------|-----|------|-----|------|
| Input leak current                      |                                                                                                                                                                                                                                                                                    | I <sub>LI</sub>   | 0.0V ≤ VIN ≤ DVDD3<br>0.0V ≤ VIN ≤ AVDD3       | -   | 0.05 | ±5  | μA   |
| Output leak current                     |                                                                                                                                                                                                                                                                                    | I <sub>LO</sub>   | 0.2 ≤ VIN ≤ DVDD3-0.2<br>0.2 ≤ VIN ≤ AVDD3-0.2 | -   | 0.05 | ±10 |      |
| Schmitt trigger Input width             |                                                                                                                                                                                                                                                                                    | V <sub>TH</sub>   |                                                | -   | 0.8  | -   | V    |
| Reset pull-up resistor                  |                                                                                                                                                                                                                                                                                    | R <sub>RST</sub>  |                                                | 25  | 45   | 100 | kΩ   |
| Programmable pull-up/pull-down resistor | Other than the following                                                                                                                                                                                                                                                           | P <sub>KH</sub>   | Pull-up                                        | 25  | 45   | 100 | kΩ   |
|                                         |                                                                                                                                                                                                                                                                                    |                   | Pull-down                                      | 25  | 45   | 100 |      |
|                                         | 5V tolerant                                                                                                                                                                                                                                                                        | P <sub>KH5</sub>  | Pull-up                                        | 40  | 70   | 150 |      |
|                                         |                                                                                                                                                                                                                                                                                    |                   | Pull-down                                      | 40  | 70   | 150 |      |
|                                         | 3V tolerant                                                                                                                                                                                                                                                                        | P <sub>KH3</sub>  | Pull-up                                        | 30  | 47   | 200 |      |
|                                         |                                                                                                                                                                                                                                                                                    |                   | Pull-down                                      | 30  | 47   | 200 |      |
| Pin capacity (except power supply pin)  |                                                                                                                                                                                                                                                                                    | C <sub>IO</sub>   | fc =1MHz                                       | -   | -    | 10  | pF   |
| Low level output current                | Per pin<br>PA0 to PA7,PB0 to PB7,<br>PC0 to PC7,PD0 to 7,PE0 to PE7,<br>PF0,PF1, PF4 to PF7,PG0,PG1,<br>PG6,PG7,PH0 to PH7,PJ0 to PJ7,<br>PK0 to PK7,PL0 to PL7,<br>PM0 to PM7, PN0 to PN7,<br>PP0 to PP7, PR0 to PR7,<br>PT0 to PT2, PT4,PU0 to PU7,<br>PV0 to PV7,PW0 to PW7,PY4 | I <sub>OL1</sub>  | DVDD3=3V<br>AVDD3=3V                           | -   | -    | 2   | mA   |
|                                         | Per pin<br>PG4, PG5,PT3,PT5                                                                                                                                                                                                                                                        | I <sub>OL2</sub>  | DVDD3=3V                                       | -   | -    | 8   |      |
|                                         | Per pin<br>PF2, PF3,PG2, PG3                                                                                                                                                                                                                                                       | I <sub>OL3</sub>  | DVDD3=3V                                       | -   | -    | 12  |      |
|                                         | Total of<br>PA0 to PA7,PB0 to PB7,PT3,PY4                                                                                                                                                                                                                                          | ΣI <sub>OL1</sub> | DVDD3=3V                                       | -   | -    | 35  |      |
|                                         | Total of<br>PD0 to PD7, PE0 to PE7,<br>PJ4 to PJ7, PU0 to PU7                                                                                                                                                                                                                      | ΣI <sub>OL2</sub> | DVDD3=3V                                       | -   | -    | 35  |      |
|                                         | Total of<br>PC0 to PC7, PF0 to PF7,<br>PJ0 to PJ3, PL6, PL7,PT2                                                                                                                                                                                                                    | ΣI <sub>OL3</sub> | DVDD3=3V                                       | -   | -    | 35  |      |
|                                         | Total of<br>PG4 to PG7, PH0 to PH7,<br>PM4 to PM7, PV4 to PV7,<br>PW0 to PW3, PT5                                                                                                                                                                                                  | ΣI <sub>OL4</sub> | DVDD3=3V                                       | -   | -    | 35  |      |
|                                         | Total of<br>PG0 to PG3, PK0 to PK7,<br>PL0 to PL5, PM0 to PM3,<br>PV0 to PV3, PW4 to PW7,PT4                                                                                                                                                                                       | ΣI <sub>OL5</sub> | DVDD3=3V                                       | -   | -    | 35  |      |
|                                         | Total of<br>PN0 to PN7,PP0 to PP7,<br>PR0 to PR7,PT0, PT1                                                                                                                                                                                                                          | ΣI <sub>OL6</sub> | AVDD3=3V                                       | -   | -    | 35  |      |

|                           |                                                                                                                                                                                                                                                                                                    |                  |                      |     |   |   |    |
|---------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|----------------------|-----|---|---|----|
| High level output current | per Pin<br>PA0 to PA7, PB0 to PB7,<br>PC0 to PC7, PD0 to PD7,<br>PE0 to PE7, PF0, PF1,<br>PF4 to PF7, PG0, PG1, PG6, PG7<br>PH0 to PH7, PJ0 to PJ7, PK0 to PK7,<br>PL0 to PL7, PM0 to PM7,<br>PN0 to PN7, PP0 to PP7,<br>PR0 to PR7, PT0 to PT2<br>PT4, PU0 to PU7, PV0 to PV7,<br>PW0 to PW7, PY4 | $I_{OH1}$        | DVDD3=3V<br>AVDD3=3V | -2  | - | - | mA |
|                           | per Pin<br>PG4, PG5, PT3, PT5                                                                                                                                                                                                                                                                      | $I_{OH2}$        | DVDD3=3V             | -8  | - | - |    |
|                           | per Pin<br>PF2, PF3, PG2, PG3                                                                                                                                                                                                                                                                      | $I_{OH3}$        | DVDD3=3V             | -12 | - | - |    |
|                           | Total of<br>PA0 to PA7, PB0 to PB7,<br>PT3, PY4                                                                                                                                                                                                                                                    | $\Sigma I_{OH1}$ | DVDD3=3V             | -35 | - | - |    |
|                           | Total of<br>PD0 to PD7, PE0 to PE7,<br>PJ4 to PJ7, PU0 to PU7                                                                                                                                                                                                                                      | $\Sigma I_{OH2}$ | DVDD3=3V             | -35 | - | - |    |
|                           | Total of<br>PC0 to PC7, PF0 to PF7,<br>PJ0 to PJ3, PL6, PL7, PT2                                                                                                                                                                                                                                   | $\Sigma I_{OH3}$ | DVDD3=3V             | -35 | - | - |    |
|                           | Total of<br>PG4 to PG7, PH0 to PH7,<br>PM4 to PM7, PV4 to PV7,<br>PW0 to PW3, PT5                                                                                                                                                                                                                  | $\Sigma I_{OH4}$ | DVDD3=3V             | -35 | - | - |    |
|                           | Total of<br>PG0 to PG3, PK0 to PK7,<br>PL0 to PL5, PM0 to PM3,<br>PV0 to PV3, PW4 to PW7, PT4                                                                                                                                                                                                      | $\Sigma I_{OH5}$ | DVDD3=3V             | -35 | - | - |    |
|                           | Total of<br>PN0 to PN7, PP0 to PP7,<br>PR0 to PR7, PT0, PT1                                                                                                                                                                                                                                        | $\Sigma I_{OH6}$ | AVDD3=3V             | -35 | - | - |    |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Typ. value is in  $T_a = 25\text{ }^{\circ}\text{C}$ , DVDD3 = AVDD3 = 3.3V, unless otherwise noted.

Note3: Apply same voltage to DVDD3 and AVDD3.

## 7.3. DC Electrical Characteristics (2/2) (Consumption current)

| Item                     | Products                                                                                                                                                                                                                                             |
|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Code Flash 1.5MB         | TMPM4G9F15FG, TMPM4G9F15XBG, TMPM4G8F15FG, TMPM4G8F15XBG                                                                                                                                                                                             |
| Code Flash 1.0MB or less | TMPM4G9F10FG, TMPM4G9FEFG, TMPM4G9FDFG, TMPM4G9F10XBG, TMPM4G9FEXBG, TMPM4G9FDXBG, TMPM4G8F10FG, TMPM4G8FEFG, TMPM4G8FDFG, TMPM4G8F10XBG, TMPM4G8FEXBG, TMPM4G8FDXBG, TMPM4G7F10FG, TMPM4G7FEFG, TMPM4G7FDFG, TMPM4G6F10FG, TMPM4G6FEFG, TMPM4G6FDFG |

For the newest status of each product, Please contact your sales representative.

Ta= -40 to 85°C

| Parameter | Symbol          | Conditions         |                                                                 |                      |                                                                 | Code Flash1.5MB |      |     | Code Flash 1.0MB or less |      |     | Unit |
|-----------|-----------------|--------------------|-----------------------------------------------------------------|----------------------|-----------------------------------------------------------------|-----------------|------|-----|--------------------------|------|-----|------|
|           |                 | Supply voltage     | High speed oscillator                                           | Low speed oscillator | Operating condition                                             | Min             | Typ. | Max | Min                      | Typ. | Max |      |
| Normal    | I <sub>DD</sub> | DVDD3= AVDD3= 3.6V | Refer to the "Table 7.2" and "Table 7.3" for detail             |                      |                                                                 | -               | 45   | 100 | -                        | 40   | 95  | mA   |
|           |                 |                    | Oscillation                                                     | Stop                 | CPU only                                                        |                 | 28   | 93  | -                        | 23   | 80  |      |
| IDLE      |                 |                    | Refer to "Table 7.2" and "Table 7.3" about Operation conditions |                      |                                                                 | -               | 13   | 78  | -                        | 9.5  | 70  |      |
| STOP1     |                 |                    | Stop                                                            | Oscillation          | Refer to "Table 7.2" and "Table 7.3" about Operation conditions | -               | 1.2  | 65  | -                        | 1.2  | 65  | μA   |
| STOP2     |                 |                    |                                                                 | Stop                 |                                                                 | -               | 13.3 | 735 | -                        | 13.3 | 735 |      |
|           |                 |                    |                                                                 |                      |                                                                 | -               | 9.6  | 700 | -                        | 9.6  | 700 |      |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Typ. value is in Ta=25 °C, DVDD3=AVDD3=3.3V, unless otherwise noted.

Note3: Apply same voltage to DVDD3 and AVDD3.

Note4: Input pin is fixed level, Output pin is open.

**Table 7.2 IDD measurement condition (Pin setting, Oscillation Circuit)**

|                                                 |                                                 | NORMAL                                 | IDLE | STOP1    | STOP2 |           |
|-------------------------------------------------|-------------------------------------------------|----------------------------------------|------|----------|-------|-----------|
|                                                 |                                                 |                                        |      | LOSC run |       | LOSC stop |
| Pin setting                                     | DVDD3=<br>AVDD3=                                | 3.3V(Typ.), 3.6V(max)                  |      |          |       |           |
|                                                 | X1,X2                                           | Oscillator connected (10MHz)           |      |          |       |           |
|                                                 | XT1,XT2                                         | Oscillator connected (32.768kHz)       |      |          |       |           |
|                                                 | Input pins                                      | Fixed                                  |      |          |       |           |
|                                                 | Output pins                                     | Open                                   |      |          |       |           |
| Operation condition<br>(Oscillation<br>Circuit) | System clock<br>(fsys)                          | High speed160MHz<br>Middle speed 80MHz |      | Stop     |       |           |
|                                                 | External High speed<br>oscillator<br>(EHOSC)    | Oscillation                            |      | Stop     |       |           |
|                                                 | Internal High speed<br>oscillator 1<br>(IHOSC1) | Stop                                   |      |          |       |           |
|                                                 | PLL                                             | run(16 times)                          |      | Stop     |       |           |
|                                                 | External Low speed<br>oscillator<br>(ELOSC)     | Oscillation                            |      |          | Stop  |           |

Table 7.3 IDD measurement condition (CPU, Peripheral)

| Peripheral       | unit number | NORMAL                                                                         | IDLE                           | STOP1            | STOP2                        |           |
|------------------|-------------|--------------------------------------------------------------------------------|--------------------------------|------------------|------------------------------|-----------|
|                  |             |                                                                                |                                | LOSC oscillation | LOSC oscillation RTC,RMC run | LOSC stop |
| CPU              | 1           | Run<br>(Dhrystone Ver.2.1)                                                     | Stop                           |                  |                              |           |
| HDMAC            | 2           | Unit A<br>(software startup of ch1,<br>memory to memory transmission)          | Stop                           |                  |                              |           |
|                  |             | Unit B<br>(software startup of ch0,memory to<br>peripheral(EBIF) transmission) |                                |                  |                              |           |
| MDMAC            | 1           | Unit A<br>(software startup,<br>memory to memory transmission)                 | Stop                           |                  |                              |           |
| ADC              | 1           | Run<br>(1.15μs, Repeated conversion)                                           | Stop                           |                  |                              |           |
| DAC              | 2           | Run                                                                            | Stop                           |                  |                              |           |
| EBIF             | 1           | Run<br>(Asynchronous separate mode,<br>Internal 4 wait access)                 | Stop                           |                  |                              |           |
| T32A             | 14          | All Ch: Run                                                                    | Stop                           |                  |                              |           |
| A-PMD            | 1           | Run                                                                            | Stop                           |                  |                              |           |
| A-ENC            | 1           | Run                                                                            | Stop                           |                  |                              |           |
| RTC              | 1           | Run                                                                            | Run                            |                  |                              | Stop      |
| SIWDT            | 1           | Run                                                                            | Stop                           |                  |                              |           |
| UART             | 6           | Data Transmission (5Mbps)                                                      | Stop                           |                  |                              |           |
| FUART            | 2           | Data Transmission (2.5Mbps)                                                    | Stop                           |                  |                              |           |
| I <sup>2</sup> C | 5           | Run only clock(fprsc = 5MHz)                                                   | Stop                           |                  |                              |           |
| TSPI             | 9           | Transfer Clock ch0 to ch3: 20MHz<br>ch4 to ch8: 10MHz                          | Stop                           |                  |                              |           |
| SMIF             | 1           | Run                                                                            | Stop                           |                  |                              |           |
| ISD              | 3           | Run                                                                            | Run                            |                  |                              | Stop      |
| LTTMR            | 1           | Run                                                                            | Stop                           |                  |                              |           |
| CEC              | 1           | Run, Transfer                                                                  | Stop<br>(supply only<br>clock) | Stop             |                              |           |
| RMC              | 2           | Run                                                                            | Run                            |                  |                              | Stop      |
| LVD              | 1           | Stop                                                                           | Stop                           |                  |                              |           |
| OFD              | 1           | Run (OFD reset output disable)                                                 | Stop                           |                  |                              |           |
| PORT             | -           | Stop                                                                           | Stop                           |                  |                              |           |

fsysm=80MHz  
Ta= -40 to 85°C

| Parameter                          | Symbol            | Conditions | Min | Typ. | Max | Unit |
|------------------------------------|-------------------|------------|-----|------|-----|------|
| Power consumption<br>(ADC,DAC run) | I <sub>AVDD</sub> | AVDD3=3.3V | -   | 2.0  | 3.0 | mA   |

## 7.4. 12-bit AD Converter Characteristics

DVDD3 = AVDD3 = 2.7V to 3.6V

DVSS = AVSS = 0V

Ta = -40 to 85°C

| Parameter                             | Symbol            | Conditions                                                                                              | Min   | Typ. | Max           | Unit |
|---------------------------------------|-------------------|---------------------------------------------------------------------------------------------------------|-------|------|---------------|------|
| Analog reference voltage (+)          | VREFH             |                                                                                                         | AVDD3 | -    | AVDD3         | V    |
| Analog input voltage                  | VAIN              |                                                                                                         | AVSS  | -    | AVDD3 (VREFH) | V    |
| Integral nonlinearity error (INL)     | -                 | 2.7V ≤ AVDD3 ≤ 3.6V<br>AIN load resistor ≤ 600Ω<br>AIN load capacity ≥ 0.1μF<br>Conversion time ≥ 1.0μs | -6    | -    | +6            | LSB  |
| Differential nonlinearity error (DNL) |                   |                                                                                                         | -5    | -    | +5            |      |
| Zero-scale error                      |                   |                                                                                                         | -6    | -    | +6            |      |
| Full-scale error                      |                   |                                                                                                         | -6    | -    | +6            |      |
| Total errors                          |                   |                                                                                                         | -7    | -    | +7            |      |
| Stable time                           | t <sub>sta</sub>  | [ADAMOD0]<DACON>= 1 is set                                                                              | 3     | -    | -             | μs   |
| Conversion time                       | t <sub>conv</sub> | 2.7V ≤ AVDD3 ≤ 3.6V                                                                                     | 1.0   | -    | 5.0           | μs   |

## 7.5. 8-bit DA Converter Characteristics

DVDD3 = AVDD3 = 2.7V to 3.6V

DVSS = AVSS = 0V

Ta = -40 to 85°C

| Parameter                            | Symbol           | Conditions                         | Min   | Typ. | Max   | Unit |
|--------------------------------------|------------------|------------------------------------|-------|------|-------|------|
| Analog reference voltage(+)          | VREFH            |                                    | AVDD3 | -    | AVDD3 | V    |
| Integral nonlinearity error(INL)     | -                | 2.7V ≤ AVDD3 ≤ 3.6V<br>Rload= 10MΩ | -2    | -    | +2    | LSB  |
| Differential nonlinearity error(DNL) |                  |                                    | -1    | -    | +1    |      |
| Total errors                         |                  |                                    | -2    | -    | +2    |      |
| Stable time                          | t <sub>sta</sub> | Cload = 20pF                       | 4.5   | -    | -     | μs   |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Typ. value is in Ta=25 °C, DVDD3=AVDD3=3.3V, unless otherwise noted.

Note3: 1LSB = (AVDD5(VREFH) - AVSS(VREFL)) / 256 [V]

Note4: This is the characteristic in case only DA converter is operating.

Note5: When using DAC0 as the reference voltage of Comparator, DAC0 pin should be open.

## 7.6. Characteristics of Internal processing at RESET

DVSS = AVSS = 0V

Ta= -40 to 85°C

| Parameter                          | Symbol             | Conditions                          | Min  | Typ. | Max  | Unit  |
|------------------------------------|--------------------|-------------------------------------|------|------|------|-------|
| Internal Initialized time          | t <sub>IINIT</sub> | Power-On                            | -    | -    | 2.4  | ms    |
|                                    |                    | STOP2 Release by RESET with RESET_N | -    | -    | 1.0  |       |
|                                    |                    | STOP2 Release by Interrupt          | -    | -    | 0.55 |       |
| Internal processing time for Reset | t <sub>IRST</sub>  |                                     | 0.13 | -    | 0.21 |       |
| Pull-up enable time of BOOT_N pin  | t <sub>pup</sub>   |                                     | -    | -    | 1.5  |       |
| Waiting time till CPU running      | t <sub>CPUWT</sub> | Cold Reset                          | 12   | -    | 15   | μs    |
|                                    |                    | Warm Reset                          | 97   | -    | 153  |       |
| Power on rising gradient           | V <sub>PON</sub>   |                                     | 0.01 | -    | 100  | mV/μs |

## 7.7. Characteristics of Power on Reset

DVSS = AVSS = 0V

Ta= -40 to 85°C

| Parameter             | Symbol            | Conditions | Min  | Typ. | Max  | Unit |
|-----------------------|-------------------|------------|------|------|------|------|
| Detection voltage     | V <sub>PREL</sub> | Power-up   | 2.05 | 2.15 | 2.25 | V    |
|                       | V <sub>PDET</sub> | Power-down | 2.0  | 2.1  | 2.2  |      |
| Detection pulse width | T <sub>PDET</sub> |            | 200  | -    | -    | μs   |

## 7.8. Characteristics of Voltage Detection Circuit

DVDD3 = AVDD3 = 2.7V to 3.6V

DVSS = AVSS = 0V

Ta = -40 to 85°C

| Parameter                     | Symbol              | Conditions | Min  | Typ. | Max  | Unit |
|-------------------------------|---------------------|------------|------|------|------|------|
| Detection voltage             | V <sub>LVL0</sub>   | Power-up   | 2.45 | 2.55 | 2.65 | V    |
|                               |                     | Power-down | 2.4  | 2.5  | 2.6  |      |
|                               | V <sub>LVL1</sub>   | Power-up   | 2.55 | 2.65 | 2.75 | V    |
|                               |                     | Power-down | 2.5  | 2.6  | 2.7  |      |
|                               | V <sub>LVL2</sub>   | Power-up   | 2.65 | 2.75 | 2.85 | V    |
|                               |                     | Power-down | 2.6  | 2.7  | 2.8  |      |
|                               | V <sub>LVL3</sub>   | Power-up   | 2.75 | 2.85 | 2.95 | V    |
|                               |                     | Power-down | 2.7  | 2.8  | 2.9  |      |
|                               | V <sub>LVL4</sub>   | Power-up   | 2.85 | 2.95 | 3.05 | V    |
|                               |                     | Power-down | 2.8  | 2.9  | 3.0  |      |
|                               | V <sub>LVL5</sub>   | Power-up   | 2.95 | 3.05 | 3.15 | V    |
|                               |                     | Power-down | 2.9  | 3.0  | 3.1  |      |
|                               | V <sub>LVL6</sub>   | Power-up   | 3.05 | 3.15 | 3.25 | V    |
|                               |                     | Power-down | 3.0  | 3.10 | 3.2  |      |
| Detection response time       | t <sub>VDDT1</sub>  | Power-up   | -    | -    | 200  | μs   |
| Detection Release time        | t <sub>VDDT2</sub>  | Power-down | -    | -    | 200  |      |
| setup time                    | t <sub>LV DEN</sub> |            | -    | -    | 50   |      |
| Detection Minimum pulse width | t <sub>LVDPW</sub>  |            | 200  | -    | -    |      |

## 7.9. AC Electrical Characteristics

### 7.9.1. Serial Peripheral Interface (TSPI)

#### 7.9.1.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3=AVDD3=2.7V to 3.6V
- Ta = -40 to 85°C (fsys≤120MHz), Ta= -40 to 70°C (fsys≤160MHz)
- Output level: High = 0.8×DVDD3, Low = 0.2×DVDD3
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

#### 7.9.1.2. AC Electrical Characteristics

“T” indicates an operation clock cycle of the TSPI. This operation clock has the same cycle of the system clock (fsys). This cycle depends on the clock gear setting.

The number of cycles can be 1 to 16. It is specified with TSPIxSCK. The value of k1 is specified with [TSPIxFMTR0]<CSSCKDL[3:0]>; the value of k2 is specified with [TSPIxFMTR0]<SCKCSDL[3:0]>. These values are 1 to 16.

(1) Master mode

k1=k2=1

| Parameter                                        | Symbol             | Equation                               |                                  | fsysh = 100MHz (Note2) |     | fsys = 80MHz (Note3) |     | Unit |
|--------------------------------------------------|--------------------|----------------------------------------|----------------------------------|------------------------|-----|----------------------|-----|------|
|                                                  |                    |                                        |                                  | ch0-3                  |     | ch4-8                |     |      |
|                                                  |                    | Min                                    | Max                              | Min                    | Max | Min                  | Max |      |
| TSPIxSCK output frequency (Note1)                | f <sub>CYC</sub>   | -                                      | ch0-3: 25                        | -                      | 25  | -                    | -   | MHz  |
|                                                  |                    |                                        | ch4-8: 10                        | -                      | -   | -                    | 10  |      |
| TSPIxSCK output cycle                            | t <sub>CYC</sub>   | -                                      | -                                | 40                     | -   | 100                  | -   | ns   |
| TSPIxSCK low level output pulse width            | t <sub>WL</sub>    | (t <sub>CYC</sub> /2)-10               | -                                | 10                     | -   | 40                   | -   |      |
| TSPIxSCK high level output pulse width           | t <sub>WH</sub>    | (t <sub>CYC</sub> /2)-10               | -                                | 10                     | -   | 40                   | -   |      |
| TSPIxCSn output<br>← TSPIxSCK rise/fall time     | t <sub>CSUM</sub>  | (t <sub>CYC</sub> ×k1)-15              | ch0-3: (t <sub>CYC</sub> ×k1)+9  | 25                     | 49  | -                    | -   |      |
|                                                  |                    |                                        | ch4-8: (t <sub>CYC</sub> ×k1)+13 | -                      | -   | 85                   | 113 |      |
| TSPIxSCK rise/fall time<br>→ TSPIxCSn hold time  | t <sub>CHD</sub>   | ch0-3: (t <sub>CYC</sub> ×k2)-10       | -                                | 30                     | -   | -                    | -   |      |
|                                                  |                    | ch4-8: (t <sub>CYC</sub> ×k2)-15       |                                  | -                      | -   | 85                   | -   |      |
| TSPIxRXD Input<br>← TSPIxSCK rise/fall time      | t <sub>DSU</sub>   | ch0-3: 20-2xT:                         | -                                | 0                      | -   | -                    | -   |      |
|                                                  |                    | ch4-8: 30-2xT:                         |                                  | -                      | -   | 5                    | -   |      |
| TSPIxSCK rise/fall time<br>→ TSPIxRXD hold time  | t <sub>DHD</sub>   | 2xT                                    | -                                | 20                     | -   | 25                   | -   |      |
| TSPIxSCK rise/fall time<br>→ TSPIxTXD hold time  | t <sub>ODLY1</sub> | ch0-3: -7                              | -                                | -7                     | -   | -                    | -   |      |
|                                                  |                    | ch4-8: -10                             |                                  | -                      | -   | -10                  | -   |      |
| TSPIxSCK rise/fall time<br>→ TSPIxTXD delay time | t <sub>ODLY2</sub> | -                                      | ch0-3: 7                         | -                      | 7   | -                    | -   |      |
|                                                  |                    |                                        | ch4-8: 13                        | -                      | -   | -                    | 13  |      |
| TSPIxCSIN fall<br>→ TSPIxTXD delay time          | t <sub>ODLY3</sub> | ch0-3: (t <sub>CYC</sub> ×(k1-0.5))-20 | (t <sub>CYC</sub> ×(k1-0.5))+9   | 0                      | 29  | -                    | -   |      |
|                                                  |                    | ch4-8: (t <sub>CYC</sub> ×(k1-0.5))-50 |                                  | -                      | -   | 0                    | 59  |      |

Note1: The output frequency is determined by the setting value of [TSPIxBR]<BRCK><BRS>. Please set the

output frequency within the range not exceeding the Max value of the Equation.

Note2: Although the maximum frequency of fsysh is 160 MHz, it is described as an example of fsysh = 100 MHz so as to show of outputting the maximum frequency (25 MHz) of TSPIxSCK

Note3: ch4 and ch5 is shown fsysh(160MHz maximum), and ch6 to ch8 is shown fsysm(80MHz maximum).

## (2) Slave mode

| Parameter                                        | Symbol             | Equation  |                        | fsysh = 100MHz |     | fsys = 80MHz (Note) |         | Unit |
|--------------------------------------------------|--------------------|-----------|------------------------|----------------|-----|---------------------|---------|------|
|                                                  |                    |           |                        | ch0-3          |     | ch4-8               |         |      |
|                                                  |                    | Min       | Max                    | Min            | Max | Min                 | Max     |      |
| TSPIxSCK Input frequency                         | f <sub>CYC</sub>   | -         | ch0-3: 20<br>ch4-8: 10 | -              | 20  | -                   | -<br>10 | MHz  |
| TSPIxSCK Input cycle                             | t <sub>CYC</sub>   | 1/fcyc    | -                      | 50             | -   | 100                 | -       | ns   |
| TSPIxSCK low level Input pulse width             | t <sub>WL</sub>    | ch0-3: 15 | -                      | 15             | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 40 |                        | -              | -   | 40                  | -       |      |
| TSPIxSCK High level Input pulse width            | t <sub>WH</sub>    | ch0-3: 15 | -                      | 15             | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 40 |                        | -              | -   | 40                  | -       |      |
| TSPIxCSIN Input<br>← TSPIxSCK rise/fall time     | t <sub>CSU1</sub>  | ch0-3: 40 | -                      | 40             | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 90 |                        | -              | -   | 90                  | -       |      |
| TSPIxCSIN Input<br>← TSPIxSCK rise/fall time     | t <sub>CSU2</sub>  | ch0-3: 40 | -                      | 40             | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 90 |                        | -              | -   | 90                  | -       |      |
| TSPIxSCK rise/fall time<br>→ TSPIxCSIN hold time | t <sub>CHD</sub>   | ch0-3: 40 | -                      | 40             | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 90 |                        | -              | -   | 90                  | -       |      |
| TSPIxRXD Input<br>← TSPIxSCK rise/fall time      | t <sub>DSU</sub>   | ch0-3: 3  | -                      | 3              | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 16 |                        | -              | -   | 16                  | -       |      |
| TSPIxSCK rise/fall<br>→ TSPIxRXD hold time       | t <sub>DHD</sub>   | ch0-3: 8  | -                      | 8              | -   | -                   | -       |      |
|                                                  |                    | ch4-8: 6  |                        | -              | -   | 6                   | -       |      |
| TSPIxSCK rise/fall<br>→ TSPIxTXD hold time       | t <sub>ODLY1</sub> | 2         | -                      | 2              | -   | 2                   | -       |      |
| TSPIxSCK rise/fall<br>→ TSPIxTXD delay time      | t <sub>ODLY2</sub> | ch0-3: 25 | -                      | -              | 25  | -                   | -       |      |
|                                                  |                    | ch4-8: 35 |                        | -              | -   | -                   | 35      |      |
| TSPIxCSIN fall<br>→ TSPIxTXD delay time          | t <sub>ODLY3</sub> | ch0-3: 25 | -                      | -              | 25  | -                   | -       |      |
|                                                  |                    | ch4-8: 38 |                        | -              | -   | -                   | 38      |      |
| TSPIxCSIN high level input pulse width           | t <sub>WDIS</sub>  | T×2+10    | -                      | 30             | -   | 35                  | -       |      |

Note: ch4 and ch5 is shown fsysh(160MHz maximum), and ch6 to ch8 is shown fsysm(80MHz maximum).

(1) 1<sup>st</sup> clock edge sampling (Master)

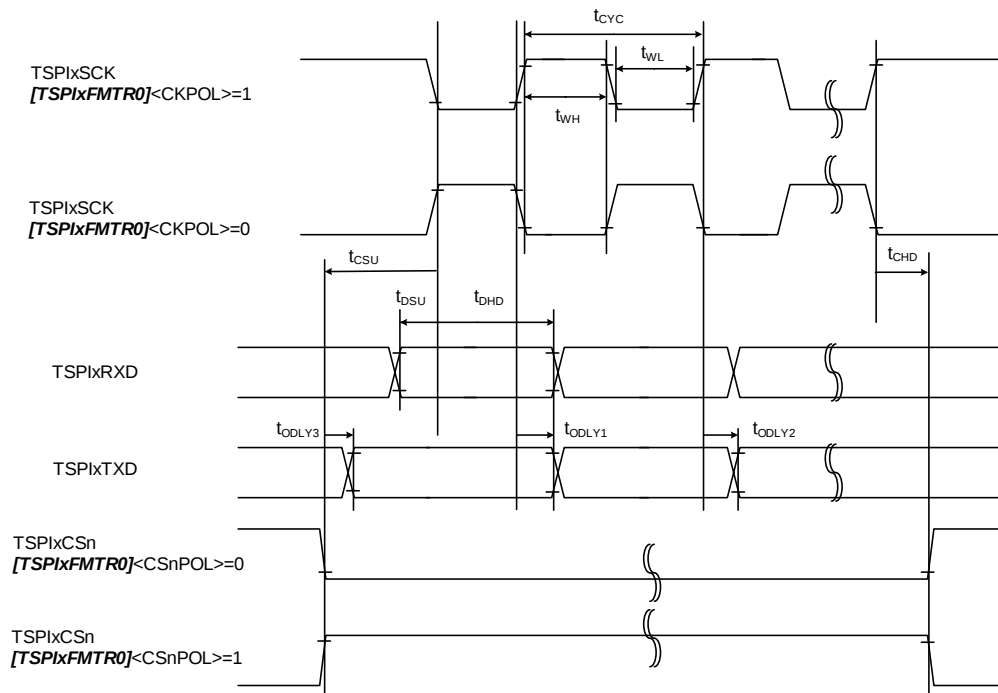


Figure 7.1 1<sup>st</sup> clock edge sampling (Master)

(2) 2<sup>nd</sup> clock edge sampling (Master)

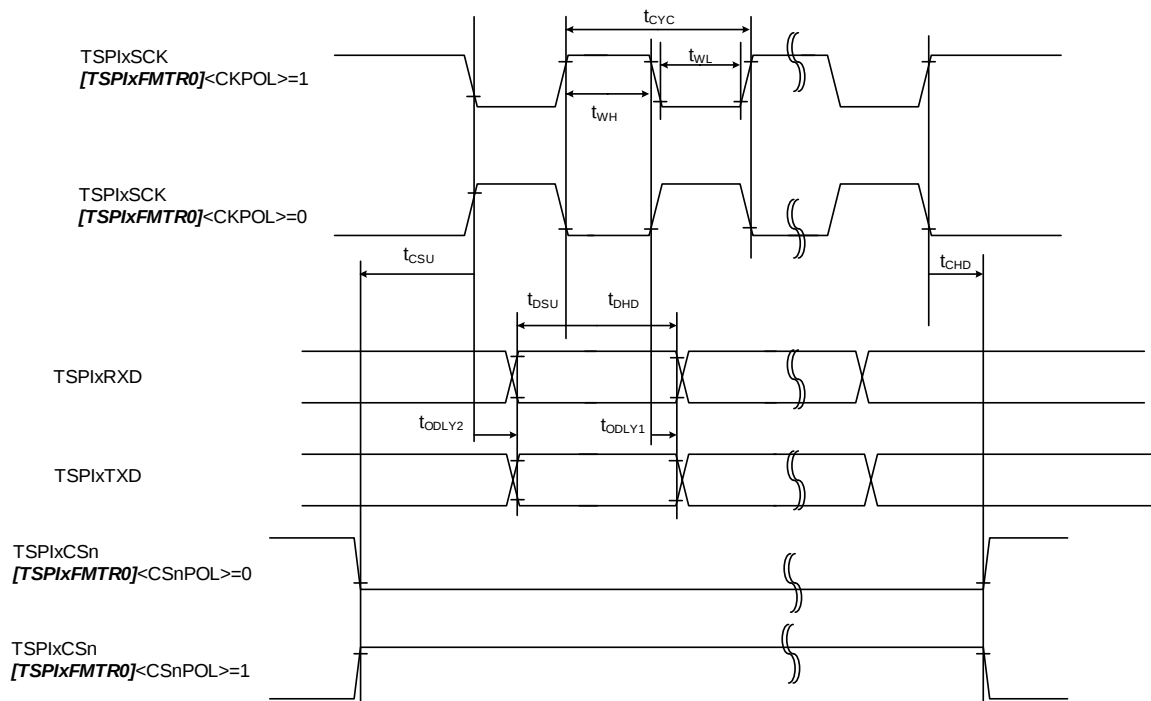


Figure 7.2 2<sup>nd</sup> clock edge sampling (Master)

(3) 2<sup>nd</sup> clock edge sampling (slave)

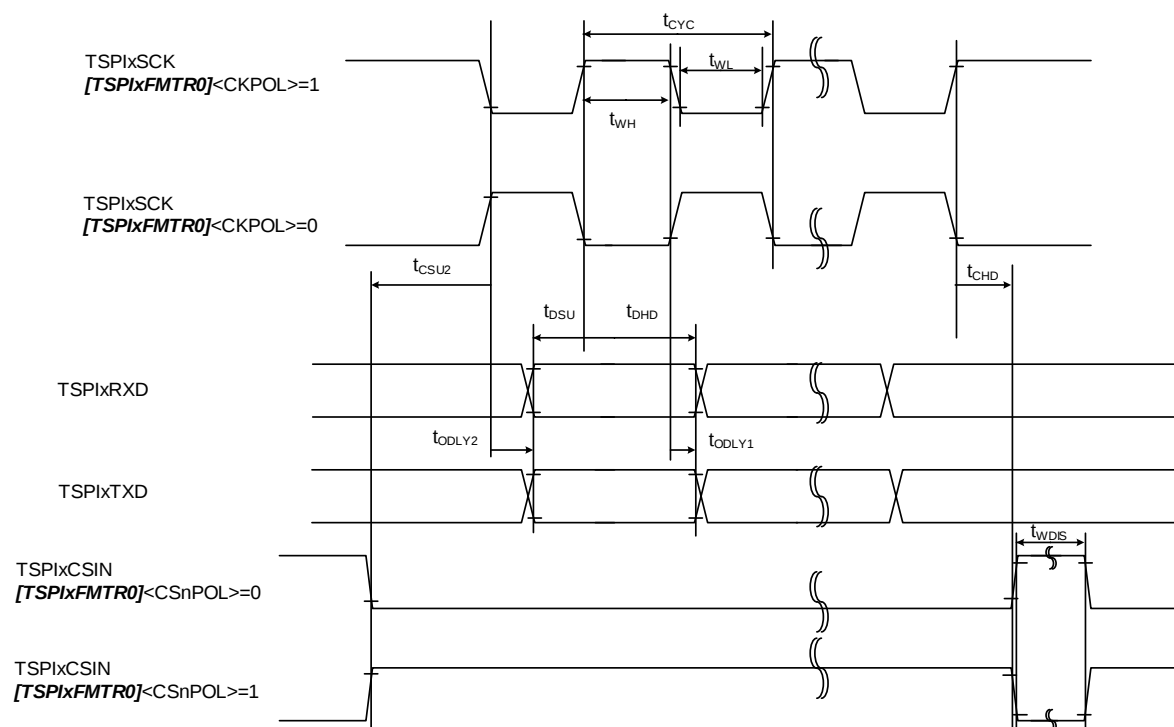


Figure 7.3 2<sup>nd</sup> clock edge sampling (Slave)

## 7.9.2. I2C Interface (I2C)

### 7.9.2.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C
- Output level: Low = 0.4V
- Input level: High = 0.7×DVDD3, Low = 0.3×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

### 7.9.2.2. AC Electrical Characteristics

“T” indicate the Operation clock cycle of I<sup>2</sup>C. The value of “n” is the SCL output clock frequency specified with **[I2CxCR1]<SCK>**.

The value of “p” is the prescaler dividing ratio specified with **[I2CxPRS]<PRSCK>**.

| Parameter                                                         | Symbol               | Standard mode |     | Fast mode |     | Unit |
|-------------------------------------------------------------------|----------------------|---------------|-----|-----------|-----|------|
|                                                                   |                      | Min           | Max | Min       | Max |      |
| SCL clock frequency                                               | f <sub>SCL</sub>     | 0             | 100 | 0         | 400 | kHz  |
| Start condition hold time                                         | t <sub>HD, STA</sub> | 4.0           | -   | 0.6       | -   | μs   |
| SCL clock Low width (Input ) (Note 1)                             | t <sub>LOW</sub>     | 4.7           | -   | 1.3       | -   |      |
| SCL clock High width (Input) (Note 2)                             | t <sub>HIGH</sub>    | 4.0           | -   | 0.6       | -   |      |
| Re-start condition setup time (Note 5)                            | t <sub>SU, STA</sub> | 4.7           | -   | 0.6       | -   |      |
| Data hold time (Input ) (Note 3, 4)                               | t <sub>HD, DAT</sub> | 0             | -   | 0         | -   |      |
| Data setup time                                                   | t <sub>SU, DAT</sub> | 250           | -   | 100       | -   | ns   |
| Stop condition setup time                                         | t <sub>SU, STO</sub> | 4.0           | -   | 0.6       | -   | μs   |
| Bus free time between stop condition and start condition (Note 5) | t <sub>BUF</sub>     | 4.7           | -   | 1.3       | -   |      |

Note1: SCL clock low level width (output):  $p \times (2^{n+1}+10)/T$  (**[I2CxOP]<NFSEL>=0**)

Note2: SCL clock high level width (output):  $p \times (2^{n+1}+6)/T$  (**[I2CxOP]<NFSEL>=0**)

On I2C bus standard, the maximum speed of standard mode/fast mode is 100kHz/400 kHz respectively.

Note that an internal SCL clock frequency is determined by the fsys and the calculation of Note 1 and Note 2 above-mentioned.

Note3: The data hold time (output) is equal to four cycles of the prescaler clock (Tprsc) started from the internal SCL.

Note4: On I2C bus standard, it is described that a data internal hold time should be set at least 300 ns to avoid unstable condition on the falling of the SCL when the SDA is input; however, this precaution is not supported in this MCU. Also, the edge slope control function for the SCL is not available. Therefore, when the customer designs the MCU, make sure to follow the data hold time (input) in the table above. Note that tr/tf on the SCL/SDA should be included in the data hold time.

Note5: Depends on software.

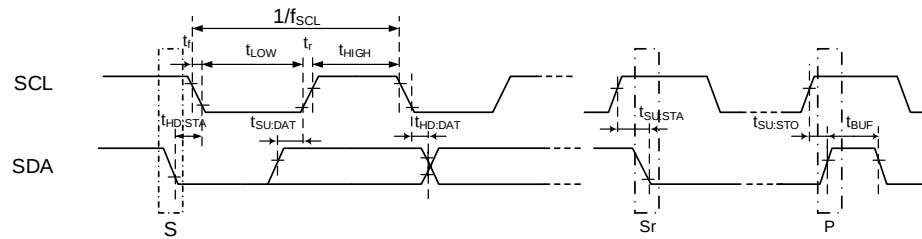


Figure 7.4 AC timing of I<sup>2</sup>C

## 7.9.3. 32-bit Timer Event Counter (T32A)

This section describes AC characteristics of T32AxINA0/A1, T32AxINB0/B1, and T32AxINC0/C1.

### 7.9.3.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

### 7.9.3.2. AC Characteristics

“T” in the table below indicates the operation clock cycle of the T32A. The operation clock of the T32A is the same cycle as the  $\Phi T0m$  clock. This cycle is depending on the Prescaler Clock setting.

(1) Operation other than the pulse count

| Parameter              | Symbol     | Equation  |     | $\Phi T0m=80\text{ MHz}$ |     | Unit |
|------------------------|------------|-----------|-----|--------------------------|-----|------|
|                        |            | Min       | Max | Min                      | Max |      |
| Low level pulse width  | $t_{VCKL}$ | $2T + 20$ | -   | 45                       | -   | ns   |
| High level pulse width | $t_{VCKH}$ | $2T + 20$ | -   | 45                       | -   |      |

(2) At the pulse count

| Parameter              | Symbol     | Equation               |     | $\Phi T0m = 80\text{ MHz}$ |     | Unit |
|------------------------|------------|------------------------|-----|----------------------------|-----|------|
|                        |            | Min                    | Max | Min                        | Max |      |
| Pulse cycle            | $t_{DCYC}$ | 1000                   | -   | 1000                       | -   | ns   |
| Low level pulse width  | $t_{PWL}$  | 500                    | -   | 500                        | -   |      |
| High level pulse width | $t_{PWH}$  | 500                    | -   | 500                        | -   |      |
| Input setup            | $t_{ABS}$  | $(NF+1) \times T + 20$ | -   | 32.5                       | -   |      |
| Input hold             | $t_{ABH}$  | $(NF+1) \times T + 20$ | -   | 32.5                       | -   |      |

NF Value is depending on the  $[T32AxPLSCR]<NF[1:0]>$  setting as following.

| $[T32AxPLSCR]<NF[1:0]>$ | NF Value of Formula |
|-------------------------|---------------------|
| 00                      | 0                   |
| 01                      | 2                   |
| 10                      | 4                   |
| 11                      | 8                   |

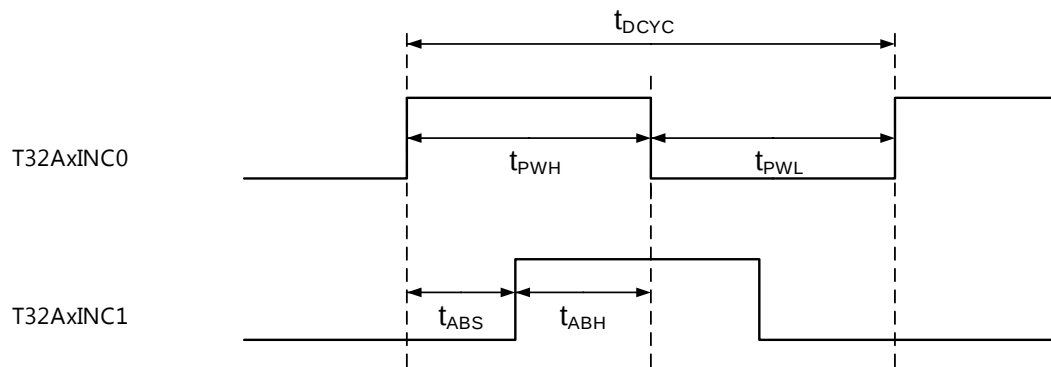


Figure 7.5 Count Pulse input

## 7.9.4. External Bus Interface(EBIF)

### 7.9.4.1. AC Measurement Conditions

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C (fsys ≤ 120MHz), Ta = -40 to 70°C (fsys ≤ 160MHz)
- Output level: High = 0.8 × DVDD3, Low = 0.2 × DVDD3
- Input level: High = 0.75 × DVDD3, Low = 0.25 × DVDD3
- Load capacity: CL = 30pF

### 7.9.4.2. Variable Condition

- RWS: Number of setup cycle insertion before RD, WR asserted.: RWS = 0, 1, 2, 4
- TW: Number of internal wait insertion: TW = 0 to 15
- TWEX: Number of external wait insertion: TWEX = any
- RWH: Number of RD, WR recovery cycle insertion: RWH = 0 to 6 or 8
- CSH: Number of ECSx\_N recovery cycle insertion: CSH = 0, 1, 2, 4

### 7.9.4.3. AC Electrical Characteristics (EEXBCLK asynchronous Separate Mode)

Variable Condition: RWS = 1, TW = 3, TWEX = 4, RWH = 1, CSH = 1

| Parameter                           | Symbol | Equation         |                      | fsysh = 80MHz |      | fsysh = 160MHz |        | Unit |
|-------------------------------------|--------|------------------|----------------------|---------------|------|----------------|--------|------|
|                                     |        | Min              | Max                  | Min           | Max  | Min            | Max    |      |
| System clock cycle (T)              | tSYS   | T                | -                    | 12.5          | -    | 6.25           | -      | ns   |
| EA[0:23] valid → ERD_N, EWR_N fall  | tAC    | T (1+RWS) - 15   | -                    | 10            | -    | -2.5           | -      |      |
| ERD_N, EWR_N rise → EA[0:23] hold   | tCAR   | T (1+RWH+CSH)-17 | -                    | 27.5          | -    | 1.75           | -      |      |
| EA[0:23] valid → ED/EAD[0:15] input | tAD    | -                | T (2+RWS+TW+TWEX)-35 | -             | 90.0 | -              | 27.5   |      |
| ERD_N fall → EA/EAD[0:15] input     | tRD    | -                | T (1+TW+TWEX)-30     | -             | 70.0 | -              | 20     |      |
| ERD_N Low level pulse width         | tRR    | T (1+TW+TWEX)-15 | -                    | 85.0          | -    | 35             | -      |      |
| ERD_N rise → EA/EAD[0:15] hold      | tHR    | 0                | -                    | 0             | -    | 0              | -      |      |
| ERD_N rise → EA[0:23] output        | tRAE   | T (1+RWH+CSH)-17 | -                    | 22.5          | -    | 1.75           | -      |      |
| EWR_N Low level pulse width         | tWW    | T (1+TW+TWEX)-15 | -                    | 85.0          | -    | 35             | -      |      |
| ED/EAD[0:15] valid → EWR_N rise     | tDW    | T (1+TW+TWEX)-15 | -                    | 85.0          | -    | 35             | -      |      |
| EWR_N rise → EA/EAD[0:15] hold      | tWD    | T (1+RWH)-17     | -                    | 15            | -    | -4.5           | -      |      |
| ERD_N/EWR_N fall → EWAIT_N fall     | tRWW   | -                | T (TW)-30            | -             | 7.5  | -              | -11.25 |      |
| EWAIT_N rise → ERD_N/EWR_N rise     | tWRW   | -                | 4T+30                | -             | 80   | -              | 55     |      |

## 1. Read cycle (minimum bus cycle)

(Neither Cycle expander, RD setup, Internal wait, CS recovery nor RD recovery are used)

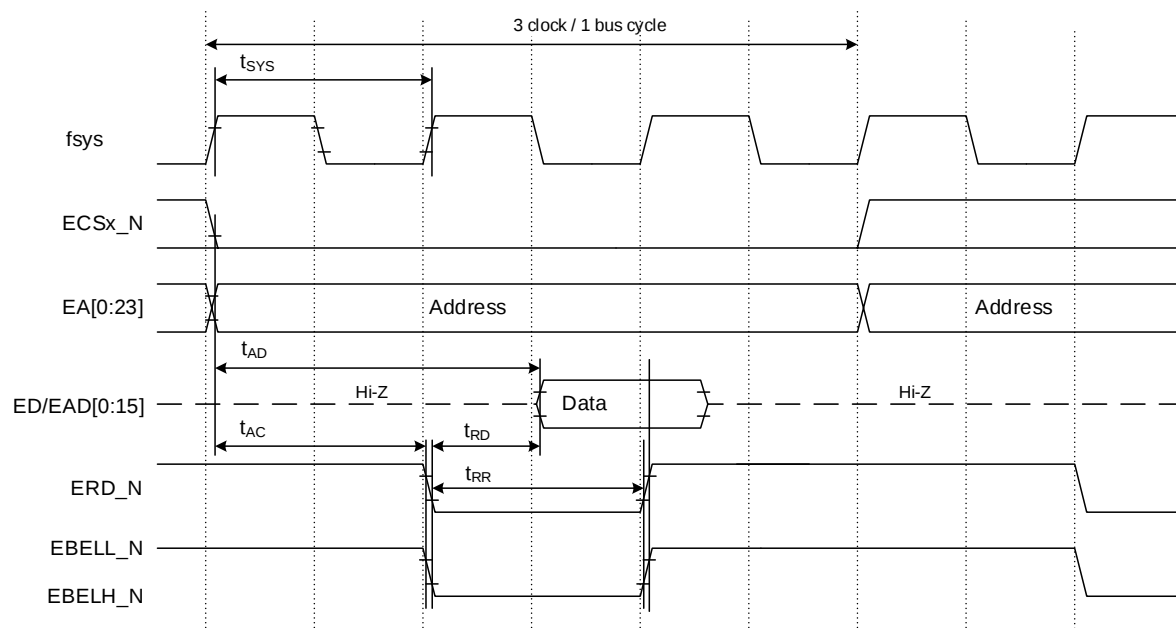


Figure 7.6 Read cycle timing (minimum bus cycle)

## 2. Read cycle (1 bus cycle per 6 clock)

(Cycle expander is not used, RD setup=1cycle, Internal wait=1cycle, CS recovery=1cycle, RD recovery=1cycle)

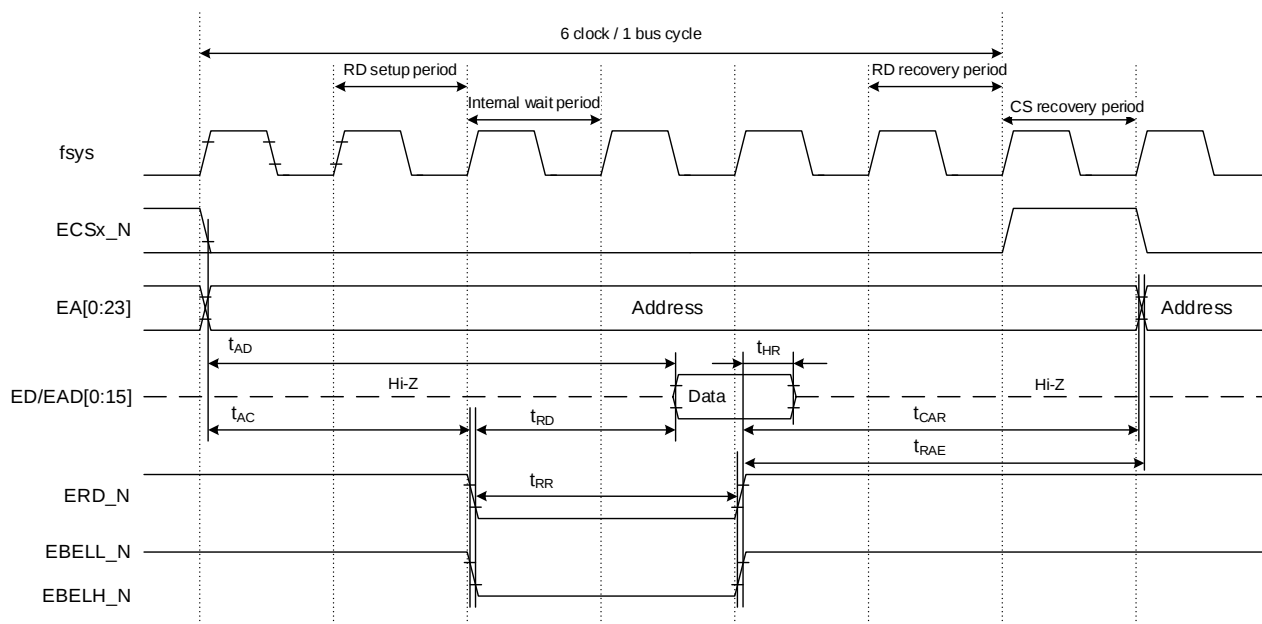


Figure 7.7 Read cycle timing (1 bus cycle per 6 clock)

### 3. Read cycle (external wait)

(Cycle expander is not used, RD setup=1cycle, Internal wait=3cycles, External wait=any, CS recovery=1cycle, RD recovery=1cycle)

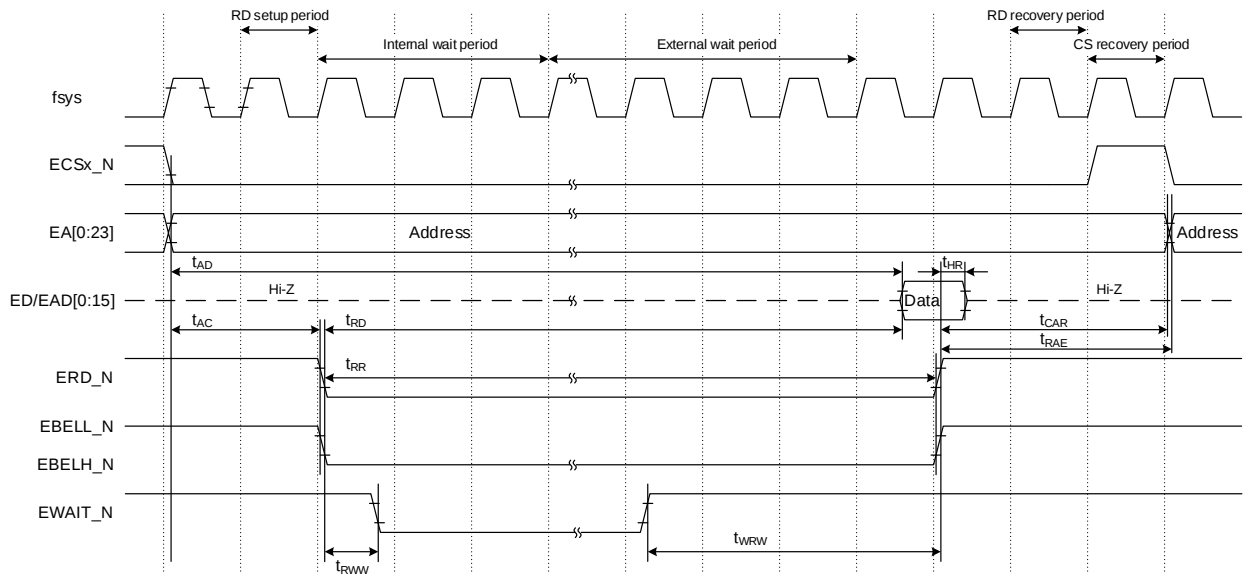


Figure 7.8 Read cycle timing (external wait)

### 4. Write cycle (minimum cycle)

(Neither Cycle expander, WR setup, Internal wait, CS recovery nor WR recovery are used)

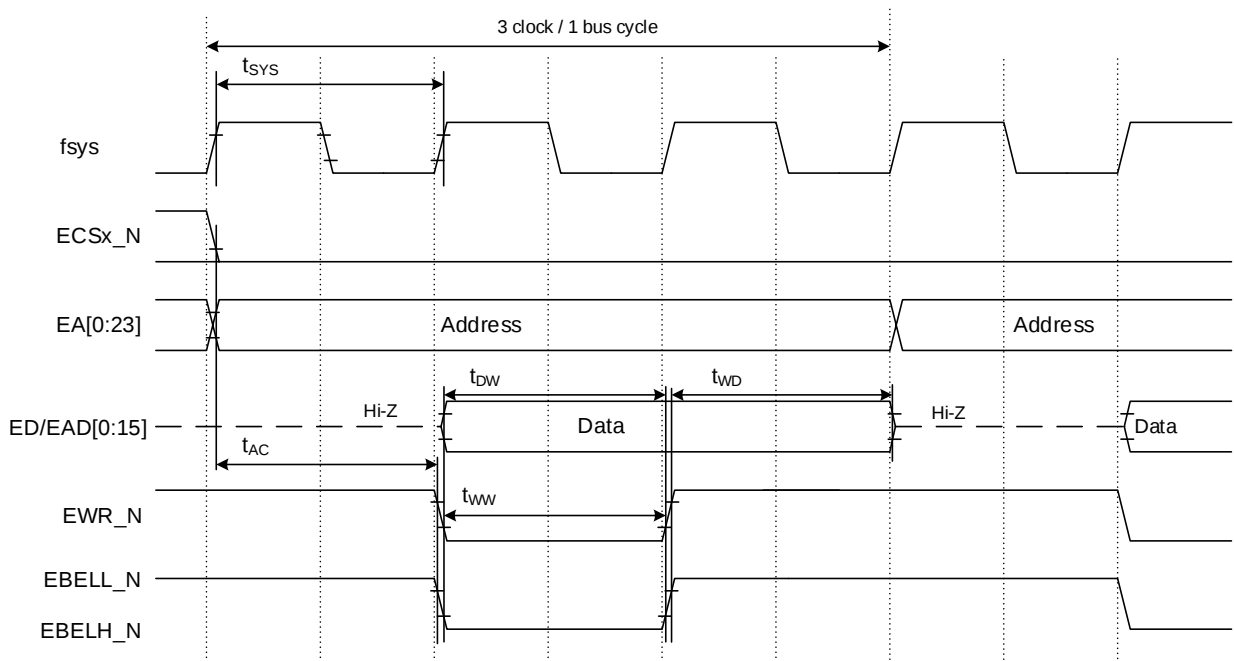


Figure 7.9 Write cycle timing (minimum cycle)

## 5. Write cycle (1 bus cycle per 6 clock)

(Cycle expander is not used, WR setup=1cycle, Internal wait=1cycle, CS recovery=1cycle, WR recovery=1cycle)

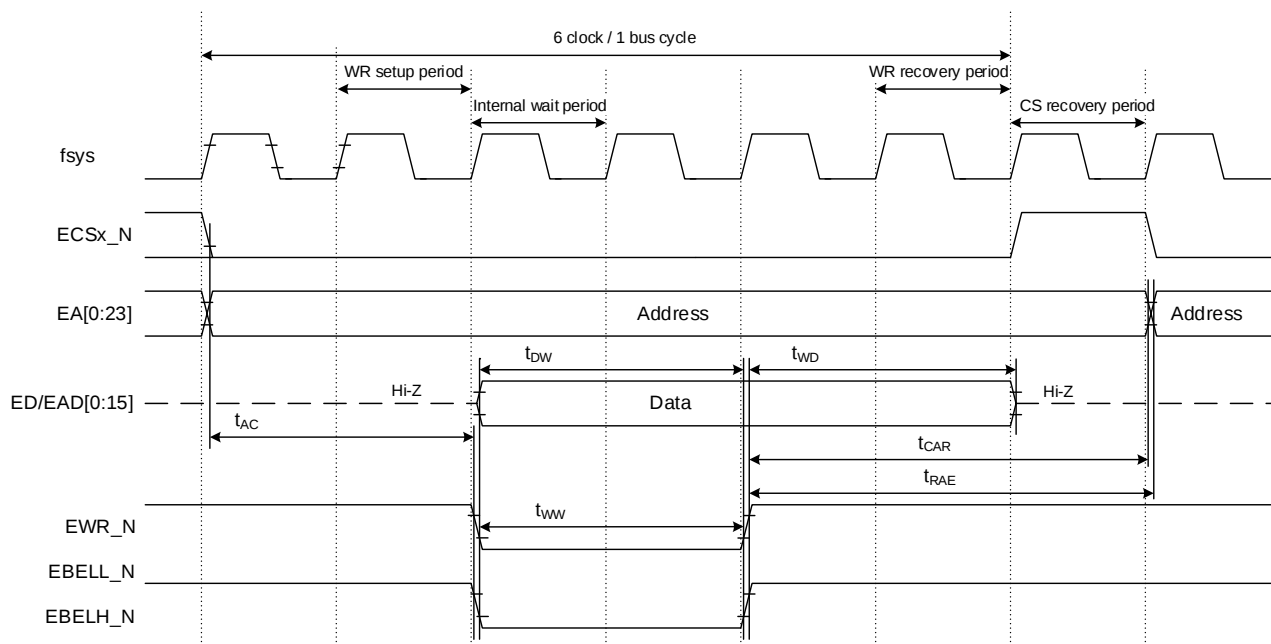


Figure 7.10 Write cycle timing (1 bus cycle per 6 clock)

## 6. Write cycle (external wait)

(Cycle expander is not used, WR setup=1cycle, Internal wait=3cycles, External wait=any, CS recovery=1cycle, WR recovery=1cycle)

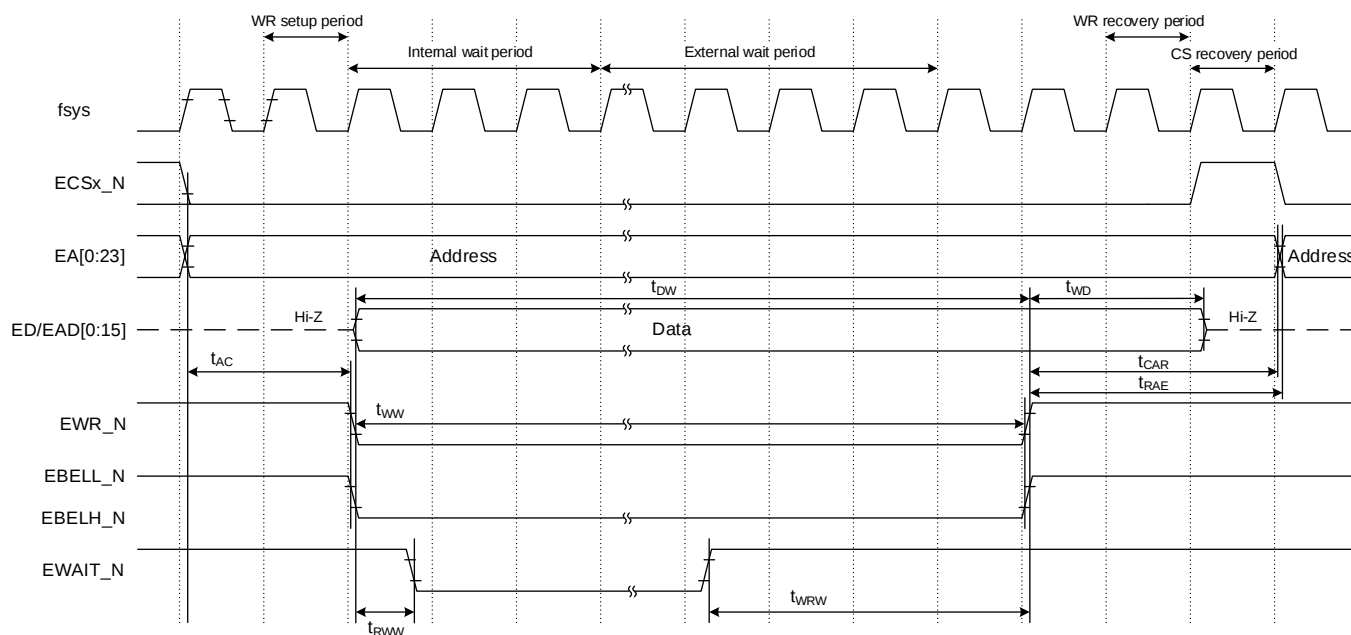


Figure 7.11 Write cycle timing (external wait)

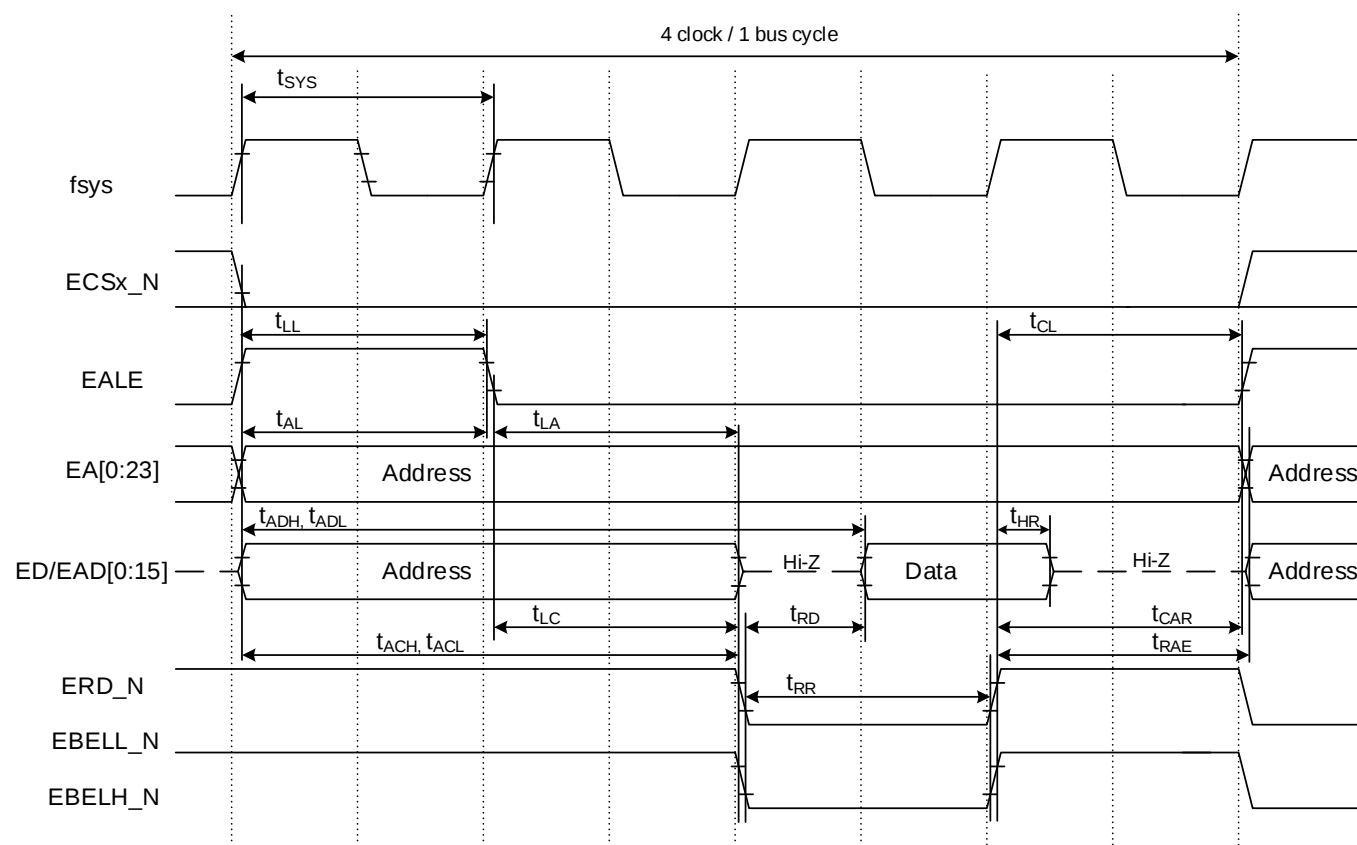
## 7.9.4.4. AC Electrical Characteristics (EEXBCLK asynchronous multiplex bus mode)

Variable Condition: ALE=1, RWS=1, TW=3, TWEX=4, RWH=1, CSH=1

| Parameter                                                                   | Symbol                               | Equation         |                              | fsysh = 80MHz |     | fsysh = 160MHz |        | Unit |
|-----------------------------------------------------------------------------|--------------------------------------|------------------|------------------------------|---------------|-----|----------------|--------|------|
|                                                                             |                                      | Min              | Max                          | Min           | Max | Min            | Max    |      |
| System clock cycle (T)                                                      | t <sub>SYS</sub>                     | T                | -                            | 12.5          | -   | 6.25           | -      | ns   |
| EA[0:23] valid → EALE fall                                                  | t <sub>AL</sub>                      | T (1+ALE)-15     | -                            | 10            | -   | -2.5           | -      |      |
| EALE fall → EA[0:23] hold                                                   | t <sub>LA</sub>                      | T (1+RWS)-15     | -                            | 15            | -   | -2.5           | -      |      |
| EALE High pulse width                                                       | t <sub>LL</sub>                      | T (1+ALE)-15     | -                            | 10            | -   | -2.5           | -      |      |
| EALE fall → ERD_N, EWR_N fall                                               | t <sub>LC</sub>                      | T(1+RWS)-15      | -                            | 15            | -   | -2.5           | -      |      |
| ERD_N, EWR_N rise → EALE rise                                               | t <sub>CL</sub>                      | T (1+RWH+CSH)-15 | -                            | 22.5          | -   | 3.75           | -      |      |
| EA[0:15] valid → ERD_N, EWR_N fall<br>EA[16:23] valid → ERD_N, EWR_N fall   | t <sub>ACL</sub><br>t <sub>ACH</sub> | T (2+ALE+RWH)-15 | -                            | 35            | -   | 10.0           | -      |      |
| ERD_N, EWR_N rise → EA[16:23] hold                                          | t <sub>CAR</sub>                     | T (1+RWH+CSH)-15 | -                            | 22.5          | -   | 3.75           | -      |      |
| EA[0:15] valid → ED/EAD[0:15] input<br>EA[16:23] valid → ED/EAD[0:15] input | t <sub>ADL</sub><br>t <sub>ADH</sub> | -                | T (3+ALE+RWS+TW+TWEX)<br>-35 | -             | 115 | -              | 40     |      |
| ERD_N fall → ED/EAD[0:15] input                                             | t <sub>RD</sub>                      | -                | T (1+TW+TWEX)-30             | -             | 70  | -              | 20     |      |
| ERD_N Low level pulse width                                                 | t <sub>RR</sub>                      | T (1+TW+TWEX)-15 | -                            | 85.0          | -   | 35             | -      |      |
| ERD_N rise → ED/EAD[0:15] hold                                              | t <sub>HR</sub>                      | 0                | -                            | 0             | -   | 0              | -      |      |
| ERD_N rise → EA[0:23] output                                                | t <sub>RAE</sub>                     | T (1+RWH+CSH)-19 | -                            | 22.5          | -   | -0.25          | -      |      |
| EWR_N Low pulse width                                                       | t <sub>WW</sub>                      | T (1+TW+TWEX)-15 | -                            | 85.0          | -   | 35             | -      |      |
| EA/EAD[0:15] valid → EWR_N rise                                             | t <sub>DW</sub>                      | T (1+TW+TWEX)-15 | -                            | 85.0          | -   | 35             | -      |      |
| EWR_N rise → ED/EAD[0:15] hold                                              | t <sub>WD</sub>                      | T (1+RWH)-17     | -                            | 15            | -   | -4.5           | -      |      |
| ERD_N/EWR_N fall → EWAIT_N fall                                             | t <sub>RWW</sub>                     | -                | T (TW)-30                    | -             | 7.5 | -              | -11.25 |      |
| WAIT rise → ERD_N/EWR_N rise                                                | t <sub>WRW</sub>                     | -                | 4T+30                        | -             | 80  | -              | 55     |      |

## 1. Read cycle (minimum cycle)

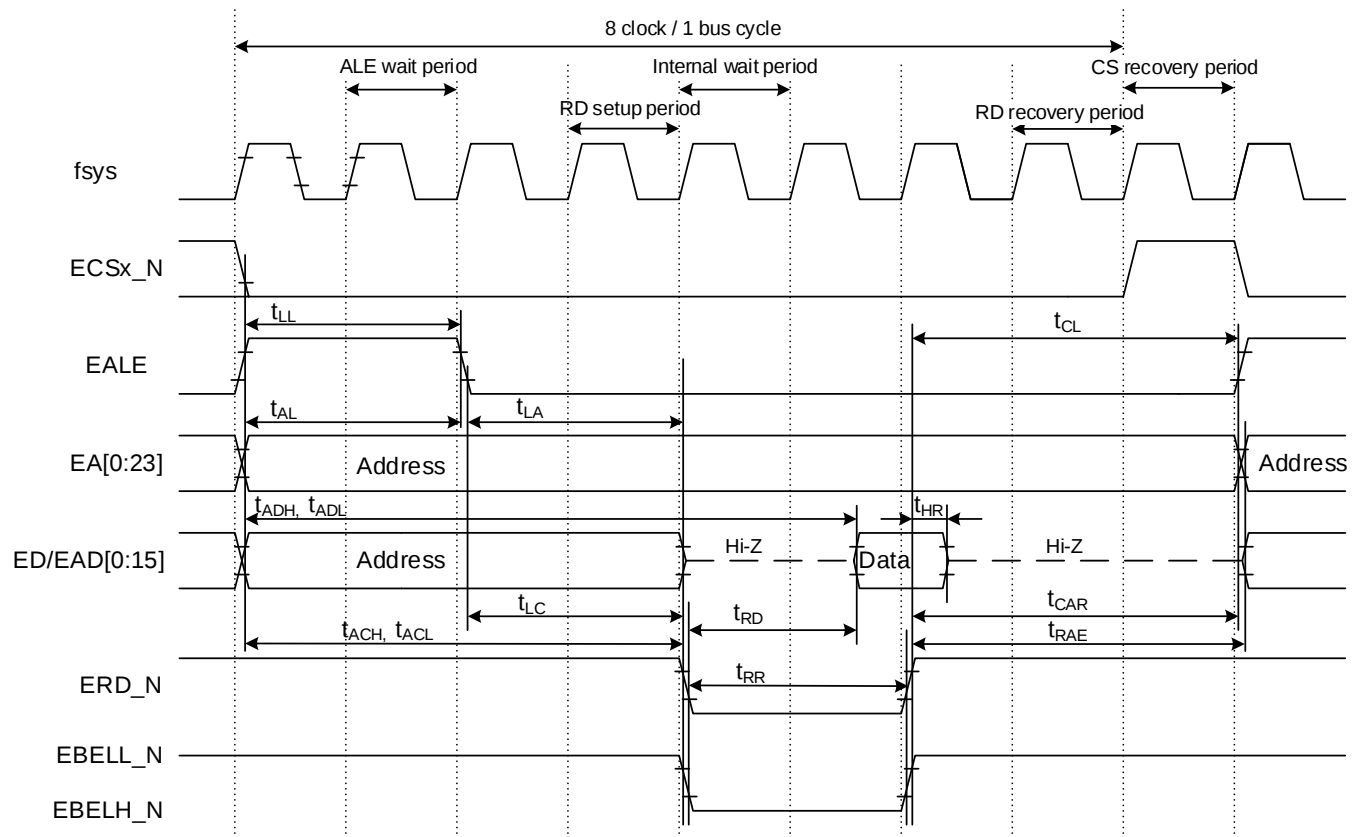
(Neither Cycle expander, ALE wait, RD setup, Internal wait, CS recovery nor RD recovery are used)



**Figure 7.12** Read cycle timing (minimum cycle)

## 2. Read cycle (1 bus cycle per 8 clock)

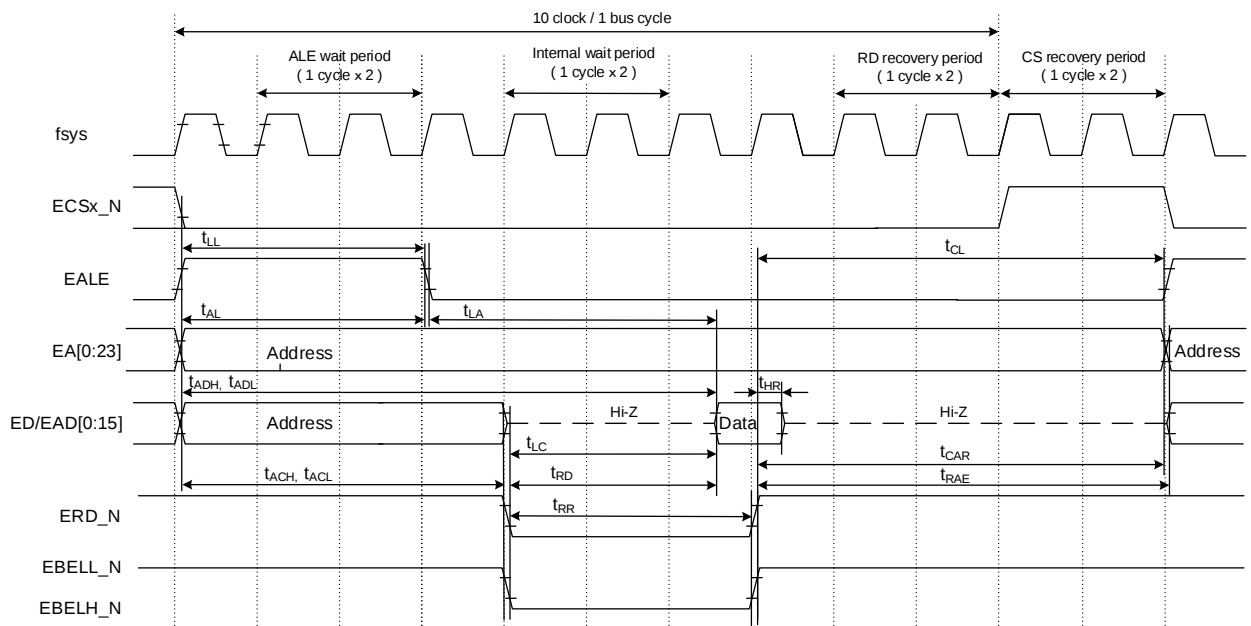
(Cycle expander is not used, ALE wait=1cycle, RD setup=1 cycle, Internal wait=1cycle, CS recovery=1cycle, RD recovery=1cycle)



**Figure 7.13** Read cycle timing (1 bus cycle per 8 clock)

### 3. Read cycle (1bus cycle per 10 clock)

(Cycle expander=double, ALE wait=1cycle, RD setup is not used, Internal wait=1cycle, CS recovery=1cycle, RD recovery=1cycle)



**Figure 7.14** Read cycle timing (1 bus cycle per 10 clock)

## 4. Read cycle (external wait)

(Cycle expander is not used, ALE wait=1cycle, RD setup=1cycle, Internal wait=3cycles, External wait=any, CS recovery=1cycle, RD recovery=1cycle)

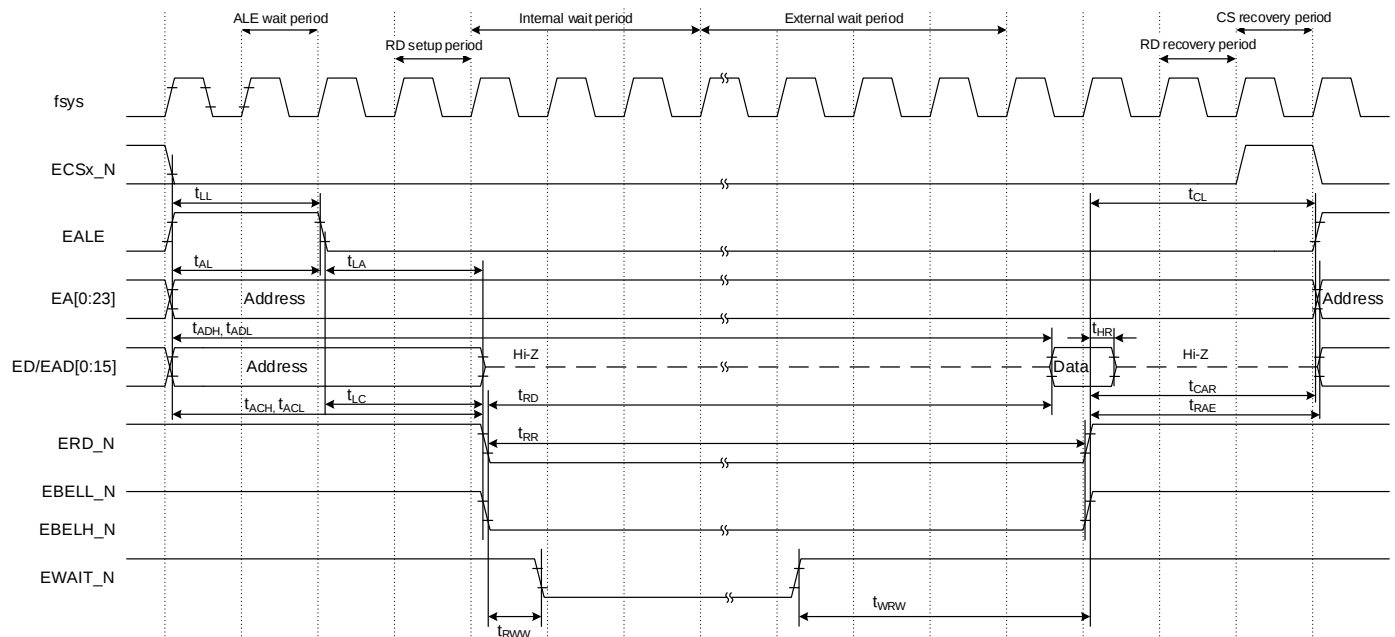
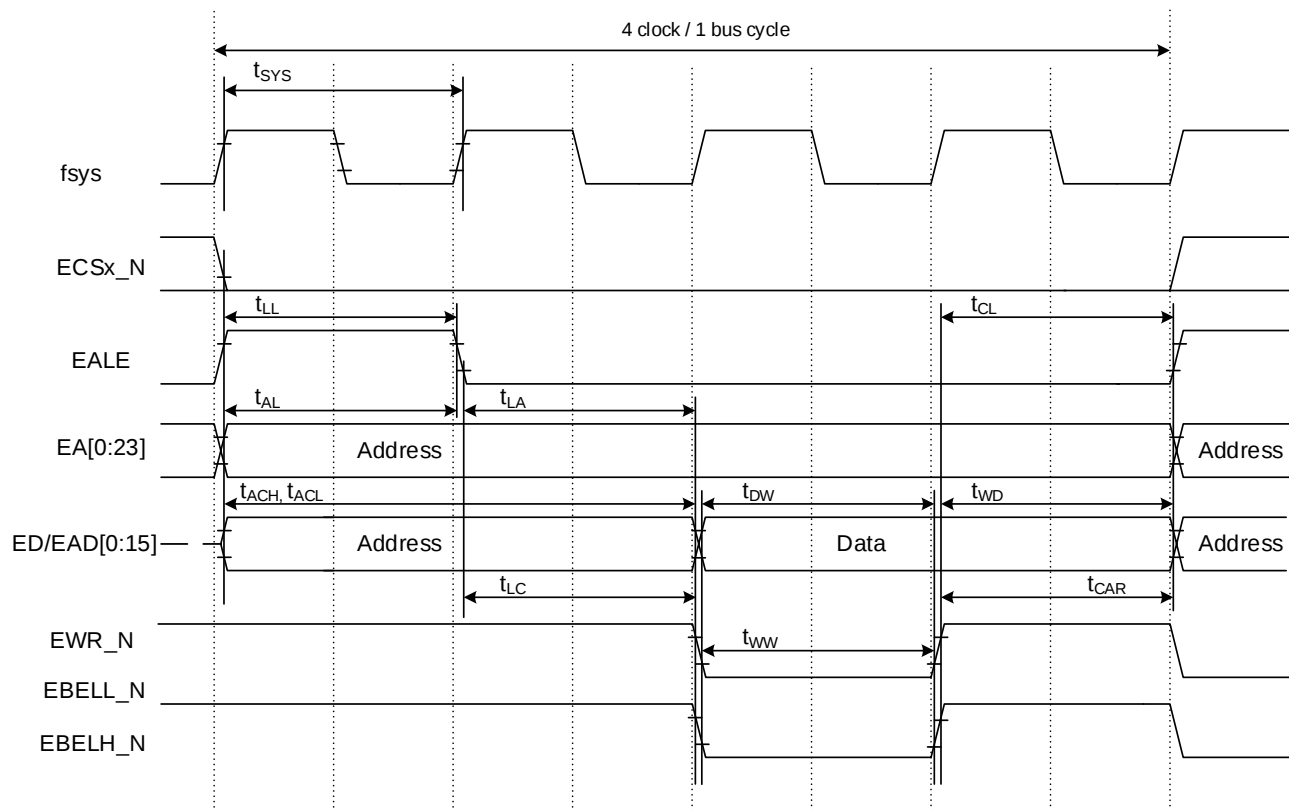


Figure 7.15 Read cycle timing (external bus wait)

5. Write cycle (minimum bus cycle)

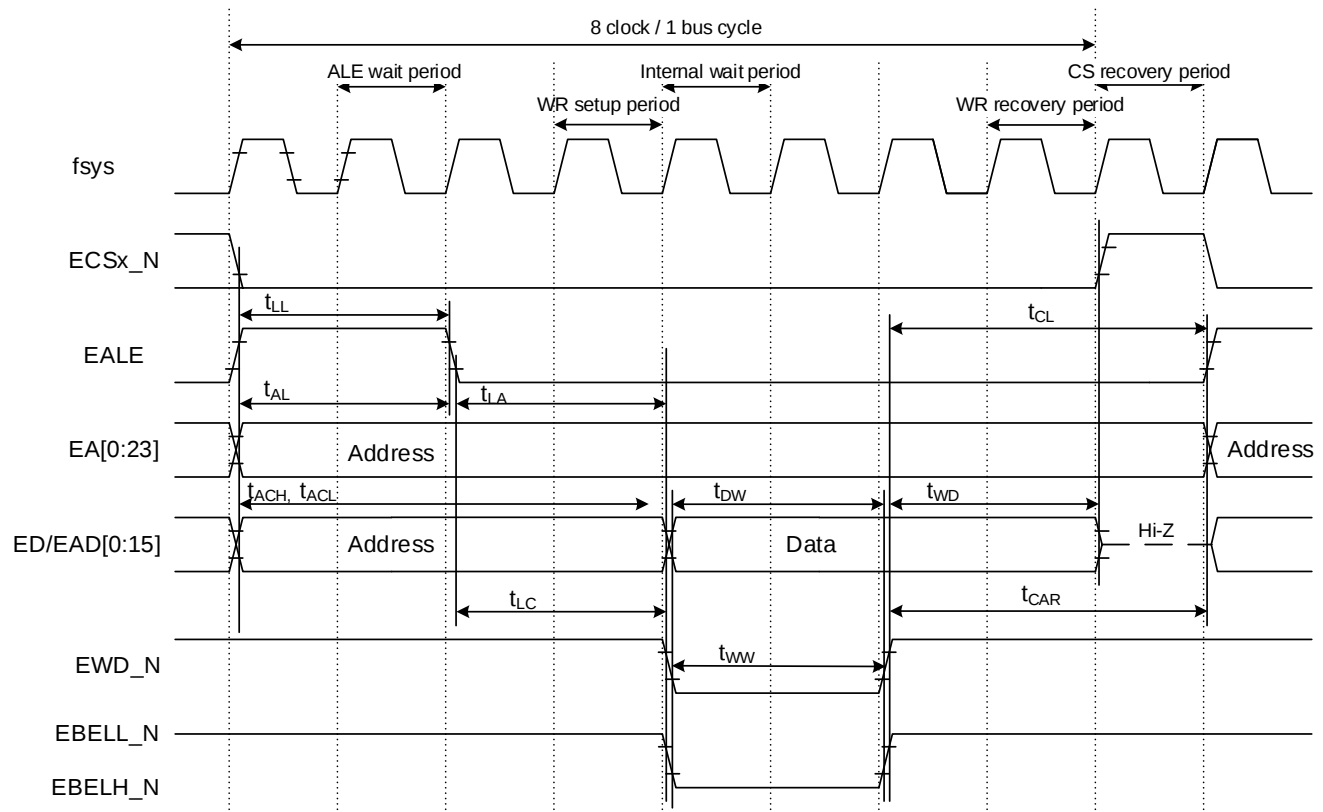
(Neither Cycle expander, ALE wait, WR setup, Internal wait, CS recovery nor WR recovery are used.)



**Figure 7.16** Write cycle timing (minimum bus cycle)

## 6. Write cycle (1 bus cycle per 8 clock)

(Cycle expander is not used, ALE wait=1cycle, WR setup=1cycle, Internal wait=1cycle, CS recovery=1cycle, WR recovery=1cycle)



**Figure 7.17** Write cycle timing (1 bus cycle per 8 clock)

## 7. Write cycle (external wait)

(Cycle expander is not used, ALE wait=1cycle, WR setup=1cycle, Internal wait=3cycles, External wait=any, CS recovery=1cycle, WR recovery=1cycle)

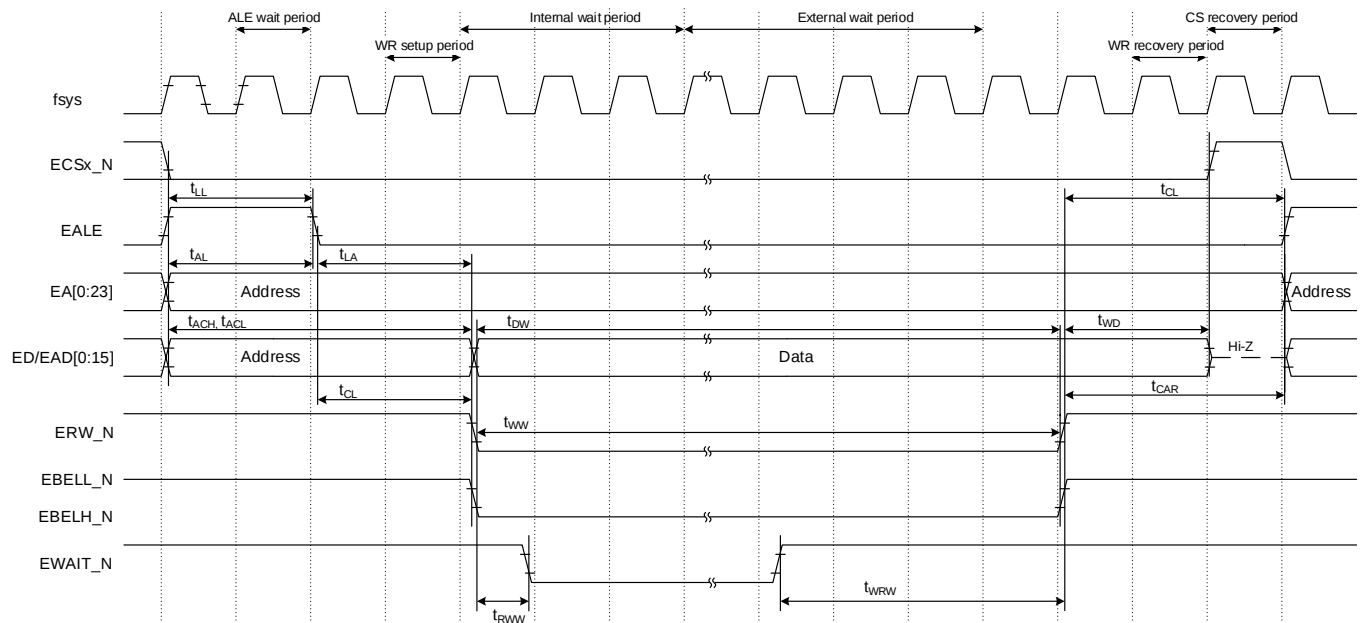
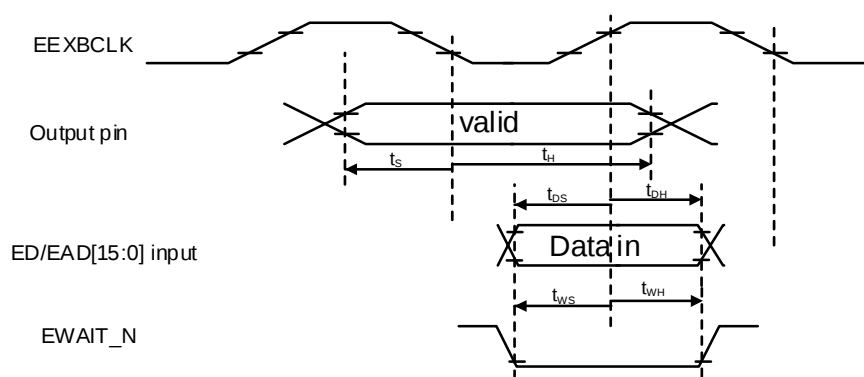


Figure 7.18 Write cycle timing (external wait)

## 7.9.4.5. AC Electrical Characteristics (EEXBCLK synchronous separate bus mode / multiplex bus mode)

| Parameter                              | Symbol   | Equation |     | fsysh=160MHz |     | Unit |
|----------------------------------------|----------|----------|-----|--------------|-----|------|
|                                        |          | Min      | Max | Min          | Max |      |
| External bus clock cycle(EEXBCLK)      | X        | 33.3     | -   | 33.3         | -   | ns   |
| Output pin fix → EEXBCLK fall          | $t_s$    | 2        | -   | 2            | -   |      |
| EEXBCLK fall → Output pin hold         | $t_H$    | 7        | -   | 7            | -   |      |
| ED/EAD[15:0] input fix → EEXBCLK rise  | $t_{DS}$ | 20       | -   | 20           | -   |      |
| EEXBCLK rise → ED/EAD[15:0] input hold | $t_{DH}$ | 0        | -   | 0            | -   |      |
| EWAIT_N input fix → EEXBCLK rise       | $t_{WS}$ | 20       | -   | 20           | -   |      |
| EEXBCLK rise → EWAIT_N input hold      | $t_{WH}$ | 0        | -   | 0            | -   |      |



**Figure 7.19** EEXBCLK synchronous separate bus mode / multiplex bus mode timing

## 7.9.5. Serial Memory Interface (SMIF)

### 7.9.5.1. AC Measurement Conditions

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C (fsysh ≤ 120MHz), Ta = -40 to 70°C (fsysh ≤ 160MHz)
- Output level: High = 0.8 × DVDD3, Low = 0.2 × DVDD3
- Input level: High = 0.75 × DVDD3, Low = 0.25 × DVDD3
- Load capacity: CL = 30pF

| Parameter                 | Symbol           | Equation | Min | Max | Unit |
|---------------------------|------------------|----------|-----|-----|------|
| SMIxCLOCK clock frequency | f <sub>CK</sub>  | -        | 20  | -   | MHz  |
| Data setup time           | t <sub>SU</sub>  | -        | 4   | -   | ns   |
| Data hold time            | t <sub>HD</sub>  | -        | 25  | -   |      |
| Output valid              | t <sub>V</sub>   | -        | -   | 9   |      |
| Output hold time          | t <sub>HO</sub>  | -        | -11 | -   |      |
| CS Setup time             | t <sub>CSS</sub> | 1.5T-20  | 55  | -   |      |
| CS hold time              | t <sub>CSH</sub> | 1.0T-20  | 30  | -   |      |

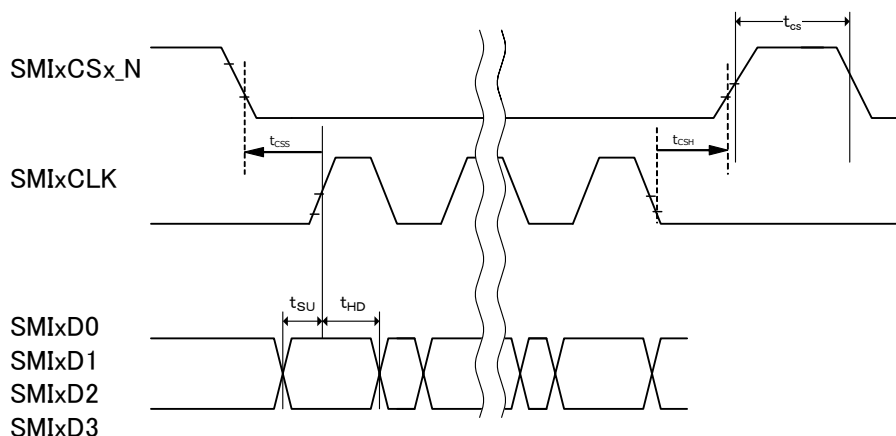


Figure 7.20 SMIF Input timing

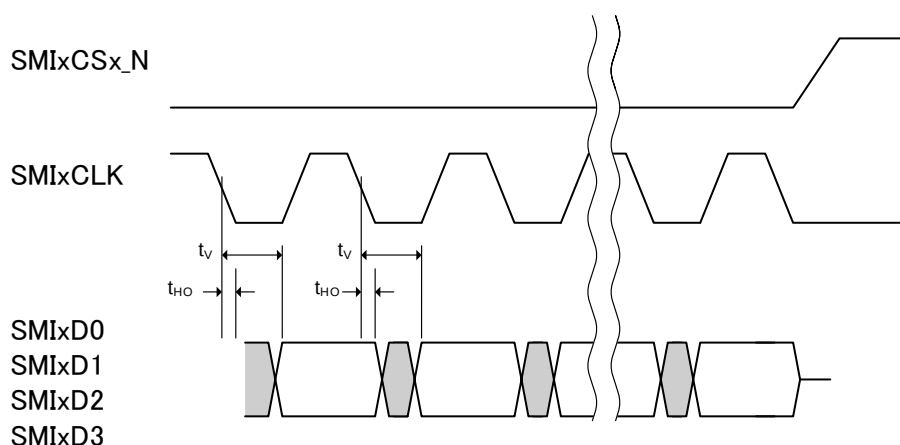


Figure 7.21 SMIF Output timing

## 7.9.6. External Interrupt

### 7.9.6.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C (fsysh ≤ 120MHz), Ta = -40 to 70°C (fsysh ≤ 160MHz)
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

### 7.9.6.2. AC Electrical Characteristics

“T” in the table below indicates the cycle of the system clock (fsys).

#### (1) NORMAL, IDLE mode

| Parameter              | Symbol              | Equation |     | fsysh=160 MHz |     | Unit |
|------------------------|---------------------|----------|-----|---------------|-----|------|
|                        |                     | Min      | Max | Min           | Max |      |
| Low level pulse width  | t <sub>INTAL1</sub> | T + 100  | -   | 106.25        | -   | ns   |
| High level pulse width | t <sub>INTAH1</sub> | T + 100  | -   | 106.25        | -   |      |

#### (2) STOP1, STOP2 mode

| Parameter              | Symbol              | Equation |     | fsysh=160 MHz |     | Unit |
|------------------------|---------------------|----------|-----|---------------|-----|------|
|                        |                     | Min      | Max | Min           | Max |      |
| Low level pulse width  | t <sub>INTCL2</sub> | 500      | -   | 500           | -   | ns   |
| High level pulse width | t <sub>INTCH2</sub> | 500      | -   | 500           | -   |      |

## 7.9.7. Trigger Input (TRGINx)

### 7.9.7.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

### 7.9.7.2. AC Electrical Characteristics

“T” in the table below indicates the cycle of the system clock (fsys).

| Parameter              | Symbol           | Equation |     | fsysm=80 MHz |     | Unit |
|------------------------|------------------|----------|-----|--------------|-----|------|
|                        |                  | Min      | Max | Min          | Max |      |
| Low level pulse width  | t <sub>ADL</sub> | 2T + 20  | -   | 45           | -   | ns   |
| High level pulse width | t <sub>ADH</sub> | 2T + 20  | -   | 45           | -   |      |

## 7.9.8. Debug Communication

### 7.9.8.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C(fsys≤120MHz), Ta= -40 to 70°C (fsysh≤160MHz)
- Output level: High = 0.8×DVDD3, Low = 0.2×DVDD3
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

## 7.9.8.2. SWD Interface

| Parameter                                            | Symbol    | Min | Max | Unit |
|------------------------------------------------------|-----------|-----|-----|------|
| CLK cycle                                            | $T_{dck}$ | 100 | -   | ns   |
| Output data hold time from the rising edge of CLK    | $T_{d1}$  | 4   | -   |      |
| Output data valid time from the rising edge of CLK   | $T_{d2}$  | -   | 30  |      |
| From input data valid time to the rising edge of CLK | $T_{ds}$  | 20  | -   |      |
| Input data hold time from the rising edge of CLK     | $T_{dh}$  | 15  | -   |      |

## 7.9.8.3. JTAG Interface

| Parameter                                            | Symbol    | Min | Max | Unit |
|------------------------------------------------------|-----------|-----|-----|------|
| CLK cycle                                            | $T_{dck}$ | 100 | -   | ns   |
| Output data hold time from the falling edge of CLK   | $T_{d3}$  | 4   | -   |      |
| Output data valid time from the falling edge of CLK  | $T_{d4}$  | -   | 50  |      |
| From input data valid time to the rising edge of CLK | $T_{ds}$  | 20  | -   |      |
| Input data hold time from the rising edge of CLK     | $T_{dh}$  | 15  | -   |      |

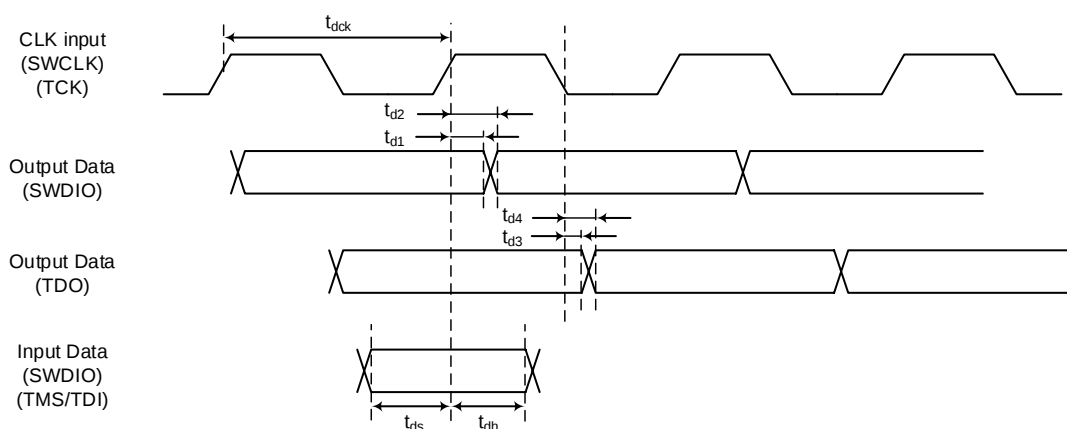
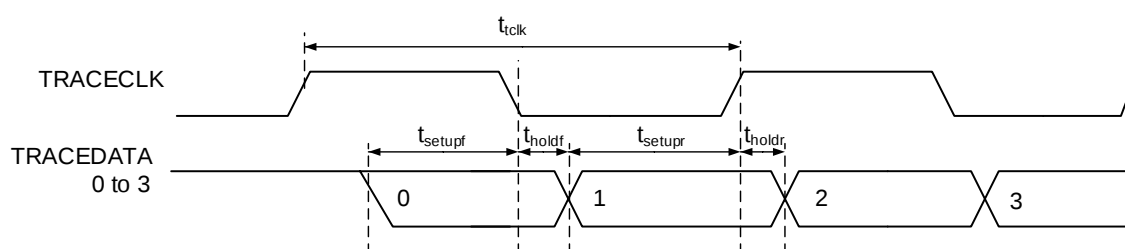


Figure 7.22 JTAG/SWD waveform

## 7.9.8.4. ETM Trace

| Parameter                                              | Symbol       | Min | Max | Unit |
|--------------------------------------------------------|--------------|-----|-----|------|
| TRACECLK cycle                                         | $t_{clk}$    | 25  | -   | ns   |
| Data valid time from rising on TRACECLK                | $t_{setupr}$ | 2   | -   |      |
| TRACEDATA hold time from the rising edge of TRACECLK   | $t_{holdr}$  | 1   | -   |      |
| TRACEDATA valid time from the falling edge of TRACECLK | $t_{setupf}$ | 2   | -   |      |
| TRACEDATA hold time from the falling edge of TRACECLK  | $t_{holdf}$  | 1   | -   |      |

Note: When  $f_{sys} > 100\text{MHz}$ , the condition is  $DVDD3=3.3\text{V}$ ,  $CL=10\text{pF}$ .



**Figure 7.23** Trace signal waveform

## 7.9.8.5. Non Break Debug Interface (NBDIF)

| Parameter                 | Symbol      | Min | Max              | Unit |
|---------------------------|-------------|-----|------------------|------|
| NBDCLK Cycle Time         | $t_{NDCYC}$ | 80  | -                | ns   |
| NBDCLK Low Pulse width    | $t_{NDL}$   | 35  | -                |      |
| NBDDATA Output Delay Time | $t_{NDD}$   | -   | $t_{NDCYC} - 20$ |      |
| NBDDATA Output Hold Time  | $t_{NDHD}$  | 5   | -                |      |
| NBDDATA Setup Time        | $t_{NDS}$   | 20  | -                |      |
| NBDDATA Hold Time         | $t_{NDH}$   | 5   | -                |      |
| NBDSYNC Setup Time        | $t_{NDSYS}$ | 20  | -                |      |
| NBDSYNC Output Hold Time  | $t_{NDSYH}$ | 5   | -                |      |

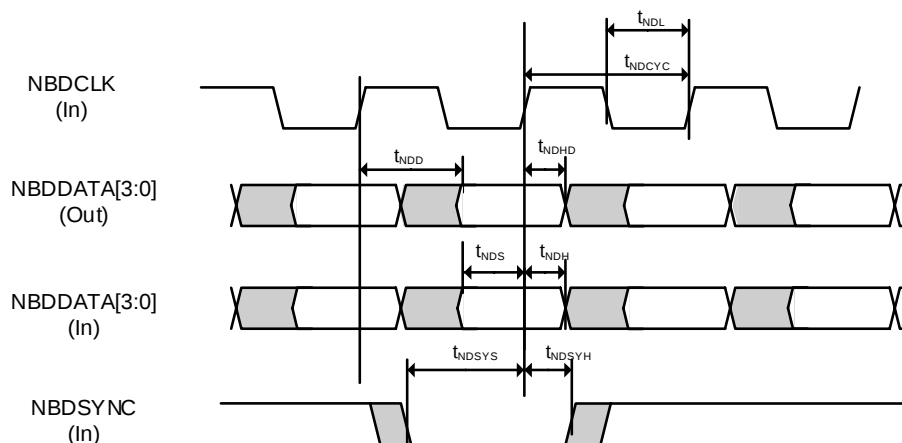


Figure 7.24 NBDIF waveform

## 7.9.8.6. Noise Filter Characteristics

| Parameter          | Condition | Min | Typ. | Max | Unit |
|--------------------|-----------|-----|------|-----|------|
| Noise cancel width |           | 15  | 30   | 60  | ns   |

## 7.9.9. External Clock Input

### 7.9.9.1. AC Measurement Conditions

The AC characteristics are the result under the measurement conditions below:

- DVDD3 = AVDD3 = 2.7V to 3.6V
- Ta = -40 to 85°C
- Input level: High = 0.75×DVDD3, Low = 0.25×DVDD3
- Load capacity: CL = 30pF

Note: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

### 7.9.9.2. AC Electrical Characteristics

#### (1) High speed clock input

| Parameter       | Symbol      | Min | Typ. | Max | Unit |
|-----------------|-------------|-----|------|-----|------|
| Clock frequency | $t_{ehcin}$ | 8   | -    | 20  | MHz  |
| Clock duty      | -           | 45  | -    | 55  | %    |
| Clock rise time | $t_r$       | -   | -    | 10  | ns   |
| Clock fall time | $t_f$       | -   | -    | 10  | ns   |

#### (4) Low speed clock input

| Parameter       | Symbol      | Min | Typ. | Max | Unit |
|-----------------|-------------|-----|------|-----|------|
| Clock frequency | $t_{ehcin}$ | 30  | -    | 34  | kHz  |
| Clock duty      | -           | 45  | -    | 55  | %    |
| Clock rise time | $t_r$       | -   | -    | 100 | ns   |
| Clock fall time | $t_f$       | -   | -    | 100 | ns   |

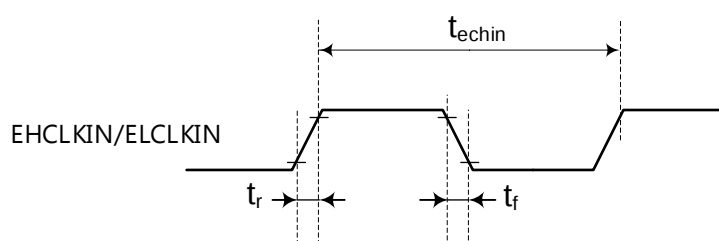


Figure 7.25 External clock input waveform

## 7.10. Flash Memory Characteristics

### 7.10.1. Code Flash

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter        | Condition              | Min | Typ.  | Max    | Unit   |
|------------------|------------------------|-----|-------|--------|--------|
| Endurance        |                        | -   | -     | 10,000 | cycles |
| Programming time | Word Program time      | -   | 29.5  | -      | μs     |
| Erase time       | Page Erase time        | -   | 18.1  | -      | ms     |
|                  | Block Erase time       | -   | 144.2 | -      |        |
|                  | Area Erase time(Note2) | -   | 18.1  | -      |        |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: No block with effective protection.

### 7.10.2. Data Flash

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter        | Condition              | Min  | Typ. | Max     | Unit   |
|------------------|------------------------|------|------|---------|--------|
| Endurance        |                        | -    | -    | 100,000 | cycles |
| Programming time |                        | -    | 64.7 | -       | μs     |
| Erase time       | Page Erase time        | 1    | -    | 3.9     | ms     |
|                  | Block Erase time       | 15.4 | -    | 62.1    |        |
|                  | Area Erase time(Note2) | -    | 9.2  | -       |        |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: No block with effective protection.

## 7.10.3. Chip Erase

| Item                     | Products                                                                                                                                                                                                                                                            |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Code Flash 1.5MB         | TMPM4G9F15FG, TMPM4G9F15XBG, TMPM4G8F15FG, TMPM4G8F15XBG                                                                                                                                                                                                            |
| Code Flash 1.0MB or less | TMPM4G9F10FG, TMPM4G9FEFG, TMPM4G9FDFG,<br>TMPM4G9F10XBG, TMPM4G9FEXBG, TMPM4G9FDXBG,<br>TMPM4G8F10FG, TMPM4G8FEFG, TMPM4G8FDFG,<br>TMPM4G8F10XBG, TMPM4G8FEXBG, TMPM4G8FDXBG,<br>TMPM4G7F10FG, TMPM4G7FEFG, TMPM4G7FDFG,<br>TMPM4G6F10FG, TMPM4G6FEFG, TMPM4G6FDFG |

For the newest status of each product, Please contact your sales representative.

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter       | Condition                                                                                                      | Code Flash<br>1.5MB |       |     | Code Flash<br>1.0MB or less |      |     | Unit |
|-----------------|----------------------------------------------------------------------------------------------------------------|---------------------|-------|-----|-----------------------------|------|-----|------|
|                 |                                                                                                                | Min                 | Typ.  | Max | Min                         | Typ. | Max |      |
| Chip Erase time | Erasing of<br>Code Flash,<br>Data Flash,<br>Protect Bits(Code),<br>Protect Bits(Data),<br>and<br>Security bits | -                   | 100.1 | -   | -                           | 82.0 | -   | ms   |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: When Chip Erase command executes, no block with effective protection.

## 7.11. Regulator

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter                        | Condition | Min | Typ. | Max | Unit |
|----------------------------------|-----------|-----|------|-----|------|
| Capacitance of REGOUT1 capacitor |           | -   | 1.0  | -   | μF   |

## 7.12. Oscillation Circuit

### 7.12.1. Internal Oscillator

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter             | Symbol              | Condition            | Min | Typ. | Max | Unit |
|-----------------------|---------------------|----------------------|-----|------|-----|------|
| Oscillation frequency | f <sub>IHOSC1</sub> | Factory out, IC data | -   | 10   | -   | MHz  |
|                       | f <sub>IHOSC2</sub> |                      | -   | 10   | -   |      |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Not included the influence depend on the variations after Factory shipping. Please execute oscillator adjustment by the trimming register, if trimming of IHOSC1 is required. However, IHOSC2 cannot execute trimming.

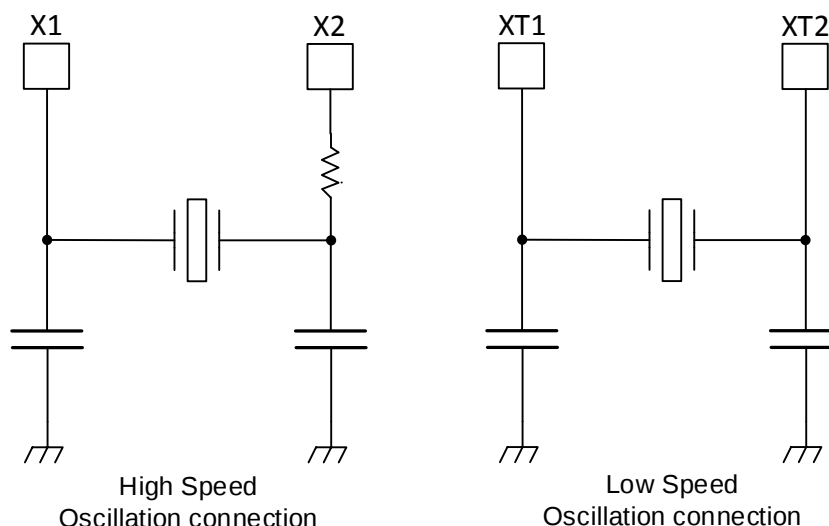
### 7.12.2. External Oscillator

DVDD3=2.7V to 3.6V  
Ta= -40 to 85°C

| Parameter             | Symbol             | Condition | Min | Typ. | Max | Unit |
|-----------------------|--------------------|-----------|-----|------|-----|------|
| Oscillation frequency | f <sub>EHOSC</sub> |           | 8   | -    | 20  | MHz  |
|                       | f <sub>ELOSC</sub> |           | 30  | -    | 34  | kHz  |

Note1: DVDD3 is generic name for DVDD3A, DVDD3B, DVDD3C, DVDD3D, DVDD3E, DVDD3F, DVDD3G, DVDD3H.

Note2: Please contact the oscillator vendor, regarding the matching data of the device and the oscillator.



**Figure 7.26 Oscillation circuit sample**

To obtain a stable oscillation, load capacity and the position of the oscillator must be configured properly. Since these factors are strongly affected by substrate patterns, please evaluate oscillation stability using the substrate you use.

This product has been evaluated by the oscillator vendor below. Please refer this information when selecting external parts.

### **7.12.3. Ceramic Oscillator**

This product has been evaluated by the ceramic oscillator by Murata Manufacturing Co., Ltd.  
Please refer to the Murata Website for details.

### **7.12.4. Crystal Oscillator**

This product has been evaluated by the crystal oscillator by KYOCERA Corporation.  
Please refer to the KYOCERA Website for details.

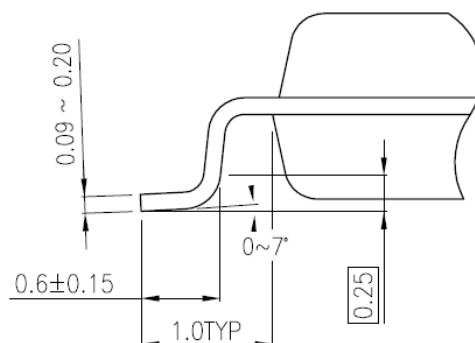
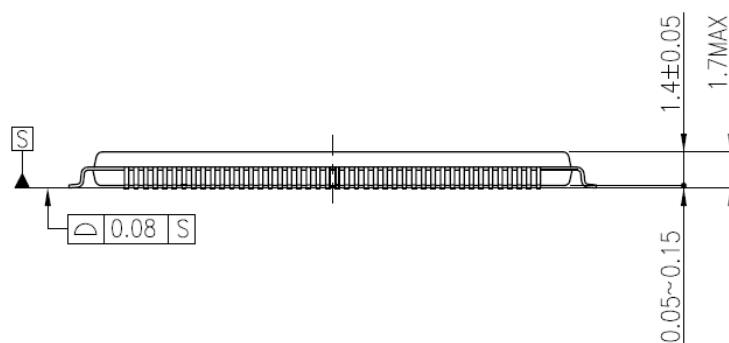
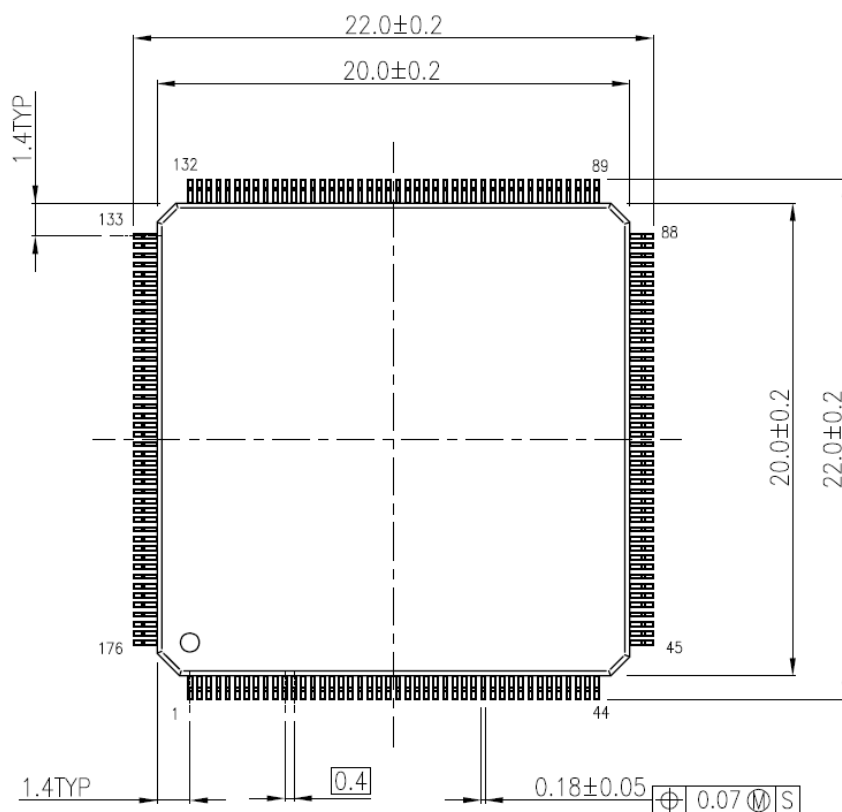
### **7.12.5. Precautions for designing printed circuit board**

Be sure to design printed circuit board patterns that connect a crystal unit with other oscillation elements so that the length of such patterns become shortest possible to prevent deterioration of characteristics due to stray capacitances and wiring inductance. For multi-layer circuit boards, it is important not to wire the ground and other signal patterns right beneath the oscillation circuit. For more information, please refer to the URL of the oscillator vendor.

## 8. Package Dimensions

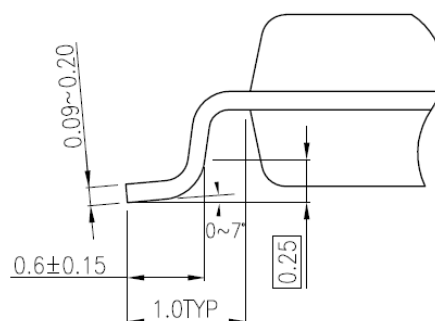
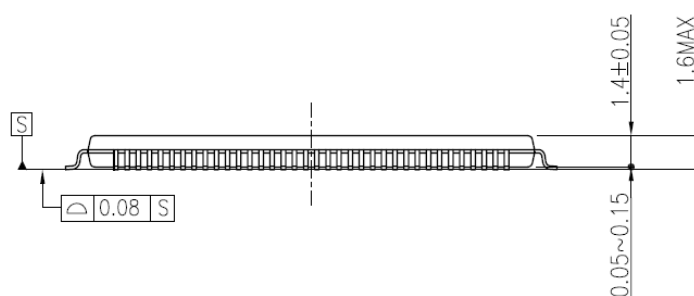
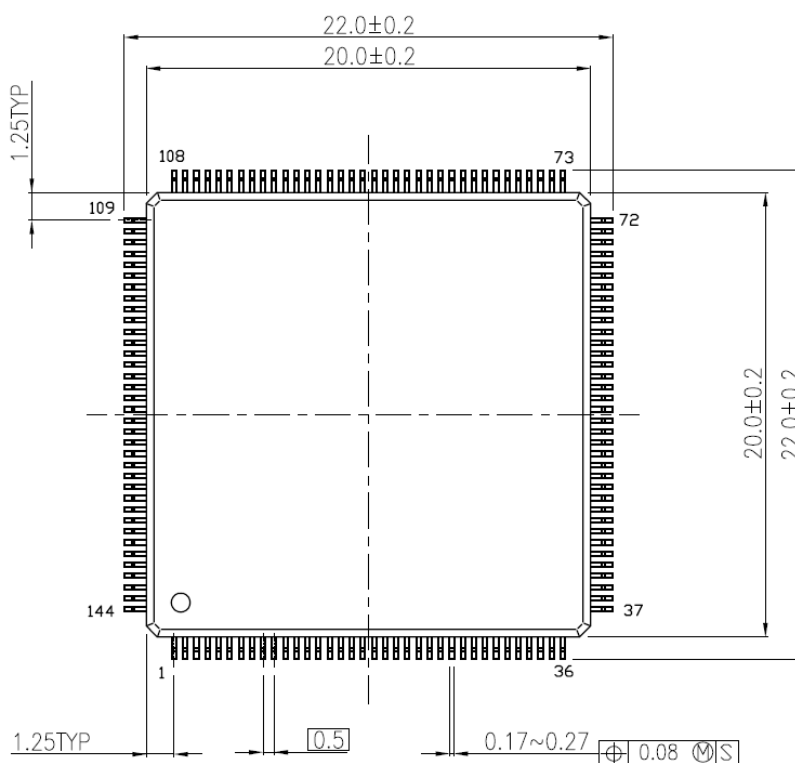
### 8.1. P-LQFP176-2020-0.40-002

Unit: mm



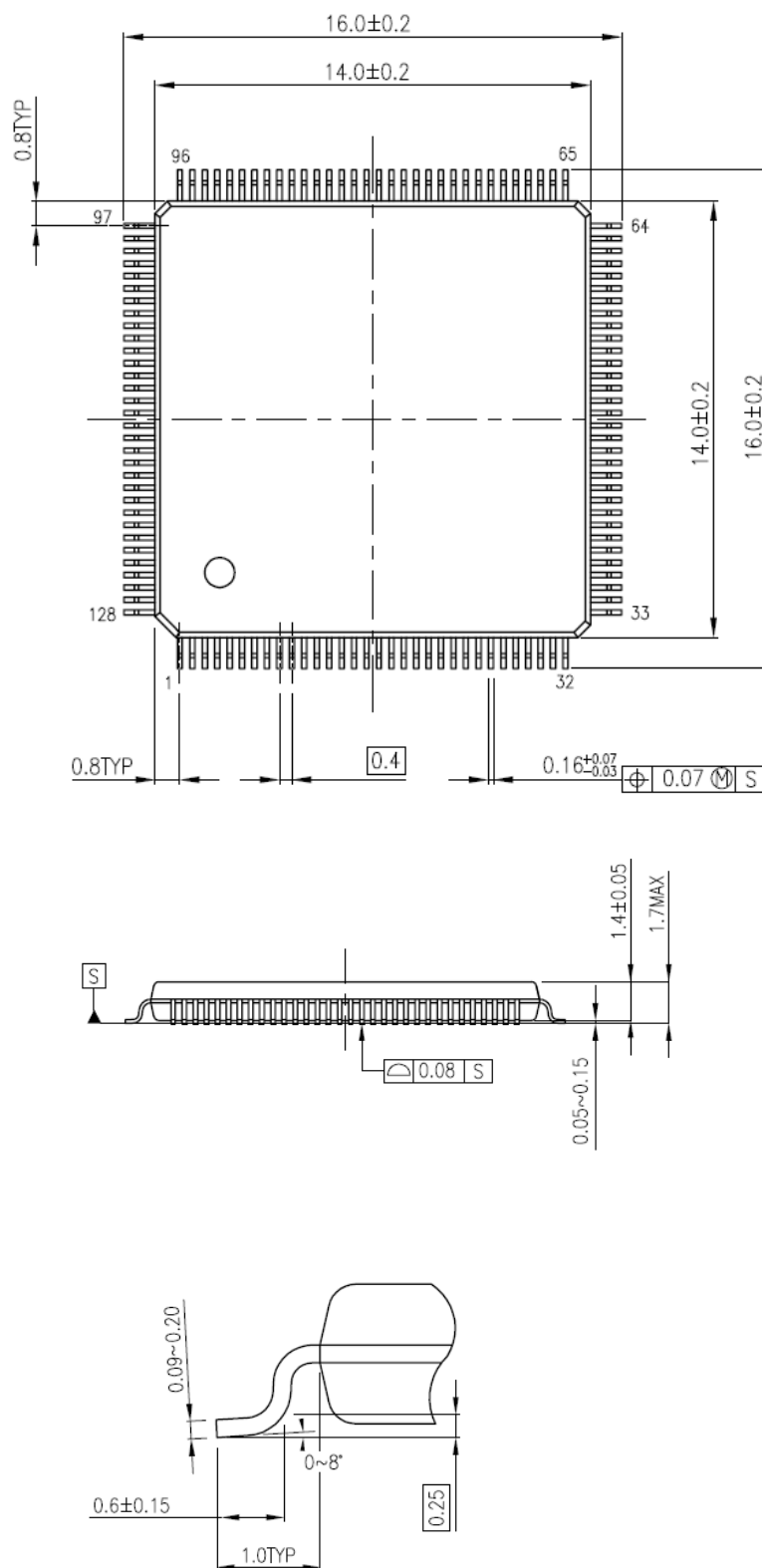
## 8.2. P-LQFP144-2020-0.50-002

Unit: mm



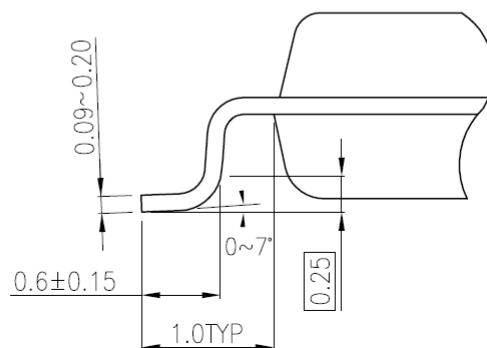
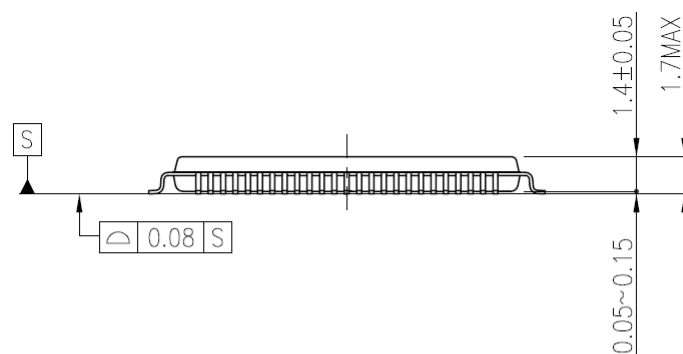
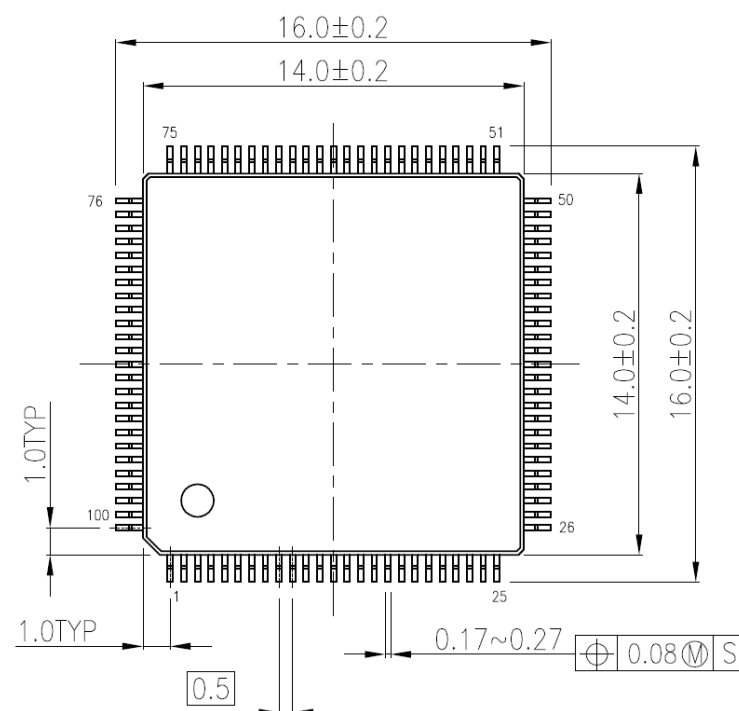
## 8.3. P-LQFP128-1414-0.40-001

Unit: mm



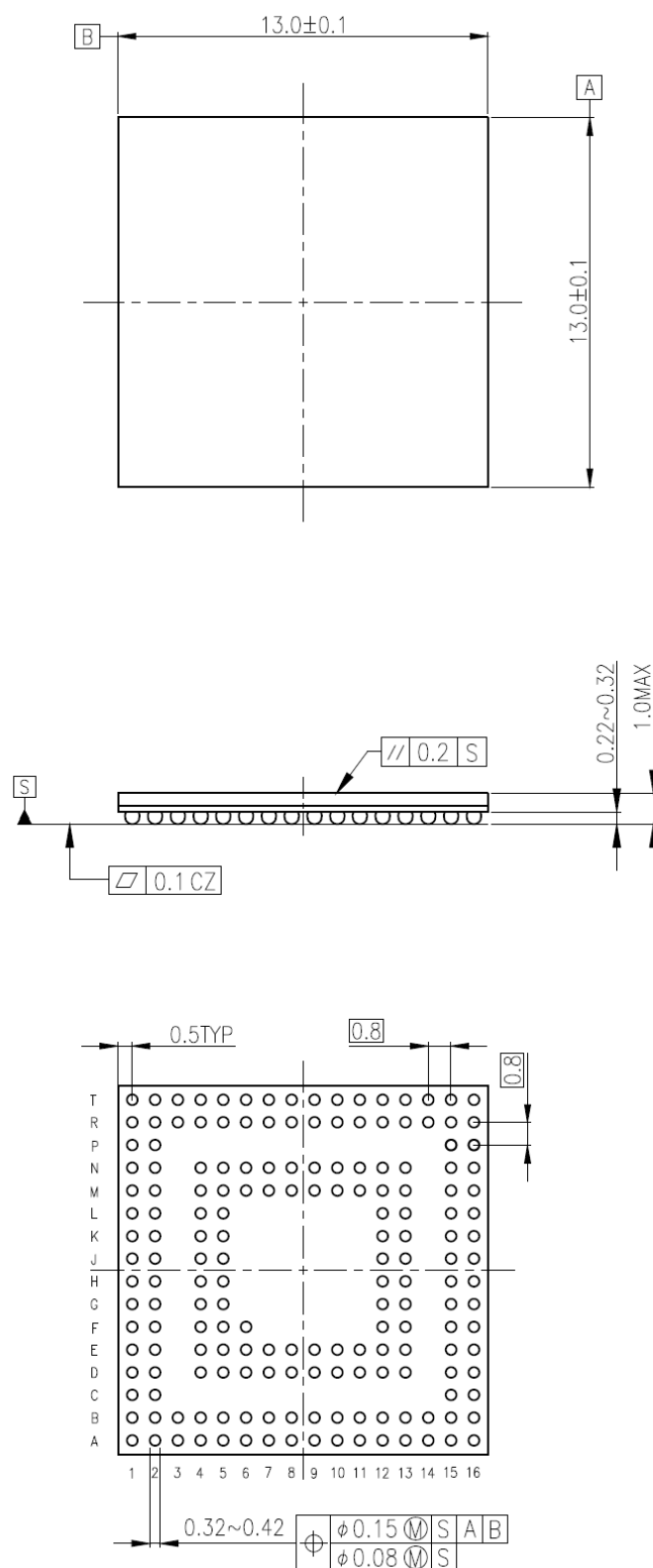
## 8.4. P-LQFP100-1414-0.50-002

Unit: mm



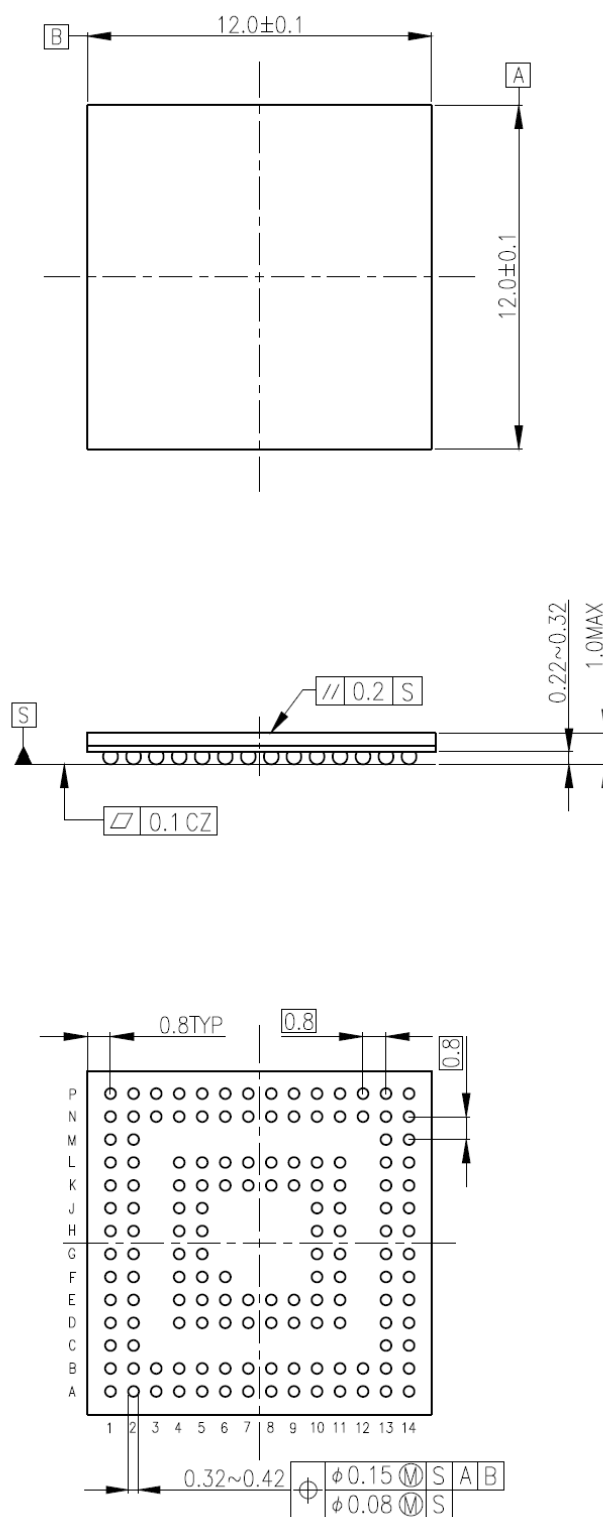
## 8.5. P-VFBGA177-1313-0.80-001

Unit: mm



## 8.6. P-VFBGA145-1212-0.80-001

Unit: mm



## 9. Precautions

This Page explains general precautions on the use of our MCUs.

Note that if there is a difference between the general precautions and the description in the body of the document, the description in the body of document has higher priority.

(1) The MCUs' operation at power-on

At power-on, internal state of the MCUs is unstable. Therefore, state of the pins is undefined until reset operation is completed.

When a reset is performed by an external reset pin, pins of the MCUs that use the reset pin are undefined until reset operation by the external pin is completed.

Also, when a reset is performed by the internal power-on reset, pins of the MCUs that use the internal power-on reset are undefined until power supply voltage reaches the voltage at which power-on reset is valid.

(5) Unused pins

Unused input/output ports of the MCUs are prohibited to use. The pins are high-impedance.

Generally, if MCUs operate while the high-impedance pins left open, electrostatic damage or latch-up may occur in the internal LSI due to induced voltage influenced from external noise.

We recommend that each unused pin should be connected to the power supply pins or GND pins via resistors.

(6) Clock oscillation stability

A reset state must be released after the clock oscillation becomes stable. If the clock is changed to another clock while the program is in progress, wait until the clock is stable.

## 10. Revision History

**Table 10.1 Revision History**

| Revision | Date       | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----------|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.0      | 2018-02-02 | First Release                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 2.0      | 2018-03-13 | <ul style="list-style-type: none"> <li>- Features                             <ul style="list-style-type: none"> <li>Modified maximum baud rate of FUART</li> <li>Added maximum data rate for IrDA of FUART</li> </ul> </li> <li>- Terms and Abbreviations                             <ul style="list-style-type: none"> <li>Corrected spelling of "Circuit" of TRM</li> </ul> </li> <li>- Products Lists Categorized by Functions                             <ul style="list-style-type: none"> <li>Changed "UNIT" to "ch" of ISD in Table1 to Table6</li> </ul> </li> <li>- 1. Block Diagram                             <ul style="list-style-type: none"> <li>Changed "UNIT" to "ch" of MDMAC, "UNIT" to "ch" of HDMAC in Figure 1.1</li> <li>Changed "4 to 12 ch" to "1 to 3 units" of ISD in Figure 1.1</li> </ul> </li> <li>- 4.2 Functional Pin and Port Assignment (Pin Number)</li> <li>- 5.12 Interval Sensor Detection Circuit(ISD)                             <ul style="list-style-type: none"> <li>Modified "UNIT" to "unit" in Table5.12</li> <li>Added TMS/SWCLK/SWV in Table4.21</li> </ul> </li> <li>- 5.13.1 Multi-Function DMA Controller (MDMAC)                             <ul style="list-style-type: none"> <li>Modified explanation</li> <li>Modified "UNIT" to "unit" in Table5.13</li> </ul> </li> <li>- 5.13.2 High Speed DMA Controller(HDMAC)                             <ul style="list-style-type: none"> <li>Modified explanation</li> <li>Modified "UNIT" to "unit" in Table5.14</li> </ul> </li> <li>- 5.21 12-bit Analog to Digital Converter (ADC)                             <ul style="list-style-type: none"> <li>Modified explanation</li> <li>Modified "UNIT" to "unit" in Table5.21</li> </ul> </li> <li>- 6.1 Port                             <ul style="list-style-type: none"> <li>Equivalent circuit of port with external interrupt input are written separately</li> <li>Modified Note of PY4/BOOT_N</li> </ul> </li> <li>- 6.4 Clock control                             <ul style="list-style-type: none"> <li>Modified EHCLKIN/ELCLKIN circuit</li> </ul> </li> <li>- 7.1 Absolute Maximum Ratings                             <ul style="list-style-type: none"> <li>Changed port name description</li> </ul> </li> <li>- 7.2 DC Electrical Characteristics (1/2)                             <ul style="list-style-type: none"> <li>Changed port name description of I<sub>OL1</sub>/I<sub>OH1</sub></li> <li>Changed "V<sub>IH1</sub>" to "V<sub>IH1</sub>"</li> </ul> </li> <li>- 7.3 DC Electrical Characteristics (2/2) (Consumption current)                             <ul style="list-style-type: none"> <li>Added specification of code flash 1.0MB or less</li> <li>Added 0 to ch0/ 3 to ch3 of TSPI in Table 7.3.</li> </ul> </li> <li>- 7.4 12-bit AD Converter Characteristics                             <ul style="list-style-type: none"> <li>Added specification of code flash 1.0MB or less</li> <li>(All products same specification)</li> </ul> </li> <li>- 7.9.2.1 AC Measurement Conditions                             <ul style="list-style-type: none"> <li>Temperature range of Ta was modified</li> </ul> </li> <li>- 7.9.3.1 AC Measurement Conditions                             <ul style="list-style-type: none"> <li>Temperature range of Ta was modified</li> </ul> </li> <li>- 7.9.4.5 AC Electrical Characteristics                             <ul style="list-style-type: none"> <li>Modified "EA/EAD[15:0] input" to "ED/EAD[15:0] input" in Figure 7.20</li> </ul> </li> <li>- 7.9.5.1 AC Electrical Characteristics                             <ul style="list-style-type: none"> <li>Modified "fsys" of Ta to "fsysh"</li> </ul> </li> <li>- 7.9.6.1 AC Electrical Characteristics                             <ul style="list-style-type: none"> <li>Modified "fsys" of Ta to "fsysh"</li> </ul> </li> <li>- 7.9.7.1 AC Measurement Conditions                             <ul style="list-style-type: none"> <li>Temperature range of Ta was modified</li> </ul> </li> <li>- 7.9.9.1 AC Measurement Conditions                             <ul style="list-style-type: none"> <li>Temperature range of Ta was modified</li> </ul> </li> <li>- 7.10.3 Chip Erase                             <ul style="list-style-type: none"> <li>Added specification of code flash 1.0MB or less</li> </ul> </li> </ul> |

|     |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-----|------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 3.0 | 2018-05-28 | <ul style="list-style-type: none"> <li>- Features <ul style="list-style-type: none"> <li>Modified maximum baud rate of FUART, 921.6kbps to 2.5Mbps</li> <li>Modified 1<sup>st</sup> line explanation of A-PMD</li> </ul> </li> <li>- Changed order of section, "contents" and "Preface"</li> <li>- 3.1 List of Memory Sizes <ul style="list-style-type: none"> <li>Modified code flash start address of TMPM4GxDF, 0x5E00000 to 0x5E000000</li> </ul> </li> <li>- 7.4 12-bit AD Converter Characteristics <ul style="list-style-type: none"> <li>Deleted "-" from Conditions</li> </ul> </li> <li>- 7.5 8-bit DA Converter Characteristics <ul style="list-style-type: none"> <li>Deleted "-" from Conditions</li> </ul> </li> <li>- 7.6 Characteristics of Internal processing at RESET <ul style="list-style-type: none"> <li>Deleted "-" from Conditions</li> </ul> </li> <li>- 7.7 Characteristics of Power on Reset <ul style="list-style-type: none"> <li>Deleted "-" from Conditions</li> </ul> </li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| 4.0 | 2018-08-21 | <ul style="list-style-type: none"> <li>- Conventions <ul style="list-style-type: none"> <li>Modified explanation of Trademark</li> </ul> </li> <li>-2.1 LQFP176 <ul style="list-style-type: none"> <li>Modified RTC0CLK to RTCOUT of PT3</li> </ul> </li> <li>-2.2 LQFP144 <ul style="list-style-type: none"> <li>Modified RTC0CLK to RTCOUT of PT3</li> </ul> </li> <li>-2.3 LQFP128 <ul style="list-style-type: none"> <li>Modified RTC0CLK to RTCOUT of PT3</li> </ul> </li> <li>-2.4 LQFP100 <ul style="list-style-type: none"> <li>Modified RTC0CLK to RTCOUT of PT3</li> </ul> </li> <li>-4.1.3Control Pins <ul style="list-style-type: none"> <li>Deleted Control pin from headline in Table 4.3</li> </ul> </li> <li>- 4.2 Functional Pin and Port Assignment <ul style="list-style-type: none"> <li>Modified RTCCLK to RTCOUT in Table4.21</li> </ul> </li> <li>- 6.3 Control Pin <ul style="list-style-type: none"> <li>Added explanation in MODE,BS</li> </ul> </li> <li>- 7.9.1.2 AC Electrical Characteristics <ul style="list-style-type: none"> <li>Corrected Value of <math>t_{WDIS}</math> in (2) Slave mode</li> <li>Corrected &lt;CSnPOL&gt;=0 to 1, &lt;CSnPOL&gt;=1 to 0 in Figure 7.1,7.2,7.3</li> <li>Deleted 1<sup>st</sup> clock edge sampling(Slave)</li> </ul> </li> <li>- 7.9.4 External Bus Interface(EBIF) <ul style="list-style-type: none"> <li>Added (EBIF) in title</li> </ul> </li> <li>- 7.9.4.4 AC Electrical Characteristics(EEXBCLK asynchronous multiplex bus mode) <ul style="list-style-type: none"> <li>Corrected Figure 7.14</li> </ul> </li> </ul>                                                                                                 |
| 4.1 | 2018-11-12 | <ul style="list-style-type: none"> <li>-Features <ul style="list-style-type: none"> <li>Modified FIFO description of TSPI</li> <li>Modified "Trigger Start/Stop" to "Trigger Start" of T32A</li> </ul> </li> <li>- 1 Block Diagram <ul style="list-style-type: none"> <li>Modified JTAG to BSC in Figure 1.1</li> <li>Modified Figure1.1 title</li> </ul> </li> <li>-4.1.1 Peripheral Function Pins <ul style="list-style-type: none"> <li>Modified function description of UTxCTS_N/ UTxRTS_N</li> </ul> </li> <li>- 5.1 Reference Manuals <ul style="list-style-type: none"> <li>Corrected "Mempry" to "Memory" in Table 5.1.</li> </ul> </li> <li>- 5.10 Debug Interface <ul style="list-style-type: none"> <li>Added Port information in Table 5.9. Deleted Previous Table5.10.</li> </ul> </li> <li>- 5.16.2 Full Universal Asynchronous Receiver Transmitter Curcuit (FUART) <ul style="list-style-type: none"> <li>Corrected chapter number 5.6.1 to 5.16.2.</li> </ul> </li> <li>-5.21 12-bit Analog to Digital Converter (ADC) <ul style="list-style-type: none"> <li>Corrected spelling error of 3<sup>rd</sup> line, "highset" to "highest".</li> </ul> </li> <li>- 5.23 32-bit Timer Event Counter (T32A) <ul style="list-style-type: none"> <li>Corrected spelling error of 4<sup>th</sup> line, "a interval" to "an interval".</li> </ul> </li> <li>- 5.28 Boundary-scan <ul style="list-style-type: none"> <li>Corrected Table title of Table5.30</li> </ul> </li> <li>- 7.1 Absolute Maximum Ratings <ul style="list-style-type: none"> <li>Modified "Operational temperature" description in Table 7.1</li> </ul> </li> <li>-7.2 DC Electrical Characteristics(1/2)</li> </ul> |

|     |            |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-----|------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |            | <p>2<sup>nd</sup> table Condition added at the top right of the table</p> <p>3<sup>rd</sup> table Modified the description of voltage at the top right of the table</p> <p>-7.3 DC Electrical Characteristics (2/2) (Consumption current)</p> <p>Corrected some spelling error in Table 7.3</p> <p>-7.6 Characteristics of Internal processing at RESET</p> <p>Corrected "T<sub>IINIT</sub>" to "t<sub>IINIT</sub>", "T<sub>IRST</sub>" to "t<sub>IRST</sub>", "T<sub>pup</sub>" to "t<sub>pup</sub>", "T<sub>CPUWT</sub>" to "t<sub>CPUWT</sub>".</p> <p>-7.9.1.1 AC Measurement Condition</p> <p>Modified Ta condition</p> <p>-7.9.1.2 AC Electrical Characteristics</p> <p>Corrected value of t<sub>WL</sub>, t<sub>WH</sub> 35 to 40, Corrected symbol of TSPIxSCK high level output pulse width "t<sub>WL</sub>" to "t<sub>WH</sub>"</p> <p>-7.9.2 I<sup>2</sup>C Interface</p> <p>Corrected Title</p> <p>-7.9.3.2 AC Characteristics</p> <p>Corrected fsysm to ΦT0m in table</p> <p>Corrected symbol t<sub>PWH</sub> to t<sub>PWL</sub>, t<sub>PWL</sub> to t<sub>PWH</sub></p> <p>Deleted T32AxINA0/T32AxINB0/T32AxINB0/T32AxINB1 from Figure 7.5</p> <p>-7.9.4.1 AC Measurement Condition</p> <p>Modified Ta condition</p> <p>-7.9.4.3 AC Electrical Characteristics (EEXBCLK asynchronous Separate Mode)</p> <p>Corrected spelling error "rize" to "rise", Corrected spelling error "wiat" to "wait" in 6. Write cycle(external wait)</p> <p>-7.9.4.4 AC Electrical Characteristics (EEXBCLK asynchronous multiplex bus mode)</p> <p>Corrected spelling error "rize" to "rise"</p> <p>-7.9.4.5 AC Electrical Characteristics (EEXBCLK synchronous separate bus mode / multiplex bus mode)</p> <p>Corrected spelling error "rize" to "rise"</p> <p>-7.9.5.1 AC Measurement Condition</p> <p>Modified Ta condition</p> <p>-7.9.6.1 AC Measurement Condition</p> <p>Modified Ta condition</p> <p>-7.9.8.1 AC Measurement Condition</p> <p>Modified Ta condition</p> <p>-7.9.8.3 JTAG Interrupt</p> <p>Corrected Parameter of T<sub>d3</sub> and T<sub>d4</sub></p> <p>-7.10.3 Chip Erase</p> <p>Delete User Information Area from Condition.</p> <p>Corrected 82.0 to 100.1 of Code Flash 1.5MB,</p> <p>Corrected 64.0 to 82.0 of Code Flash 1.0MB</p> <p>-7.12.1 Internal Oscillator</p> <p>Modified Sybl "IHOSC1" to "f<sub>IHOSC1</sub>", "IHOSC2" to "f<sub>IHOSC2</sub>"</p> <p>Modified description of Note2</p> <p>-7.12.2 External Oscillator</p> <p>Modified Sybl "EHOSC" to "f<sub>EHOSC</sub>", "ELOSC" to "f<sub>ELOSC</sub>"</p> |
| 4.2 | 2019-03-26 | <p>- Added Commercial Product Data</p> <p>- Terms and Abbreviations</p> <p>Added BSC</p> <p>- 6.3 Control Pin</p> <p>Added R<sub>RST</sub> to Pull-up</p> <p>- 7.9.8.2 SWD Interface</p> <p>Modified Parameter of T<sub>ds</sub></p> <p>- 7.9.8.3 JTAG Interface</p> <p>Modified Parameter of T<sub>ds</sub></p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

## Appendix

### Part Naming Conventions

**TMP M4G 9 F 15 x FG**

The identification of  
Toshiba microcontrollers

Revision

#### Package

| Symbol        | Package                                                    |
|---------------|------------------------------------------------------------|
| QG            | Plastic shrink quad outline non-leaded package; dry-packed |
| UG,DUG,FG,DFG | Plastic quad flat package; dry-packed                      |
| MG,DMG        | Plastic small-outline package; dry-packed                  |
| XBG           | Plastic ball grid array; dry-packed                        |

Core

| Symbol | Core          |
|--------|---------------|
| M4     | ARM Cortex-M4 |
| M3     | ARM Cortex-M3 |
| M0     | ARM Cortex-M0 |

#### Product Group

| Family | Group | Application                                                   |
|--------|-------|---------------------------------------------------------------|
| TXZ    | H     | For General-purpose/Consumer electronic equipment             |
|        | K     | For Motor/Inverter control industrial equipment(MCU+AMP/COMP) |
|        | G     | For OA/Digital equipment/industrial equipment                 |

#### ROM Size

| Symbol | Size[KB] |
|--------|----------|
| M      | 32       |
| P      | 48       |
| S      | 64       |
| U      | 96       |
| W      | 128      |
| Y      | 256      |
| Z      | 384      |
| D      | 512      |
| E      | 768      |
| 10     | 1,023    |
| 15     | 1,536    |
| 20     | 2,048    |
| 40     | 4,096    |
| 80     | 8,192    |

#### Pin Count

| Symbol | Pin count        | Symbol | Pin count        |
|--------|------------------|--------|------------------|
| 0, G   | Under 32pin      | 8, Q   | 129pin to 144pin |
| 1, H   | 33pin to 44pin   | 9, R   | 145pin to 176pin |
| 2, J   | 45pin to 48pin   | A, S   | 177pin to 200pin |
| 3, K   | 49pin to 52pin   | B, T   | 201pin to 224pin |
| 4, L   | 53pin to 64pin   | C, U   | 225pin to 250pin |
| 5, M   | 65pin to 80pin   | D, V   | 251pin to 300pin |
| 6, N   | 81pin to 100pin  |        |                  |
| 7, P   | 101pin to 128pin |        |                  |

#### ROM Type

| Symbol | Type  |
|--------|-------|
| F      | Flash |
| C      | Mask  |

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