

MG32F02U128

MG32F02U064

Data Sheet

Version: 1.21

Features

❖ CPU Core

- ARM 32-bit Cortex-M0 CPU
- Operation frequency up to 48MHz
- Built-in one NVIC for 32 external interrupt inputs with 4-level priority
- Built-in one 24-bit system tick timer
- Built-in one single-cycle 32-bit multiplier
- Built-in one SWD serial wire debugger with 2 watch points and 4 breakpoints

❖ Flash Memory

- Built-in embedded max. 128K bytes flash memory for application code
- Support ICP (In-circuit program) for ISP boot code update through SWD interface
- Support ISP (In-system program) for application code update
 - Support programmable ISP flash memory size for ISP boot code
- Support IAP (In-application program) for application data update
 - Support programmable IAP flash memory size

❖ SRAM Memory

- Built-in embedded max. 16K bytes SRAM
 - Support private 2K bytes for DMA and 14K bytes for software to improve access performance
- Built-in extra 512 bytes SRAM for USB endpoints' packet buffer.

❖ Power

- Built-in two embedded regulators for core logic power and USB analog macro
- Built-in brown-out detectors
 - BOD0 detect 1.4V
 - BOD1 detect by selected level 4.2V/3.7V/2.4V/2.0V
 - BOD2 detect 1.7V
- Built-in a power management controller with power-down and wakeup control
- Support three power operation modes
 - ON(Normal) mode and SLEEP , STOP power down modes
- Support wake-up from SLEEP/STOP modes via multiple sources

❖ Reset

- Built-in embedded POR (power-on reset) circuit
- Built-in one reset source controller
 - Programmable chip cold reset and warm reset for reset source
 - Independent software reset control for internal modules
- Provide multiple reset source
 - POR/BOD/External reset pin input/Software force reset
 - IWDW/WWDT/ADC/Analog Comparator
 - Illegal address error reset/Flash access protect error reset
 - Missing clock detect (MCD) reset

❖ Clock

- Built-in embedded ILRCO (internal low frequency RC oscillator) by 32KHz
- Built-in embedded IHRCO (internal high frequency RC oscillator)
 - Trimmed to 11.059 or 12MHz $\pm 1\%$ at +25°C
- Built-in embedded PLL clock output for system clock
- Built-in embedded XOSC oscillator with MCD for external 32KHz and 4 ~ 25MHz Xtal
- Support external clock input up to 36MHz
- Built-in a clock source controller with independent clock enable control for modules
- Support internal XOSC oscillator and internal ILRCO/IHRCO clock output

❖ DMA (Direct Memory Access)

- **5 independently configurable channels with dedicated hardware DMA requests**
 - Access to Memory, APB and AHB Peripherals as source and destination
 - Support SRAM/Flash/EMB as memory source and SRAM/EMB as memory destination
- **DMA transfer management type**
 - memory-to-memory (channel 0,3 only)
 - peripheral-to-memory
 - memory-to-peripheral
 - peripheral-to-peripheral
- **Built-in two type of priority control between channel requests**
 - Channel request by Round Robin
 - Software configurable priority level
- **Programmable transfer number of data and up to 131072**
- **Programmable burst length 1,2,4**
- **Support transfer loop mode and start address auto reload control**
- **Provide single/block/demand mode for external pin trigger request**

❖ GPIO

- **Support general purpose IO pins for application**
 - Maximum 73 GPIO pins for LQFP80 package
 - Maximum 59 GPIO pins for LQFP64 package
 - Maximum 44 GPIO pins for LQFP48 package
- **Provide selectable IO modes by pin independent**
 - Push-Pull output
 - Quasi bidirectional (PC pins only)
 - Open-drain output
 - Digital Input with high impedance
 - Analog IO
- **Flexible pin alternate function selection**
- **Support programmable drive strength by pin independent**
- **Support IO deglitch filter by pin independent**
- **Support input inverse selection by pin independent**
- **Support pull-high option by pin independent**
- **Support high speed option by pin independent except RSTN, XIN**
- **GPIO pin state and IO mode setting keep optional after reset**

❖ Interrupt Support

- **Built-in one EXIC (external interrupt controller) for NVIC connection**
 - Independent high/low level and rising/falling edge trigger selection
- **Built-in one WIC (wakeup interrupt controller) for wakeup event control**
- **All GPIO pins can be configured as interrupt source and key pad input**
 - Support port OR logic for interrupt function
 - Support port AND logic for KBI function
- **Support external pins for CPU NMI/RXEV/TXEV function**

❖ Timer

- **Provide seven timers/counters : TM00, TM01, TM10, TM16, TM20, TM26, TM36**
- **Timer module common functions**
 - Selectable Full-counter, Cascade, Separate timer operation modes
 - Multiple internal and external signals as timer clock source or trigger source
 - Support timer reset, trigger start and clock gating for trigger source function
 - Timer overflow as clock output to external pin output
 - Auto-stop mode by main counter counting

- **Provide TM36 timer module**
 - 32-bit timer/counter
 - 4 CCP (input Capture/output Compare/PWM) channels
 - 3 CCP channels with OCN (complementary output compare)
 - PWM function with center/edge-align, dead time control and break control
 - QEI(Quadrature Encoder Interface) support
 - One IC and three OC with DMA capability
 - Extra repetition counter for auto-stop mode
- **Provide TM2x timer modules (TM20, TM26)**
 - 32-bit timer/counter
 - 2 CCP (input Capture/output Compare/PWM) channels
 - 2 CCP channels with OCN (complementary output compare)
 - PWM function with edge-align
 - QEI(Quadrature Encoder Interface) support(TM26 only)
 - Extra repetition counter for auto-stop mode
- **Provide TM1x timer modules (TM10, TM16)**
 - 32-bit timer/counter
- **Provide TM0x timer modules (TM00, TM01)**
 - 16-bit timer/counter

❖ RTC

- **Built-in 32-bit counter with selectable clock source**
- **Support alarm function and time-stamp function**
- **Support wakeup from STOP mode**
- **Support periodic timer tick interrupt or wakeup**

❖ Watchdog Timer

- **Built-in one IWDWT (Independent Watch Dog Timer)**
 - 8-bit down counter with 12-bit prescaler and clocked by ILRCO clock
 - Operating capability in SLEEP and STOP modes
 - Selectable reset or interrupt when the counter underflow
 - Support two early wakeup comparators with interrupt
- **Built-in one WWDT (Window Watch Dog Timer)**
 - 10-bit counter with 1 or 256 divider , 1/2/4~/128 divider
 - Configurable time-window to detect abnormally late or early application behavior
 - Selectable reset or interrupt when the counter is underflow or reloaded outside the window
 - Support warning interrupt

❖ I2C

- **Provide two identical I2c modules : I2C0 , I2C1**
- **I2C module common functions**
 - Support master and slave mode
 - Support programmable clock rate control and clock rate up to 1 MHz
 - Support programmable high/low period control for master mode
 - Support clock stretching for slave mode
 - Support general call function
 - Support multi-master processing capability
 - Support both Byte mode and Buffer mode flow control
 - Support Byte mode bus event code for simplex firmware control
 - Support Buffer mode 4-byte data buffer and 32-bit data register for high speed communication
 - Received and transmitted data are buffered with DMA capability
 - Support slave address hardware detection wakeup from STOP mode

- Support SMBus timeout detection

❖ UART

- **Provide seven UART modules : URT0~2, URT4~7**
- **UART module common functions**
 - Provide precise UART baud-rate control by programmable oversampling rate
 - Support baud rate up to 6 Mbit/s
 - Programmable data word length - 7 or 8 bits
 - Programmable 4~32 oversampling rate
 - Hardware parity checking and parity generation
 - Swappable TX/RX pin configuration
 - Separate signal polarity control for transmission and reception
- **Provide URT0/1/2 advanced UART module**
 - Support UART, Synchronous, SPI master/slave, SmartCard, LIN, Multi-processor modes
 - Selectable MSB or LSB first data order
 - Configurable stop bits - 0.5, 1, 1.5 or 2 stop bits
 - Support a timeout timer for Idle/RX/Break/Calibration timeout detection
 - Support 4-byte data buffer and 32-bit data register for high speed communication
 - Support auto baud-rate detection and calibration
 - Support multiprocessor communication for master and slave mode - Idle-Line , Address-Bit
 - Support low speed UART-like frame format IrDA
 - Support transceiver hardware flow control by CTS/RTS signals only
 - Provide driver enable signal to activate the transmission for bidirectional communication
 - Support transmission-error hardware detection and auto resent control for Smart-card application
 - Support receiving parity error hardware detection and auto retry control for Smart-card application
 - Received and transmitted data are buffered with DMA capability
- **Provide URT4/5/6/7 basic UART modules**
 - Support fundamental UART mode
 - Support TX/RX independent 8-bit data register for simplex firmware control
 - Configurable stop bits - 1 or 2 stop bits

❖ SPI

- **Provide four modules for SPI communication: SPI0, URT0, URT1, URT2**
 - Provide one advanced SPI module: SPI0
 - Provide three configurable SPI modules: URT0, URT1, URT2 (Refer to UART features)
- **Support master and slave mode**
 - Support full duplex , half duplex or simplex communication mode
 - Support data communication without NSS(slave select signal)
- **Support programmable clock rate control**
- **Selectable 4~32-bit frame size**
 - Support 4-byte data buffer and 32-bit data register for high speed communication
- **Received and transmitted data are buffered with DMA capability**
- **Support multi-master processing capability**
- **Selectable clock polarity and phase**
- **Selectable MSB or LSB first data order**
- **NSS line management by hardware or software for master mode**
- **Configurable data transfer modes**
 - Standard SPI mode (separated transmit and receive line)
 - Single/Dual/Quad/Octal SPI mode with bidirectional data transfer
- **Data transmit/receive overrun detect**

❖ USB

- **USB 2.0 full-speed with 12Mbps**

- Compliant with USB specification v1.1/v2.0.
- **Supports USB suspend/resume and remote wake-up**
- **Support 8 endpoints with In and Out directions**
 - Each endpoint support flexible In, Out, simultaneous In and Out operations
 - Support 7 configurable endpoints with relocated address value except endpoint-0
 - Support independently receive and transmit buffer with separated start address for each endpoint
 - Support double buffer mode for each endpoint independently
- **Support control transfer for endpoint 0**
- **Support interrupt, bulk and isochronous transfer for all endpoints except endpoint-0**
- **Supports USB SRAM size 512 bytes shared for all endpoints**
- **Supports USB 2.0 Link Power Management**
- **Received and transmitted data are buffered with DMA capability for EP3,4**

❖ **EMB (External Memory Bus)**

- **Support SRAM, NOR/NAND-flash, LCD interface**
- **Support synchronous or asynchronous timing mode control**
- **Support multiple types of address and data multiplex mode**
- **Provide optional 16/24/30-bit address mode**
 - Memory space 2G/32M/128K-byte for 16-bit data width
- **Configurable time cycle for address latch time and data access time**
- **Received and transmitted data are buffered with DMA capability**
- **Allow running CPU code on external SRAM**

❖ **ADC**

- **12-bit SAR ADC with 1.5Msps**
 - Configurable resolution : 12/10/8-bit
 - Configurable sampling time
- **Provide external 16 channels and internal 8 channels input**
 - Internal extra channel source : VBUF, VSSA, LDO VR0, DAC out, 1/2VDD, V33, VPG, TS out
- **Support auto-sampling and trigger by external pin, internal events and software bit**
- **Data alignment for output code left/right justify**
- **Built-in input buffer stage with bypass option**
 - PGA with programmable gain : 1~4
- **Optional ADC top voltage reference from external VREF+ or internal IVR24**
- **Interrupt generation at the end of sampling, end of conversion, end of sequence conversion**
- **Support voltage window detection and output code limitation**
- **Built-in three channel independent hardware accumulators for ADC output code**
- **Support one-shot/channel scan/loop scan**
- **ADC data are buffered with DMA capability**
- **Support wait mode to prevent ADC overrun**

❖ **Analog Comparator**

- **Provide 2 fast Rail-to-rail comparators**
- **Programmable 64-step threshold of internal voltage reference**
- **Provide external total 6 channels input for all comparators**
 - Two common and two independent external channels, two internal channels
- **Programmable input hysteresis voltage**
- **Programmable response time for optimal current consumption**
- **Selectable compare output polarity**
- **Support wakeup from SLEEP and STOP modes**
- **Support analog watch dog as a reset source**

❖ **DAC**

MG32F02U128/U064

- One 12-bit voltage DAC
 - Maximum conversion rate is 1Msps
- Conversion start trigger by register written, external pin and internal events
- Build in internal output buffer
- Data alignment for input code left/right justify
 - Configurable code width : 12/10/8-bit
- Output data are buffered with DMA capability

❖ Temperature Sensor

- Built-in a temperature sensor in ADC macro
- Temperature resolution : +/- 2 °C (Typical)
- Temperature operation range : -40°C ~ 125°C

❖ GPL (General Purpose Logic)

- Support data inverse, bit order change, byte order change and parity check
 - Data bit order change for 8/16/32-bit reverse
 - Data byte order change between Little endian and Big endian for 16/32-bit range
 - Parity Check for 8/16/32 bit range
- Support CRC (Cyclic Redundancy Check) calculation
 - Programmable CRC initial value
 - CRC output bit order change
- CRC with fixed common polynomial
 - CRC8 polynomial 0x07
 - CRC16 polynomial 0x8005
 - CCITT16 polynomial 0x1021
 - CRC32(IEEE 802.3) polynomial 0x4C11DB7
- Support signed/unsigned 32-bit divider
 - Operation in 8 clock cycles
- Input data are buffered with DMA capability

❖ Misc.

- Timer synchronous enable global control
- OBM(Output Signal Break and Modulation) control
 - Support two sets of OBM for output signal break and modulation control
- NCO(Numerically Controlled Oscillator) output with FDC and PF modes
- Support two sets of CCL(Configurable Custom Logic)
- 32-bit non-reset backup register
- Provide on chip 16 bytes Unique ID code

❖ Operating

- Operating voltage range 1.8V ~ 5.5V
- Operating temperature range -40°C ~ 105°C (**1)
- Operating frequency range up to 48MHz

❖ Package Types

- LQFP80 / LQFP64 / LQFP48

(**1): Tested by sampling.

List of Contents

Features 3

List of Contents..... 9

List of Figures 13

List of Tables 14

1. General Description 15

2. Order Information..... 16

3. Block Diagram 18

 3.1. System Function Block..... 18

 3.2. Chip Main Block 19

4. Pin Description 20

 4.1. Pin Outline..... 20

 4.1.1. LQFP80 Package Pinout..... 20

 4.1.1. LQFP64 Package Pinout..... 23

 4.1.2. LQFP48 Package Pinout..... 26

 4.2. Pin Definition 28

 4.3. Pin AFS Summary Table 48

 4.4. Analog Function Pin Table..... 50

 4.5. Alternate Functions Pin List..... 51

5. Memory Map 57

 5.1. Memory Organization 57

 5.2. CPU Memory Map..... 58

 5.3. Peripheral Memory Boundary..... 59

 5.4. Boot Modes 60

6. Functional Description 61

 6.1. CPU Core..... 61

 6.1.1. Introduction 61

 6.1.2. CPU Features 61

 6.1.3. ARM Cortex-M0 Processor 61

 6.2. Power Management 62

 6.2.1. Introduction 62

 6.2.2. Chip Power Features 62

 6.2.3. Power Operation Mode 62

 6.2.4. Power Supply..... 62

 6.2.5. CPU Power Down 63

 6.3. System Reset..... 63

 6.3.1. Introduction 63

 6.3.2. Chip Reset Features 63

 6.3.3. Chip Reset Levels..... 63

 6.3.4. External Reset 64

 6.3.5. Module Reset..... 64

 6.4. System Clock 64

 6.4.1. Introduction 64

 6.4.2. Chip Clock Features..... 64

 6.4.3. System Clock Source..... 64

- 6.4.4. PLL Clock..... 64
- 6.4.5. Module Process Clock Control..... 64
- 6.5. System Common Control 64
 - 6.5.1. Introduction 64
 - 6.5.2. Features..... 64
- 6.6. Memory Access 65
 - 6.6.1. Introduction 65
 - 6.6.2. Features..... 65
 - 6.6.3. Memory Controller 65
 - 6.6.4. ICP/ISP/IAP for Flash Memory..... 65
 - 6.6.5. Hardware Option Byte Flash Memory 65
- 6.7. External Memory Bus 66
 - 6.7.1. Features..... 66
 - 6.7.2. EMB Control Function..... 66
- 6.8. GPIO 66
 - 6.8.1. Introduction 66
 - 6.8.2. Features..... 66
 - 6.8.3. GPIO Control Block..... 67
- 6.9. Interrupt..... 67
 - 6.9.1. Introduction 67
 - 6.9.2. Interrupt Features 67
 - 6.9.3. Interrupt Structure 68
 - 6.9.4. Nested Vectored Interrupt Controller 68
 - 6.9.5. Wakeup Interrupt Controller 69
 - 6.9.6. External Interrupt Controller..... 69
- 6.10. General Purpose Logic..... 69
 - 6.10.1. Introduction 69
 - 6.10.2. Features..... 69
 - 6.10.3. GPL Control Block 69
- 6.11. APB Common Control 70
 - 6.11.1. Introduction 70
 - 6.11.2. Features..... 70
 - 6.11.3. APB Control Block 70
- 6.12. APX..... 70
 - 6.12.1. Introduction 70
 - 6.12.2. Features..... 70
 - 6.12.3. APX Control Block 70
- 6.13. Direct Memory Access..... 71
 - 6.13.1. Introduction 71
 - 6.13.2. Features..... 71
 - 6.13.3. DMA Control 71
- 6.14. ADC..... 72
 - 6.14.1. Introduction 72
 - 6.14.2. Features..... 72
 - 6.14.3. ADC Control Block 72
- 6.15. Analog Comparator 73

6.15.1. Introduction	73
6.15.2. Features.....	73
6.15.3. CMP Control Block.....	73
6.16. DAC.....	74
6.16.1. Introduction	74
6.16.2. Features.....	74
6.16.3. DAC Control Block	74
6.17. IWDT.....	74
6.17.1. Introduction	74
6.17.2. Features.....	74
6.17.3. IWDT Control	74
6.18. WWDT.....	75
6.18.1. Introduction	75
6.18.2. Features.....	75
6.18.3. WWDT Control.....	75
6.19. RTC.....	75
6.19.1. Introduction	75
6.19.2. Features.....	75
6.19.3. RTC Control	75
6.20. Timer	76
6.20.1. Introduction	76
6.20.2. Features.....	76
6.20.3. Module Functions.....	77
6.20.4. Timer Control Block	77
6.21. I2C.....	78
6.21.1. Introduction	78
6.21.2. Features.....	78
6.21.3. I2C Control.....	78
6.22. UART	79
6.22.1. Introduction	79
6.22.2. Features.....	79
6.22.3. Module Functions.....	80
6.22.4. UART Control.....	80
6.23. SPI	81
6.23.1. Introduction	81
6.23.2. Features.....	81
6.23.3. SPI Control.....	82
6.24. USB.....	82
6.24.1. Introduction	82
6.24.2. Features.....	82
6.24.3. Module Functions.....	82
6.24.4. USB Control	83
7. Application Notes.....	84
7.1. Power Supply Circuit.....	84
7.2. Reset Circuit.....	85
7.3. Xtal Oscillating Circuit	85

7.4. ADC Application Circuit	87
7.5. DAC Application Circuit	87
7.6. USB Application Circuit	88
8. Electrical Characteristics	90
8.1. Parameter Glossary	90
8.2. Absolute Maximum Rating	90
8.3. DC Characteristics	91
8.4. IO Characteristics.....	93
8.5. External Clock Characteristics	96
8.6. PLL Characteristics	96
8.7. IHRCO Characteristics.....	96
8.8. ILRCO Characteristics.....	97
8.9. LDO Characteristics	97
8.10. Flash Characteristics.....	97
8.11. ADC Characteristics	98
8.12. ADC PGA Characteristics.....	99
8.13. Analog Comparator Characteristics.....	100
8.14. Temperature Sensor Characteristics	101
8.15. DAC Characteristics	101
8.16. USB Characteristics	102
8.17. UART Characteristics	103
8.18. SPI Characteristics.....	104
8.19. I2C Characteristics.....	106
9. Package Dimension	107
9.1. LQFP-80.....	107
9.2. LQFP-64.....	108
9.3. LQFP-48.....	109
10. Revision History	110
11. Disclaimers	112

List of Figures

Figure 2-1. Part Numbering16

Figure 3-1. System Function Block18

Figure 3-2. Chip Main Block19

Figure 4-1. LQFP80 Package Pinout20

Figure 4-2. LQFP64 Package Pinout23

Figure 4-3. LQFP48 Package Pinout26

Figure 5-1. Memory Organization Map57

Figure 6-1. ARM Cortex-M0 Processor61

Figure 7-1. Power Supply Circuit for USB series chip84

Figure 7-2. Reset Circuit85

Figure 7-3. XTAL Oscillating Circuit85

Figure 7-4. ADC Application Circuit87

Figure 7-5. DAC Application Circuit88

Figure 7-6. USB Application Circuit88

Figure 7-7. USB PCB Layout Suggestion on 2-layer 1.6mm FR4 PCB88

Figure 8-1. UART Timing Waveform103

Figure 8-2. SPI Master Timing Waveform105

Figure 8-3. SPI Slave Timing Waveform105

Figure 8-4. I2C Timing Waveform106

Figure 9-1. LQFP-80 (10mm X 10mm) ~ AD80107

Figure 9-2. LQFP-64 (7mm X 7mm) ~ AD64108

Figure 9-3. LQFP-48 (7mm X 7mm) ~ AD48109

List of Tables

Table 2-1. Chip Selection Table17

Table 4-1. LQFP80 Pin AFS List21

Table 4-2. LQFP64 Pin AFS List23

Table 4-3. LQFP48 Pin AFS List26

Table 4-4. Abbreviations for pin definition28

Table 4-5. Pin Descriptions28

Table 4-6. Pin AFS Summary Table48

Table 4-7. Analog Function Pin Table50

Table 4-8. Alternate Functions Pin List51

Table 5-1. CPU Memory Address Map58

Table 5-2. Peripheral Memory Boundary Address59

Table 6-1. Power-Down Mode Selection63

Table 6-2. Interrupt Source Table68

Table 6-3. Timer Module Function Table77

Table 6-4. UART Module Function Table80

Table 6-5. USB Endpoint Function Table82

Table 7-1. Internal Total Equivalent Capacitance for XOSC circuit86

Table 7-2. Reference Capacitance of C1 & C2 for crystal oscillating circuit86

Table 8-1. Parameter Glossary90

Table 8-2. Absolute Maximum Rating90

Table 8-3. DC Characteristics91

Table 8-4. Current Measurement Condition Level Definition Table92

Table 8-5. IO Characteristics93

Table 8-6. External Clock Characteristics96

Table 8-7. PLL Characteristics96

Table 8-8. IHRCO Characteristics96

Table 8-9. ILRCO Characteristics97

Table 8-10. LDO Characteristics97

Table 8-11. Flash Characteristics97

Table 8-12. ADC Characteristics98

Table 8-13. ADC PGA Characteristics99

Table 8-14. Analog Comparator Characteristics100

Table 8-15. Temperature Characteristics101

Table 8-16. DAC Characteristics101

Table 8-17. USB Characteristics102

Table 8-18. UART Characteristics103

Table 8-19. SPI Characteristics104

Table 8-20. I2C Characteristics106

1. General Description

The **MG32F02U** is a single-chip 32-bit microcontroller based on a high performance Core ARM 32-bit Cortex™-M0 CPU with embedded Nested Vectored Interrupt Controller (NVIC).

The **MG32F02U** has up to **128K** bytes of embedded main flash memory for code and data, programmable memory size of embedded system flash memory for boot load code and 64 bytes of embedded option-byte flash memory for chip configuration. The all flash memory can be programmed either in serial writer mode (ICP, In-Circuit-Programming). Also, the main flash memory can be programmed in ISP (In-System Programming) mode or SRAM (Boot on SRAM) mode. ICP and ISP allow the user to download new code without removing the microcontroller from the actual end product; IAP means that the device can write non-volatile data in the flash memory while the application program is running. There needs no external high voltage for programming due to its built-in charge-pumping circuitry.

The **MG32F02U** retains all features of the ARM 32-bit Cortex™-M0 with **16K** bytes of SRAM, **5** I/O ports, **32** external interrupts source with 4-level interrupt controller and seven 8/16-bits timer/counters. In addition, the **MG32F02U** has a System Tick Timer, two Watchdog Timers, three Advance timer modules with IC/OC, four Basic timer modules for universal using, on-chip crystal oscillator for 32.768 KHz to 25MHz, two high precision internal oscillators IHRCO for 11.059/12MHz and ILRCO for 32 KHz, one 12-bit ADC with one temperature sensor, two programmable threshold comparators and one 12-bit voltage mode DAC.

Also, the **MG32F02U** support multiple and flexible communicate interface for production application. It provides alternate function pins those are including of GPIO, I2C, SPI, UART, Timer with IC/PWM, ADC, Analog Comparator, DAC, EMB, NCO, CCL and SWD(on chip debug). It has maximum 73 GPIO pins and provides programmable IO type - quasi-bidirectional , push-pull output , open-drain output , input only(Hi-z) with optional pull-high. In addition, it is built-in internal de-bounce circuit to deglitch noise for worse signals.

One direct memory access (DMA) controller is used to improve data transfer between peripherals and memory and memory to memory. The data can be transfer by DMA controller and does not cost any CPU time.

One external memory bus (EMB) controller is used to access external SRAM, NOR/NAND flash or 8080 interface LCD display panel. It supports multiple address bus and data bus multiplex modes. Also it supports synchronous or asynchronous timing with programmable cycle time for external devices.

For **MG32F02U series**, the chip provides a USB (Universal Serial Bus) full-speed device with relocated endpoint addresses. It is fully compliable with USB specification 2.0 and 1.1 to support various USB applications. The USB block contains an on-chip 3.3V regulator, a USB transceiver which transmits and receives differential USB signal, a USB Core to perform NRZI encoding and decoding, bit stuffing, CRC generation and checking, serial-parallel data transforming, data flow between USB data buffer and CPU.

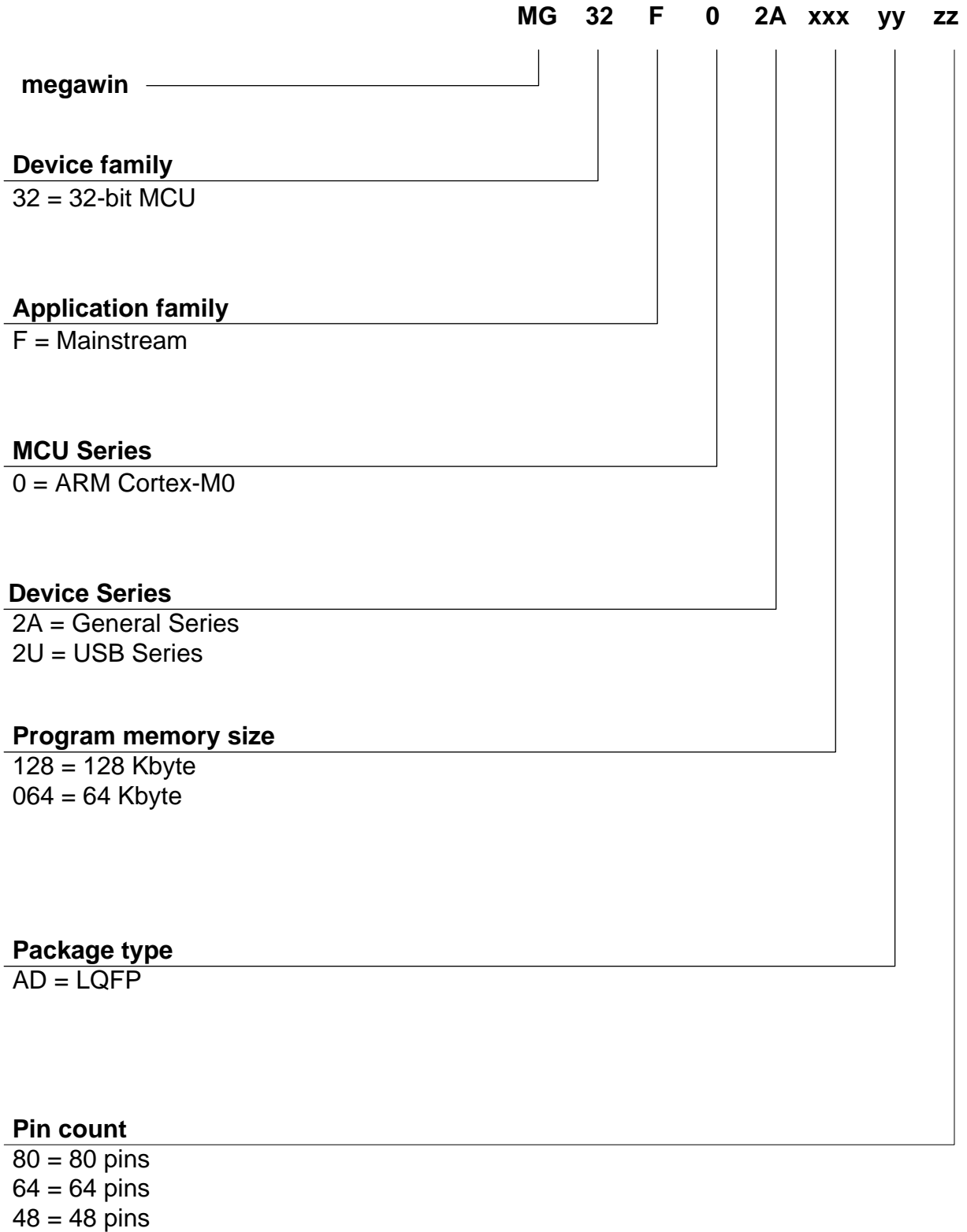
For power management and reset control, the **MG32F02U** is built-in a power supervisor including of a Low Voltage Detector(LVD), three Brown-out Detectors(BOD0/BOD1/BOD2), a Power-On Reset(POR) , a Low-voltage Reset(LVR). The **MG32F02U** has multiple power-down modes to reduce the current consumption: Sleep mode and Stop mode.

In the Sleep mode the CPU is frozen while the peripherals and the interrupt system are still operating. In the Stop mode the RAM and SFRs' value are saved and all other functions are inoperative; most importantly, in the Sleep mode the chip can be waked up by many interrupt or reset sources(POR/LVR/BOD0/BOD1/BOD2).

2. Order Information

Please contact the megawin sales for available options (memory size, package ...) and more information about this device.

Figure 2-1. Part Numbering



● Chip Selection

Table 2-1. Chip Selection Table

Functions	Chip	MG32F02U128	MG32F02U064	Comment
Flash ROM		128KB	64KB	memory space of AP+IAP+ISP
SRAM		16KB	16KB	
Package		LQFP80/64	LQFP64/48	
IO Number		73/59	59/44	IO number by package
Max. CPU Frequency		48MHz	48MHz	
Internal Clock Source		ILRCO+IHRCO	ILRCO+IHRCO	12MHz(default) & 11.059MHz option for IHRCO
Voltage Detector		LVR+BOD0/1/2	LVR+BOD0/1/2	Low Voltage Reset (LVR), BOD1: 4.2/3.7/2.4/2.0V
Timers		16-bit*2: TM00/01 32-bit*5: TM1x/2x/36	16-bit*2: TM00/01 32-bit*5: TM1x/2x/36	support Full-Counter, Cascade , Separate modes
IC/OC/PWM Channels		8-CH (16-bit) or 16-CH(8-bit)	8-CH (16-bit) or 16-CH(8-bit)	IC: Input Capture, OC: Output Compare (support normal + complement output)
WDT		IWDT + WWDT	IWDT + WWDT	IWDT: Independent Watch Dog Timer, WWDT: System Window Watch Dog Timer
RTC		32-Bit	32-Bit	
ADC		12-Bit , 16-CH 1.5Msps	12-Bit , 16-CH 1.5Msps	embedded one input buffer with PGA at room temperature
ACMP Units		2	2	fast rail-to-rail analog comparators with two R-ladder voltage reference
DAC		voltage DAC 12-Bit , 1-CH	voltage DAC 12-Bit , 1-CH	02V ~ VDD-0.2V full scale range with output buffer on
UART Units		Advanced *3 Basic *4	Advanced *3 Basic *4	URT0~3 can configurable to SPI, Multi-processor, IrDA, LIN, ISO-7816 (SmartCard) and support Hardware flow control
UART as SPI		Master/Slave *3	Master/Slave *3	configurable and shared in advanced UART module
UART SPI mode Max. Clock Rate (3.3V/1.8V)		Master: 18/16 MHz Slave: 12/12 MHz	Master: 18/16 MHz Slave: 12/12 MHz	VDD (5~3.3V / 3.3~1.8V)
SPI Units		1	1	master/slave mode with or without NSS control
SPI Max. Clock Rate (3.3V/1.8V)		Master: 22/16 MHz Slave: 16/12 MHz	Master: 22/16 MHz Slave: 16/12 MHz	VDD (5~3.3V / 3.3~1.8V)
I2C Units		2	2	optional Byte/Buffer mode, with/without clock stretching
USB Units		USB Device *1	USB Device *1	USB full speed device with USB 2.0 compliant, embedded 3.3v LDO for USB operation power
EMB		16/8-Bit Bus	16/8-Bit Bus	support SRAM,NOR/NAND flash,8088 LCD IF
DMA Channels		5-CH	5-CH	single/block/demand mode for external pin trigger
CRC		CRC8+16+32	CRC8+16+32	CRC8/CRC16/CCITT16/CRC32 fixed polynomial
HW Divider		32bit/32bit	32bit/32bit	hardware divider with 8 clock cycles (Dividend/Divisor)
OBM Units		2	2	Output Signal Break and Modulation
NCO Units		1	1	numerically controlled oscillator, Output frequency <= 1/2 Input frequency
CCL Units		2	2	configurable custom logic
Operation Voltage		1.8~5.5V	1.8~5.5V	
Operating Temperature		-40~105°C	-40~105°C	test by sampling
Flash Regions		AP,IAP,ISP	AP,IAP,ISP	Application flash, In-Application-Programming data flash, In-System-Programming flash (ISP: In-System-Programming data flash)

● Part Number List

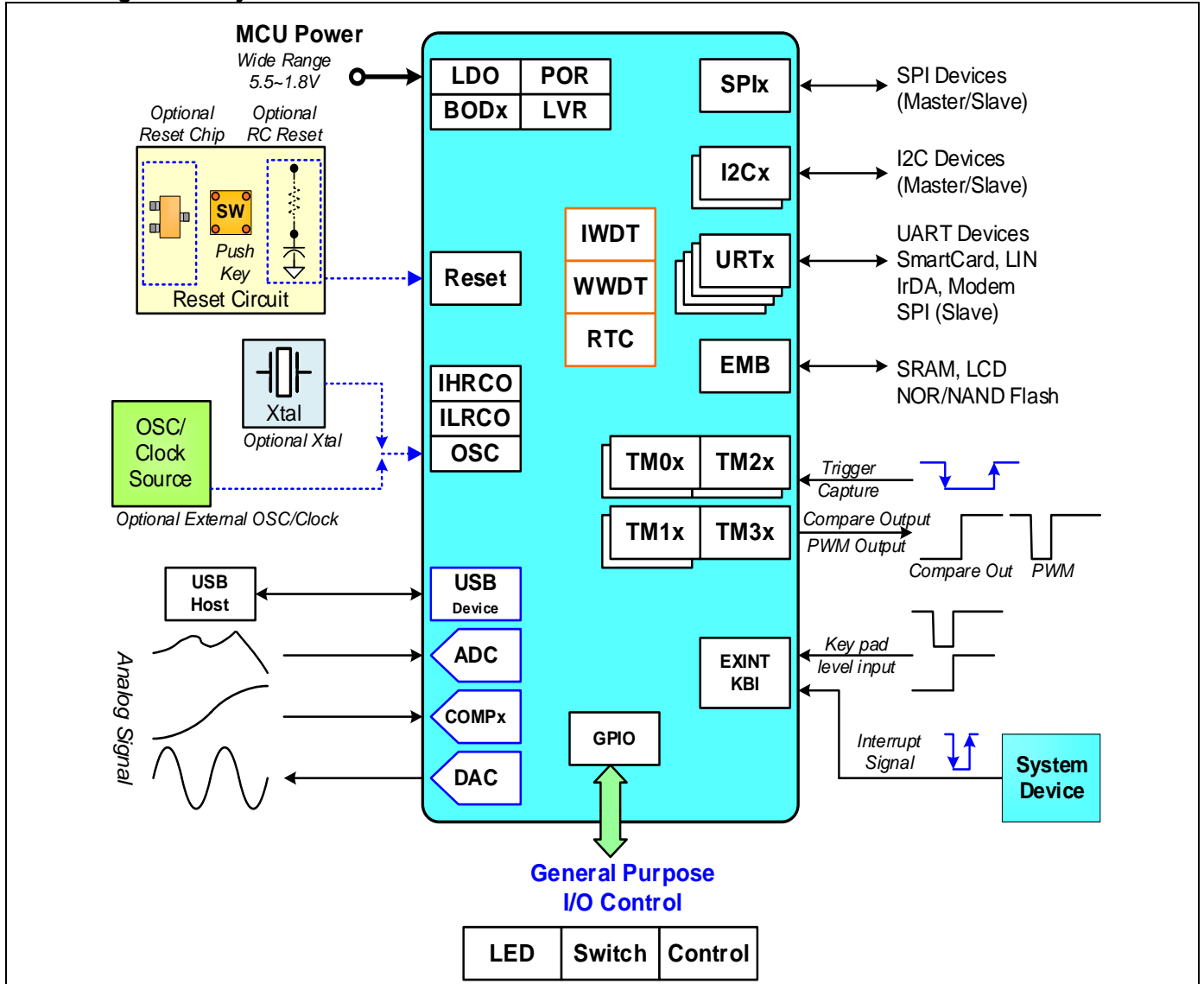
- MG32F02U128AD80 : LQFP80 (10mm x 10mm), 128KB Flash, USB Device
- MG32F02U128AD64 : LQFP64 (7mm x 7mm), 128KB Flash, USB Device
- MG32F02U064AD64 : LQFP64 (7mm x 7mm), 64KB Flash, USB Device
- MG32F02U064AD48 : LQFP48 (7mm x 7mm), 64KB Flash, USB Device

3. Block Diagram

3.1. System Function Block

The following diagram is showing the system function block for application.

Figure 3-1. System Function Block

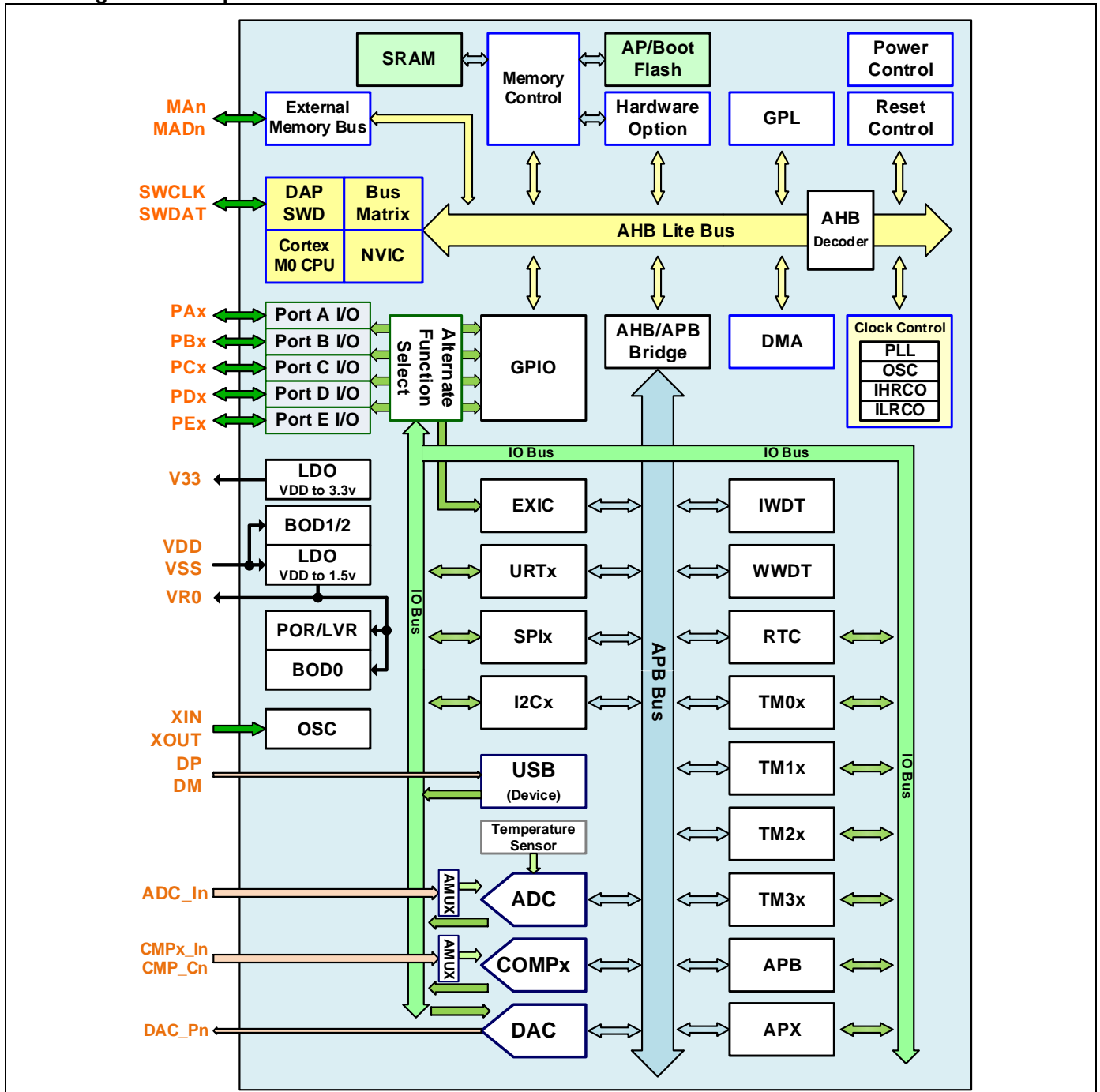


3.2. Chip Main Block

The following diagram is showing the block of internal devices in the chip.

There are one embedded ARM Cortex-M0 processor with NVIC (Nested Vectored Interrupt Controller) and DAP (Debug Access Port); AHB lite bus with SRAM/Flash memory, Power/Reset/Clock system controllers, EMB (External Memory Bus) controller, GPIO control blocks and GPL (General Purpose Logic); APB bus with UART/SPI/I2C/USB communication controllers, timers of general timer / IWDT / WWDT / RTC and analog control block of ADC / analog comparators / DAC; analog devices of POR (power on reset), BOD0/BOD1/BOD2 (Brown-Out Detectors), ILRCO (Internal Low-frequency RC Oscillator)/IHRCO Internal High-frequency RC Oscillator)/PLL.

Figure 3-2. Chip Main Block

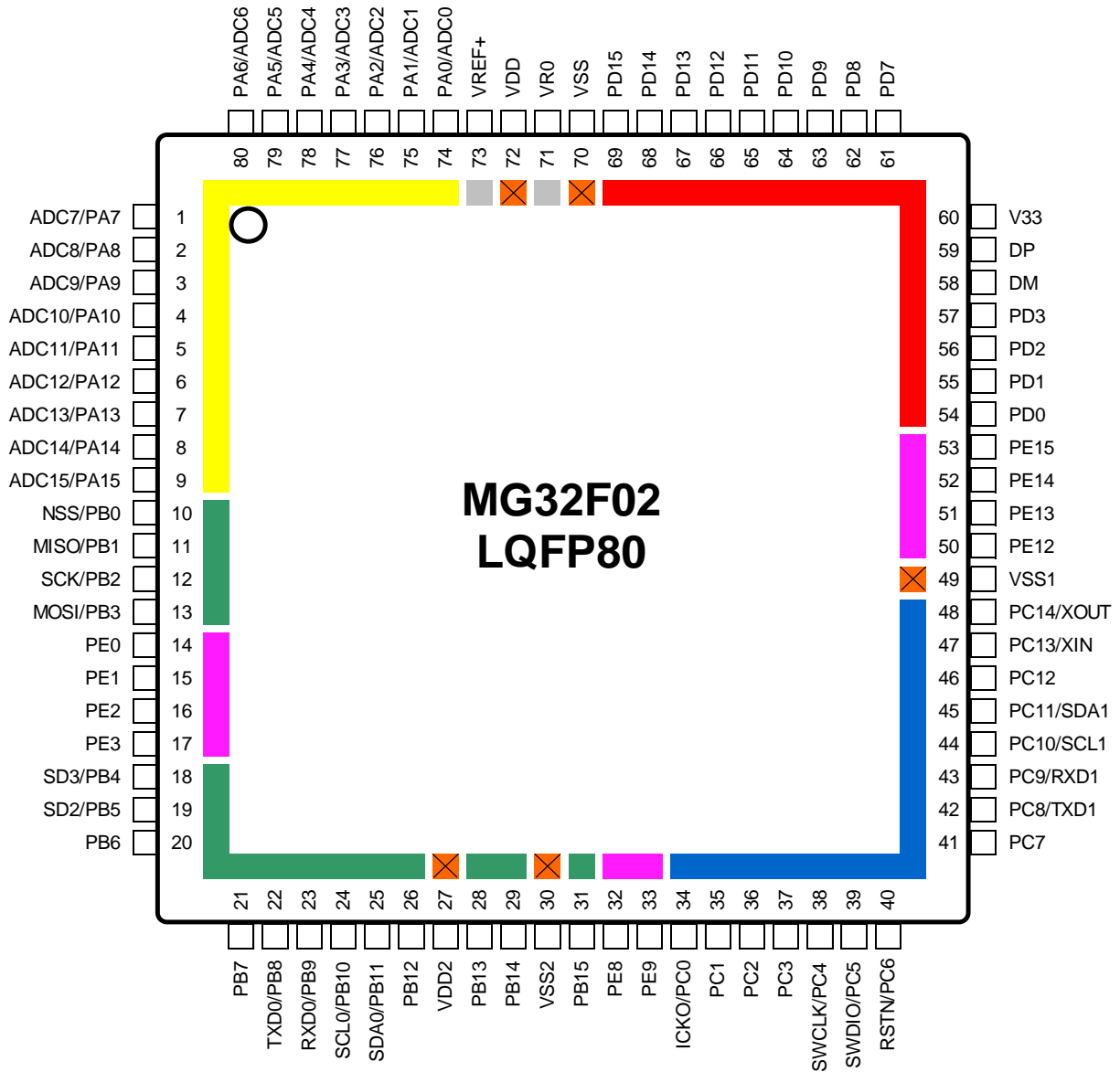


4. Pin Description

4.1. Pin Outline

4.1.1. LQFP80 Package Pinout

Figure 4-1. LQFP80 Package Pinout



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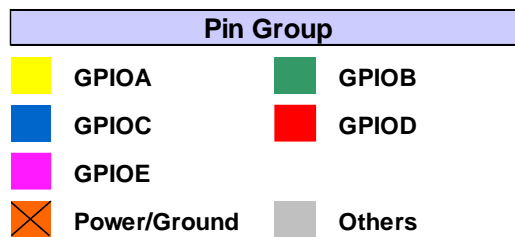


Table 4-1. LQFP80 Pin AFS List

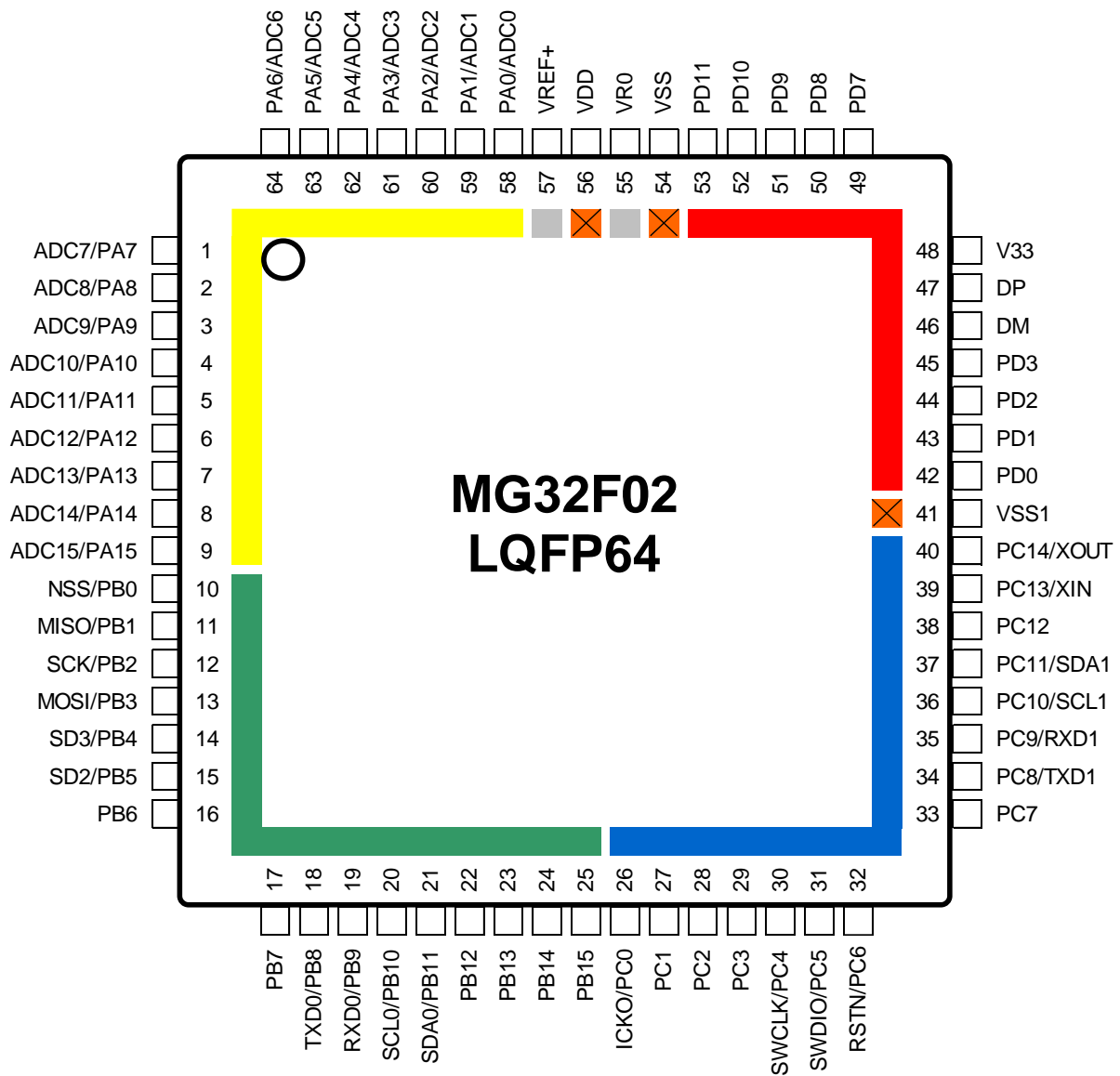
Pin	Name	Pin AFS List	Analog Function
1	PA7	GPA7, SPI0_D2, MA7, MAD7, TM20_OC1H, URT0_NSS	ADC_I7
2	PA8	GPA8, DMA_TRG0, I2C0_SCL, URT2_BRO, SDT_I0, TM20_IC0, SPI0_NSS, MA8, MAD0, TM36_OC0H, URT4_TX	ADC_I8, CMP0_I0, VBG_OUT
3	PA9	GPA9, DMA_TRG1, I2C1_SCL, URT2_TMO, TM20_IC1, SPI0_MISO, MA9, MAD1, TM36_OC1H, URT5_TX	ADC_I9, CMP0_I1
4	PA10	GPA10, TM36_BK0, SPI0_D2, I2C0_SDA, URT2_CTS, SDT_I1, TM26_IC0, SPI0_CLK, MA10, MAD2, TM36_OC2H, URT4_RX	ADC_I10, CMP1_I0, ADC_PGA
5	PA11	GPA11, DAC_TRG0, SPI0_D3, I2C1_SDA, URT2_RTS, TM26_IC1, SPI0_MOSI, MA11, MAD3, TM36_OC3H, URT5_RX	ADC_I11, CMP1_I1
6	PA12	GPA12, USB_S0, URT1_BRO, TM10_ETR, TM36_IC0, SPI0_D5, MA12, MAD4, TM26_OC00, URT6_TX	ADC_I12
7	PA13	GPA13, CPU_TXEV, USB_S1, URT0_BRO, URT1_TMO, TM10_TRGO, TM36_IC1, SPI0_D6, MA13, MAD5, TM26_OC10, URT6_RX	ADC_I13
8	PA14	GPA14, CPU_RXEV, OBM_I0, URT0_TMO, URT1_CTS, TM16_ETR, TM36_IC2, SPI0_D7, MA14, MAD6, TM26_OC0H, URT7_TX	ADC_I14
9	PA15	GPA15, CPU_NMI, OBM_I1, URT0_DE, URT1_RTS, TM16_TRGO, TM36_IC3, SPI0_D4, MA15, MAD7, TM26_OC1H, URT7_RX	ADC_I15
10	PB0	GPB0, I2C1_SCL, SPI0_NSS, TM01_ETR, TM00_CKO, TM16_ETR, TM26_IC0, TM36_ETR, MA15, URT1_NSS, URT2_NSS, URT6_TX	CMP_C0
11	PB1	GPB1, I2C1_SDA, SPI0_MISO, TM01_TRGO, TM10_CKO, TM16_TRGO, TM26_IC1, TM36_TRGO, URT1_RX, URT2_CLK, URT6_RX	CMP_C1
12	PB2	GPB2, ADC0_TRG, SPI0_CLK, TM01_CKO, URT2_TX, TM16_CKO, TM26_OC0H, I2C0_SDA, URT1_CLK, URT0_TX, URT7_TX	DAC_P0
13	PB3	GPB3, ADC0_OUT, SPI0_MOSI, NCO_P0, URT2_RX, TM36_CKO, TM26_OC1H, I2C0_SCL, URT1_TX, URT0_RX, URT7_RX	
14	PE0	GPE0, OBM_I0, URT0_TX, DAC_TRG0, SPI0_NSS, TM20_OC00, TM26_OC00, MALE, MAD8, URT4_TX	
15	PE1	GPE1, OBM_I1, URT0_RX, DMA_TRG1, SPI0_MISO, TM20_OC01, TM26_OC01, MOE, MAD9, TM36_OC0H, URT4_RX	
16	PE2	GPE2, OBM_P0, I2C1_SCL, URT1_TX, NCO_P0, SPI0_CLK, TM20_OC02, TM26_OC02, MWE, MAD10, TM36_OC1H, URT5_TX	
17	PE3	GPE3, OBM_P1, I2C1_SDA, URT1_RX, NCO_CK0, SPI0_MOSI, TM20_OC0N, TM26_OC0N, MCE, MALE2, URT5_RX	
18	PB4	GPB4, TM01_CKO, SPI0_D3, TM26_TRGO, URT2_CLK, TM20_IC0, TM36_IC0, MALE, MAD8	
19	PB5	GPB5, TM16_CKO, SPI0_D2, TM26_ETR, URT2_NSS, TM20_IC1, TM36_IC1, MOE, MAD9	
20	PB6	GPB6, CPU_RXEV, SPI0_NSSI, URT0_BRO, URT2_CTS, TM20_ETR, TM36_IC2, MWE, MAD10, URT2_TX	
21	PB7	GPB7, CPU_TXEV, URT0_TMO, URT2_RTS, TM20_TRGO, TM36_IC3, MCE, MALE2, URT2_RX	
22	PB8	GPB8, CMP0_P0, RTC_OUT, URT0_TX, URT2_BRO, TM20_OC01, TM36_OC01, SPI0_D3, MAD0, SDT_P0, OBM_P0, URT4_TX	
23	PB9	GPB9, CMP1_P0, RTC_TS, URT0_RX, URT2_TMO, TM20_OC02, TM36_OC02, SPI0_D2, MAD1, MAD8, OBM_P1, URT4_RX	
24	PB10	GPB10, I2C0_SCL, URT0_NSS, URT2_DE, TM20_OC11, TM36_OC11, URT1_TX, MAD2, MAD1, SPI0_NSSI	
25	PB11	GPB11, I2C0_SDA, URT0_DE, IR_OUT, TM20_OC12, TM36_OC12, URT1_RX, MAD3, MAD9, DMA_TRG0, URT0_CLK	
26	PB12	GPB12, DMA_TRG0, NCO_P0, USB_S0, URT1_CLK, MAD4, MAD2, URT5_TX	
27	VDD2		
28	PB13	GPB13, DAC_TRG0, TM00_ETR, URT0_CTS, TM20_ETR, TM36_ETR, URT0_CLK, MAD5, MAD10, CCL_P0, URT4_RX	
29	PB14	GPB14, DMA_TRG0, TM00_TRGO, URT0_RTS, TM20_TRGO, TM36_BK0, URT0_NSS, MAD6, MAD3, CCL_P1, URT4_TX	
30	VSS2		
31	PB15	GPB15, IR_OUT, NCO_CK0, USB_S1, URT1_NSS, MAD7, MAD11, URT5_RX	
32	PE8	GPE8, CPU_TXEV, OBM_I0, URT2_TX, SDT_I0, TM36_CKO, TM20_CKO, TM26_CKO, MAD11, URT4_TX	
33	PE9	GPE9, CPU_RXEV, OBM_I1, URT2_RX, SDT_I1, TM36_TRGO, TM20_TRGO, TM26_TRGO, MOE, URT4_RX	
34	PC0	GPC0, ICK0, TM00_CKO, URT0_CLK, URT2_CLK, TM20_OC00, TM36_OC00, I2C0_SCL, MCLK, MWE, URT0_TX, URT5_TX	
35	PC1	GPC1, ADC0_TRG, TM01_CKO, TM36_IC0, URT1_CLK, TM20_OC0N, TM36_OC0N, I2C0_SDA, MAD8, MAD4, URT0_RX, URT5_RX	
36	PC2	GPC2, ADC0_OUT, TM10_CKO, OBM_P0, URT2_CLK, TM20_OC10, TM36_OC10, SDT_I0, MAD9, MAD12	
37	PC3	GPC3, OBM_P1, TM16_CKO, URT0_CLK, URT1_CLK, TM20_OC1N, TM36_OC1N, SDT_I1, MAD10, MAD5	
38	PC4	GPC4, SWCLK, I2C0_SCL, URT0_RX, URT1_RX, TM36_OC2, SDT_I0, URT6_RX	
39	PC5	GPC5, SWDIO, I2C0_SDA, URT0_TX, URT1_TX, TM36_OC3, SDT_I1, URT6_TX	
40	PC6	GPC6, RSTN, RTC_TS, URT0_NSS, URT1_NSS, TM20_ETR, TM26_ETR, MBW1, MALE	
41	PC7	GPC7, ADC0_TRG, RTC_OUT, URT0_DE, URT1_NSS, TM36_TRGO, MBW0, MCE	
42	PC8	GPC8, ADC0_OUT, I2C0_SCL, URT0_BRO, URT1_TX, TM20_OC0H, TM36_OC0H, TM36_OC0N, MAD11, MAD13, CCL_P0, URT6_TX	
43	PC9	GPC9, CMP0_P0, I2C0_SDA, URT0_TMO, URT1_RX, TM20_OC1H, TM36_OC1H, TM36_OC1N,	

MG32F02U128/U064

		MAD12, MAD6, CCL_P1, URT6_RX	
44	PC10	GPC10, CMP1_P0, I2C1_SCL, URT0_TX, URT2_TX, URT1_TX, TM36_OC2H, TM36_OC2N, MAD13, MAD14, URT7_TX	
45	PC11	GPC11, I2C1_SDA, URT0_RX, URT2_RX, URT1_RX, TM36_OC3H, TM26_OC01, MAD14, MAD7, URT7_RX	
46	PC12	GPC12, IR_OUT, DAC_TRG0, URT1_DE, TM10_TRGO, TM36_OC3, TM26_OC02, MAD15, SDT_P0, URT1_CLK, MAM1	
47	PC13	GPC13, XIN, URT1_NSS, URT0_CTS, URT2_RX, TM10_ETR, TM26_ETR, TM36_OC00, TM20_IC0, SDT_I0, URT6_RX	
48	PC14	GPC14, XOUT, URT1_TMO, URT0_RTS, URT2_TX, TM10_CKO, TM26_TRGO, TM36_OC10, TM20_IC1, SDT_I1, URT6_TX	
49	VSS1		
50	PE12	GPE12, ADC0_TRG, USB_S0, TM01_CKO, TM16_CKO, TM20_OC10, TM26_OC10, MBW0, URT6_TX	
51	PE13	GPE13, ADC0_OUT, USB_S1, TM01_TRGO, TM16_TRGO, TM20_OC11, TM26_OC11, MBW1, TM36_OC2H, URT6_RX	
52	PE14	GPE14, RTC_OUT, I2C1_SCL, TM01_ETR, TM16_ETR, TM20_OC12, TM26_OC12, MALE2, CCL_P0, TM36_OC3H, URT7_TX	
53	PE15	GPE15, RTC_TS, I2C1_SDA, TM36_BK0, TM36_ETR, TM20_OC1N, TM26_OC1N, MALE, CCL_P1, URT7_RX	
54	PD0	GPD0, OBM_I0, TM10_CKO, URT0_CLK, TM26_OC1N, TM20_CKO, TM36_OC2, SPI0_NSS, MA0, MCLK, URT2_NSS	
55	PD1	GPD1, OBM_I1, TM16_CKO, URT0_CLK, NCO_CK0, TM26_CKO, TM36_OC2N, SPI0_CLK, MA1, URT2_CLK	
56	PD2	GPD2, USB_S0, TM00_CKO, URT1_CLK, TM26_OC00, TM20_CKO, TM36_CKO, SPI0_MOSI, MA2, MAD4, URT2_TX	
57	PD3	GPD3, USB_S1, TM01_CKO, URT1_CLK, SPI0_MISO, TM26_CKO, SPI0_D3, MA3, MAD7, TM36_TRGO, URT2_RX	
58	DM		
59	DP		
60	V33		
61	PD7	GPD7, TM00_CKO, TM01_ETR, URT1_DE, SPI0_MISO, TM26_OC0N, SPI0_D4, MA7, MAD0, TM36_IC0	
62	PD8	GPD8, CPU_TXEV, TM01_TRGO, URT1_RTS, SPI0_D2, TM26_OC10, SPI0_D7, MA8, MAD3, TM36_IC1, SPI0_CLK	
63	PD9	GPD9, CPU_RXEV, TM00_TRGO, URT1_CTS, SPI0_NSSI, TM26_OC11, SPI0_D6, MA9, MAD2, TM36_IC2, SPI0_NSS	
64	PD10	GPD10, CPU_NMI, TM00_ETR, URT1_BRO, RTC_OUT, TM26_OC12, SPI0_D5, MA10, MAD1, TM36_IC3, SPI0_MOSI	
65	PD11	GPD11, CPU_NMI, DMA_TRG1, URT1_TMO, SPI0_D3, TM26_OC1N, SPI0_NSS, MA11, MWE	
66	PD12	GPD12, CMP0_P0, TM10_CKO, OBM_P0, TM00_CKO, SPI0_CLK, TM20_OC0H, TM26_OC0H, MA12, MALE2	
67	PD13	GPD13, CMP1_P0, TM10_TRGO, OBM_P1, TM00_TRGO, NCO_CK0, TM20_OC1H, TM26_OC1H, MA13, MCE	
68	PD14	GPD14, TM10_ETR, DAC_TRG0, TM00_ETR, TM20_IC0, TM26_IC0, MA14, MOE, CCL_P0, URT5_TX	
69	PD15	GPD15, NCO_P0, IR_OUT, DMA_TRG0, TM20_IC1, TM26_IC1, MA15, CCL_P1, URT5_RX	
70	VSS		
71	VR0		
72	VDD		
73	VREF+		
74	PA0	GPA0, SDT_P0, CCL_P0, MA0, MAD0, TM36_OC00, URT4_TX	ADC_I0
75	PA1	GPA1, CCL_P1, MA1, MAD1, TM36_OC10, URT4_RX	ADC_I1
76	PA2	GPA2, SDT_I0, MA2, MAD2, TM36_OC2, URT5_TX	ADC_I2
77	PA3	GPA3, SDT_I1, MA3, MAD3, TM36_OC2N, URT5_RX	ADC_I3
78	PA4	GPA4, MA4, MAD4, TM20_OC00, URT0_TX	ADC_I4
79	PA5	GPA5, MA5, MAD5, TM20_OC10, URT0_RX	ADC_I5
80	PA6	GPA6, SPI0_D3, MA6, MAD6, TM20_OC0H, URT0_CLK	ADC_I6

4.1.1. LQFP64 Package Pinout

Figure 4-2. LQFP64 Package Pinout



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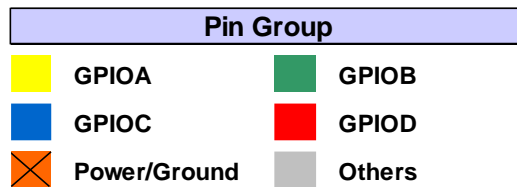


Table 4-2. LQFP64 Pin AFS List

Pin	Name	Pin AFS List	Analog Function
1	PA7	GPA7, SPI0_D2, MA7, MAD7, TM20_OC1H, URT0_NSS	ADC_I7
2	PA8	GPA8, DMA_TRG0, I2C0_SCL, URT2_BRO, SDT_I0, TM20_IC0, SPI0_NSS, MA8, MAD0, TM36_OC0H, URT4_TX	ADC_I8, CMP0_I0, VBG_OUT
3	PA9	GPA9, DMA_TRG1, I2C1_SCL, URT2_TMO, TM20_IC1, SPI0_MISO, MA9, MAD1, TM36_OC1H, URT5_TX	ADC_I9, CMP0_I1
4	PA10	GPA10, TM36_BK0, SPI0_D2, I2C0_SDA, URT2_CTS, SDT_I1, TM26_IC0, SPI0_CLK, MA10, MAD2, TM36_OC2H, URT4_RX	ADC_I10, CMP1_I0, ADC_PGA

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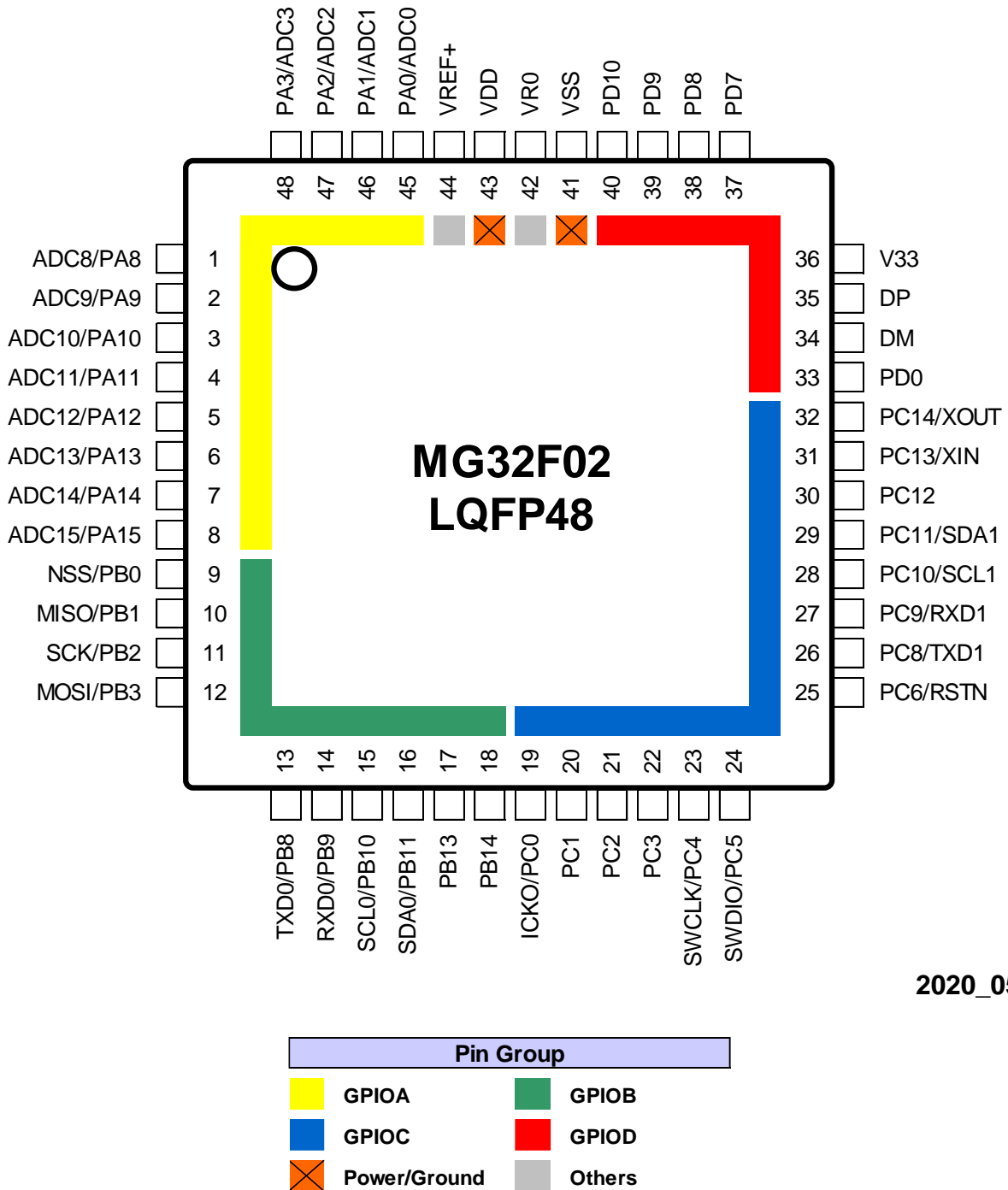
5	PA11	GPA11, DAC_TRG0, SPI0_D3, I2C1_SDA, URT2_RTS, TM26_IC1, SPI0_MOSI, MA11, MAD3, TM36_OC3H, URT5_RX	ADC_I11, CMP1_I1
6	PA12	GPA12, USB_S0, URT1_BRO, TM10_ETR, TM36_IC0, SPI0_D5, MA12, MAD4, TM26_OC00, URT6_TX	ADC_I12
7	PA13	GPA13, CPU_TXEV, USB_S1, URT0_BRO, URT1_TMO, TM10_TRGO, TM36_IC1, SPI0_D6, MA13, MAD5, TM26_OC10, URT6_RX	ADC_I13
8	PA14	GPA14, CPU_RXEV, OBM_I0, URT0_TMO, URT1_CTS, TM16_ETR, TM36_IC2, SPI0_D7, MA14, MAD6, TM26_OC0H, URT7_TX	ADC_I14
9	PA15	GPA15, CPU_NMI, OBM_I1, URT0_DE, URT1_RTS, TM16_TRGO, TM36_IC3, SPI0_D4, MA15, MAD7, TM26_OC1H, URT7_RX	ADC_I15
10	PB0	GPB0, I2C1_SCL, SPI0_NSS, TM01_ETR, TM00_CKO, TM16_ETR, TM26_IC0, TM36_ETR, MA15, URT1_NSS, URT2_NSS, URT6_TX	CMP_C0
11	PB1	GPB1, I2C1_SDA, SPI0_MISO, TM01_TRGO, TM10_CKO, TM16_TRGO, TM26_IC1, TM36_TRGO, URT1_RX, URT2_CLK, URT6_RX	CMP_C1
12	PB2	GPB2, ADC0_TRG, SPI0_CLK, TM01_CKO, URT2_TX, TM16_CKO, TM26_OC0H, I2C0_SDA, URT1_CLK, URT0_TX, URT7_TX	DAC_P0
13	PB3	GPB3, ADC0_OUT, SPI0_MOSI, NCO_P0, URT2_RX, TM36_CKO, TM26_OC1H, I2C0_SCL, URT1_TX, URT0_RX, URT7_RX	
14	PB4	GPB4, TM01_CKO, SPI0_D3, TM26_TRGO, URT2_CLK, TM20_IC0, TM36_IC0, MALE, MAD8	
15	PB5	GPB5, TM16_CKO, SPI0_D2, TM26_ETR, URT2_NSS, TM20_IC1, TM36_IC1, MOE, MAD9	
16	PB6	GPB6, CPU_RXEV, SPI0_NSSI, URT0_BRO, URT2_CTS, TM20_ETR, TM36_IC2, MWE, MAD10, URT2_TX	
17	PB7	GPB7, CPU_TXEV, URT0_TMO, URT2_RTS, TM20_TRGO, TM36_IC3, MCE, MALE2, URT2_RX	
18	PB8	GPB8, CMP0_P0, RTC_OUT, URT0_TX, URT2_BRO, TM20_OC01, TM36_OC01, SPI0_D3, MAD0, SDT_P0, OBM_P0, URT4_TX	
19	PB9	GPB9, CMP1_P0, RTC_TS, URT0_RX, URT2_TMO, TM20_OC02, TM36_OC02, SPI0_D2, MAD1, MAD8, OBM_P1, URT4_RX	
20	PB10	GPB10, I2C0_SCL, URT0_NSS, URT2_DE, TM20_OC11, TM36_OC11, URT1_TX, MAD2, MAD1, SPI0_NSSI	
21	PB11	GPB11, I2C0_SDA, URT0_DE, IR_OUT, TM20_OC12, TM36_OC12, URT1_RX, MAD3, MAD9, DMA_TRG0, URT0_CLK	
22	PB12	GPB12, DMA_TRG0, NCO_P0, USB_S0, URT1_CLK, MAD4, MAD2, URT5_TX	
23	PB13	GPB13, DAC_TRG0, TM00_ETR, URT0_CTS, TM20_ETR, TM36_ETR, URT0_CLK, MAD5, MAD10, CCL_P0, URT4_RX	
24	PB14	GPB14, DMA_TRG0, TM00_TRGO, URT0_RTS, TM20_TRGO, TM36_BK0, URT0_NSS, MAD6, MAD3, CCL_P1, URT4_TX	
25	PB15	GPB15, IR_OUT, NCO_CK0, USB_S1, URT1_NSS, MAD7, MAD11, URT5_RX	
26	PC0	GPC0, ICKO, TM00_CKO, URT0_CLK, URT2_CLK, TM20_OC00, TM36_OC00, I2C0_SCL, MCLK, MWE, URT0_TX, URT5_TX	
27	PC1	GPC1, ADC0_TRG, TM01_CKO, TM36_IC0, URT1_CLK, TM20_OC0N, TM36_OC0N, I2C0_SDA, MAD8, MAD4, URT0_RX, URT5_RX	
28	PC2	GPC2, ADC0_OUT, TM10_CKO, OBM_P0, URT2_CLK, TM20_OC10, TM36_OC10, SDT_I0, MAD9, MAD12	
29	PC3	GPC3, OBM_P1, TM16_CKO, URT0_CLK, URT1_CLK, TM20_OC1N, TM36_OC1N, SDT_I1, MAD10, MAD5	
30	PC4	GPC4, SWCLK, I2C0_SCL, URT0_RX, URT1_RX, TM36_OC2, SDT_I0, URT6_RX	
31	PC5	GPC5, SWDIO, I2C0_SDA, URT0_TX, URT1_TX, TM36_OC3, SDT_I1, URT6_TX	
32	PC6	GPC6, RSTN, RTC_TS, URT0_NSS, URT1_NSS, TM20_ETR, TM26_ETR, MBW1, MALE	
33	PC7	GPC7, ADC0_TRG, RTC_OUT, URT0_DE, URT1_NSS, TM36_TRGO, MBW0, MCE	
34	PC8	GPC8, ADC0_OUT, I2C0_SCL, URT0_BRO, URT1_TX, TM20_OC0H, TM36_OC0H, TM36_OC0N, MAD11, MAD13, CCL_P0, URT6_TX	
35	PC9	GPC9, CMP0_P0, I2C0_SDA, URT0_TMO, URT1_RX, TM20_OC1H, TM36_OC1H, TM36_OC1N, MAD12, MAD6, CCL_P1, URT6_RX	
36	PC10	GPC10, CMP1_P0, I2C1_SCL, URT0_TX, URT2_TX, URT1_TX, TM36_OC2H, TM36_OC2N, MAD13, MAD14, URT7_TX	
37	PC11	GPC11, I2C1_SDA, URT0_RX, URT2_RX, URT1_RX, TM36_OC3H, TM26_OC01, MAD14, MAD7, URT7_RX	
38	PC12	GPC12, IR_OUT, DAC_TRG0, URT1_DE, TM10_TRGO, TM36_OC3, TM26_OC02, MAD15, SDT_P0, URT1_CLK, MAM1	
39	PC13	GPC13, XIN, URT1_NSS, URT0_CTS, URT2_RX, TM10_ETR, TM26_ETR, TM36_OC00, TM20_IC0, SDT_I0, URT6_RX	
40	PC14	GPC14, XOUT, URT1_TMO, URT0_RTS, URT2_TX, TM10_CKO, TM26_TRGO, TM36_OC10, TM20_IC1, SDT_I1, URT6_TX	
41	VSS1		
42	PD0	GPD0, OBM_I0, TM10_CKO, URT0_CLK, TM26_OC1N, TM20_CKO, TM36_OC2, SPI0_NSS, MA0, MCLK, URT2_NSS	
43	PD1	GPD1, OBM_I1, TM16_CKO, URT0_CLK, NCO_CK0, TM26_CKO, TM36_OC2N, SPI0_CLK, MA1, URT2_CLK	
44	PD2	GPD2, USB_S0, TM00_CKO, URT1_CLK, TM26_OC00, TM20_CKO, TM36_CKO, SPI0_MOSI, MA2, MAD4, URT2_TX	
45	PD3	GPD3, USB_S1, TM01_CKO, URT1_CLK, SPI0_MISO, TM26_CKO, SPI0_D3, MA3, MAD7, TM36_TRGO, URT2_RX	
46	DM		
47	DP		
48	V33		
49	PD7	GPD7, TM00_CKO, TM01_ETR, URT1_DE, SPI0_MISO, TM26_OC0N, SPI0_D4, MA7, MAD0,	

		TM36_IC0	
50	PD8	GPD8, CPU_TXEV, TM01_TRGO, URT1_RTS, SPI0_D2, TM26_OC10, SPI0_D7, MA8, MAD3, TM36_IC1, SPI0_CLK	
51	PD9	GPD9, CPU_RXEV, TM00_TRGO, URT1_CTS, SPI0_NSSI, TM26_OC11, SPI0_D6, MA9, MAD2, TM36_IC2, SPI0_NSS	
52	PD10	GPD10, CPU_NMI, TM00_ETR, URT1_BRO, RTC_OUT, TM26_OC12, SPI0_D5, MA10, MAD1, TM36_IC3, SPI0_MOSI	
53	PD11	GPD11, CPU_NMI, DMA_TRG1, URT1_TMO, SPI0_D3, TM26_OC1N, SPI0_NSS, MA11, MWE	
54	VSS		
55	VR0		
56	VDD		
57	VREF+		
58	PA0	GPA0, SDT_P0, CCL_P0, MA0, MAD0, TM36_OC00, URT4_TX	ADC_I0
59	PA1	GPA1, CCL_P1, MA1, MAD1, TM36_OC10, URT4_RX	ADC_I1
60	PA2	GPA2, SDT_I0, MA2, MAD2, TM36_OC2, URT5_TX	ADC_I2
61	PA3	GPA3, SDT_I1, MA3, MAD3, TM36_OC2N, URT5_RX	ADC_I3
62	PA4	GPA4, MA4, MAD4, TM20_OC00, URT0_TX	ADC_I4
63	PA5	GPA5, MA5, MAD5, TM20_OC10, URT0_RX	ADC_I5
64	PA6	GPA6, SPI0_D3, MA6, MAD6, TM20_OC0H, URT0_CLK	ADC_I6

MG32F02U128/U064

4.1.2. LQFP48 Package Pinout

Figure 4-3. LQFP48 Package Pinout



2020_0515

Table 4-3. LQFP48 Pin AFS List

Pin	Name	Pin AFS List	Analog Function
1	PA8	GPA8, DMA_TRG0, I2C0_SCL, URT2_BRO, SDT_I0, TM20_IC0, SPI0_NSS, MA8, MAD0, TM36_OC0H, URT4_TX	ADC_I8, CMP0_I0, VBG_OUT
2	PA9	GPA9, DMA_TRG1, I2C1_SCL, URT2_TMO, TM20_IC1, SPI0_MISO, MA9, MAD1, TM36_OC1H, URT5_TX	ADC_I9, CMP0_I1
3	PA10	GPA10, TM36_BK0, SPI0_D2, I2C0_SDA, URT2_CTS, SDT_I1, TM26_IC0, SPI0_CLK, MA10, MAD2, TM36_OC2H, URT4_RX	ADC_I10, CMP1_I0, ADC_PGA
4	PA11	GPA11, DAC_TRG0, SPI0_D3, I2C1_SDA, URT2_RTS, TM26_IC1, SPI0_MOSI, MA11, MAD3,	ADC_I11, CMP1_I1

		TM36_OC3H, URT5_RX	
5	PA12	GPA12, USB_S0, URT1_BRO, TM10_ETR, TM36_IC0, SPI0_D5, MA12, MAD4, TM26_OC00, URT6_TX	ADC_I12
6	PA13	GPA13, CPU_TXEV, USB_S1, URT0_BRO, URT1_TMO, TM10_TRGO, TM36_IC1, SPI0_D6, MA13, MAD5, TM26_OC10, URT6_RX	ADC_I13
7	PA14	GPA14, CPU_RXEV, OBM_I0, URT0_TMO, URT1_CTS, TM16_ETR, TM36_IC2, SPI0_D7, MA14, MAD6, TM26_OC0H, URT7_TX	ADC_I14
8	PA15	GPA15, CPU_NMI, OBM_I1, URT0_DE, URT1_RTS, TM16_TRGO, TM36_IC3, SPI0_D4, MA15, MAD7, TM26_OC1H, URT7_RX	ADC_I15
9	PB0	GPB0, I2C1_SCL, SPI0_NSS, TM01_ETR, TM00_CKO, TM16_ETR, TM26_IC0, TM36_ETR, MA15, URT1_NSS, URT2_NSS, URT6_TX	CMP_C0
10	PB1	GPB1, I2C1_SDA, SPI0_MISO, TM01_TRGO, TM10_CKO, TM16_TRGO, TM26_IC1, TM36_TRGO, URT1_RX, URT2_CLK, URT6_RX	CMP_C1
11	PB2	GPB2, ADC0_TRG, SPI0_CLK, TM01_CKO, URT2_TX, TM16_CKO, TM26_OC0H, I2C0_SDA, URT1_CLK, URT0_TX, URT7_TX	DAC_P0
12	PB3	GPB3, ADC0_OUT, SPI0_MOSI, NCO_P0, URT2_RX, TM36_CKO, TM26_OC1H, I2C0_SCL, URT1_TX, URT0_RX, URT7_RX	
13	PB8	GPB8, CMP0_P0, RTC_OUT, URT0_TX, URT2_BRO, TM20_OC01, TM36_OC01, SPI0_D3, MAD0, SDT_P0, OBM_P0, URT4_TX	
14	PB9	GPB9, CMP1_P0, RTC_TS, URT0_RX, URT2_TMO, TM20_OC02, TM36_OC02, SPI0_D2, MAD1, MAD8, OBM_P1, URT4_RX	
15	PB10	GPB10, I2C0_SCL, URT0_NSS, URT2_DE, TM20_OC11, TM36_OC11, URT1_TX, MAD2, MAD1, SPI0_NSSI	
16	PB11	GPB11, I2C0_SDA, URT0_DE, IR_OUT, TM20_OC12, TM36_OC12, URT1_RX, MAD3, MAD9, DMA_TRG0, URT0_CLK	
17	PB13	GPB13, DAC_TRG0, TM00_ETR, URT0_CTS, TM20_ETR, TM36_ETR, URT0_CLK, MAD5, MAD10, CCL_P0, URT4_RX	
18	PB14	GPB14, DMA_TRG0, TM00_TRGO, URT0_RTS, TM20_TRGO, TM36_BK0, URT0_NSS, MAD6, MAD3, CCL_P1, URT4_TX	
19	PC0	GPC0, ICKO, TM00_CKO, URT0_CLK, URT2_CLK, TM20_OC00, TM36_OC00, I2C0_SCL, MCLK, MWE, URT0_TX, URT5_TX	
20	PC1	GPC1, ADC0_TRG, TM01_CKO, TM36_IC0, URT1_CLK, TM20_OC0N, TM36_OC0N, I2C0_SDA, MAD8, MAD4, URT0_RX, URT5_RX	
21	PC2	GPC2, ADC0_OUT, TM10_CKO, OBM_P0, URT2_CLK, TM20_OC10, TM36_OC10, SDT_I0, MAD9, MAD12	
22	PC3	GPC3, OBM_P1, TM16_CKO, URT0_CLK, URT1_CLK, TM20_OC1N, TM36_OC1N, SDT_I1, MAD10, MAD5	
23	PC4	GPC4, SWCLK, I2C0_SCL, URT0_RX, URT1_RX, TM36_OC2, SDT_I0, URT6_RX	
24	PC5	GPC5, SWDIO, I2C0_SDA, URT0_TX, URT1_TX, TM36_OC3, SDT_I1, URT6_TX	
25	PC6	GPC6, RSTN, RTC_TS, URT0_NSS, URT1_NSS, TM20_ETR, TM26_ETR, MBW1, MALE	
26	PC8	GPC8, ADC0_OUT, I2C0_SCL, URT0_BRO, URT1_TX, TM20_OC0H, TM36_OC0H, TM36_OC0N, MAD11, MAD13, CCL_P0, URT6_TX	
27	PC9	GPC9, CMP0_P0, I2C0_SDA, URT0_TMO, URT1_RX, TM20_OC1H, TM36_OC1H, TM36_OC1N, MAD12, MAD6, CCL_P1, URT6_RX	
28	PC10	GPC10, CMP1_P0, I2C1_SCL, URT0_TX, URT2_TX, URT1_TX, TM36_OC2H, TM36_OC2N, MAD13, MAD14, URT7_TX	
29	PC11	GPC11, I2C1_SDA, URT0_RX, URT2_RX, URT1_RX, TM36_OC3H, TM26_OC01, MAD14, MAD7, URT7_RX	
30	PC12	GPC12, IR_OUT, DAC_TRG0, URT1_DE, TM10_TRGO, TM36_OC3, TM26_OC02, MAD15, SDT_P0, URT1_CLK, MAM1	
31	PC13	GPC13, XIN, URT1_NSS, URT0_CTS, URT2_RX, TM10_ETR, TM26_ETR, TM36_OC00, TM20_IC0, SDT_I0, URT6_RX	
32	PC14	GPC14, XOUT, URT1_TMO, URT0_RTS, URT2_TX, TM10_CKO, TM26_TRGO, TM36_OC10, TM20_IC1, SDT_I1, URT6_TX	
33	PD0	GPD0, OBM_I0, TM10_CKO, URT0_CLK, TM26_OC1N, TM20_CKO, TM36_OC2, SPI0_NSS, MA0, MCLK, URT2_NSS	
34	DM		
35	DP		
36	V33		
37	PD7	GPD7, TM00_CKO, TM01_ETR, URT1_DE, SPI0_MISO, TM26_OC0N, SPI0_D4, MA7, MAD0, TM36_IC0	
38	PD8	GPD8, CPU_TXEV, TM01_TRGO, URT1_RTS, SPI0_D2, TM26_OC10, SPI0_D7, MA8, MAD3, TM36_IC1, SPI0_CLK	
39	PD9	GPD9, CPU_RXEV, TM00_TRGO, URT1_CTS, SPI0_NSSI, TM26_OC11, SPI0_D6, MA9, MAD2, TM36_IC2, SPI0_NSS	
40	PD10	GPD10, CPU_NMI, TM00_ETR, URT1_BRO, RTC_OUT, TM26_OC12, SPI0_D5, MA10, MAD1, TM36_IC3, SPI0_MOSI	
41	VSS		
42	VRO		
43	VDD		
44	VREF+		
45	PA0	GPA0, SDT_P0, CCL_P0, MA0, MAD0, TM36_OC00, URT4_TX	ADC_I0
46	PA1	GPA1, CCL_P1, MA1, MAD1, TM36_OC10, URT4_RX	ADC_I1
47	PA2	GPA2, SDT_I0, MA2, MAD2, TM36_OC2, URT5_TX	ADC_I2
48	PA3	GPA3, SDT_I1, MA3, MAD3, TM36_OC2N, URT5_RX	ADC_I3

4.2. Pin Definition

Table 4-4. Abbreviations for pin definition

IO Type		IO Structure	
P	Power/Ground pin	I	Digital Input
B	Bidirection	P	Output Push-pull capability
I	Input	O	Output Open drain capability
O	Output	Q	Quasi-bidirectional
A	Analog I/O	A	Analog I/O (Digital I/O disable)
AO	Analog output only	U	Internal pull-up
AI	Analog input only	H	High Speed
-		C2	Programmable 2-level driving strength
-		C4	Programmable 4-level driving strength
-		CF	Fixed driving strength(GPIO mode)

Table 4-5. Pin Descriptions

Pin Name	Pin Number			IO Type	Default		IO Structure	Alternate Functions	Description
	LQFP80	LQFP64	LQFP48		Type	Value			
PA0	74	58	45	B	A		A,I,P,O,U,H,C2	GPA0	GPIO/Interrupt/KBI Port-A function pin-0
								SDT_P0	SDT output signal-0
								CCL_P0	CCL output signal-0
								MA0	External memory bus address pin 0
								MAD0	External memory bus address/data pin 0
								TM36_OC00	TM36 output compare/PWM channel-00
								URT4_TX	URT4 transmit TX signal. URT4_RX and URT4_TX can be swapped by register setting.
ADC_I0	ADC analog single-end input channel 0								
PA1	75	59	46	B	A		A,I,P,O,U,H,C2	GPA1	GPIO/Interrupt/KBI Port-A function pin-1
								CCL_P1	CCL output signal-1
								MA1	External memory bus address pin 1
								MAD1	External memory bus address/data pin 1
								TM36_OC10	TM36 output compare/PWM channel-10
								URT4_RX	URT4 receive RX signal. URT4_RX and URT4_TX can be swapped by register setting.
								ADC_I1	ADC analog single-end input channel 1
PA2	76	60	47	B	A		A,I,P,O,U,H,C2	GPA2	GPIO/Interrupt/KBI Port-A function pin-2
								SDT_I0	State detect input signal-0
								MA2	External memory bus address pin 2
								MAD2	External memory bus address/data pin 2
								TM36_OC2	TM36 output compare/PWM channel-2
								URT5_TX	URT5 transmit TX signal. URT5_RX and URT5_TX can be swapped by register setting.
								ADC_I2	ADC analog single-end input channel 2
PA3	77	61	48	B	A		A,I,P,O,U,H,C2	GPA3	GPIO/Interrupt/KBI Port-A function pin-3
								SDT_I1	State detect input signal-1

										MA3	External memory bus address pin 3
										MAD3	External memory bus address/data pin 3
										TM36_OC2N	TM36 output compare/PWM complement channel-2
										URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.
										ADC_I3	ADC analog single-end input channel 3
PA4	78	62		B	A		A,I,P,O,U,H,C2		GPA4	GPIO/Interrupt/KBI Port-A function pin-4	
									MA4	External memory bus address pin 4	
									MAD4	External memory bus address/data pin 4	
									TM20_OC00	TM20 output compare/PWM channel-00	
									URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.	
									ADC_I4	ADC analog single-end input channel 4	
PA5	79	63		B	A		A,I,P,O,U,H,C2		GPA5	GPIO/Interrupt/KBI Port-A function pin-5	
									MA5	External memory bus address pin 5	
									MAD5	External memory bus address/data pin 5	
									TM20_OC10	TM20 output compare/PWM channel-10	
									URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.	
									ADC_I5	ADC analog single-end input channel 5	
PA6	80	64		B	A		A,I,P,O,U,H,C2		GPA6	GPIO/Interrupt/KBI Port-A function pin-6	
									SPI0_D3	SPI0 data-3 signal for 4-I/O mode	
									MA6	External memory bus address pin 6	
									MAD6	External memory bus address/data pin 6	
									TM20_OC0H	TM20 output compare/PWM high channel-0	
									URT0_CLK	URT0 clock signal	
									ADC_I6	ADC analog single-end input channel 6	
PA7	1	1		B	A		A,I,P,O,U,H,C2		GPA7	GPIO/Interrupt/KBI Port-A function pin-7	
									SPI0_D2	SPI0 data-2 signal for 4-I/O mode	
									MA7	External memory bus address pin 7	
									MAD7	External memory bus address/data pin 7	
									TM20_OC1H	TM20 output compare/PWM high channel-1	
									URT0_NSS	URT0 SPI NSS input/output signal	
									ADC_I7	ADC analog single-end input channel 7	
PA8	2	2	1	B	A		A,I,P,O,U,H,C2		GPA8	GPIO/Interrupt/KBI Port-A function pin-8	
									DMA_TRG0	DMA external trigger pin-0 input	
									I2C0_SCL	I2C0 SCL signal	
									URT2_BRO	URT2 baud-rate timer overflow output signal	
									SDT_I0	State detect input signal-0	
									TM20_IC0	TM20 input capture channel-0	
									SPI0_NSS	SPI0 slave select input/output signal	
									MA8	External memory bus address pin 8	
									MAD0	External memory bus address/data pin 0	
									TM36_OC0H	TM36 output compare/PWM high channel-0	

								URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.
								ADC_I11	ADC analog single-end input channel 11
								CMP1_I1	Comparator-1 analog input channel 1
PA12	6	6	5	B	A		A,I,P,O,U,H,C2	GPA12	GPIO/Interrupt/KBI Port-A function pin-12
								USB_S0	USB signal-0 output
								URT1_BRO	URT1 baud-rate timer overflow output signal
								TM10_ETR	TM10 external trigger/clock input signal
								TM36_IC0	TM36 input capture channel-0
								SPI0_D5	SPI0 data-1 signal for 2nd SPI device 4-I/O mode
								MA12	External memory bus address pin 12
								MAD4	External memory bus address/data pin 4
								TM26_OC00	TM26 output compare/PWM channel-00
								URT6_TX	URT6 transmit TX signal. URT6_RX and URT6_TX can be swapped by register setting.
								ADC_I12	ADC analog single-end input channel 12
								PA13	7
CPU_TXEV	CPU wakeup event output								
USB_S1	USB signal-1 output								
URT0_BRO	URT0 baud-rate timer overflow output signal								
URT1_TMO	URT1 timeout timer overflow output signal								
TM10_TRGO	TM10 trigger output signal								
TM36_IC1	TM36 input capture channel-1								
SPI0_D6	SPI0 data-2 signal for 2nd SPI device 4-I/O mode								
MA13	External memory bus address pin 13								
MAD5	External memory bus address/data pin 5								
TM26_OC10	TM26 output compare/PWM channel-10								
URT6_RX	URT6 receive RX signal. URT6_RX and URT6_TX can be swapped by register setting.								
ADC_I13	ADC analog single-end input channel 13								
PA14	8	8	7	B	A		A,I,P,O,U,H,C2	GPA14	GPIO/Interrupt/KBI Port-A function pin-14
								CPU_RXEV	CPU wakeup event input
								OBM_I0	Output signal break control input signal-0
								URT0_TMO	URT0 timeout timer overflow output signal
								URT1_CTS	URT1 CTS input control signal
								TM16_ETR	TM16 external trigger/clock input signal
								TM36_IC2	TM36 input capture channel-2
								SPI0_D7	SPI0 data-3 signal for 2nd SPI device 4-I/O mode
								MA14	External memory bus address pin 14
								MAD6	External memory bus address/data pin 6
								TM26_OC0H	TM26 output compare/PWM high channel-0
								URT7_TX	URT7 transmit TX signal. URT7_RX and URT7_TX can be swapped by register setting.
ADC_I14	ADC analog single-end input channel 14								
PA15	9	9	8	B	A		A,I,P,O,U,H,C2	GPA15	GPIO/Interrupt/KBI Port-A function pin-15

							TM01_CKO	TM01 timer overflow output signal
							URT2_TX	URT2 transmit TX signal, SPI master/slave data output signal. URT2_RX and URT2_TX can be swapped by register setting.
							TM16_CKO	TM16 timer overflow output signal
							TM26_OC0H	TM26 output compare/PWM high channel-0
							I2C0_SDA	I2C0 SDA signal
							URT1_CLK	URT1 clock signal
							URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.
							URT7_TX	URT7 transmit TX signal. URT7_RX and URT7_TX can be swapped by register setting.
							DAC_P0	DAC analog output channel 0
PB3	13	13	12	B	A	A,I,P,O,U,H,C4	GPB3	GPIO/Interrupt/KBI Port-B function pin-3
							ADC0_OUT	ADC threshold window compare output
							SPI0_MOSI	SPI0 master output / slave input signal or data-0 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
							NCO_P0	NCO clock output signal-0
							URT2_RX	URT2 receive RX signal, SPI master/slave data input signal. URT2_RX and URT2_TX can be swapped by register setting.
							TM36_CKO	TM36 timer overflow output signal
							TM26_OC1H	TM26 output compare/PWM high channel-1
							I2C0_SCL	I2C0 SCL signal
							URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
							URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.
							URT7_RX	URT7 receive RX signal. URT7_RX and URT7_TX can be swapped by register setting.
PB4	18	14		B	A	A,I,P,O,U,H,C4	GPB4	GPIO/Interrupt/KBI Port-B function pin-4
							TM01_CKO	TM01 timer overflow output signal
							SPI0_D3	SPI0 data-3 signal for 4-I/O mode
							TM26_TRGO	TM26 trigger output signal
							URT2_CLK	URT2 clock signal
							TM20_IC0	TM20 input capture channel-0
							TM36_IC0	TM36 input capture channel-0
							MALE	External memory bus address latch enable(ALE) or data/command select(DC) pin
							MAD8	External memory bus address/data pin 8
PB5	19	15		B	A	A,I,P,O,U,H,C4	GPB5	GPIO/Interrupt/KBI Port-B function pin-5
							TM16_CKO	TM16 timer overflow output signal
							SPI0_D2	SPI0 data-2 signal for 4-I/O mode
							TM26_ETR	TM26 external trigger/clock input signal

MG32F02U128/U064

							URT2_NSS	URT2 SPI NSS input/output signal
							TM20_IC1	TM20 input capture channel-1
							TM36_IC1	TM36 input capture channel-1
							MOE	External memory bus output enable(OE) or read strobe (RD) signal pin
							MAD9	External memory bus address/data pin 9
PB6	20	16		B	A	A,I,P,O,U,H,C2	GPB6	GPIO/Interrupt/KBI Port-B function pin-6
							CPU_RXEV	CPU wakeup event input
							SPI0_NSSI	SPI0 slave select input only signal
							URT0_BRO	URT0 baud-rate timer overflow output signal
							URT2_CTS	URT2 CTS input control signal
							TM20_ETR	TM20 external trigger/clock input signal
							TM36_IC2	TM36 input capture channel-2
							MWE	External memory bus write enable(WE) or write strobe(WR) signal pin
							MAD10	External memory bus address/data pin 10
							URT2_TX	URT2 transmit TX signal, SPI master/slave data output signal. URT2_RX and URT2_TX can be swapped by register setting.
PB7	21	17		B	A	A,I,P,O,U,H,C2	GPB7	GPIO/Interrupt/KBI Port-B function pin-7
							CPU_TXEV	CPU wakeup event output
							URT0_TMO	URT0 timeout timer overflow output signal
							URT2_RTS	URT2 RTS output control signal
							TM20_TRGO	TM20 trigger output signal
							TM36_IC3	TM36 input capture channel-3
							MCE	External memory bus chip enable/select pin
							MALE2	External memory bus 2nd address latch enable(ALE2) or command latch enable(CLE) pin
							URT2_RX	URT2 receive RX signal, SPI master/slave data input signal. URT2_RX and URT2_TX can be swapped by register setting.
PB8	22	18	13	B	A	A,I,P,O,U,H,C4	GPB8	GPIO/Interrupt/KBI Port-B function pin-8
							CMP0_P0	Comparator-0 data output
							RTC_OUT	RTC selection output signal
							URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.
							URT2_BRO	URT2 baud-rate timer overflow output signal
							TM20_OC01	TM20 output compare/PWM channel-01
							TM36_OC01	TM36 output compare/PWM channel-01
							SPI0_D3	SPI0 data-3 signal for 4-I/O mode
							MAD0	External memory bus address/data pin 0
							SDT_P0	SDT output signal-0
							OBM_P0	Output signal break control output signal-0
							URT4_TX	URT4 transmit TX signal. URT4_RX and URT4_TX can be swapped by register setting.
PB9	23	19	14	B	A	A,I,P,O,U,H,C4	GPB9	GPIO/Interrupt/KBI Port-B function pin-9

								CMP1_P0	Comparator-1 data output
								RTC_TS	RTC time stamp input signal
								URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.
								URT2_TMO	URT2 timeout timer overflow output signal
								TM20_OC02	TM20 output compare/PWM channel-02
								TM36_OC02	TM36 output compare/PWM channel-02
								SPI0_D2	SPI0 data-2 signal for 4-I/O mode
								MAD1	External memory bus address/data pin 1
								MAD8	External memory bus address/data pin 8
								OBM_P1	Output signal break control output signal-1
								URT4_RX	URT4 receive RX signal. URT4_RX and URT4_TX can be swapped by register setting.
PB10	24	20	15	B	A		A,I,P,O,U,H,C2	GPB10	GPIO/Interrupt/KBI Port-B function pin-10
								I2C0_SCL	I2C0 SCL signal
								URT0_NSS	URT0 SPI NSS input/output signal
								URT2_DE	URT2 external drive enable output signal
								TM20_OC11	TM20 output compare/PWM channel-11
								TM36_OC11	TM36 output compare/PWM channel-11
								URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
								MAD2	External memory bus address/data pin 2
								MAD1	External memory bus address/data pin 1
								SPI0_NSSI	SPI0 slave select input only signal
PB11	25	21	16	B	A		A,I,P,O,U,H,C2	GPB11	GPIO/Interrupt/KBI Port-B function pin-11
								I2C0_SDA	I2C0 SDA signal
								URT0_DE	URT0 external drive enable output signal
								IR_OUT	IR output signal
								TM20_OC12	TM20 output compare/PWM channel-12
								TM36_OC12	TM36 output compare/PWM channel-12
								URT1_RX	URT1 receive RX signal, SPI master/slave data input signal. URT1_RX and URT1_TX can be swapped by register setting.
								MAD3	External memory bus address/data pin 3
								MAD9	External memory bus address/data pin 9
								DMA_TRG0	DMA external trigger pin-0 input
								URT0_CLK	URT0 clock signal
PB12	26	22		B	A		A,I,P,O,U,H,C2	GPB12	GPIO/Interrupt/KBI Port-B function pin-12
								DMA_TRG0	DMA external trigger pin-0 input
								NCO_P0	NCO clock output signal-0
								USB_S0	USB signal-0 output
								URT1_CLK	URT1 clock signal
								MAD4	External memory bus address/data pin 4
								MAD2	External memory bus address/data pin 2
								URT5_TX	URT5 transmit TX signal. URT5_RX and URT5_TX can be swapped by register setting.

MG32F02U128/U064

PB13	28	23	17	B	A	A,I,P,O,U,H,C2	GPB13	GPIO/Interrupt/KBI Port-B function pin-13	
							DAC_TRG0	DAC trigger start input	
							TM00_ETR	TM00 external trigger/clock input signal	
							URT0_CTS	URT0 CTS input control signal	
							TM20_ETR	TM20 external trigger/clock input signal	
							TM36_ETR	TM36 external trigger/clock input signal	
							URT0_CLK	URT0 clock signal	
							MAD5	External memory bus address/data pin 5	
							MAD10	External memory bus address/data pin 10	
							CCL_P0	CCL output signal-0	
							URT4_RX	URT4 receive RX signal. URT4_RX and URT4_TX can be swapped by register setting.	
PB14	29	24	18	B	A	A,I,P,O,U,H,C2	GPB14	GPIO/Interrupt/KBI Port-B function pin-14	
							DMA_TRG0	DMA external trigger pin-0 input	
							TM00_TRGO	TM00 trigger output signal	
							URT0_RTS	URT0 RTS output control signal	
							TM20_TRGO	TM20 trigger output signal	
							TM36_BK0	TM36 break input signal	
							URT0_NSS	URT0 SPI NSS input/output signal	
							MAD6	External memory bus address/data pin 6	
							MAD3	External memory bus address/data pin 3	
							CCL_P1	CCL output signal-1	
							URT4_TX	URT4 transmit TX signal. URT4_RX and URT4_TX can be swapped by register setting.	
PB15	31	25		B	A	A,I,P,O,U,H,C2	GPB15	GPIO/Interrupt/KBI Port-B function pin-15	
							IR_OUT	IR output signal	
							NCO_CK0	NCO external clock input signal-0	
							USB_S1	USB signal-1 output	
							URT1_NSS	URT1 SPI NSS input/output signal	
							MAD7	External memory bus address/data pin 7	
							MAD11	External memory bus address/data pin 11	
							URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.	
PC0	34	26	19	B	Q	H	A,I,P,O,Q,U,H,C 2	GPC0	GPIO/Interrupt/KBI Port-C function pin-0
								ICKO	Internal clock source clock output
								TM00_CKO	TM00 timer overflow output signal
								URT0_CLK	URT0 clock signal
								URT2_CLK	URT2 clock signal
								TM20_OC00	TM20 output compare/PWM channel-00
								TM36_OC00	TM36 output compare/PWM channel-00
								I2C0_SCL	I2C0 SCL signal
								MCLK	External memory bus clock pin
								MWE	External memory bus write enable(WE) or write strobe(WR) signal pin
								URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.

									URT5_TX	URT5 transmit TX signal. URT5_RX and URT5_TX can be swapped by register setting.
PC1	35	27	20	B	Q	H	A,I,P,O,Q,U,H,C 2	GPC1	GPIO/Interrupt/KBI Port-C function pin-1	
								ADC0_TRG	ADC trigger start input	
								TM01_CKO	TM01 timer overflow output signal	
								TM36_IC0	TM36 input capture channel-0	
								URT1_CLK	URT1 clock signal	
								TM20_OC0N	TM20 output compare/PWM complement channel-0	
								TM36_OC0N	TM36 output compare/PWM complement channel-0	
								I2C0_SDA	I2C0 SDA signal	
								MAD8	External memory bus address/data pin 8	
								MAD4	External memory bus address/data pin 4	
								URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.	
URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.									
PC2	36	28	21	B	Q	H	A,I,P,O,Q,U,H,C 2	GPC2	GPIO/Interrupt/KBI Port-C function pin-2	
								ADC0_OUT	ADC threshold window compare output	
								TM10_CKO	TM10 timer overflow output signal	
								OBM_P0	Output signal break control output signal-0	
								URT2_CLK	URT2 clock signal	
								TM20_OC10	TM20 output compare/PWM channel-10	
								TM36_OC10	TM36 output compare/PWM channel-10	
								SDT_I0	State detect input signal-0	
								MAD9	External memory bus address/data pin 9	
								MAD12	External memory bus address/data pin 12	
PC3	37	29	22	B	Q	H	A,I,P,O,Q,U,H,C 2	GPC3	GPIO/Interrupt/KBI Port-C function pin-3	
								OBM_P1	Output signal break control output signal-1	
								TM16_CKO	TM16 timer overflow output signal	
								URT0_CLK	URT0 clock signal	
								URT1_CLK	URT1 clock signal	
								TM20_OC1N	TM20 output compare/PWM complement channel-1	
								TM36_OC1N	TM36 output compare/PWM complement channel-1	
								SDT_I1	State detect input signal-1	
								MAD10	External memory bus address/data pin 10	
MAD5	External memory bus address/data pin 5									
PC4	38	30	23	B	Q	H	A,I,P,O,Q,U,H,C 2	GPC4	GPIO/Interrupt/KBI Port-C function pin-4	
								SWCLK	Serial wire debug clock signal	
								I2C0_SCL	I2C0 SCL signal	
								URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.	

MG32F02U128/U064

									URT1_RX	URT1 receive RX signal, SPI master/slave data input signal. URT1_RX and URT1_TX can be swapped by register setting.
									TM36_OC2	TM36 output compare/PWM channel-2
									SDT_I0	State detect input signal-0
									URT6_RX	URT6 receive RX signal. URT6_RX and URT6_TX can be swapped by register setting.
PC5	39	31	24	B	Q	H	A,I,P,O,Q,U,H,C 2		GPC5	GPIO/Interrupt/KBI Port-C function pin-5
									SWDIO	Serial wire debug data signal
									I2C0_SDA	I2C0 SDA signal
									URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.
									URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
									TM36_OC3	TM36 output compare/PWM channel-3
									SDT_I1	State detect input signal-1
									URT6_TX	URT6 transmit TX signal. URT6_RX and URT6_TX can be swapped by register setting.
PC6	40	32	25	B	Q	H	A,I,P,O,Q,U,H,C F		GPC6	GPIO/Interrupt/KBI Port-C function pin-6
									RSTN	External hardware reset input
									RTC_TS	RTC time stamp input signal
									URT0_NSS	URT0 SPI NSS input/output signal
									URT1_NSS	URT1 SPI NSS input/output signal
									TM20_ETR	TM20 external trigger/clock input signal
									TM26_ETR	TM26 external trigger/clock input signal
									MBW1	External memory bus byte write enable 1 pin
	MALE	External memory bus address latch enable(ALE) or data/command select(DC) pin								
PC7	41	33		B	Q	H	A,I,P,O,Q,U,H,C 2		GPC7	GPIO/Interrupt/KBI Port-C function pin-7
									ADC0_TRG	ADC trigger start input
									RTC_OUT	RTC selection output signal
									URT0_DE	URT0 external drive enable output signal
									URT1_NSS	URT1 SPI NSS input/output signal
									TM36_TRGO	TM36 trigger output signal
									MBW0	External memory bus byte write enable 0 pin
	MCE	External memory bus chip enable/select pin								
PC8	42	34	26	B	Q	H	A,I,P,O,Q,U,H,C 2		GPC8	GPIO/Interrupt/KBI Port-C function pin-8
									ADC0_OUT	ADC threshold window compare output
									I2C0_SCL	I2C0 SCL signal
									URT0_BRO	URT0 baud-rate timer overflow output signal
									URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
									TM20_OC0H	TM20 output compare/PWM high channel-0
									TM36_OC0H	TM36 output compare/PWM high channel-0
	TM36_OC0N	TM36 output compare/PWM complement								

										channel-0	
										MAD11	External memory bus address/data pin 11
										MAD13	External memory bus address/data pin 13
										CCL_P0	CCL output signal-0
										URT6_TX	URT6 transmit TX signal. URT6_RX and URT6_TX can be swapped by register setting.
PC9	43	35	27	B	Q	H	A,I,P,O,Q,U,H,C	2	GPC9	GPIO/Interrupt/KBI Port-C function pin-9	
										CMP0_P0	Comparator-0 data output
										I2C0_SDA	I2C0 SDA signal
										URT0_TMO	URT0 timeout timer overflow output signal
										URT1_RX	URT1 receive RX signal, SPI master/slave data input signal. URT1_RX and URT1_TX can be swapped by register setting.
										TM20_OC1H	TM20 output compare/PWM high channel-1
										TM36_OC1H	TM36 output compare/PWM high channel-1
										TM36_OC1N	TM36 output compare/PWM complement channel-1
										MAD12	External memory bus address/data pin 12
										MAD6	External memory bus address/data pin 6
										CCL_P1	CCL output signal-1
										URT6_RX	URT6 receive RX signal. URT6_RX and URT6_TX can be swapped by register setting.
PC10	44	36	28	B	Q	H	A,I,P,O,Q,U,H,C	2	GPC10	GPIO/Interrupt/KBI Port-C function pin-10	
										CMP1_P0	Comparator-1 data output
										I2C1_SCL	I2C1 SCL signal
										URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.
										URT2_TX	URT2 transmit TX signal, SPI master/slave data output signal. URT2_RX and URT2_TX can be swapped by register setting.
										URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
										TM36_OC2H	TM36 output compare/PWM high channel-2
										TM36_OC2N	TM36 output compare/PWM complement channel-2
										MAD13	External memory bus address/data pin 13
										MAD14	External memory bus address/data pin 14
										URT7_TX	URT7 transmit TX signal. URT7_RX and URT7_TX can be swapped by register setting.
PC11	45	37	29	B	Q	H	A,I,P,O,Q,U,H,C	2	GPC11	GPIO/Interrupt/KBI Port-C function pin-11	
										I2C1_SDA	I2C1 SDA signal
										URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.

								SDT_I1	State detect input signal-1
								URT6_TX	URT6 transmit TX signal. URT6_RX and URT6_TX can be swapped by register setting.
PD0	54	42	33	B	A		A,I,P,O,U,H,C4	GPD0	GPIO/Interrupt/KBI Port-D function pin-0
								OBM_I0	Output signal break control input signal-0
								TM10_CKO	TM10 timer overflow output signal
								URT0_CLK	URT0 clock signal
								TM26_OC1N	TM26 output compare/PWM complement channel-1
								TM20_CKO	TM20 timer overflow output signal
								TM36_OC2	TM36 output compare/PWM channel-2
								SPI0_NSS	SPI0 slave select input/output signal
								MA0	External memory bus address pin 0
								MCLK	External memory bus clock pin
								URT2_NSS	URT2 SPI NSS input/output signal
PD1	55	43		B	A		A,I,P,O,U,H,C4	GPD1	GPIO/Interrupt/KBI Port-D function pin-1
								OBM_I1	Output signal break control input signal-1
								TM16_CKO	TM16 timer overflow output signal
								URT0_CLK	URT0 clock signal
								NCO_CK0	NCO external clock input signal-0
								TM26_CKO	TM26 timer overflow output signal
								TM36_OC2N	TM36 output compare/PWM complement channel-2
								SPI0_CLK	SPI0 clock signal
								MA1	External memory bus address pin 1
URT2_CLK	URT2 clock signal								
PD2	56	44		B	A		A,I,P,O,U,H,C4	GPD2	GPIO/Interrupt/KBI Port-D function pin-2
								USB_S0	USB signal-0 output
								TM00_CKO	TM00 timer overflow output signal
								URT1_CLK	URT1 clock signal
								TM26_OC00	TM26 output compare/PWM channel-00
								TM20_CKO	TM20 timer overflow output signal
								TM36_CKO	TM36 timer overflow output signal
								SPI0_MOSI	SPI0 master output / slave input signal or data-0 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
								MA2	External memory bus address pin 2
								MAD4	External memory bus address/data pin 4
								URT2_TX	URT2 transmit TX signal, SPI master/slave data output signal. URT2_RX and URT2_TX can be swapped by register setting.
PD3	57	45		B	A		A,I,P,O,U,H,C4	GPD3	GPIO/Interrupt/KBI Port-D function pin-3
								USB_S1	USB signal-1 output
								TM01_CKO	TM01 timer overflow output signal
								URT1_CLK	URT1 clock signal
								SPI0_MISO	SPI0 master input / slave output signal or data-1 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.

MG32F02U128/U064

							TM26_CKO	TM26 timer overflow output signal
							SPI0_D3	SPI0 data-3 signal for 4-I/O mode
							MA3	External memory bus address pin 3
							MAD7	External memory bus address/data pin 7
							TM36_TRGO	TM36 trigger output signal
							URT2_RX	URT2 receive RX signal, SPI master/slave data input signal. URT2_RX and URT2_TX can be swapped by register setting.
PD7	61	49	37	B	A	A,I,P,O,U,H,C4	GPD7	GPIO/Interrupt/KBI Port-D function pin-7
							TM00_CKO	TM00 timer overflow output signal
							TM01_ETR	TM01 external trigger/clock input signal
							URT1_DE	URT1 external drive enable output signal
							SPI0_MISO	SPI0 master input / slave output signal or data-1 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
							TM26_OC0N	TM26 output compare/PWM complement channel-0
							SPI0_D4	SPI0 data-0 signal for 2nd SPI device 4-I/O mode
							MA7	External memory bus address pin 7
							MAD0	External memory bus address/data pin 0
PD8	62	50	38	B	A	A,I,P,O,U,H,C4	TM36_IC0	TM36 input capture channel-0
							GPD8	GPIO/Interrupt/KBI Port-D function pin-8
							CPU_TXEV	CPU wakeup event output
							TM01_TRGO	TM01 trigger output signal
							URT1_RTS	URT1 RTS output control signal
							SPI0_D2	SPI0 data-2 signal for 4-I/O mode
							TM26_OC10	TM26 output compare/PWM channel-10
							SPI0_D7	SPI0 data-3 signal for 2nd SPI device 4-I/O mode
							MA8	External memory bus address pin 8
PD9	63	51	39	B	A	A,I,P,O,U,H,C2	MAD3	External memory bus address/data pin 3
							TM36_IC1	TM36 input capture channel-1
							SPI0_CLK	SPI0 clock signal
							GPD9	GPIO/Interrupt/KBI Port-D function pin-9
							CPU_RXEV	CPU wakeup event input
							TM00_TRGO	TM00 trigger output signal
							URT1_CTS	URT1 CTS input control signal
							SPI0_NSSI	SPI0 slave select input only signal
							TM26_OC11	TM26 output compare/PWM channel-11
PD10	64	52	40	B	A	A,I,P,O,U,H,C2	SPI0_D6	SPI0 data-2 signal for 2nd SPI device 4-I/O mode
							MA9	External memory bus address pin 9
							MAD2	External memory bus address/data pin 2
							TM36_IC2	TM36 input capture channel-2
							SPI0_NSS	SPI0 slave select input/output signal
							GPD10	GPIO/Interrupt/KBI Port-D function pin-10
CPU_NMI	CPU NMI external pin input							

							TM00_ETR	TM00 external trigger/clock input signal
							URT1_BRO	URT1 baud-rate timer overflow output signal
							RTC_OUT	RTC selection output signal
							TM26_OC12	TM26 output compare/PWM channel-12
							SPI0_D5	SPI0 data-1 signal for 2nd SPI device 4-I/O mode
							MA10	External memory bus address pin 10
							MAD1	External memory bus address/data pin 1
							TM36_IC3	TM36 input capture channel-3
							SPI0_MOSI	SPI0 master output / slave input signal or data-0 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
PD11	65	53		B	A	A,I,P,O,U,H,C2	GPD11	GPIO/Interrupt/KBI Port-D function pin-11
							CPU_NMI	CPU NMI external pin input
							DMA_TRG1	DMA external trigger pin-1 input
							URT1_TMO	URT1 timeout timer overflow output signal
							SPI0_D3	SPI0 data-3 signal for 4-I/O mode
							TM26_OC1N	TM26 output compare/PWM complement channel-1
							SPI0_NSS	SPI0 slave select input/output signal
							MA11	External memory bus address pin 11
							MWE	External memory bus write enable(WE) or write strobe(WR) signal pin
PD12	66			B	A	A,I,P,O,U,H,C2	GPD12	GPIO/Interrupt/KBI Port-D function pin-12
							CMP0_P0	Comparator-0 data output
							TM10_CKO	TM10 timer overflow output signal
							OBM_P0	Output signal break control output signal-0
							TM00_CKO	TM00 timer overflow output signal
							SPI0_CLK	SPI0 clock signal
							TM20_OC0H	TM20 output compare/PWM high channel-0
							TM26_OC0H	TM26 output compare/PWM high channel-0
							MA12	External memory bus address pin 12
							MALE2	External memory bus 2nd address latch enable(ALE2) or command latch enable(CLE) pin
PD13	67			B	A	A,I,P,O,U,H,C2	GPD13	GPIO/Interrupt/KBI Port-D function pin-13
							CMP1_P0	Comparator-1 data output
							TM10_TRGO	TM10 trigger output signal
							OBM_P1	Output signal break control output signal-1
							TM00_TRGO	TM00 trigger output signal
							NCO_CK0	NCO external clock input signal-0
							TM20_OC1H	TM20 output compare/PWM high channel-1
							TM26_OC1H	TM26 output compare/PWM high channel-1
							MA13	External memory bus address pin 13
							MCE	External memory bus chip enable/select pin
PD14	68			B	A	A,I,P,O,U,H,C2	GPD14	GPIO/Interrupt/KBI Port-D function pin-14
							TM10_ETR	TM10 external trigger/clock input signal
							DAC_TRG0	DAC trigger start input

MG32F02U128/U064

																			TM00_ETR	TM00 external trigger/clock input signal
																			TM20_IC0	TM20 input capture channel-0
																			TM26_IC0	TM26 input capture channel-0
																			MA14	External memory bus address pin 14
																			MOE	External memory bus output enable(OE) or read strobe (RD) signal pin
																			CCL_P0	CCL output signal-0
																			URT5_TX	URT5 transmit TX signal. URT5_RX and URT5_TX can be swapped by register setting.
PD15	69				B	A				A,I,P,O,U,H,C2									GPD15	GPIO/Interrupt/KBI Port-D function pin-15
																			NCO_P0	NCO clock output signal-0
																			IR_OUT	IR output signal
																			DMA_TRG0	DMA external trigger pin-0 input
																			TM20_IC1	TM20 input capture channel-1
																			TM26_IC1	TM26 input capture channel-1
																			MA15	External memory bus address pin 15
																			CCL_P1	CCL output signal-1
																			URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.
PE0	14				B	A				A,I,P,O,U,H,C4									GPE0	GPIO/Interrupt/KBI Port-E function pin-0
																			OBM_I0	Output signal break control input signal-0
																			URT0_TX	URT0 transmit TX signal, SPI master/slave data output signal. URT0_RX and URT0_TX can be swapped by register setting.
																			DAC_TRG0	DAC trigger start input
																			SPI0_NSS	SPI0 slave select input/output signal
																			TM20_OC00	TM20 output compare/PWM channel-00
																			TM26_OC00	TM26 output compare/PWM channel-00
																			MALE	External memory bus address latch enable(ALE) or data/command select(DC) pin
																			MAD8	External memory bus address/data pin 8
																			URT4_TX	URT4 transmit TX signal. URT4_RX and URT4_TX can be swapped by register setting.
PE1	15				B	A				A,I,P,O,U,H,C4									GPE1	GPIO/Interrupt/KBI Port-E function pin-1
																			OBM_I1	Output signal break control input signal-1
																			URT0_RX	URT0 receive RX signal, SPI master/slave data input signal. URT0_RX and URT0_TX can be swapped by register setting.
																			DMA_TRG1	DMA external trigger pin-1 input
																			SPI0_MISO	SPI0 master input / slave output signal or data-1 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
																			TM20_OC01	TM20 output compare/PWM channel-01
																			TM26_OC01	TM26 output compare/PWM channel-01
																			MOE	External memory bus output enable(OE) or read strobe (RD) signal pin
																			MAD9	External memory bus address/data pin 9
																			TM36_OC0H	TM36 output compare/PWM high channel-0

							URT4_RX	URT4 receive RX signal. URT4_RX and URT4_TX can be swapped by register setting.
PE2	16			B	A	A,I,P,O,U,H,C4	GPE2	GPIO/Interrupt/KBI Port-E function pin-2
							OBM_P0	Output signal break control output signal-0
							I2C1_SCL	I2C1 SCL signal
							URT1_TX	URT1 transmit TX signal, SPI master/slave data output signal. URT1_RX and URT1_TX can be swapped by register setting.
							NCO_P0	NCO clock output signal-0
							SPI0_CLK	SPI0 clock signal
							TM20_OC02	TM20 output compare/PWM channel-02
							TM26_OC02	TM26 output compare/PWM channel-02
							MWE	External memory bus write enable(WE) or write strobe(WR) signal pin
							MAD10	External memory bus address/data pin 10
							TM36_OC1H	TM36 output compare/PWM high channel-1
							URT5_TX	URT5 transmit TX signal. URT5_RX and URT5_TX can be swapped by register setting.
PE3	17			B	A	A,I,P,O,U,H,C4	GPE3	GPIO/Interrupt/KBI Port-E function pin-3
							OBM_P1	Output signal break control output signal-1
							I2C1_SDA	I2C1 SDA signal
							URT1_RX	URT1 receive RX signal, SPI master/slave data input signal. URT1_RX and URT1_TX can be swapped by register setting.
							NCO_CK0	NCO external clock input signal-0
							SPI0_MOSI	SPI0 master output / slave input signal or data-0 signal for 4-I/O mode. SPI0_MOSI and SPI0_MISO can be swapped by register setting.
							TM20_OC0N	TM20 output compare/PWM complement channel-0
							TM26_OC0N	TM26 output compare/PWM complement channel-0
							MCE	External memory bus chip enable/select pin
							MALE2	External memory bus 2nd address latch enable(ALE2) or command latch enable(CLE) pin
							URT5_RX	URT5 receive RX signal. URT5_RX and URT5_TX can be swapped by register setting.
							PE8	32
CPU_TXEV	CPU wakeup event output							
OBM_I0	Output signal break control input signal-0							
URT2_TX	URT2 transmit TX signal, SPI master/slave data output signal. URT2_RX and URT2_TX can be swapped by register setting.							
SDT_I0	State detect input signal-0							
TM36_CKO	TM36 timer overflow output signal							
TM20_CKO	TM20 timer overflow output signal							
TM26_CKO	TM26 timer overflow output signal							

MG32F02U128/U064

							MAD11	External memory bus address/data pin 11
							URT4_TX	URT4 transmit TX signal. URT4_RX and URT4_TX can be swapped by register setting.
PE9	33			B	A	A,I,P,O,U,H,C2	GPE9	GPIO/Interrupt/KBI Port-E function pin-9
							CPU_RXEV	CPU wakeup event input
							OBM_I1	Output signal break control input signal-1
							URT2_RX	URT2 receive RX signal, SPI master/slave data input signal. URT2_RX and URT2_TX can be swapped by register setting.
							SDT_I1	State detect input signal-1
							TM36_TRGO	TM36 trigger output signal
							TM20_TRGO	TM20 trigger output signal
							TM26_TRGO	TM26 trigger output signal
							MOE	External memory bus output enable(OE) or read strobe (RD) signal pin
							URT4_RX	URT4 receive RX signal. URT4_RX and URT4_TX can be swapped by register setting.
PE12	50			B	A	A,I,P,O,U,H,C2	GPE12	GPIO/Interrupt/KBI Port-E function pin-12
							ADC0_TRG	ADC trigger start input
							USB_S0	USB signal-0 output
							TM01_CKO	TM01 timer overflow output signal
							TM16_CKO	TM16 timer overflow output signal
							TM20_OC10	TM20 output compare/PWM channel-10
							TM26_OC10	TM26 output compare/PWM channel-10
							MBW0	External memory bus byte write enable 0 pin
							URT6_TX	URT6 transmit TX signal. URT6_RX and URT6_TX can be swapped by register setting.
PE13	51			B	A	A,I,P,O,U,H,C2	GPE13	GPIO/Interrupt/KBI Port-E function pin-13
							ADC0_OUT	ADC threshold window compare output
							USB_S1	USB signal-1 output
							TM01_TRGO	TM01 trigger output signal
							TM16_TRGO	TM16 trigger output signal
							TM20_OC11	TM20 output compare/PWM channel-11
							TM26_OC11	TM26 output compare/PWM channel-11
							MBW1	External memory bus byte write enable 1 pin
							TM36_OC2H	TM36 output compare/PWM high channel-2
							URT6_RX	URT6 receive RX signal. URT6_RX and URT6_TX can be swapped by register setting.
PE14	52			B	A	A,I,P,O,U,H,C2	GPE14	GPIO/Interrupt/KBI Port-E function pin-14
							RTC_OUT	RTC selection output signal
							I2C1_SCL	I2C1 SCL signal
							TM01_ETR	TM01 external trigger/clock input signal
							TM16_ETR	TM16 external trigger/clock input signal
							TM20_OC12	TM20 output compare/PWM channel-12
							TM26_OC12	TM26 output compare/PWM channel-12
							MALE2	External memory bus 2nd address latch enable(ALE2) or command latch enable(CLE) pin

								CCL_P0	CCL output signal-0
								TM36_OC3H	TM36 output compare/PWM high channel-3
								URT7_TX	URT7 transmit TX signal. URT7_RX and URT7_TX can be swapped by register setting.
PE15	53			B	A		A,I,P,O,U,H,C2	GPE15	GPIO/Interrupt/KBI Port-E function pin-15
								RTC_TS	RTC time stamp input signal
								I2C1_SDA	I2C1 SDA signal
								TM36_BK0	TM36 break input signal
								TM36_ETR	TM36 external trigger/clock input signal
								TM20_OC1N	TM20 output compare/PWM complement channel-1
								TM26_OC1N	TM26 output compare/PWM complement channel-1
								MALE	External memory bus address latch enable(ALE) or data/command select(DC) pin
								CCL_P1	CCL output signal-1
								URT7_RX	URT7 receive RX signal. URT7_RX and URT7_TX can be swapped by register setting.
VSS	70	54	41	P					IO/Core/ADC ground
VSS2	30			P					IO ground
VSS1	49	41		P					IO ground
VR0	71	55	42	AO	AO				Core power supply/LDO output (place 0.1uF+4.7uF capacitors and close pin)
VDD	72	56	43	P					IO power supply/LDO input (place 0.1uF+10uF capacitors and close pin)
VDD2	27			P					IO power supply (place 0.1uF+10uF capacitors and close pin)
VREF+	73	57	44	AI	AI				ADC voltage reference (place 0.1uF+4.7uF capacitors and close pin)
V33	60	48	36	P					USB +3.3v power (place 4.7uF capacitors and close pin)
DP	59	47	35	A	A				USB DP
DM	58	46	34	A	A				USB DM

4.3. Pin AFS Summary Table

The following table is the AFS signal list of the related IO pin for all pins' summary. (AFS=n, n: I/O pin AFS setting value)

Table 4-6. Pin AFS Summary Table

Pin	AFS=0	AFS=1	AFS=2	AFS=3	AFS=4	AFS=5	AFS=6	AFS=7	AFS=8	AFS=9	AFS=10	AFS=11
PA0	GPA0						SDT_P0	CCL_P0	MA0	MAD0	TM36_OC00	URT4_TX
PA1	GPA1							CCL_P1	MA1	MAD1	TM36_OC10	URT4_RX
PA2	GPA2						SDT_I0		MA2	MAD2	TM36_OC2	URT5_TX
PA3	GPA3						SDT_I1		MA3	MAD3	TM36_OC2N	URT5_RX
PA4	GPA4								MA4	MAD4	TM20_OC00	URT0_TX
PA5	GPA5								MA5	MAD5	TM20_OC10	URT0_RX
PA6	GPA6							SPI0_D3	MA6	MAD6	TM20_OC0H	URT0_CLK
PA7	GPA7							SPI0_D2	MA7	MAD7	TM20_OC1H	URT0_NSS
PA8	GPA8	DMA_TRG0		I2C0_SCL	URT2_BRO	SDT_I0	TM20_IC0	SPI0_NSS	MA8	MAD0	TM36_OC0H	URT4_TX
PA9	GPA9	DMA_TRG1		I2C1_SCL	URT2_TMO		TM20_IC1	SPI0_MISO	MA9	MAD1	TM36_OC1H	URT5_TX
PA10	GPA10	TM36_BK0	SPI0_D2	I2C0_SDA	URT2_CTS	SDT_I1	TM26_IC0	SPI0_CLK	MA10	MAD2	TM36_OC2H	URT4_RX
PA11	GPA11	DAC_TRG0	SPI0_D3	I2C1_SDA	URT2_RTS		TM26_IC1	SPI0_MOSI	MA11	MAD3	TM36_OC3H	URT5_RX
PA12	GPA12		USB_S0		URT1_BRO	TM10_ETR	TM36_IC0	SPI0_D5	MA12	MAD4	TM26_OC00	URT6_TX
PA13	GPA13	CPU_TXEV	USB_S1	URT0_BRO	URT1_TMO	TM10_TRGO	TM36_IC1	SPI0_D6	MA13	MAD5	TM26_OC10	URT6_RX
PA14	GPA14	CPU_RXEV	OBM_I0	URT0_TMO	URT1_CTS	TM16_ETR	TM36_IC2	SPI0_D7	MA14	MAD6	TM26_OC0H	URT7_TX
PA15	GPA15	CPU_NMI	OBM_I1	URT0_DE	URT1_RTS	TM16_TRGO	TM36_IC3	SPI0_D4	MA15	MAD7	TM26_OC1H	URT7_RX
PB0	GPB0	I2C1_SCL	SPI0_NSS	TM01_ETR	TM00_CKO	TM16_ETR	TM26_IC0	TM36_ETR	MA15	URT1_NSS		URT6_TX
PB1	GPB1	I2C1_SDA	SPI0_MISO	TM01_TRGO	TM10_CKO	TM16_TRGO	TM26_IC1	TM36_TRGO		URT1_RX		URT6_RX
PB2	GPB2	ADC0_TRG	SPI0_CLK	TM01_CKO	URT2_TX	TM16_CKO	TM26_OC0H	I2C0_SDA		URT1_CLK	URT0_TX	URT7_TX
PB3	GPB3	ADC0_OUT	SPI0_MOSI	NCO_P0	URT2_RX	TM36_CKO	TM26_OC1H	I2C0_SCL		URT1_TX	URT0_RX	URT7_RX
PB4	GPB4	TM01_CKO	SPI0_D3	TM26_TRGO	URT2_CLK	TM20_IC0	TM36_IC0		MALE	MAD8		
PB5	GPB5	TM16_CKO	SPI0_D2	TM26_ETR	URT2_NSS	TM20_IC1	TM36_IC1		MOE	MAD9		
PB6	GPB6	CPU_RXEV	SPI0_NSSI	URT0_BRO	URT2_CTS	TM20_ETR	TM36_IC2		MWE	MAD10		URT2_TX
PB7	GPB7	CPU_TXEV		URT0_TMO	URT2_RTS	TM20_TRGO	TM36_IC3		MCE	MALE2		URT2_RX
PB8	GPB8	CMP0_P0	RTC_OUT	URT0_TX	URT2_BRO	TM20_OC01	TM36_OC01	SPI0_D3	MAD0	SDT_P0	OBM_P0	URT4_TX
PB9	GPB9	CMP1_P0	RTC_TS	URT0_RX	URT2_TMO	TM20_OC02	TM36_OC02	SPI0_D2	MAD1	MAD8	OBM_P1	URT4_RX
PB10	GPB10		I2C0_SCL	URT0_NSS	URT2_DE	TM20_OC11	TM36_OC11	URT1_TX	MAD2	MAD1	SPI0_NSSI	
PB11	GPB11		I2C0_SDA	URT0_DE	IR_OUT	TM20_OC12	TM36_OC12	URT1_RX	MAD3	MAD9	DMA_TRG0	URT0_CLK
PB12	GPB12	DMA_TRG0	NCO_P0	USB_S0				URT1_CLK	MAD4	MAD2		URT5_TX
PB13	GPB13	DAC_TRG0	TM00_ETR	URT0_CTS		TM20_ETR	TM36_ETR	URT0_CLK	MAD5	MAD10	CCL_P0	URT4_RX
PB14	GPB14	DMA_TRG0	TM00_TRGO	URT0_RTS		TM20_TRGO	TM36_BK0	URT0_NSS	MAD6	MAD3	CCL_P1	URT4_TX
PB15	GPB15	IR_OUT	NCO_CK0	USB_S1				URT1_NSS	MAD7	MAD11		URT5_RX
PC0	GPC0	ICKO	TM00_CKO	URT0_CLK	URT2_CLK	TM20_OC00	TM36_OC00	I2C0_SCL	MCLK	MWE	URT0_TX	URT5_TX
PC1	GPC1	ADC0_TRG	TM01_CKO	TM36_IC0	URT1_CLK	TM20_OC0N	TM36_OC0N	I2C0_SDA	MAD8	MAD4	URT0_RX	URT5_RX
PC2	GPC2	ADC0_OUT	TM10_CKO	OBM_P0	URT2_CLK	TM20_OC10	TM36_OC10	SDT_I0	MAD9	MAD12		
PC3	GPC3	OBM_P1	TM16_CKO	URT0_CLK	URT1_CLK	TM20_OC1N	TM36_OC1N	SDT_I1	MAD10	MAD5		
PC4	GPC4	SWCLK	I2C0_SCL	URT0_RX	URT1_RX		TM36_OC2	SDT_I0				URT6_RX
PC5	GPC5	SWDIO	I2C0_SDA	URT0_TX	URT1_TX		TM36_OC3	SDT_I1				URT6_TX
PC6	GPC6	RSTN	RTC_TS	URT0_NSS	URT1_NSS	TM20_ETR	TM26_ETR		MBW1	MALE		
PC7	GPC7	ADC0_TRG	RTC_OUT	URT0_DE	URT1_NSS		TM36_TRGO		MBW0	MCE		
PC8	GPC8	ADC0_OUT	I2C0_SCL	URT0_BRO	URT1_TX	TM20_OC0H	TM36_OC0H	TM36_OC0N	MAD11	MAD13	CCL_P0	URT6_TX

PC9	GPC9	CMP0_P0	I2C0_SDA	URT0_TMO	URT1_RX	TM20_OC1H	TM36_OC1H	TM36_OC1N	MAD12	MAD6	CCL_P1	URT6_RX
PC10	GPC10	CMP1_P0	I2C1_SCL	URT0_TX	URT2_TX	URT1_TX	TM36_OC2H	TM36_OC2N	MAD13	MAD14		URT7_TX
PC11	GPC11		I2C1_SDA	URT0_RX	URT2_RX	URT1_RX	TM36_OC3H	TM26_OC01	MAD14	MAD7		URT7_RX
PC12	GPC12		IR_OUT	DAC_TRG0	URT1_DE	TM10_TRGO	TM36_OC3	TM26_OC02	MAD15	SDT_P0		
PC13	GPC13	XIN	URT1_NSS	URT0_CTS	URT2_RX	TM10_ETR	TM26_ETR	TM36_OC00	TM20_IC0	SDT_I0		URT6_RX
PC14	GPC14	XOUT	URT1_TMO	URT0_RTS	URT2_TX	TM10_CKO	TM26_TRGO	TM36_OC10	TM20_IC1	SDT_I1		URT6_TX
PD0	GPD0	OBM_I0	TM10_CKO	URT0_CLK	TM26_OC1N	TM20_CKO	TM36_OC2	SPI0_NSS	MA0	MCLK		URT2_NSS
PD1	GPD1	OBM_I1	TM16_CKO	URT0_CLK	NCO_CK0	TM26_CKO	TM36_OC2N	SPI0_CLK	MA1			URT2_CLK
PD2	GPD2	USB_S0	TM00_CKO	URT1_CLK	TM26_OC00	TM20_CKO	TM36_CKO	SPI0_MOSI	MA2	MAD4		URT2_TX
PD3	GPD3	USB_S1	TM01_CKO	URT1_CLK		SPI0_MISO	TM26_CKO	SPI0_D3	MA3	MAD7	TM36_TRGO	URT2_RX
PD7	GPD7	TM00_CKO	TM01_ETR	URT1_DE		SPI0_MISO	TM26_OC0N	SPI0_D4	MA7	MAD0	TM36_IC0	
PD8	GPD8	CPU_TXEV	TM01_TRGO	URT1_RTS		SPI0_D2	TM26_OC10	SPI0_D7	MA8	MAD3	TM36_IC1	SPI0_CLK
PD9	GPD9	CPU_RXEV	TM00_TRGO	URT1_CTS		SPI0_NSSI	TM26_OC11	SPI0_D6	MA9	MAD2	TM36_IC2	SPI0_NSS
PD10	GPD10	CPU_NMI	TM00_ETR	URT1_BRO		RTC_OUT	TM26_OC12	SPI0_D5	MA10	MAD1	TM36_IC3	SPI0_MOSI
PD11	GPD11	CPU_NMI	DMA_TRG1	URT1_TMO		SPI0_D3	TM26_OC1N	SPI0_NSS	MA11	MWE		
PD12	GPD12	CMP0_P0	TM10_CKO	OBM_P0	TM00_CKO	SPI0_CLK	TM20_OC0H	TM26_OC0H	MA12	MALE2		
PD13	GPD13	CMP1_P0	TM10_TRGO	OBM_P1	TM00_TRGO	NCO_CK0	TM20_OC1H	TM26_OC1H	MA13	MCE		
PD14	GPD14		TM10_ETR	DAC_TRG0	TM00_ETR		TM20_IC0	TM26_IC0	MA14	MOE	CCL_P0	URT5_TX
PD15	GPD15		NCO_P0	IR_OUT	DMA_TRG0		TM20_IC1	TM26_IC1	MA15		CCL_P1	URT5_RX
PE0	GPE0	OBM_I0		URT0_TX	DAC_TRG0	SPI0_NSS	TM20_OC00	TM26_OC00	MALE	MAD8		URT4_TX
PE1	GPE1	OBM_I1		URT0_RX	DMA_TRG1	SPI0_MISO	TM20_OC01	TM26_OC01	MOE	MAD9	TM36_OC0H	URT4_RX
PE2	GPE2	OBM_P0	I2C1_SCL	URT1_TX	NCO_P0	SPI0_CLK	TM20_OC02	TM26_OC02	MWE	MAD10	TM36_OC1H	URT5_TX
PE3	GPE3	OBM_P1	I2C1_SDA	URT1_RX	NCO_CK0	SPI0_MOSI	TM20_OC0N	TM26_OC0N	MCE	MALE2		URT5_RX
PE8	GPE8	CPU_TXEV	OBM_I0	URT2_TX	SDT_I0	TM36_CKO	TM20_CKO	TM26_CKO		MAD11		URT4_TX
PE9	GPE9	CPU_RXEV	OBM_I1	URT2_RX	SDT_I1	TM36_TRGO	TM20_TRGO	TM26_TRGO		MOE		URT4_RX
PE10	GPE10	I2C0_SCL	I2C1_SCL	URT0_TX	URT4_TX					SDT_I0		
PE11	GPE11	I2C0_SDA	I2C1_SDA	URT0_RX	URT4_RX					SDT_I1		
PE12	GPE12	ADC0_TRG	USB_S0		TM01_CKO	TM16_CKO	TM20_OC10	TM26_OC10	MBW0			URT6_TX
PE13	GPE13	ADC0_OUT	USB_S1		TM01_TRGO	TM16_TRGO	TM20_OC11	TM26_OC11	MBW1		TM36_OC2H	URT6_RX
PE14	GPE14	RTC_OUT	I2C1_SCL		TM01_ETR	TM16_ETR	TM20_OC12	TM26_OC12	MALE2	CCL_P0	TM36_OC3H	URT7_TX
PE15	GPE15	RTC_TS	I2C1_SDA		TM36_BK0	TM36_ETR	TM20_OC1N	TM26_OC1N	MALE	CCL_P1		URT7_RX
Pin	AFS=0	AFS=1	AFS=2	AFS=3	AFS=4	AFS=5	AFS=6	AFS=7	AFS=8	AFS=9	AFS=10	AFS=11

[Package Pin Group Indication by Background Color]

- Light Blue Color : Not supported High Speed Pins
- Light Cyan Color : Supported ODC 4-Level Pins

4.4. Analog Function Pin Table

The following table is the analog signal pin list for all the analog function.

Table 4-7. Analog Function Pin Table

Pin Name	ADC	CMP	Others
PA0	ADC_I0		
PA1	ADC_I1		
PA2	ADC_I2		
PA3	ADC_I3		
PA4	ADC_I4		
PA5	ADC_I5		
PA6	ADC_I6		
PA7	ADC_I7		
PA8	ADC_I8	CMP0_I0	VBG_OUT
PA9	ADC_I9	CMP0_I1	
PA10	ADC_I10	CMP1_I0	ADC_PGA
PA11	ADC_I11	CMP1_I1	
PA12	ADC_I12		
PA13	ADC_I13		
PA14	ADC_I14		
PA15	ADC_I15		
PB0		CMP_C0	
PB1		CMP_C1	
PB2			DAC_P0
DM			DM
DP			DP

4.5. Alternate Functions Pin List

The following table is the pin list of the related AFS IO signal for all AFS signals' summary.

Table 4-8. Alternate Functions Pin List

No.	AFS List		Pin List for the AFS IO ([] : AFS setting value)							
	Group	AFS Name	Pin-1 Name	Pin-2 Name	Pin-3 Name	Pin-4 Name	Pin-5 Name	Pin-6 Name	Pin-7 Name	Pin-8 Name
1	GPA	GPA0	PA0 [0]							
2		GPA1	PA1 [0]							
3		GPA2	PA2 [0]							
4		GPA3	PA3 [0]							
5		GPA4	PA4 [0]							
6		GPA5	PA5 [0]							
7		GPA6	PA6 [0]							
8		GPA7	PA7 [0]							
9		GPA8	PA8 [0]							
10		GPA9	PA9 [0]							
11		GPA10	PA10 [0]							
12		GPA11	PA11 [0]							
13		GPA12	PA12 [0]							
14		GPA13	PA13 [0]							
15		GPA14	PA14 [0]							
16	GPA15	PA15 [0]								
17	GPB	GPB0	PB0 [0]							
18		GPB1	PB1 [0]							
19		GPB2	PB2 [0]							
20		GPB3	PB3 [0]							
21		GPB4	PB4 [0]							
22		GPB5	PB5 [0]							
23		GPB6	PB6 [0]							
24		GPB7	PB7 [0]							
25		GPB8	PB8 [0]							
26		GPB9	PB9 [0]							
27		GPB10	PB10 [0]							
28		GPB11	PB11 [0]							
29		GPB12	PB12 [0]							
30		GPB13	PB13 [0]							
31		GPB14	PB14 [0]							
32	GPB15	PB15 [0]								
33	GPC	GPC0	PC0 [0]							
34		GPC1	PC1 [0]							
35		GPC2	PC2 [0]							
36		GPC3	PC3 [0]							
37		GPC4	PC4 [0]							
38		GPC5	PC5 [0]							
39		GPC6	PC6 [0]							
40	GPC7	PC7 [0]								

MG32F02U128/U064

41		GPC8	PC8 [0]						
42		GPC9	PC9 [0]						
43		GPC10	PC10 [0]						
44		GPC11	PC11 [0]						
45		GPC12	PC12 [0]						
46		GPC13	PC13 [0]						
47		GPC14	PC14 [0]						
48	GPD	GPD0	PD0 [0]						
49		GPD1	PD1 [0]						
50		GPD2	PD2 [0]						
51		GPD3	PD3 [0]						
52		GPD7	PD7 [0]						
53		GPD8	PD8 [0]						
54		GPD9	PD9 [0]						
55		GPD10	PD10 [0]						
56		GPD11	PD11 [0]						
57		GPD12	PD12 [0]						
58		GPD13	PD13 [0]						
59		GPD14	PD14 [0]						
60		GPD15	PD15 [0]						
61	GPE	GPE0	PE0 [0]						
62		GPE1	PE1 [0]						
63		GPE2	PE2 [0]						
64		GPE3	PE3 [0]						
65		GPE8	PE8 [0]						
66		GPE9	PE9 [0]						
67		GPE12	PE12 [0]						
68		GPE13	PE13 [0]						
69		GPE14	PE14 [0]						
70		GPE15	PE15 [0]						
71	Chip	SWCLK	PC4 [1]						
72		SWDIO	PC5 [1]						
73		RSTN	PC6 [1]						
74		ICKO	PC0 [1]						
75		XIN	PC13 [1]						
76		XOUT	PC14 [1]						
77		CPU_TXEV	PA13 [1]	PB7 [1]	PD8 [1]	PE8 [1]			
78		CPU_RXEV	PA14 [1]	PB6 [1]	PD9 [1]	PE9 [1]			
79		CPU_NMI	PA15 [1]	PD10 [1]	PD11 [1]				
80	ANAI0	ADC0_TRG	PB2 [1]	PC1 [1]	PC7 [1]	PE12 [1]			
81		ADC0_OUT	PB3 [1]	PC2 [1]	PC8 [1]	PE13 [1]			
82		CMP0_P0	PB8 [1]	PC9 [1]	PD12 [1]				
83		CMP1_P0	PB9 [1]	PC10 [1]	PD13 [1]				
84		DAC_TRG0	PA11 [1]	PB13 [1]	PC12 [3]	PD14 [3]	PE0 [4]		
85	I2C0	I2C0_SCL	PA8 [3]	PB3 [7]	PB10 [2]	PC0 [7]	PC4 [2]	PC8 [2]	
86		I2C0_SDA	PA10 [3]	PB2 [7]	PB11 [2]	PC1 [7]	PC5 [2]	PC9 [2]	
87	I2C1	I2C1_SCL	PA9 [3]	PB0 [1]	PC10 [2]	PE2 [2]	PE14 [2]		
88		I2C1_SDA	PA11 [3]	PB1 [1]	PC11 [2]	PE3 [2]	PE15 [2]		

89	URT0	URT0_TX	PA4 [11]	PB2 [10]	PB8 [3]	PC5 [3]	PC10 [3]	PE0 [3]	PC0 [10]	
90		URT0_RX	PA5 [11]	PB3 [10]	PB9 [3]	PC4 [3]	PC11 [3]	PE1 [3]	PC1 [10]	
91		URT0_CLK	PA6 [11]	PC0 [3]	PC3 [3]	PD0 [3]	PD1 [3]	PB11 [11]	PB13 [7]	
92		URT0_NSS	PA7 [11]	PB10 [3]	PC6 [3]	PB14 [7]				
93		URT0_BRO	PA13 [3]	PB6 [3]	PC8 [3]					
94		URT0_TMO	PA14 [3]	PB7 [3]	PC9 [3]					
95		URT0_DE	PA15 [3]	PB11 [3]	PC7 [3]					
96		URT0_CTS	PB13 [3]	PC13 [3]						
97		URT0_RTS	PB14 [3]	PC14 [3]						
98	URT1	URT1_TX	PB3 [9]	PB10 [7]	PC5 [4]	PC8 [4]	PC10 [5]	PE2 [3]		
99		URT1_RX	PB1 [9]	PB11 [7]	PC4 [4]	PC9 [4]	PC11 [5]	PE3 [3]		
100		URT1_CLK	PB2 [9]	PB12 [7]	PC1 [4]	PC3 [4]	PC12 [10]	PD2 [3]	PD3 [3]	
101		URT1_NSS	PB0 [9]	PB15 [7]	PC6 [4]	PC7 [4]	PC13 [2]			
102		URT1_BRO	PA12 [4]	PD10 [3]						
103		URT1_TMO	PA13 [4]	PC14 [2]	PD11 [3]					
104		URT1_DE	PD7 [3]	PC12 [4]						
105		URT1_CTS	PA14 [4]	PD9 [3]						
106		URT1_RTS	PA15 [4]	PD8 [3]						
107	URT2	URT2_TX	PB2 [4]	PC10 [4]	PC14 [4]	PD2 [11]	PE8 [3]	PB6 [11]		
108		URT2_RX	PB3 [4]	PC11 [4]	PC13 [4]	PD3 [11]	PE9 [3]	PB7 [11]		
109		URT2_CLK	PB1 [10]	PB4 [4]	PC0 [4]	PC2 [4]	PD1 [11]			
110		URT2_NSS	PB0 [10]	PB5 [4]	PD0 [11]					
111		URT2_BRO	PA8 [4]	PB8 [4]						
112		URT2_TMO	PA9 [4]	PB9 [4]						
113		URT2_DE	PB10 [4]							
114		URT2_CTS	PA10 [4]	PB6 [4]						
115		URT2_RTS	PA11 [4]	PB7 [4]						
116	URT4567	URT4_TX	PA0 [11]	PA8 [11]	PB8 [11]	PB14 [11]	PE0 [11]	PE8 [11]		
117		URT4_RX	PA1 [11]	PA10 [11]	PB9 [11]	PB13 [11]	PE1 [11]	PE9 [11]		
118		URT5_TX	PA2 [11]	PA9 [11]	PB12 [11]	PC0 [11]	PD14 [11]	PE2 [11]		
119		URT5_RX	PA3 [11]	PA11 [11]	PB15 [11]	PC1 [11]	PD15 [11]	PE3 [11]		
120		URT6_TX	PA12 [11]	PB0 [11]	PC5 [11]	PC8 [11]	PC14 [11]	PE12 [11]		
121		URT6_RX	PA13 [11]	PB1 [11]	PC4 [11]	PC9 [11]	PC13 [11]	PE13 [11]		
122		URT7_TX	PA14 [11]	PB2 [11]	PC10 [11]	PE14 [11]				
123		URT7_RX	PA15 [11]	PB3 [11]	PC11 [11]	PE15 [11]				
124	SPI0	SPI0_CLK	PB2 [2]	PD12 [5]	PE2 [5]	PA10 [7]	PD1 [7]	PD8 [11]		
125		SPI0_MOSI	PB3 [2]	PE3 [5]	PA11 [7]	PD2 [7]	PD10 [11]			
126		SPI0_MISO	PB1 [2]	PD3 [5]	PD7 [5]	PE1 [5]	PA9 [7]			
127		SPI0_NSS	PB0 [2]	PD0 [7]	PE0 [5]	PA8 [7]	PD11 [7]	PD9 [11]		
128		SPI0_D2	PA10 [2]	PB5 [2]	PB9 [7]	PD8 [5]	PA7 [7]			
129		SPI0_D3	PA11 [2]	PB4 [2]	PB8 [7]	PD11 [5]	PA6 [7]	PD3 [7]		
130		SPI0_NSSI	PB6 [2]	PB10 [10]	PD9 [5]					
131		SPI0_D4	PA15 [7]	PD7 [7]						
132		SPI0_D5	PA12 [7]	PD10 [7]						
133		SPI0_D6	PA13 [7]	PD9 [7]						
134		SPI0_D7	PA14 [7]	PD8 [7]						
135	TM00	TM00_CKO	PB0 [4]	PC0 [2]	PD2 [2]	PD7 [1]	PD12 [4]			
136		TM00_TRGO	PB14 [2]	PD9 [2]	PD13 [4]					

MG32F02U128/U064

137		TM00_ETR	PB13 [2]	PD10 [2]	PD14 [4]					
138	TM01	TM01_CKO	PB2 [3]	PB4 [1]	PC1 [2]	PD3 [2]	PE12 [4]			
139		TM01_TRGO	PB1 [3]	PD8 [2]	PE13 [4]					
140		TM01_ETR	PB0 [3]	PD7 [2]	PE14 [4]					
141	TM10	TM10_CKO	PB1 [4]	PC2 [2]	PC14 [5]	PD0 [2]	PD12 [2]			
142		TM10_TRGO	PA13 [5]	PC12 [5]	PD13 [2]					
143		TM10_ETR	PA12 [5]	PC13 [5]	PD14 [2]					
144	TM16	TM16_CKO	PB2 [5]	PB5 [1]	PC3 [2]	PD1 [2]	PE12 [5]			
145		TM16_TRGO	PA15 [5]	PB1 [5]	PE13 [5]					
146		TM16_ETR	PA14 [5]	PB0 [5]	PE14 [5]					
147	TM20	TM20_CKO	PD0 [5]	PD2 [5]	PE8 [6]					
148		TM20_TRGO	PB7 [5]	PB14 [5]	PE9 [6]					
149		TM20_ETR	PB6 [5]	PB13 [5]	PC6 [5]					
150		TM20_IC0	PA8 [6]	PB4 [5]	PC13 [8]	PD14 [6]				
151		TM20_IC1	PA9 [6]	PB5 [5]	PC14 [8]	PD15 [6]				
152		TM20_OC00	PA4 [10]	PC0 [5]	PE0 [6]					
153		TM20_OC01	PB8 [5]	PE1 [6]						
154		TM20_OC02	PB9 [5]	PE2 [6]						
155		TM20_OC0N	PC1 [5]	PE3 [6]						
156		TM20_OC10	PA5 [10]	PC2 [5]	PE12 [6]					
157		TM20_OC11	PB10 [5]	PE13 [6]						
158		TM20_OC12	PB11 [5]	PE14 [6]						
159		TM20_OC1N	PC3 [5]	PE15 [6]						
160		TM20_OC0H	PA6 [10]	PC8 [5]	PD12 [6]					
161		TM20_OC1H	PA7 [10]	PC9 [5]	PD13 [6]					
162	TM26	TM26_CKO	PD1 [5]	PD3 [6]	PE8 [7]					
163		TM26_TRGO	PB4 [3]	PC14 [6]	PE9 [7]					
164		TM26_ETR	PB5 [3]	PC6 [6]	PC13 [6]					
165		TM26_IC0	PA10 [6]	PB0 [6]	PD14 [7]					
166		TM26_IC1	PA11 [6]	PB1 [6]	PD15 [7]					
167		TM26_OC00	PA12 [10]	PD2 [4]	PE0 [7]					
168		TM26_OC01	PC11 [7]	PE1 [7]						
169		TM26_OC02	PC12 [7]	PE2 [7]						
170		TM26_OC0N	PD7 [6]	PE3 [7]						
171		TM26_OC10	PA13 [10]	PD8 [6]	PE12 [7]					
172		TM26_OC11	PD9 [6]	PE13 [7]						
173		TM26_OC12	PD10 [6]	PE14 [7]						
174		TM26_OC1N	PD0 [4]	PD11 [6]	PE15 [7]					
175		TM26_OC0H	PA14 [10]	PB2 [6]	PD12 [7]					
176		TM26_OC1H	PA15 [10]	PB3 [6]	PD13 [7]					
177	TM36	TM36_CKO	PB3 [5]	PD2 [6]	PE8 [5]					
178		TM36_TRGO	PB1 [7]	PC7 [6]	PD3 [10]	PE9 [5]				
179		TM36_ETR	PB0 [7]	PB13 [6]	PE15 [5]					
180		TM36_IC0	PA12 [6]	PB4 [6]	PD7 [10]	PC1 [3]				
181		TM36_IC1	PA13 [6]	PB5 [6]	PD8 [10]					
182		TM36_IC2	PA14 [6]	PB6 [6]	PD9 [10]					
183		TM36_IC3	PA15 [6]	PB7 [6]	PD10 [10]					
184		TM36_OC00	PA0 [10]	PC0 [6]	PC13 [7]					

185		TM36_OC01	PB8 [6]							
186		TM36_OC02	PB9 [6]							
187		TM36_OC0N	PC1 [6]	PC8 [7]						
188		TM36_OC10	PA1 [10]	PC2 [6]	PC14 [7]					
189		TM36_OC11	PB10 [6]							
190		TM36_OC12	PB11 [6]							
191		TM36_OC1N	PC3 [6]	PC9 [7]						
192		TM36_OC2	PA2 [10]	PC4 [6]	PD0 [6]					
193		TM36_OC2N	PA3 [10]	PD1 [6]	PC10 [7]					
194		TM36_OC3	PC5 [6]	PC12 [6]						
195		TM36_OC0H	PA8 [10]	PC8 [6]	PE1 [10]					
196		TM36_OC1H	PA9 [10]	PC9 [6]	PE2 [10]					
197		TM36_OC2H	PA10 [10]	PC10 [6]	PE13 [10]					
198		TM36_OC3H	PA11 [10]	PC11 [6]	PE14 [10]					
199		TM36_BK0	PB14 [6]	PA10 [1]	PE15 [4]					
200	RTC	RTC_OUT	PB8 [2]	PC7 [2]	PD10 [5]	PE14 [1]				
201		RTC_TS	PB9 [2]	PC6 [2]	PE15 [1]					
202	EMB	MAD0	PB8 [8]	PA0 [9]	PA8 [9]	PD7 [9]				
203		MAD1	PB9 [8]	PA1 [9]	PA9 [9]	PB10 [9]	PD10 [9]			
204		MAD2	PB10 [8]	PA2 [9]	PA10 [9]	PB12 [9]	PD9 [9]			
205		MAD3	PB11 [8]	PA3 [9]	PA11 [9]	PB14 [9]	PD8 [9]			
206		MAD4	PB12 [8]	PA4 [9]	PA12 [9]	PC1 [9]	PD2 [9]			
207		MAD5	PB13 [8]	PA5 [9]	PA13 [9]	PC3 [9]				
208		MAD6	PB14 [8]	PA6 [9]	PA14 [9]	PC9 [9]				
209		MAD7	PB15 [8]	PA7 [9]	PA15 [9]	PC11 [9]	PD3 [9]			
210		MAD8	PC1 [8]	PB4 [9]	PB9 [9]	PE0 [9]				
211		MAD9	PC2 [8]	PB5 [9]	PB11 [9]	PE1 [9]				
212		MAD10	PC3 [8]	PB6 [9]	PB13 [9]	PE2 [9]				
213		MAD11	PC8 [8]	PB15 [9]	PE8 [9]					
214		MAD12	PC9 [8]	PC2 [9]						
215		MAD13	PC10 [8]	PC8 [9]						
216		MAD14	PC11 [8]	PC10 [9]						
217		MAD15	PC12 [8]							
218		MWE	PB6 [8]	PE2 [8]	PC0 [9]	PD11 [9]				
219		MOE	PB5 [8]	PE1 [8]	PD14 [9]	PE9 [9]				
220		MALE	PB4 [8]	PE0 [8]	PE15 [8]	PC6 [9]				
221		MCE	PB7 [8]	PE3 [8]	PC7 [9]	PD13 [9]				
222		MCLK	PC0 [8]	PD0 [9]						
223		MBW0	PC7 [8]	PE12 [8]						
224		MBW1	PC6 [8]	PE13 [8]						
225		MALE2	PE14 [8]	PB7 [9]	PD12 [9]	PE3 [9]				
226		MAM1	PC12 [11]							
227		MA0	PA0 [8]	PD0 [8]						
228		MA1	PA1 [8]	PD1 [8]						
229		MA2	PA2 [8]	PD2 [8]						
230		MA3	PA3 [8]	PD3 [8]						
231		MA4	PA4 [8]							
232		MA5	PA5 [8]							

MG32F02U128/U064

233		MA6	PA6 [8]						
234		MA7	PA7 [8]	PD7 [8]					
235		MA8	PA8 [8]	PD8 [8]					
236		MA9	PA9 [8]	PD9 [8]					
237		MA10	PA10 [8]	PD10 [8]					
238		MA11	PA11 [8]	PD11 [8]					
239		MA12	PA12 [8]	PD12 [8]					
240		MA13	PA13 [8]	PD13 [8]					
241		MA14	PA14 [8]	PD14 [8]					
242		MA15	PA15 [8]	PB0 [8]	PD15 [8]				
243	Other	IR_OUT	PB11 [4]	PB15 [1]	PC12 [2]	PD15 [3]			
244		OBM_I0	PA14 [2]	PD0 [1]	PE0 [1]	PE8 [2]			
245		OBM_I1	PA15 [2]	PD1 [1]	PE1 [1]	PE9 [2]			
246		OBM_P0	PB8 [10]	PC2 [3]	PD12 [3]	PE2 [1]			
247		OBM_P1	PB9 [10]	PC3 [1]	PD13 [3]	PE3 [1]			
248		USB_S0	PA12 [2]	PB12 [3]	PD2 [1]	PE12 [2]			
249		USB_S1	PA13 [2]	PB15 [3]	PD3 [1]	PE13 [2]			
250		CCL_P0	PA0 [7]	PB13 [10]	PC8 [10]	PD14 [10]	PE14 [9]		
251		CCL_P1	PA1 [7]	PB14 [10]	PC9 [10]	PD15 [10]	PE15 [9]		
252		DMA_TRG0	PA8 [1]	PB11 [10]	PB12 [1]	PB14 [1]	PD15 [4]		
253		DMA_TRG1	PA9 [1]	PD11 [2]	PE1 [4]				
254		SDT_I0	PA2 [6]	PC2 [7]	PC4 [7]	PC13 [9]	PE8 [4]	PA8 [5]	
255		SDT_I1	PA3 [6]	PC3 [7]	PC5 [7]	PC14 [9]	PE9 [4]	PA10 [5]	
256		SDT_P0	PA0 [6]	PB8 [9]	PC12 [9]				
257		NCO_P0	PB3 [3]	PB12 [2]	PD15 [2]	PE2 [4]			
258		NCO_CK0	PB15 [2]	PD1 [4]	PD13 [5]	PE3 [4]			

5. Memory Map

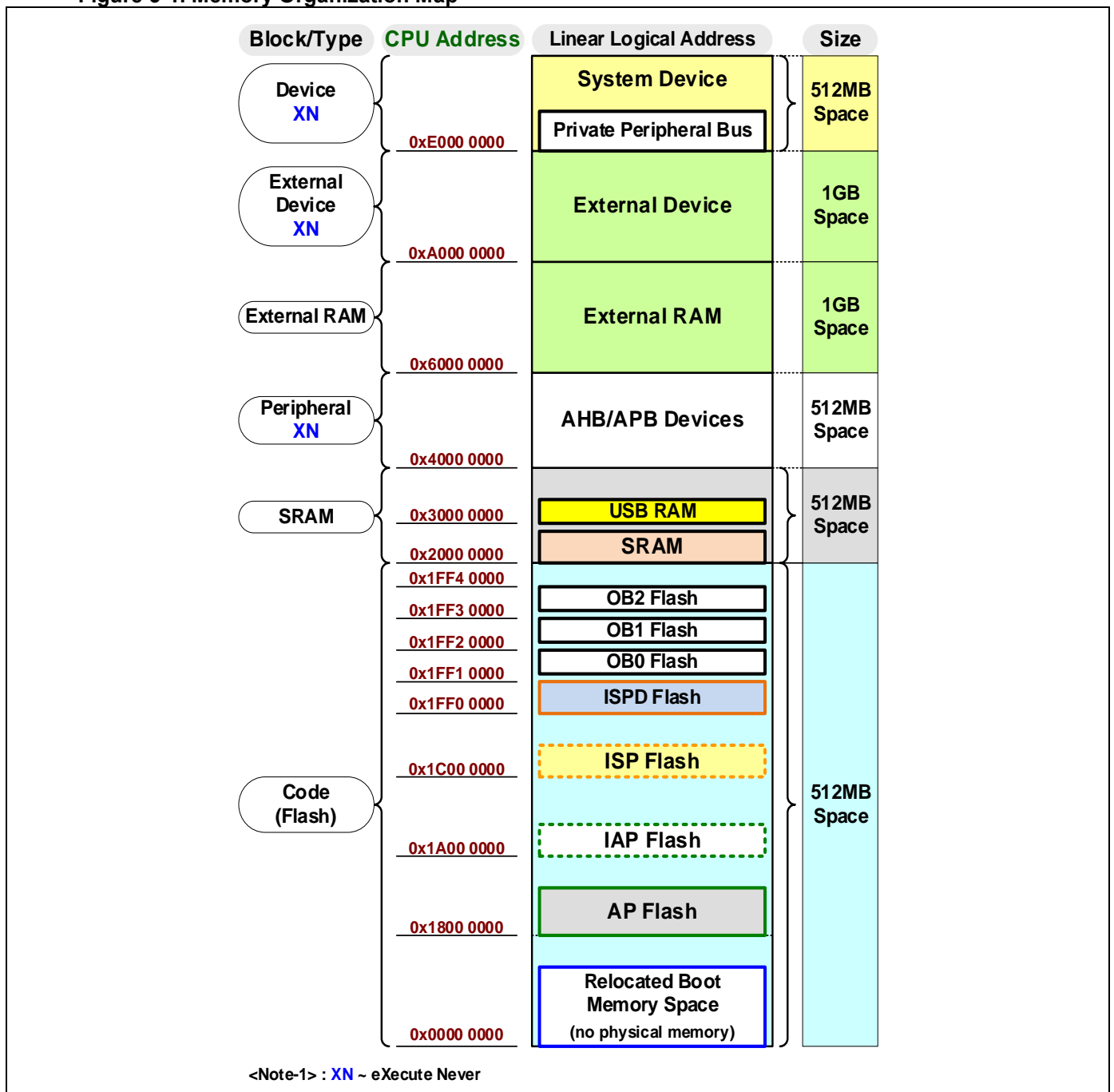
5.1. Memory Organization

There are up to **16K** bytes of SRAM built in the chip. The chip has up to **128K** bytes of embedded main flash memory for code and data, programmable memory size of embedded system flash memory for boot load code and 64 bytes of embedded option-byte (**OB**) flash memory for chip configuration. Others, there are many module independent hardware control registers and locate at the memory space of AHB/APB devices.

User can configure the whole flash to store for his Application Program (AP) code, In-System-Program (ISP) code and In-Application-Program (IAP) memory. User can adjust the size for the three flash memories.

The following diagram is showing the memory organization map. There are separated eight memory blocks and the memory size is 512M-byte for each block. The block is signed "XN" which is not able to execute code.

Figure 5-1. Memory Organization Map



5.2. CPU Memory Map

The following table is showing the memory address map of CPU. The block is signed “XN” which is not able to execute code.

Table 5-1. CPU Memory Address Map

Block Index	Block Name	XN	Boundary address		Size	Address Space	Note
			Start address	End address			
7	System Device	XN	0xE010 0000	0xFFFF FFFF	511MB	VENDOR_SYS	
			0xE000 0000	0xE00F FFFF	1MB	Private Peripheral Bus(PPB)	M0 Reserved Cortex M0 internal peripherals
6	External Device	XN	0xC000 0000	0xDFFF FFFF	512MB	Reserved	External memory (SRAM, Flash)
5	External Device	XN	0xA000 0000	0xBFFF FFFF	512MB	Reserved	External memory (SRAM, Flash)
4	External RAM		0x8000 0000	0x9FFF FFFF	512MB	Reserved	External memory (SRAM, Flash)
3	External RAM		0x6000 0000	0x7FFF FFFF	512MB	Reserved	External memory (SRAM, Flash)
2	Peripheral	XN	0x4000 0000	0x5FFF FFFF	512MB	APB/AHB	APB/AHB modules
1	SRAM		0x3000 0200	0x3FFF FFFF	256MB	Reserved	
			0x3000 0000	0x3000 01FF	512B	USB SRAM	
			0x2000 4000	0x2FFF FFFF	256MB	Reserved	
			0x2000 3800	0x2000 3FFF	2KB	SRAM	Upper 2K-byte suggestion for DMA
			0x2000 0000	0x2000 37FF	14KB	SRAM	
0	Code		0x1FF3 0200	0x1FFF FFFF	832KB	Reserved	
			0x1FF3 0040	0x1FF3 01FF	448B	OB Flash-2	
			0x1FF3 0000	0x1FF3 003F	64B		Hardware Option byte-2 (64-byte)
			0x1FF2 0200	0x1FF2 FFFF	64KB	Reserved	
			0x1FF2 0050	0x1FF2 01FF	432B	OB Flash-1	
			0x1FF2 0040	0x1FF2 004F	16B		Unique ID (16-byte)
			0x1FF2 0000	0x1FF2 003F	64B	Hardware Option byte-1 (64-byte)	
			0x1FF1 0200	0x1FF1 FFFF	64KB	Reserved	
			0x1FF1 0040	0x1FF1 01FF	448B	OB Flash-0	
			0x1FF1 0000	0x1FF1 003F	64B		Hardware Option byte-0 (64-byte)
			0x1FF0 0200	0x1FF0 FFFF	64KB	Reserved	
			0x1FF0 0000	0x1FF0 01FF	512B	ISPD Flash	ISP data flash
			0x1C02 0000	0x1FEF FFFF	63MB	Reserved	
			0x1C00 0000	0x1C01 FFFF	128KB	ISP Flash	Boot Flash memory (configurable size)
			0x1A02 0000	0x1BFF FFFF	32MB	Reserved	
			0x1A00 0000	0x1A01 FFFF	128KB	IAP Flash	Data Flash memory (configurable size)
			0x1802 0000	0x19FF FFFF	32MB	Reserved	
			0x1800 0000	0x1801 FFFF	128KB	AP Flash	Application Flash memory (configurable size by chip option)
			0x0002 0000	0x17FF FFFF	384MB	Reserved	
			0x0000 0000	0x0001 FFFF	128KB	Relocated memory space	Interrupt Vector 0x0000 00C0~0x0000 0000

XN : eXecute Never , 1 Block = 512MB

Relocated memory space : Main flash memory, Boot flash memory or SRAM depending on BOOT configuration

5.3. Peripheral Memory Boundary

Table 5-2. Peripheral Memory Boundary Address

Address Type	Boundary address		Size	Sections / Groups Peripheral	Module	Note
	Start address	End address				
APB	0x5F01 0100	0x5FFF FFFF	16MB	APB	Reserved	
	0x5F01 0000	0x5F01 00FF	256B		APX	APB module extended control
	0x5F00 0100	0x5F00 FFFF	64KB		Reserved	
	0x5F00 0000	0x5F00 00FF	256B		APB	APB module global control
	0x5E00 0000	0x5EFF FFFF	16MB	Reserved	Reserved	
	0x5D04 0100	0x5DFF FFFF	16MB	WDT/RTC	Reserved	
	0x5D04 0000	0x5D04 00FF	256B		RTC	Real Time Clock
	0x5D01 0100	0x5D03 FFFF	192KB		Reserved	
	0x5D01 0000	0x5D01 00FF	256B		WWDT	Window WatchDog Timer
	0x5D00 0100	0x5D00 FFFF	64KB		Reserved	
	0x5D00 0000	0x5D00 00FF	256B		IWDT	Independent WatchDog Timer
	0x5C08 0100	0x5CFF FFFF	15MB	CMP/DAC	Reserved	
	0x5C08 0000	0x5C08 00FF	256B		DAC	Digital-to-Analog controller
	0x5C00 0100	0x5C07 FFFF	512KB		Reserved	
	0x5C00 0000	0x5C00 00FF	256B		CMP	Analog Comparator 0,1
	0x5B00 0100	0x5BFF FFFF	16MB	ADC	Reserved	
	0x5B00 0000	0x5B00 00FF	256B		ADC	Analog-to-Digital controller
	0x5700 0000	0x5AFF FFFF	64MB	Reserved	Reserved	
	0x5686 0100	0x56FF FFFF	8MB	TM2x/3x	Reserved	
	0x5686 0000	0x5686 00FF	256B		TM36	32-bit Timer with 4 IC/OC/PWM
	0x5606 0100	0x5685 FFFF	8MB		Reserved	
	0x5606 0000	0x5606 00FF	256B		TM26	32-bit Timer with 2 IC/OC/PWM
	0x5600 0100	0x5605 FFFF	384KB		Reserved	
	0x5600 0000	0x5600 00FF	256B		TM20	32-bit Timer with 2 IC/OC/PWM
	0x5586 0100	0x55FF FFFF	8MB	TM0x/1x	Reserved	
	0x5586 0000	0x5586 00FF	256B		TM16	Basic32-bit Timer/Counter
	0x5580 0100	0x5585 FFFF	384KB		Reserved	
	0x5580 0000	0x5580 00FF	256B		TM10	Basic32-bit Timer/Counter
	0x5501 0100	0x557F FFFF	8MB		Reserved	
	0x5501 0000	0x5501 00FF	256B		TM01	Basic 16-bit Timer/Counter
	0x5500 0100	0x5500 FFFF	64KB		Reserved	
	0x5500 0000	0x5500 00FF	256B		TM00	Basic 16-bit Timer/Counter
	0x5401 0000	0x54FF FFFF	16MB	Reserved	Reserved	
	0x5400 0100	0x5400 FFFF	64KB	USB	Reserved	
	0x5400 0000	0x5400 00FF	256B		USB	USB bus controller
	0x5300 0100	0x53FF FFFF	16MB	SPI	Reserved	
	0x5300 0000	0x5300 00FF	256B		SPI0	SPI bus controller with data buffer
	0x5207 0100	0x52FF FFFF	16MB	UART	Reserved	
	0x5207 0000	0x5207 00FF	256B		URT7	Basic UART bus controller
	0x5206 0100	0x5206 FFFF	64KB		Reserved	
	0x5206 0000	0x5206 00FF	256B		URT6	Basic UART bus controller
	0x5205 0100	0x5205 FFFF	64KB		Reserved	
0x5205 0000	0x5205 00FF	256B	URT5		Basic UART bus controller	
0x5204 0100	0x5204 FFFF	64KB	Reserved			
0x5204 0000	0x5204 00FF	256B	URT4		Basic UART bus controller	
0x5202 0100	0x5203 FFFF	128KB	Reserved			
0x5202 0000	0x5202 00FF	256B	URT2		Advance UART bus controller	
0x5201 0100	0x5201 FFFF	64KB	Reserved			
0x5201 0000	0x5201 00FF	256B	URT1		Advance UART bus controller	
0x5200 0100	0x5200 FFFF	64KB	Reserved			

MG32F02U128/U064

	0x5200 0000	0x5200 00FF	256B		URT0	Advance UART bus controller
	0x5101 0100	0x51FF FFFF	16MB	I2C	Reserved	
	0x5101 0000	0x5101 00FF	256B		I2C1	I2C bus controller
	0x5100 0100	0x5100 FFFF	64KB		Reserved	
	0x5100 0000	0x5100 00FF	256B		I2C0	I2C bus controller
	0x5000 0100	0x50FF FFFF	16MB	EXT Interrupt	Reserved	
	0x5000 0000	0x5000 00FF	256B		EXIC	External Interrupt Controller
AHB	0x4FF0 0100	0x4FFF FFFF	1024KB	Chip	Reserved	
	0x4FF0 0000	0x4FF0 00FF	256B		CFG	Hardware option (NVR0/1/2)
	0x4F00 0100	0x4FEF FFFF	15MB		Reserved	
	0x4F00 0000	0x4F00 00FF	256B		WRI	Writer Interface Control
	0x4E00 0000	0x4EFF FFFF	16MB	Reserved	Reserved	
	0x4D02 0100	0x4DFF FFFF	16MB	Memory	Reserved	
	0x4D02 0000	0x4D02 00FF	256B		EMB	External Memory Bus Controller
	0x4D00 0100	0x4D01 FFFF	128KB		Reserved	
	0x4D00 0000	0x4D00 00FF	256B		MEM	Internal Memory Controller
	0x4C03 0100	0x4CFF FFFF	16MB	System	Reserved	
	0x4C03 0000	0x4C03 00FF	256B		SYS	System and Chip Control
	0x4C02 0100	0x4C02 FFFF	64KB		Reserved	
	0x4C02 0000	0x4C02 00FF	256B		PW	Power Management Controller
	0x4C01 0100	0x4C01 FFFF	64KB		Reserved	
	0x4C01 0000	0x4C01 00FF	256B		CSC	Clock Source Controller
	0x4C00 0100	0x4C00 FFFF	64KB		Reserved	
	0x4C00 0000	0x4C00 00FF	256B		RST	Reset Source Controller
	0x4BF0 0100	0x4BFF FFFF	1024KB	General Purpose	Reserved	
	0x4BF0 0000	0x4BF0 00FF	256B		DMA	Direct memory access
	0x4B00 0100	0x4BEF FFFF	15MB		Reserved	
	0x4B00 0000	0x4B00 00FF	256B		GPL	General Purpose Logic
	0x4500 0000	0x4AFF FFFF	96MB	Reserved	Reserved	Reserved for future design
	0x4404 0100	0x44FF FFFF	16MB	IO Configure	Reserved	
	0x4404 0000	0x4404 00FF	256B		PE	
	0x4403 0100	0x4403 FFFF	64KB		Reserved	
	0x4403 0000	0x4403 00FF	256B		PD	
	0x4402 0100	0x4402 FFFF	64KB		Reserved	
	0x4402 0000	0x4402 00FF	256B		PC	
	0x4401 0100	0x4401 FFFF	64KB		Reserved	
	0x4401 0000	0x4401 00FF	256B		PB	
	0x4400 0100	0x4400 FFFF	64KB		Reserved	
	0x4400 0000	0x4400 00FF	256B		PA	
0x4100 0200	0x43FF FFFF	48MB	Reserved			Reserved for future design
0x4100 0000	0x4100 01FF	512B	GPIO		IOP	IO Port Input/Output
0x4000 0000	0x40FF FFFF	16MB	Reserved		Reserved for future design	

5.4. Boot Modes

During chip startup, the hardware configuration option-byte (**OB**) is used to select one of the three boot options:

- **Boot from User Application Program (AP) Flash**
- **Boot from In-System-Program (ISP)**
- **Boot from embedded SRAM**

6. Functional Description

6.1. CPU Core

6.1.1. Introduction

The chip is embedded a CPU core of Cortex™-M0 processor. The processor is a configurable, multistage, 32-bit RISC processor. It has an AMBA AHB-Lite interface and includes an NVIC component. It also has optional DAP hardware debug functionality.

The processor can execute Thumb code and is compatible with other Cortex-M profile processor. The profile supports two modes -Thread mode and Handler mode. Handler mode is entered as a result of an exception. An exception return can only be issued in Handler mode. Thread mode is entered on Reset, and can be entered as a result of an exception return.

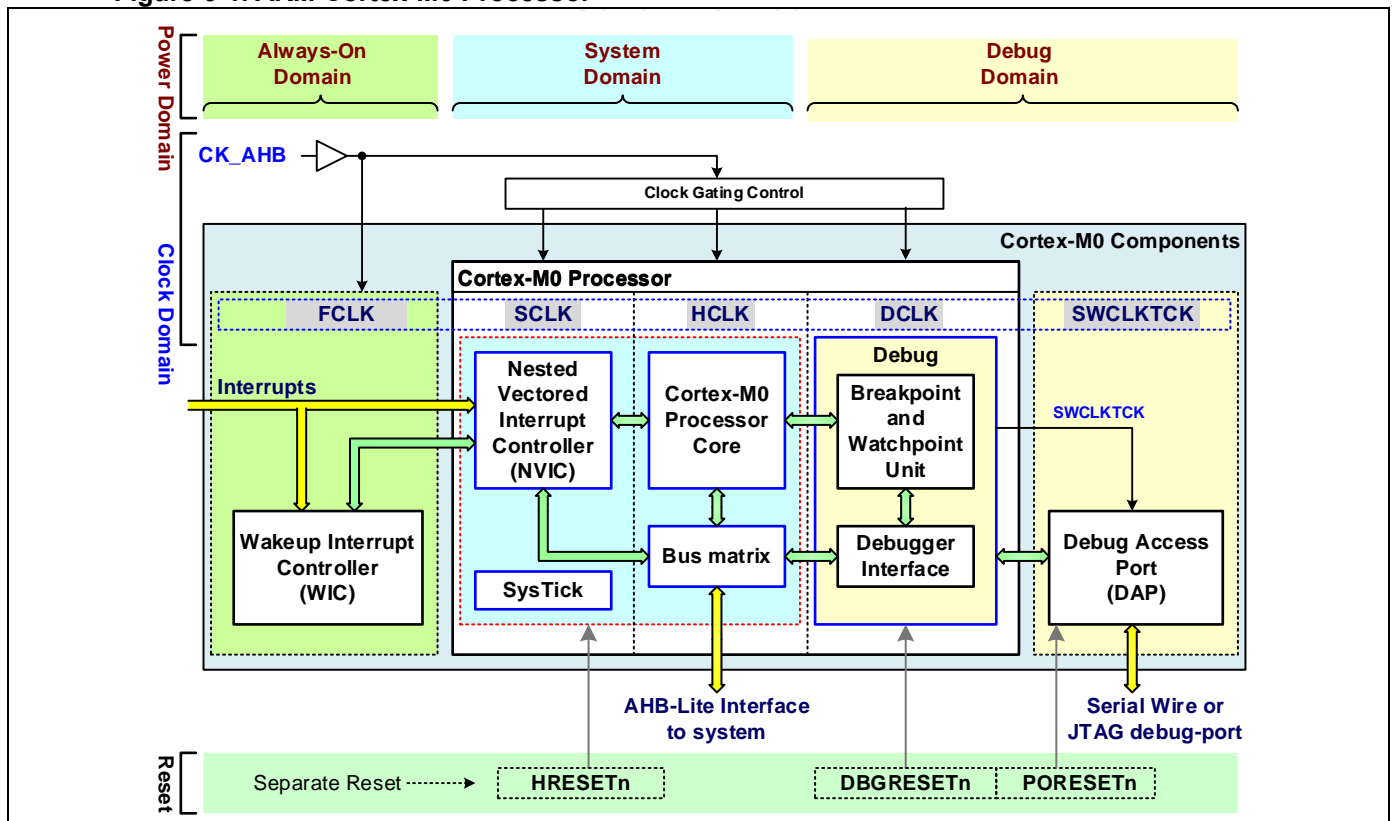
6.1.2. CPU Features

- ARM 32-bit Cortex-M0 CPU
- Operation frequency up to 48MHz
- Built-in one NVIC for 32 external interrupt inputs with 4-level priority
- Built-in one 24-bit system tick timer
- Built-in one single-cycle 32-bit multiplier
- Built-in one SWD serial wire debugger with 2 watch points and 4 breakpoint
- The ARMv6-M Thumb® instruction set

6.1.3. ARM Cortex-M0 Processor

The following diagram is showing the block of ARM Cortex-M0 Processor.

Figure 6-1. ARM Cortex-M0 Processor



6.2. Power Management

6.2.1. Introduction

The chip power is implemented only by single power supply input and embedded one LDO to supply the internal core logic power. The chip supports one power controller (PW) to manage Power-on reset (POR) circuit, Low-voltage reset (LVR) circuit, Brown-Out Detectors (BOD0/1/2), power down control and wakeup control.

It supports power-down modes: **SLEEP** mode and **STOP** modes. The power-down modes reduce chip power and provide the different power-saving scheme for chip application.

6.2.2. Chip Power Features

- Built-in one embedded regulator for core logic power
- Built-in brown-out detectors
 - BOD0 detect 1.4V
 - BOD1 detect by selected level 4.2V/3.7V/2.4V/2.0V
 - BOD2 detect 1.7V
- Built-in a power management controller with power-down and wakeup control
- Support three power operation modes
 - ON(Normal) mode and SLEEP , STOP power down modes
- Support wake-up from SLEEP/STOP modes via multiple sources

6.2.3. Power Operation Mode

There are three power operation modes of **ON**, **SLEEP**, **STOP** to be supported in the power controller.

- **ON mode**

In **ON** mode, the CPU is able running in full speed. All peripheral modules can use full power to do normally full function operation. These modules can enable or disable independent to save current consumption.

- **SLEEP mode**

In **SLEEP** mode, only the CPU is stopped and entering CPU sleep mode. All peripheral modules can be configurable to continue to operate or sleep.

In this mode, the chip can be waked up by the related interrupt or event occurs.

- **STOP mode**

The **STOP** mode provides the lowest current consumption. The different from SLEEP mode is that CPU is entering CPU deep-sleep mode and all peripheral modules are disabled except some special modules or devices. These modules or devices can be configurable to continue to operate in STOP mode or not. They include of IWDT, RTC, CMP modules and LVR, BOD0, BOD1, BOD2 devices. The internal voltage regulator is also running in low power mode.

In this mode, the chip can be waked up by some of the external input lines (GPIO) and some events detection.

6.2.4. Power Supply

The chip is embedded two internal low dropout linear regulators (LDO) to generate the +1.5 volt voltage power VDDC for core logic power supply and the +3.3 volt voltage power for USB macro power supply.

The **VDD** pin(s) is/are using for IO power supply input and internal LDO input. The **VSS** pin(s) is/are used to connect the external ground for internal reference ground of internal LDO, hard macros and digital logic. The **VR0** pin and **V33** pin are the LDO output and them need to connect bypass capacitors for normal operation. The **+VREF** pin is the input of ADC reference voltage which can connect to **VDD** pin for general application.

6.2.5. CPU Power Down

For chip entering power down mode, the firmware must execute WFI or WFE instruction to force the CPU enters sleep mode or deep sleep mode. Then the chip will enter the power down mode of **SLEEP** or **STOP**. User can configure the CPU sleep mode by setting CPU register of SLEEPDEEP after firmware executes WFI or WFE instruction.

Table 6-1. Power-Down Mode Selection

CPU	System	CPU Register
		SLEEPDEEP
Run	ON	x
sleep	SLEEP	0
deep sleep	STOP	1

6.3. System Reset

6.3.1. Introduction

During reset, all Registers are set to their initial values, and the program starts execution from the Reset Vector. The chip includes a reset source controller (RST) to manage multiple sources of reset and generates Warm reset and Cold reset signals to chip system and internal modules. This controller also provides the reset event flags for firmware, which are used to recognize the reset occurred source.

6.3.2. Chip Reset Features

- Built-in embedded POR(power-on reset)/LVR(low-voltage reset) circuit
- Built-in one reset source controller
 - Programmable chip cold reset and warm reset for reset source
 - Independent software reset control for internal modules
- Provide multiple reset sources
 - POR/LVR/BOD /External reset pin input/Software force reset
 - IWDG/WWDT/ADC/Comparator
 - IAR(Illegal address error reset)/Flash access protect error reset
 - Missing clock detect (MCD) reset

6.3.3. Chip Reset Levels

The chip provides three reset levels – POR reset, Cold reset and Warm reset. POR reset is the highest priority reset and is generated by chip hardware. Cold reset is the 2nd priority and Warm reset is the lowest priority reset.

When POR reset occurred, it will cause to generate Cold reset to chip. Also when Cold reset occurred, it will cause to generate Warm reset to chip.

● Power-On Reset

Power-on reset (**POR**) is used to internally reset the chip and also the CPU during power-up. The chip will keep in reset state and will not start to work until the VDD power rises above the voltage of Power-On Reset. And, the reset state is activated again whenever the VDD power falls below the POR threshold voltage. During a power off cycle, VDD must fall below the POR threshold voltage before power is reapplied in order to ensure a power-on reset.

● Cold Reset

Cold reset is the 2nd priority reset. The Cold reset is also generated and caused by POR reset occurred. It sends to some modules like as IWDG, WWDT ... to do deep level module reset. It will cause to reload all hardware configurations **OB** and disable the register lock function for the modules which are support the register lock function.

● Warm Reset

Warm reset is the lowest priority reset. The Warm reset is also generated and caused by Cold reset occurred. It sends to all modules to clear flags and hardware circuit. It will cause to reload some hardware configuration **OB** and reset the registers of module to default value if the module is unlocked or not supported

lock function. It will clear Warm reset source enable bits in RST controller if the RST controller is unlocked.

6.3.4. External Reset

The chip provides an external hardware reset input from **RSTN** pin, which is accomplished by holding low level for the **RSTN** pin. The **RSTN** pin is configured to as external reset pin or others (GPIO ...) by hardware configuration **OB**. To ensure a reliable power-up reset, then the hardware reset from **RSTN** pin is necessary.

6.3.5. Module Reset

For each AHB or APB control module, it can receive the system Warm reset signal to reset the module's control flags, registers and logical circuit. For some modules of IWDT, WWDT, RTC, PW, CSC and MEM, they can receive the Cold reset to unlock the register locked function and reset the module.

6.4. System Clock

6.4.1. Introduction

The chip builds in a clock source controller (CSC) for system clock source management. There are four clock sources for the system application: Internal High-frequency RC Oscillator (**IHRCO**), Internal crystal oscillator (**XOSC**), Internal Low-frequency RC Oscillator (**ILRCO**) and External Clock Input (**EXTCK**).

One **XOSC** oscillator is embedded for external Xtal circuit. One PLL is embedded to multiply the frequency of clock source and output clock for CPU and other peripheral modules. One missing clock detector (**MCD**) is built-in to monitor the clock of external Xtal or external clock source.

6.4.2. Chip Clock Features

- Built-in embedded ILRCO (internal low frequency RC oscillator) by 32KHz
- Built-in embedded IHRCO (internal high frequency RC oscillator)
 - Trimmed to 11.059 or 12MHz $\pm 1\%$ at +25°C
- Built-in embedded PLL clock output for system clock
- Built-in embedded XOSC oscillator with MCD for external 32KHz or 4 to 25MHz Xtal
- Support external clock input up to 36MHz
- Built-in a clock source controller with clock enable control for modules
- Support internal XOSC oscillator and internal ILRCO/IHRCO clock output

6.4.3. System Clock Source

There are four clock sources for the system application: Internal High-frequency RC Oscillator (**IHRCO**), Internal crystal oscillator (**XOSC**), Internal Low-frequency RC Oscillator (**ILRCO**) and External Clock Input (**EXTCK**). Software can select the one of the four clock sources by application required and switches them on the fly. But software needs to settle the clock source stably before clock switching.

6.4.4. PLL Clock

One PLL is embedded to multiply the frequency of system clock source from **IHRCO**, **ILRCO**, **XOSC** and **EXTCK**. The PLL multiplication value can be from 4 to 32. The PLL input frequency range is about 4~8 MHz and PLL VCO output frequency is up to over 150MHz. Usually, the PLL output frequency should be divided to do as CPU or others clock source. Refer the Electrical Characteristics chapter for detail specification about PLL.

6.4.5. Module Process Clock Control

The CSC module is able to do the process clock enable setting and select the process clock source for internal modules. User must select the module process clock and enable the module process clock before configure the module for operation normal.

6.5. System Common Control

6.5.1. Introduction

The chip embeds one system control (SYS) module for system common control. It is including of one system event interrupt global enable control, chip manufacture identification code.

6.5.2. Features

- System interrupt global enable control for system interrupt source
- Chip manufacture identification code - Device ID, Product ID, User ID, Module Options

6.6. Memory Access

6.6.1. Introduction

The chip has separate address spaces for program and data memory. The logical separation of program and data memory allows the memory to be accessed by 32bit addresses, which can be quickly stored and manipulated by the CPU. The chip supports one memory controller (MEM) to manage the internal flash memory and SRAM access operation.

6.6.2. Features

❖ Embedded Memory

- Built-in embedded 128K bytes flash memory for application code
 - Optional 64K/128K bytes flash memory by different product
- Built-in embedded 16K bytes SRAM
 - Support private 2K bytes for DMA and 14K bytes for software to improve access performance
- Built-in extra 512 bytes SRAM for USB endpoints' packet buffer.
 - Available and shared for USB, DMA and CPU firmware usage

❖ Memory Controller Features

- Support ICP (In-circuit program) for ISP boot code update through SWD interface
- Support ISP (In-system program) for application code update
 - Support programmable ISP flash memory size for ISP boot code
 - Provide fixed 512 bytes ISPD flash memory as ISP private data
- Support IAP (In-application program) for application data update
 - Support programmable IAP flash memory size
- Support flash memory page erase in 512 bytes

6.6.3. Memory Controller

A memory controller is supported to access on chip flash memory, SRAM on AHB bus. It includes **ICP** (In-Circuit Programming)/ **ISP** (In-System Programming)/ **IAP** (In-Application Programming) circuits for flash memory accessing, option byte loader for hardware option registers loading and an external memory bus EMB interface with the capability of accessing external program memory.

The chip has up to 128K bytes of embedded main flash memory for code and data, programmable memory size of embedded system flash memory for boot load code and 64 bytes of embedded option-byte flash memory for chip configuration.

The memory controller (MEM) supports to Read/ Program (Write)/ Erase the flash memory. User can directly read the data from flash memory by CPU read instruction commands and do not need through any register. For “Program” mode, MEM provides the 32-bit data write operation into flash memory for new data updated. For “Erase” mode, the Erase address is only valid at low 9-bit CPU address=0 (X...XX0 0000 0000B) and is addressing 512-byte alignment.

6.6.4. ICP/ISP/IAP for Flash Memory

There are 3 flash access modes are provided in chip for ICP, ISP and IAP application: program mode and read mode. ICP is allowed to update the entire contents of the flash memory by using the hardware SWD interface and no any firmware request. Others, User can use these two modes of ISP and IAP to update new data into flash storage and get flash content by a firmware flash memory access handler.

6.6.5. Hardware Option Byte Flash Memory

There can be up to 64 bytes of on-chip Option Bytes Flash memory. It is used to store the hardware option configuration setting.

The embedded option-byte (**OB**) flash memory will load into the hardware configuration option-byte register (**OR**) after power-on reset. The hardware configuration **OR** are designed to configure the clock source from

internal RC oscillator or crystal oscillator; the booted memory selection from AP, ISP flash memory or SRAM; the memory size of IAP flash memory; other chip configurations ... etc.

6.7. External Memory Bus

The chip has built in an external memory bus (EMB) controller to access the external device of SRAM, NOR/NAND flash and 8080 interface LCD. The EMB controller supports address bus and data bus multiplex mode. Also, it provides two address latch enable signals to support the multiple control of the address and data cycle.

6.7.1. Features

- Support SRAM, NAND/NOR flash, LCD interface
- Support synchronous or asynchronous timing mode control
- Support 8/16-bit data width
- Support multiple types of address and data multiplex mode
- Provide optional 16/24/30-bit address mode
 - Memory space 2G/32M/128K-byte for 16-bit data width
 - Memory space 16M/64K-byte for 8-bit data width
- Received and transmitted data are buffered with DMA capability
- Configurable time cycle for address latch time and data access time
- Allow running CPU code on external SRAM

6.7.2. EMB Control Function

EMB supports optional data bus 8/16-bit data width and optional 16/24/30-bit address mode. The maximum memory space size of external device is 2G/32M/128K-byte for 16-bit data width or 1G/16M/64K-byte for 8-bit data width.

EMB supports multiple types of address and data interface modes. They include multiple types of address and data multiplex modes.

EMB provides multiple timing states and programmable timing cycle for external device flexible design.

6.8. GPIO

6.8.1. Introduction

The chip has following I/O ports: **PA[15:0]**, **PB[15:0]**, **PC[14:0]**, **PD[15:0]**, **PE[0:3][8:9][12:15]**. Support maximum 73 GPIO pins for LQFP80 package. **RSTN** pin is an alternated function pin on **PC6**. If select external crystal oscillator as system clock input, **PC13** and **PC14** are configured to **XIN** and **XOUT**. The exact number of I/O pins available depends upon the package types.

The chip has built in several IO mode control (**PA/PB/PC/PD/PE**) modules for each GPIO port. These modules are used for GPIO pin IO mode control, alternated function selection, driver strength setting, input inverse selection, pull-high enable, deglitch filter setting and high speed enable. Also one IO Port access control (**IOP**) module is built-in to control the input and output state of GPIO mode for all GPIO ports.

6.8.2. Features

- Support general purpose IO pins for application
 - Maximum 73 GPIO pins for LQFP80 package
 - Maximum 59 GPIO pins for LQFP64 package
 - Maximum 44 GPIO pins for LQFP48 package
- Provide selectable IO modes by pin independent
 - Push-Pull output
 - Quasi bidirectional
 - Open-drain output
 - Input only with high impedance
 - Analog IO

- Flexible pin alternate function selection
- Support programmable drive strength by pin independent
- Support IO deglitch filter by pin independent
- Support input inverse selection by pin independent
- Support pull-high option by pin independent
- Support high speed option by pin independent except RSTN,XIN
- GPIO pin state and IO mode setting keep optional after reset

6.8.3. GPIO Control Block

The GPIO Control block includes IOM (IO pad Mode control), IOP (IO Port access control) and AFS (Alternate Function Select) blocks.

- **IO Operation Mode**

The IO operating modes are supported analog IO, digital input, push-pull output, and open-drain output, quasi-bidirectional. Provide selectable IO modes by pin independent.

The IO mode control block supports programmable IO operation modes, output high speed option, pull-high option, output drive strength, IO deglitch filter and input inverse selection by pin independent.

- **IO Port Access**

When the AFS setting is set GPIO function mode for any IO pin, user can directly set the logical output or get the logical input for the IO pin. There is one independent data out register bit to store the output logic value for each GPIO pin. Also user can directly read the input data register bit to get the GPIO pin logical state for each GPIO pin.

For firmware control, there are one set control bit to set the data out register bit and one clear control bit to clear the data out register bit for each GPIO pin.

The chip provides one set-or-clear register control bit to set, clear the data out register bit or read pin status for each GPIO pin. The register bit is written 1 to set data bit and written 0 to clear data. Read the register bit to get the GPIO pin status. As this register bit is cost eight bit memory space, firmware is easy to control single GPIO pin by CPU byte-access instruction command. It is like the bit access IO control of 8051 MCU.

- **Alternate Function Select Control**

User can configure the alternate function between module function IO and IO pins through the AFS matrix for each GPIO pin independently. Usually the AFS default setting is GPIO function for each GPIO pin except the **XIN/XOUT**, **SWCLK/SWDIO** and **RSTN** function pins. These pins may be changed by hardware configuration **OB**.

6.9. Interrupt

6.9.1. Introduction

After reset, the CPU begins execution from the location of reset interrupt vector (0x00000004) addressing, where should be the starting of the user's application code. To service the interrupts, the interrupt service locations (called interrupt vectors) should be located in the address 0x000000BF~0x00000000.

The chip is built-in ARM cortex M0 CPU and is embedded a NVIC (Nested Vectored Interrupt Controller) for 32 external interrupt inputs with 4-level priority. Also builds in an EXIC (External Interrupt Controller) module and connects to NVIC.

6.9.2. Interrupt Features

- Built-in one NVIC for 32 external interrupt inputs with 4-level priority
- Built-in one EXIC (external interrupt controller) for NVIC connection
 - Independent high/low level and rising/falling edge trigger selection
- Built-in one WIC (wakeup interrupt controller) for wakeup event control
- All GPIO pins can be configured as interrupt source and key pad input
 - Support port OR logic for interrupt function
 - Support port AND logic for KBI function
- Support external pins for CPU NMI/RXEV/TXEV function
 - Configurable pin for CPU NMI input function

- Configurable pin for CPU RXEV input function
- Configurable pin for CPU TXEV output function

6.9.3. Interrupt Structure

Each interrupt is assigned a fixed location in the program memory. The interrupt causes the CPU to jump to that location, where it commences execution of the service routine. NMI interrupt, for example, is assigned to location 0x00000008. If NMI is going to be used, its service routine must begin at location 0x00000008.

The interrupt service locations are spaced at an interval of 4 bytes: 0x00000004 for Reset Interrupt, 0x00000008 for **NMI**, 0x0000000C for **Hard-Fault**, 0x0000002C for **SVC**Call, 0x00000038 for **PendSV**, 0x0000003C for **SysTick**, etc.

- **Exception types**

The NVIC has 7 exception types: **Reset**, **NMI**, **HardFault**, **SVC**Call, **PendSV**, **SysTick** and Interrupt (IRQ). The NVIC supports 32 external interrupt input. An interrupt is an exception signaled by a peripheral or generated by a software request. The four priority level interrupt structure allows great flexibility in handling these interrupt sources.

- **Interrupt Sources**

The ‘Pending Bits’ are the interrupt flags that will generate an interrupt if it is enabled by setting the ‘Set Enable Bit’. The ‘Pending Bits’ can be set or cleared by software, with the same result as though it had been set or cleared by hardware. That is, interrupts can be generated or pending interrupts can be cancelled in software. The ‘Priority Bits’ determine the priority level for each interrupt. The ‘Priority within Level’ is the polling sequence used to resolve simultaneous requests of the same priority level. The ‘Vector Address’ is the entry point of an interrupt service routine in the program memory.

Table 6-2. Interrupt Source Table

NVIC						Comment
Exception No.	IRQ No.	Interrupt Name	Priority	Activation	Exception handlers	
0	-	Initial	-			
1	-	Reset	-3	Asynchronous		Reset exception
2	-14	NMI	-2	Asynchronous	System handlers	Non Maskable Interrupt
3	-13	HardFault	-1	Synchronous	Fault handler	Cortex-M0 Hard Fault Interrupt
4~10	-	Reserved	-			
11	-5	SVC	Configurable	Synchronous	System handlers	Cortex-M0 SV Call Interrupt
12~13	-	Reserved	-			
14	-2	PendSV	Configurable	Asynchronous	System handlers	Cortex-M0 Pend SV Interrupt
15	-1	SysTick	Configurable	Asynchronous	System handlers	Cortex-M0 System Tick Interrupt
16~47	0~31	-	Configurable	Asynchronous	ISRs	Peripheral Interrupts

Configurable : Programmable priority level 0~3

- **Interrupt Priority**

The priority scheme for servicing the interrupts has four interrupt levels. The priority bits in CPU registers, IPR0-7, SHPR2 and SHPR3, determine the priority level of each interrupt.

The interrupt priority registers provide an 8-bit priority field for each interrupt and each register holds four priority fields. The processor implements only bits [7:6] of each field, bits [5:0] read as zero and ignore writes.

Higher-priority interrupt will be not interrupted by lower-priority interrupt request. If two interrupt requests of different priority levels are received simultaneously, the request of higher priority is serviced. If interrupt requests of the same priority level are received simultaneously, an internal polling sequence determine which request is serviced. The table of “interrupt sources” shows the internal polling sequence in the same priority level and the interrupt vector address. The lower exception number gets the higher priority.

6.9.4. Nested Vectored Interrupt Controller

The Cortex-M0 processor integrates a configurable Nested Vectored Interrupt Controller (NVIC) that supports low latency interrupt processing and includes a non-mask interrupt (*NMI*). The NVIC provides a zero-jitter interrupt option and four interrupt priority levels.

Interrupt handlers do not require any assembler wrapper code, removing any code overhead from the ISRs. Tail-chaining optimization also significantly reduces the overhead when switching from one ISR to another.

To optimize low-power designs, the NVIC integrates with sleep mode. Optionally, sleep mode support can include a deep sleep function that enables the entire device to be rapidly powered down.

6.9.5. Wakeup Interrupt Controller

The chip includes a Wakeup Interrupt Controller (WIC) which can detect an interrupt or wakeup event from EXIC and wake the processor from deep sleep mode. The WIC is enabled only when the DEEPSLEEP bit in the CPU register of SCR is set to 1. The WIC is not programmable, and does not have any registers or user interface. It operates entirely from hardware signals.

6.9.6. External Interrupt Controller

The External Interrupt Controller (EXIC) includes four external port interrupt blocks (EXINT) to manage the external pin input interrupt events, one wakeup control block for wakeup event control and control the NMI/RXEV events. The EXIC also do as the interface controller between internal modules and NVIC for the interrupt and wakeup events management

6.10. General Purpose Logic

6.10.1. Introduction

The chip builds in one general purpose logic (GPL) module. It provides the combined functions of Data Order Change, Parity Check, Data Inverse and CRC.

6.10.2. Features

- **Support data inverse, bit order change, byte order change and parity check**
 - Data bit order change for 8/16/32-bit reverse
 - Data byte order change between Little endian and Big endian for 16/32-bit range
 - Parity Check for 8/16/32 bit range
- **Support CRC (Cyclic Redundancy Check) calculation**
 - Programmable CRC initial value
 - CRC output bit order change
- **CRC with fixed common polynomial**
 - CRC8 polynomial 0x07
 - CRC16 polynomial 0x8005
 - CCITT16 polynomial 0x1021
 - CRC32(IEEE 802.3) polynomial 0x4C11DB7
- **Support signed/unsigned 32-bit divider**
 - Operation in 8 clock cycles
- **Input data are buffered with DMA capability**

6.10.3. GPL Control Block

- **Byte Order Change**

The GPL can change the byte order of input data for big or little endian format for 32-bit range or 16-bit range.

- **Bit Order Change**

The GPL can change the bit order of input data for 8/16/32-bit reversion. This process is able to select data size of 8-bit, 16-bit and 32-bit.

- **Data Invert**

The GPL can invert the data value from input data.

- **Parity Check**

The GPL can set the parity check polarity by odd or even and calculate parity.

- **CRC Calculation**

The CRC (cyclic redundancy check) block is used to get an 8/16/32-bit CRC data code and calculates the result. The CRC block can process continuously with sequent CRC code and store the last result into data buffer always.

- **Hardware Arithmetic Divider**

The GPL module is including a 32-bit hardware arithmetic divider. The arithmetic divider is general using for firmware development. The hardware divider is supported both unsigned and signed arithmetic calculation by register setting.

6.11. APB Common Control

6.11.1. Introduction

The chip builds in one APB (APB bus common control) module for the common control of APB devices.

6.11.2. Features

- **Timer synchronous enable global control**
- **OBM(Output Signal Break and Modulation) control**
 - Support two sets of OBM for output signal break and modulation control
- **NCO(Numerically Controlled Oscillator) output with FDC and PF modes**
- **Infrared Remote Modulation Output**

6.11.3. APB Control Block

- **Timer Common Control**

The TMx modules supports two timer enable control bits of **TMx_EN** and **TMx_EN2** to enable the Main timer and 2nd timer separately for each TMx module.

In APB module, there are the same control bits of **APB_TMx_EN** and **APB_TMx_EN2** as the timer enable bits of **TMx_EN** and **TMx_EN2**. These control register bits are built in one 32-bit register and can be enabled or disabled synchronously by setting **APB_TMx_EN** or **APB_TMx_EN2** registers for firmware easy control. (x = Timer module index).

The ITR6 and the ITR7 are used as the common signals of trigger event or clock signal for all timer modules. User can select the trigger source signal by register setting. The **APB_ITR6** and **APB_ITR7** signals can be selected from others TMx timer, URTx, ADC0, RTC modules and EXIC global interrupt events.

- **OBM Control**

The APB module is including of two identical sets of output signal break and modulation (OBM) block. The OBM block is used to break one of the output signals or do signal modulation.

- **IR Control**

The APB module is including of one IR (Infrared Remote) modulation block. This block is used to do signal modulation for the transmission of IR control.

- **NCO Control**

The APB module is including of one Numerically Controlled Oscillator (NCO) block. The NCO block is used to generate a divided frequency with a decimal clock signal from input clock signal. It is useful for the accurate frequency clock requested application.

6.12. APX

6.12.1. Introduction

The chip builds in one APX module for the extended function control of APB devices.

6.12.2. Features

- **Support two sets of CCL(Configurable Custom Logic)**

6.12.3. APX Control Block

- **CCL Control**

The APX module is including of two sets of Configurable Custom Logic (CCL) block. Each CCL block can be connected to the device pins or other internal peripherals' signal. The CCL can eliminate external extra logic gate devices for simple glue logic functions on user application. It supports the L-to-H signal detected event flag and the interrupt.

6.13. Direct Memory Access

6.13.1. Introduction

The chip is built-in a direct memory access controller (DMA) which is used to improve the performance of data transfer between peripheral and memory, memory to memory and peripheral to peripheral. Data can be quickly transfer by through DMA without costing any CPU resources.

Notify: The sign of (n= DMA channel index number) is using for Registers, Signals and Pins/Ports in the descriptions of this chapter.

6.13.2. Features

- **5 independently configurable channels with dedicated hardware DMA requests**
 - Access to Memory, APB and AHB Peripherals as source and destination
 - Support SRAM/Flash/EMB access memory space as memory source and destination
 - Peripheral is including of ADC0,DAC,I2Cx,URTx,SPIx,TM36, USB modules
- **DMA transfer management type**
 - memory-to-memory (channel 0,3 only)
 - peripheral-to-memory
 - memory-to-peripheral
 - peripheral-to-peripheral
- **Built-in two type priority control between channel requests**
 - Channel request by Round Robin
 - Software configurable priority level
- **Programmable transfer number of data and up to 131072**
- **Programmable burst length 1,2,4**
- **Support transfer loop mode and start address auto reload control**
- **Provide single/block/demand mode for external pin trigger request**

6.13.3. DMA Control

The DMA controller (DMA) is used to transfer data between these sources and destinations of AHB peripheral, APB peripheral, SRAM and external memory. Two external pins of **DMA_TRG0** and **DMA_TRG1** are able to input as the trigger signal of DMA data transfer.

Each DMA channel is able to process the transfer types of peripheral-to-memory, memory-to-peripheral and peripheral-to-peripheral. The transfer type of memory-to-memory is only support for channel-0 and channel-3. The transferred memory sources can be embedded SRAM, Flash or external SRAM, Flash, 8080 LCD device by through EMB interface.

6.14. ADC

6.14.1. Introduction

The chip builds in one ADC0 module which embeds one 12-bit successive approximation ADC (analog-to-digital converter), one PGA (programmable gain amplifier) with gain 1~4 and digital logic for output code control. It supports the configurable multiplexed channels those include 16 external and 4 internal sources. The analog-to-digital conversion can be performed in one-shot, continuous, one-loop scan or continuous loop scan modes.

The ADC is embedded one temperature sensor to measure the internal thermal of chip for product application.

6.14.2. Features

- **12-bit SAR ADC with 1.5Msps**
 - Configurable resolution : 12/10/8-bit
 - Configurable sampling time
- **Provide external 16 channels and internal 8 channels input**
 - Internal channel source : VBUF, VSSA , LDO VR0, DAC out, 1/2VDD, V33, VPG, TS out
- **Support auto-sampling and trigger by external pin , internal events and software bit**
- **Data alignment for output code left/right justify**
- **Built-in input buffer stage with bypass option**
- **PGA with programmable gain : 1~4**
- **Interrupt generation at the end of sampling, end of conversion, end of sequence conversion**
- **Support voltage window detect and output code limitation**
 - Two level programmable window threshold
- **Built-in three channel independent hardware accumulator for ADC output code**
- **Support one-shot/channel scan/loop scan**
- **ADC data are buffered with DMA capability**
- **Support wait mode**
 - Prevents ADC overrun in application with low frequency
- **Support auto off mode**
 - ADC auto power off except during the active conversion phase
- **Built-in a temperature sensor**
 - Temperature resolution : +/- 2 °C (Typical)
 - Temperature operation range : -40°C ~ 125°C
 - Current consumption: 10uA

6.14.3. ADC Control Block

The ADC control block consists of an analog multiplexer (AMUX) with 16 input channels, a **1.5Msps/12-bit** SAR (successive-approximation-register) ADC, reference voltage circuit, ADC conversion trigger start control block and change scan control block.

● **ADC Input Channels**

The analog multiplexer (AMUX) selects the inputs to the ADC, allowing any of the input pins to be measured in single-ended mode.

The analog input pins used for the A/D converters also have its I/O pins for digital input and output function. In order to give the proper analog performance, a pin that is being used with the ADC should have its digital output as disabled. It is done by putting the port pin into the input-only mode. And when an analog signal is applied to the **ADC_[15:0]** pin and the digital input from this pin is not needed, software could set the corresponding pin to AIO mode to turn off the digital input buffer to reduce current consumption.

● **Single-End Mode**

The ADC supports single-end operation modes. The ADC can convert the ADC output to unsigned code for single-end mode.

● **ADC Sampling Time**

For input signal quality and conversion speedy issue, user can adjust the ADC sampling time. Usually

increase the ADC sampling time to get more stable voltage and better ADC performance if the conversion rate and signal bandwidth are reasonable and valid for actual application.

- **ADC Conversion Mode**

The ADC is supported three conversion modes of One Shot, Channel Scan and Loop Scan.

- **ADC Output Control**

When an ADC conversion is complete, the ADC raw code is generated and sends to the ADC output control blocks those are including of Digital Offset Adjuster, Signed Code Converter, Digital Resolution Adjuster, Voltage Window Detector, Code Limiter and Data Alignment Adjuster.

The ADC output code will be adjusted by the ADC output control blocks and store the conversion result data to the ADC data register.

- **Voltage Window Detect and Code Limit**

The ADC can compare the input voltage by a threshold window. Also the ADC output code can be compared by a code limit area to skip or clamp the code by the same threshold window.

- **ADC Data Sum Accumulate**

The ADC built-in one hardware accumulator for ADC output code. The accumulator is used to accumulate the sequential ADC data with programmable data number and records the sum to the summary registers. User can set the accumulated ADC data number. The ADC is supported three sum data registers and user can get the accumulated sum from these registers.

- **ADC Wait and Auto-Off**

The ADC supports a wait mode function to prevent ADC overrun in application with low frequency ADC sampling clock. Also ADC supports an auto off mode function to force the ADC auto entering power-off except during the active conversion phase.

6.15. Analog Comparator

6.15.1. Introduction

The chip builds in one CMP module which embeds two general purpose analog comparators with flexible input multiplexer, two internal voltage references of R-ladder and independent digital synchronized filter for each analog comparator. These analog comparators can be configured to two standalone comparators or a combined window comparator. The module provides the comparator output result status bit and the interrupt flags of rising edge or falling edge change. Also the output result can be output to external pin or internal other modules for trigger event.

6.15.2. Features

- Provide 2 fast Rail-to-rail comparators
- Programmable 64-step threshold of internal voltage reference
- Provide external total 6 channels input for all comparators
- Provide flexible 6 channels input for each +/- input path selection
- Programmable response time for optimal current consumption
- Combined window comparator from two comparators
- Selectable compare output polarity
- Support wakeup from SLEEP and STOP modes
- Compare output to I/O , interrupt or as internal module trigger event
 - Timer internal trigger, Capture events, or Break events
- Support analog watch dog as a reset source

6.15.3. CMP Control Block

The CMP module includes two general purpose analog comparators CMP0~1 by the same design structure and two internal voltage references *IVREF/IVREF2* by R-ladder structure. Each one is with the independent input multiplexer, digital synchronized filter and digital output circuit. The *IVREF* is only using for CMP0 and the *IVREF2* is only using for CMP1.

The analog comparator is built-in two internal voltage references – *IVREF* and *IVREF2* with 64-steps R-ladder structure. They can use as one of the analog comparator input and compare with another input from

external source.

Each the analog multiplexer (AMUX) of the positive or negative input of any analog comparator has flexible 6 channels input. These channels are including of two common external channels, two comparator independently external channels and two common internal channels.

The two common external channels are from **CMP_C0** and **CMP_C1** pins those can input to all analog comparators. The two independent external channels are from **CMPn_I0** and **CMPn_I1** pins those can input to the analog comparator CMP0/1. The two common internal channels are from internal voltage reference of **IVREF** or **IVREF2** and internal DAC output **DAC_P0** those can input to all analog comparators.

The analog input pins used for the comparators also have its I/O port's digital input and output function. In order to give the proper analog performance, a pin that is being used should have its digital output as disabled. It is done by putting the port pin into the digital input mode. And when an analog signal is applied to the analog input pin and the digital input from this pin is not needed, software could set the corresponding pin to AIO mode to reduce current consumption in the digital input buffer.

6.16. DAC

6.16.1. Introduction

The chip builds in one DAC module which embeds one 12-bit voltage mode DAC (digital-to-analog converter) and digital logic for input code control. The digital-to-analog conversion can be performed and start trigger by data register written, events (external pin input or internal events). The DAC can output a full-scale voltage from 0.2 volt to VDD-0.2 volt under the conversion rate up to 1MHz when DAC output buffer is on.

6.16.2. Features

- **One 12-bit voltage DAC**
 - **Maximum conversion rate is 1MHz**
 - **Analog output to ADC internal channel**
- **Conversion start trigger by register written, external pin and internal events**
- **Build in internal output buffer**
- **Data alignment for input code left/right justify**
 - **Configurable code width : 12/10/8-bit**
- **Output data are buffered with DMA capability**

6.16.3. DAC Control Block

The DAC control block consists of a 1Msps/12-bit voltage mode DAC, reference voltage circuit, a DAC data code register, a DAC conversion output register (**DAC_DOR0**) and DAC conversion trigger start control block.

The DAC output is programmable to full-scale output voltage from 0.2 volt to VDD-0.2 volt with DAC output buffer on. The voltage DAC output resistive load is minimum 7.5Kohm with DAC output buffer on.

6.17. IWDT

6.17.1. Introduction

The chip has one independent Watch-dog timer to use as a recovery method in situations where the CPU may be subjected to software upset. It will trigger system reset when the counter reaches a given timeout value.

6.17.2. Features

- **8-bit down counter with 12-bit prescaler and clocked by its own CK_ILRCO**
- **Operating capability in SLEEP and STOP modes**
- **Selectable reset or interrupt when the counter underflow**
- **Support two early wakeup comparators with interrupt**
- **Support register key-protected and reset-locked functions**

6.17.3. IWDT Control

The IWDT watch-dog timer consists of a 12-bit prescaler and an 8-bit timer. When the watch-dog timer is enabled, software should always reset the timer before the timer is timeout. When the watch-dog timer is reset,

the timer will be reloaded 0xFF value to restart counting.

If the chip is out of control by any disturbance, the firmware may miss to reset the timer and the timer timeout will be coming. It makes the IWDT generating a reset event and sends it to Reset Source Controller (RST) to do as the warm reset events or cold reset events.

The IWDT is able to record default initialized value in hardware option byte (**OB**) about IWDT on/off, input clock divider value, IWDT registers write protection.

The IWDT is able to operate in **STOP** mode and the APB clock is stopped and the module is asynchronous control for all logic.

The IWDT supports to wakeup chip in **STOP** mode by the events of watch-dog timer underflow and early wakeup-0/1 detection. When the chip is entering **STOP** mode and any of these IWDT wakeup events is happened, the IWDT will send the wakeup event to Power Controller (PW) to do as the system wakeup events.

6.18. WWDT

6.18.1. Introduction

The system window watchdog is used to detect the occurrence of a software fault which causes the application program abnormal. The watchdog circuit generates a system reset when the counter reaches a given timeout value.

The WWDT has a configurable time-window that can be programmed to detect abnormally late or early application behavior.

6.18.2. Features

- 10-bit counter with 1 or 256 divider , 1/2/4~1/128 divider
- Configurable time-window to detect abnormally late or early application behavior
- Selectable reset or interrupt when the counter is underflow or reloaded outside the window
- Support warning interrupt
- Support register key-protected and reset-locked functions

6.18.3. WWDT Control

The WWDT watch-dog timer consists of one /1 or /256 clock prescaler, one 7-bit clock divider and one 10-bit timer. When the watch-dog timer is enabled, software should always reset the timer before the timer is timeout. When the watch-dog timer is reset, the timer will reload the value to restart counting.

When the firmware is out of control, which may miss to reset the timer and the timer timeout will be coming. It makes the WWDT generating a reset event and sends it to Reset Source Controller (RST) to do as the warm reset events or cold reset events. If the firmware reset the timer and the counter value is over the threshold value of window compare threshold in the same time, it also makes the WWDT generating a reset event.

6.19. RTC

6.19.1. Introduction

The real-time clock is an independent 32-bit timer. The RTC provides a time clock with programmable alarm interrupt. User can use as a calendar with software programmable alarm seconds, minutes, hours, day, and date.

The RTC provides a wakeup flag to perform auto wakeup from power down mode with interrupt.

6.19.2. Features

- Built-in 32-bit counter with selectable clock source
- Support alarm function and time-stamp function
 - Support alarm function with 32-bit programmable compare register
- Support wakeup from Stop mode
- Support periodic timer tick interrupt or wakeup
- Support register key-protected and reset-locked functions

6.19.3. RTC Control

The RTC supports an alarm function and one register to sets the RTC alarm compare value. When the RTC timer value is matched with RTC alarm compare value, the RTC alarm flag is asserted and generates an interrupt. Also the RTC can capture from the 32-bit timer value or reload value to the 32-bit timer.

The RTC supports a time stamp function by external input. User can select input trigger edge of rising edge, falling edge or dual-edge. When an external input signal is matched, the RTC time stamp flag is asserted and generates an interrupt.

One **RTC_OUT** output is able to output the RTC internal signals to internal modules or external pin. There are four signals of timer overflow signal toggle output, time stamp trigger event, timer input periodic clock signal and alarm compare output event which can be selected and sent from **RTC_OUT** output.

The RTC is able to operate in **STOP** mode and the APB clock is stopped and the module is asynchronous control for all logic.

The RTC supports to wakeup chip in **STOP** mode by the events of timer overflow, timer input periodic clock and alarm compare output. When the chip is entering **STOP** mode and any of these RTC wakeup events is happened, the RTC will send the wakeup event to Power Controller (PW) to do as the system wakeup events.

6.20. Timer

6.20.1. Introduction

The chip has seven Timer/Counter modules: TM00, TM01, TM10, TM16, TM20, TM26 and TM36. All of them can be configured as timers or event counters.

TM0x has an 8-bit timer/counter with 8-bit prescaler. TM1x has a 16-bit timer/counter with 16-bit prescaler. TM2x has a 16-bit timer/counter with 16-bit prescaler and embeds two input capture/output compare channels. TM36 has a 16-bit timer/counter with 16-bit prescaler and embeds four input capture/output compare channels.

6.20.2. Features

- **Provide seven timers/counters : TM00, TM01, TM10, TM16, TM20, TM26, TM36**
- **Timer module common functions**
 - **Selectable Full-counter , Cascade , Separate modes**
 - **Multiple internal and external signals as timer clock source or trigger source**
 - **Internal timer events output to pin or other modules as input trigger event**
 - **Support timer reset , trigger start and clock gating for trigger source function**
 - **Timer overflow as clock output to external pin output**
 - **Programmable counter auto-stop mode**
 - **Main counter support up/down control (TM16/TM26/TM36 only)**
 - **2nd counter support up/down control (Separate mode)**
- **Provide TM36 timer module**
 - **32-bit timer/counter**
 - **4 CCP (input Capture/output Compare/PWM) channels**
 - **3 CCP channels with OCN (complementary output compare)**
 - **PWM function with center-align, dead time control and break control**
 - **Support OC comparator split to two separated comparators mode**
 - **QEI(Quadrature Encoder Interface) support**
 - **One IC and three OC with DMA capability**
 - **Extra repetition counter for auto-stop mode**
- **Provide TM2x timer modules**
 - **32-bit timer/counter**
 - **2 CCP (input Capture/output Compare/PWM) channels**
 - **2 CCP channels with OCN (complementary output compare)**
 - **PWM function with edge-align**
 - **Support OC comparator split to two separated comparators mode**
 - **QEI(Quadrature Encoder Interface) support (TM26 only)**
 - **Extra repetition counter for auto-stop mode**

- Provide TM1x timer modules (TM10, TM16)
 - 32-bit timer/counter
- Provide TM0x timer modules (TM00, TM01)
 - 16-bit timer/counter

6.20.3. Module Functions

The following table is showing the implemented functions of Timer modules.

Table 6-3. Timer Module Function Table

Module Functions	TM00	TM01	TM10	TM16	TM20	TM26	TM36
Timer/Counter total bits	16	16	32	32	32	32	32
Timer Cascade Mode	yes	yes	yes	yes	yes	yes	yes
Timer Separate Mode	yes	yes	yes	yes	yes	yes	yes
Timer Full-Counter Mode	yes	yes	yes	yes	yes	yes	yes
Independent channels					2	2	4
Internal TRGI lines	8	8	8	8	8	8	8
External TRGI lines	1	1	1	1	1	1	1
Output TRGO lines	1	1	1	1	1	1	1
Output CKO lines	1	1	1	1	1	1	1
Input Capture IC lines					2	2	4
Output OC lines					2	2	4
Output OCN lines					2	2	3
Output OCH lines					2	2	4
Input Break lines							1
PWM separated two					yes	yes	yes
PWM edge-align					yes	yes	yes
PWM center-align							yes
Dead-time generator							yes
Up/Down of 1st Timer	U	U	U	U/D	U	U/D	U/D
Up/Down of 2nd Timer	U/D	U/D	U/D	U/D	U/D	U/D	U/D
Timer auto Stop	yes	yes	yes	yes	yes	yes	yes
QEI timer U/D control						yes	yes
3-input XOR to CH-0							yes
DMA request capability							yes

- <Note>** 1. Timer Cascade Mode ~ 16-bit_counter+16-bit_prescaler or 8-bit_counter+8-bit_prescaler
 2. Timer Separate Mode ~ two 16-bit_counter or 8-bit_counter
 3. Timer Full-Counter Mode ~ 32-bit_counter or 16-bit counter

6.20.4. Timer Control Block

The TMx module is including of a Trigger/Clock control block, a Counter Stage, an Capture/Compare control block and Input/Output Stages of channel I/O control (TM2x, TM3x only) and a Break control block (TM36 only). TMx support three timer operation modes: (1) Cascade Mode (2) Separate Mode (3) Full-Counter Mode.

● Trigger Control Block

The Trigger Control block has two functions, one is to control the timer trigger input events and another is to control the timer trigger output events.

The timer trigger input events are including of Reset Timer, Gated Clock and Timer-Start Trigger for Main Timer and 2nd Timer. The input source of the timer trigger input events is selected from external trigger signal, internal trigger signals or external channel input signal of **TMx_IN0/TMx_IN1**.

The source of the timer trigger output events are able to come from many internal events or signals of this timer module. Also user can use the software register to set the trigger output directly. This source of output event can select and invert the output signal by registers.

● Timer Input/Output Channels

The following table is showing the channel input signals for each timer module. TM0x and TM1x modules are no channel input selection function as the input capture/output compare is not support. Each channel has four input lines.

- **Timer Input Capture and Output Compare**

The input capture (IC) and output compare (OC) functions are only supported for TM2x and TM3x modules. TM0x and TM1x modules are no the functions of the input capture/output compare.

User can configure each of the timer IC/OC channel independently as input capture, output compare or PWM mode.

- **PWM Dead-Time Control**

The Dead Time Generator (DTG) is only support for TM36 module. User can use with the DTG function and configure the timer channel as 16bit PWM mode or Two 8bit PWMs mode.

- **Break Control Block**

The break control block is only support for TM36 module. The module can input the break events from internal events, external events or software register to break the timer output signals.

- **QEI Control Block**

The QEI (Quadrature Encoder Interface) control block is only support for TM26 and TM36 modules. The QEI block can input from two external signals to control the Main Timer up or down counting. The QEI block provides five control modes and user can enable QEI control and configure the QEI control mode by register.

When the QEI control block is enabled, the timer will reset during up counting or reload the auto-reload value during down counting if detect the index signal active pulse.

6.21. I2C

6.21.1. Introduction

The I2C interface is a two-wire, bi-directional serial bus. It is ideally suited for typical microcontroller applications. The I2C protocol allows the systems designer to interconnect up to 128 different devices using only two bi-directional bus lines, one for clock (SCL) and one for data (SDA). The I2C bus provides control of SDA, SCL generation and synchronization, arbitration logic, and START/STOP control and generation. The only external hardware needed to implement this bus is a single pull-up resistor for each of the I2C bus lines. All devices connected to the bus have individual addresses, and mechanisms for resolving bus contention are inherent in the I2C protocol.

The I2C module builds in the shadow buffer and data register to improve transmit and receive communication performance.

6.21.2. Features

- **Provide two identical I2c modules : I2C0 , I2C1**
- **Support master and slave mode**
- **Support programmable clock rate control and clock rate up to 1 MHz**
- **Support programmable high/low period control for master mode**
- **Support clock stretching for slave mode**
- **Support general call function**
- **Support multi-master processing capability**
- **Support both Byte mode and Buffer mode flow control**
- **Support Byte mode bus event code for simplex firmware control**
- **Support Buffer mode 4-byte data buffer and 32-bit data register for high speed communication**
- **Received and transmitted data are buffered with DMA capability**
- **Support slave address hardware detection wakeup from STOP mode**
- **Support SMBus timeout detection**

6.21.3. I2C Control

- **I2C Data Byte Mode Control**

The module is provides one bus event register to get the I2C Event Code for software byte-mode simplex control. An 8-bit shift buffer and an 8-bit data register are using for the I2C data Byte mode.

- **I2C Data Buffer Mode Control**

The module implements an 8-bit shift buffer, a 32-bit shadow buffer and a 32-bit data register for data flow control of data Buffer mode..

- **I2C Master Timing Control**

Two timing control registers are simply used to configure the I2C timing of high and low cycle time.

- **I2C Timeout Timer Control**

The module is provides one 8-bit timeout timer (TMO) for I2C access time-out control.

6.22. UART

6.22.1. Introduction

The UART module support full-duplex transmission, meaning it can transmit and receive simultaneously. The module builds in the shadow buffer and data register by transmit and receive independently to improve transmit and receive communication performance. It can commence reception of a second byte before a previously received byte has been read from the register. However, if the first byte still hasn't been read by the time reception of the second byte is complete, one of the bytes will be lost.

The module can operate in multiple modes: asynchronous communication, synchronous communication, SPI master, *SmartCard*, *LIN*, multi-processor mode. The asynchronous communication operates as a full-duplex Universal Asynchronous Receiver and Transmitter (UART), which can transmit and receive simultaneously and at different baud rates.

6.22.2. Features

- **Provide seven UART modules : URT0~2, URT4~7**
- **UART module common functions**
 - Provide precise UART baud-rate control by programmable oversampling rate
 - Support baud rate up to 6 Mbit/s
 - Programmable data word length - 7 or 8 bits
 - Hardware parity checking and parity generation
 - Programmable 4~32 oversampling rate
 - Swappable TX/RX pin configuration
 - Separate signal polarity control for transmission and reception
- **Provide URT0/1/2 advanced UART module**
 - Support UART, Synchronous, SPI master/slave, SmartCard, LIN, Multi-processor modes
 - Selectable MSB or LSB first data order
 - Configurable stop bits - 0.5,1,1.5 or 2 stop bits
 - Support a timeout timer for Idle/RX/Break/Calibration timeout detection
 - Support 4-byte data buffer and 32-bit data register for high speed communication
 - Support auto baud-rate detection and calibration
 - Support multiprocessor communication for master and slave mode - Idle-Line , Address-Bit
 - Support low speed UART-like frame format IrDA
 - Support transceiver hardware flow control by CTS/RTS signals only
 - Provide driver enable signal to activate the transmission for bidirectional communication
 - Support transmission-error hardware detection and auto resent control for Smart-card application
 - Support receiving parity error hardware detection and auto retry control for Smart-card application
 - Received and transmitted data are buffered with DMA capability
- **Provide URT4/5/6/7 basic UART modules**
 - Support TX/RX independent 8-bit data register for simplex firmware control
 - Configurable stop bits - 1 or 2 stop bits

6.22.3. Module Functions

The following table is showing the implemented functions of UART modules.

Table 6-4. UART Module Function Table

Module Functions	URT0/1/2	URT4/5/6/7	Comment
UART - asynchronous	yes	yes	
Synchronous - SPI Master mode	yes		Synchronous - Master 2 data lines
Synchronous - SPI Slave mode	yes		Synchronous - Slave 2 data lines
SmartCard - ISO7816-3	yes		
LIN	yes		
Multiprocessor - Address Bit	yes		
Multiprocessor - Idle Line	yes		
IrDA - UART Like	yes		low speed UART-like frame format IrDA (SIR Normal Mode)
Hardware flow control	yes		only support CTS/RTS
External Clock pin	1		
Timer BRO,TMO pins	2		
Shadow Buffer	4-byte		
Data 7-bit option	yes	yes	
TX parity bit generation	yes	yes	hardware auto generate the parity bit from the data byte
Msb/Lsb transfer option	yes		
Configurable stop bits	0.5, 1, 1.5, 2	1, 2	programmable Stop bit length
Auto Baud-Rate calibration	yes		auto Baud-Rate detection and calibration
Mute mode auto enter/exit	yes		enter mute mode if address match does not occur
Break condition detect	yes		
Idle line detect	yes		
Programmable over sampling number	4~32	4~32	
Programmable clock phase/polarity	yes		for synchronous mode
General timer control	yes	yes	baud-rate timer and timeout timer as general timer
Drive enable	yes		Drive enable signal of the transmission mode for the external transceiver.
RX parity error detect	yes	yes	checks parity of received data byte
Frame error detect	yes	yes	
Data overrun detect	yes	yes	receive buffer over threshold level; transmit buffer empty
TX error detect	yes		SmartCard/LIN
Noise character detect	yes		skip or not for noise character
Idle timeout detect	yes		for SmartCard application
RX timeout detect	yes		aging character detection
Break timeout detect	yes		for LIN application
Calibration timeout detect	yes		for LIN application
DMA request capability	yes		

6.22.4. UART Control

The UART module is able to configure the control mode from one of UART (asynchronous mode), SYNC (synchronous mode), IDLE (multi-processor idle mode) and ADR (multi-processor address-bit mode).

The UART module implements two operation modes of Idle-Line mode or Address-Bit mode for multi-processor communication.

- **UART Data Buffer**

The UART module implements two 8-bit shift buffers, two 32-bit shadow buffer and two 32-bit data register for data flow control and reduce the CPU overhead.

- **UART Data Character Format Setting**

The UART character is defined as the data unit for UART transaction. Generally, the character is including of one Start bit, 8-bit or 7-bit data bits and one Stop bit. Others, it also can insert one parity bit (PAR) and one

address bit (ADR) for multi-processor mode.

- **UART TMO Timeout Control**

The module is provides one 16-bit timeout timer (TMO) for UART access time-out control. It can configure as an UART timeout timer or a general using timer by register. When the TMO timer is configured as a general using timer, there is one reload register for the timer.

The TMO timer can use to detect Idle Line condition, Break Timeout, RX Timeout, Idle Timeout and Baud-Rate Calibration Timeout.

- **UART Baud-Rate Control**

The Baud-Rate timer (BR) can configure as an UART Baud-Rate generator or a general using timer. The Baud-Rate timer generator is able to output the internal clock for UART communication Baud-Rate control.

- **UART Mute Mode Control**

The UART module is support a mute mode to disable receiving data character but the shift buffer is still operation for status detection. When the UART is entering mute mode, the RX shadow buffer is never load into data from shift buffer. The mute mode is useful for multi-processor communication.

The mute mode can be automatic by hardware detection to enter or exit by register configuration. Also it can be directly forced to enter or exit by register setting and user can manual to control the mute mode entering and exiting.

- **UART IrDA Control**

The UART module is built an IrDA encoder and an IrDA decoder in the data interface for IrDA communication.

- **UART DE Control**

The UART module provides one data enable signal of **URTx_DE**. This signal is used to indicate the data transmitted period and can output to external signal drive device. The external signal drive device can receive the UART TX signal and drive it with a signal enhanced buffer to the target of UART receiver for long distance communication.

- **UART Hardware Flow Control**

The UART supports a hardware flow control function for data transaction and provides two control signals of **URTx_CTS** (Clear to Send) and **URTx_RTS** (Request to Send) for the hardware flow control.

6.23. SPI

6.23.1. Introduction

The chip provides a high-speed serial peripheral interface (SPI). SPI is a full-duplex, high-speed and synchronous communication bus with two operation modes: Master mode and Slave mode. The SPI clock rate can be up to 22 MHz for Master mode and up to 16 MHz for Slave mode under a 48MHz APB clock.

The SPI module builds in the shadow buffer and data register by transmit and receive independently to improve transmit and receive communication performance.

6.23.2. Features

- **Support master and slave mode**
 - Support full duplex , half duplex or simplex communication mode
 - Support data communication without NSS(slave select signal)
 - Support master data input sampling delay half of SPI clock
 - Support configurable idle state for SPI master standard mode data output
 - Support asynchronous clock mode for SPI slave standard mode
- **Support programmable clock rate control**
- **Selectable 4~32-bit frame size**
 - Support 4-byte data buffer and 32-bit data register for high speed communication
- **Received and transmitted data are buffered with DMA capability**
- **Support multi-master processing capability**
- **Selectable clock polarity and phase**
- **Selectable MSB or LSB first data order**

- NSS line management by hardware or software for master mode
- Configurable data transfer modes
 - Standard SPI mode (separated transmit and receive line)
 - Single /Dual/Quad/Octal SPI mode with bidirectional data transfer
- Support DTR (Double Transfer Rate) mode
- Data transmit/receive overrun detect
- Support hardware master mode failure detection and auto slave mode change

6.23.3. SPI Control

- **SPI Data Buffer Mode Control**

The module implements two 32-bit shift buffers, two 32-bit shadow buffer and two 32-bit data register for data flow control and reduce the CPU overhead.

- **SPI Data Frame**

User can set the data frame bit size from 4-bit to 32-bit by register. Also user can configure the frame data order by Lsb first or Msb first.

- **SPI Data Modes**

The SPI module provides several data modes and can be configured to one of the modes of standard SPI, 1-Line SPI, 2-Line SPI, 4-Line SPI, two duplicated 4-Line SPI or 8-Line SPI for flexible SPI application.

6.24. USB

6.24.1. Introduction

The chip provides a USB (Universal Serial Bus) device with full-speed function. It is fully compliant with USB specification 2.0 and 1.1 to support various USB applications. The USB block contains an on-chip 3.3V regulator, a USB transceiver which transmits and receives differential USB signal, a USB Core to perform NRZI encoding and decoding, bit stuffing, CRC generation and checking, serial-parallel data transforming, data flow between USB data buffer and CPU.

An independent 512-byte SRAM is as USB receiving and transmission data packet buffer which can be configurable and shared for all endpoints. Also the data packet buffer is able to directly access by CPU and use for firmware whenever the USB function is enabled or disabled.

6.24.2. Features

- **USB 2.0 full-speed with 12Mbps**
- **Compliant with USB specification v1.1/v2.0.**
- **Supports USB suspend/resume and remote wake-up**
- **Support 8 endpoints with In and Out directions**
 - Each endpoint support flexible In, Out, simultaneous In and Out operations
 - Support 7 configurable endpoints with relocated address value except endpoint-0
 - Support independently receive and transmit buffer with separated start address for each endpoint
 - Support double buffer mode for each endpoint independently
- **Support control transfer for endpoint 0**
- **Support interrupt, bulk and isochronous transfer for all endpoints except endpoint-0**
- **Supports USB SRAM size 512 bytes shared for all endpoints**
- **Received and transmitted data are buffered with DMA capability**

6.24.3. Module Functions

The following table is showing the Endpoint functions of USB module.

Table 6-5. USB Endpoint Function Table

Function	USB Endpoint							
	EP0	EP1	EP2	EP3	EP4	EP5	EP6	EP7
Control Transfer	V							

Interrupt Transfer		V	V	V	V	V	V	V
Bulk Transfer		V	V	V	V	V	V	V
ISO Transfer		V	V	V	V	V	V	V
Double Buffer		V	V	V	V	V	V	V
DMA				V	V			
Programmable Endpoint Address		V	V	V	V	V	V	V
Relocated Buffer Address	V	V	V	V	V	V	V	V
Receiving Overflow Detect	V	V	V	V	V	V	V	V

Note : " V " ~ Support

6.24.4. USB Control

- **USB PHY**

The USB physical interface (PHY) is an analog front-end which includes the embedded DP/DM pull-up and pull-down resistors and a differential analog transceiver of USB device to connect to external USB host.

- **USB SIE**

The USB serial interface engine (SIE) is interfaced with the USB transceiver to do data transaction between external USB host and internal USB endpoints' data buffer. It implements the NRZI encoding and decoding, bit-stuffing, CRC generation and checking, PID detection and generation, and serial-parallel data transforming.

- **Packet Buffer Interface**

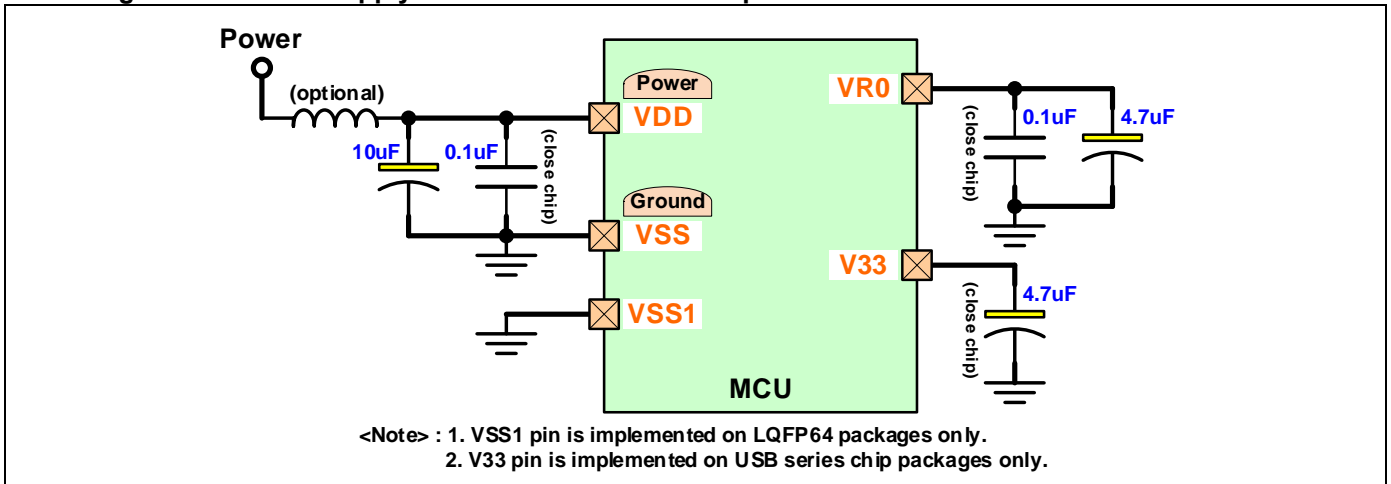
The packet buffer interface controls the USB transaction data between SIE and SRAM USB buffer. It manages the both transmission and reception direction to access the related SRAM buffer area for request USB endpoint. The SRAM USB buffer is used to store the endpoints' packet data. The usage is flexible for relocatable memory start address and programmable memory size by registers' setting.

7. Application Notes

7.1. Power Supply Circuit

To have the chip work with power supply varying from 1.8V to 5.5V, adding some external decoupling and bypass capacitors is necessary on **VDD/VSS** power pins, as shown in following figure. Also the same application suggestion on **VDD2/VSS2** power pins for LQFP80 package. The **VR0** pin is the embedded LDO voltage output as internal core logic power supply. It needs to place one 0.1uF capacitor and one 4.7uF capacitor to be closed the pin. For USB series chip, one external decoupling and bypass 4.7uF capacitor is necessary on **V33** power pin.

Figure 7-1. Power Supply Circuit for USB series chip



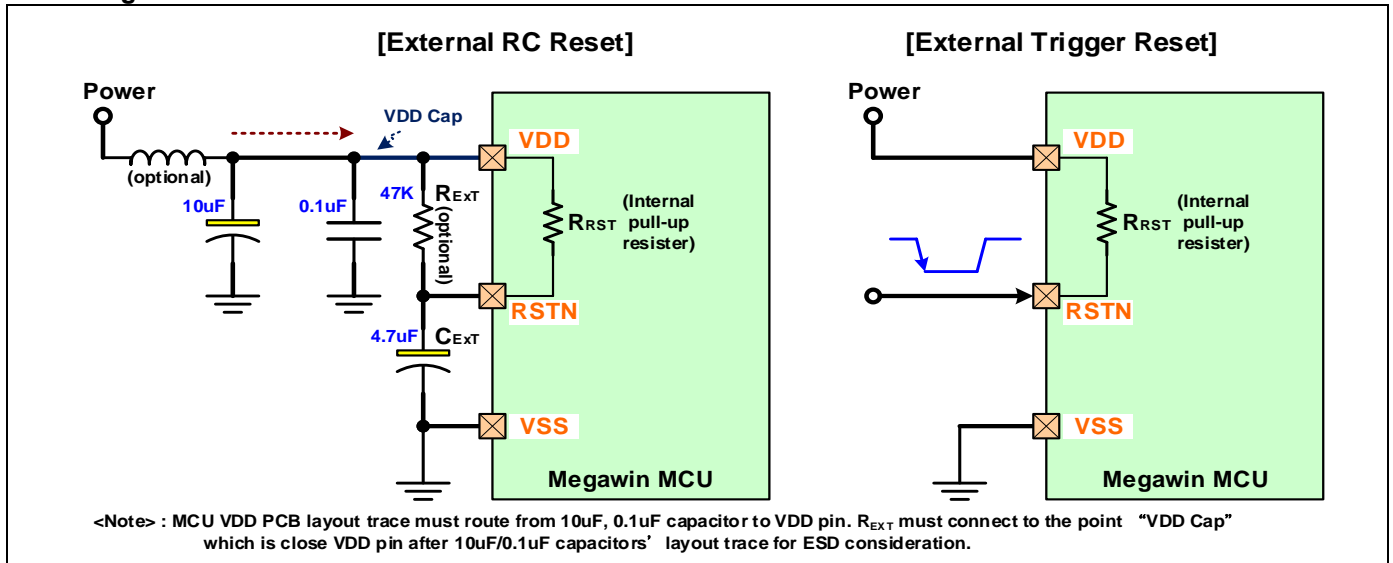
7.2. Reset Circuit

Normally, the power-on reset can be successfully generated during power-up. However, to further ensure the MCU a reliable reset during power-up, the external reset is necessary. The following figure shows the external reset circuit, which consists of a capacitor C_{EXT} connected to VSS (ground) and a resistor R_{EXT} connected to VDD (power supply).

In general, R_{EXT} is optional because the $RSTN$ pin has an internal pull-high resistor (R_{RST}). This internal diffused resistor to VDD permits a power-up reset using only an external capacitor C_{EXT} to VSS .

Strongly suggestion, the $RSTN$ pin must set to output mode if it is used to do as both chip reset and GPIO functions in application. In this condition, the pin input low may make chip reset locked error if it set to GPIO input mode.

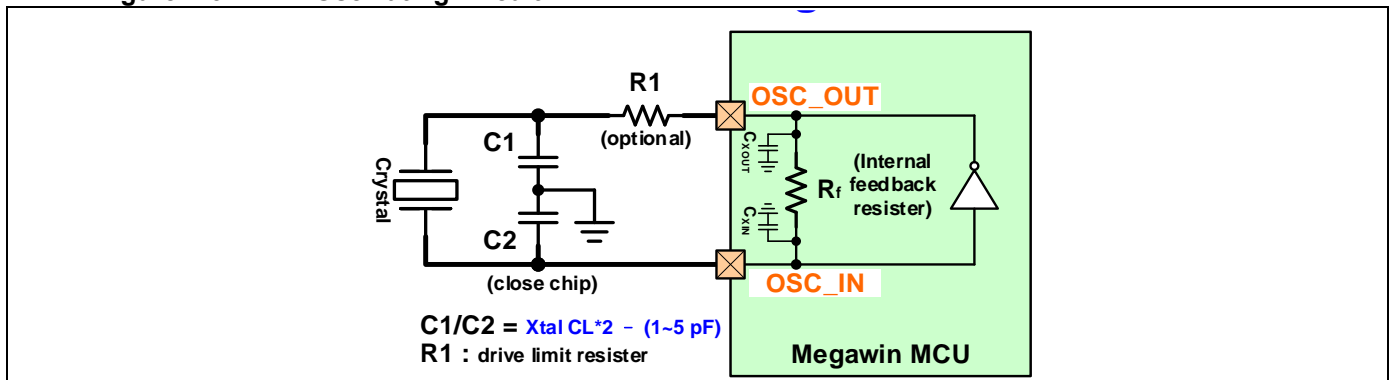
Figure 7-2. Reset Circuit



7.3. Xtal Oscillating Circuit

To achieve successful and exact oscillating (up to 25MHz), the capacitors $C1$ and $C2$ are necessary, as shown in following figure. Normally, $C1$ and $C2$ have the same value. Refer the capacitor load (CL) value in Xtal manufacture specification for the final matching capacitor of $C1$ & $C2$.

Figure 7-3. XTAL Oscillating Circuit



❖ Xtal Capacitor Selection

C_{XIN} / C_{XOUT} : Chip internal total equivalent capacitance of internal oscillator circuit, bounding pad, bounding wire, lead frame.

Table 7-1. Internal Total Equivalent Capacitance for XOSC circuit

Component	Capacitance Value
C_{XOUT}	1.5pF (0.9~2.0pF)
C_{XIN}	2.3pF (2.2~2.4pF)

The XTAL Load Capacitance $CL = C11 // C22 + Cp$

$$C11 = C1 + C_{XOUT}$$

$$C22 = C2 + C_{XIN}$$

Cp : the distribution/stray capacitance that is generated by PCB layout path

= 1.18 pF/in for 2-layer FR4 PCB (Trace width=12mil, PCB height= 1.6mm)

= 3.16 pF/in for 4-layer FR4 PCB (Trace width=10mil, Subtract height=6mil)

The following table lists the suggested **C1** & **C2** value for the different capacitor load (**CL**) crystal application.

Table 7-2. Reference Capacitance of C1 & C2 for crystal oscillating circuit

Crystal C Load	C1, C2 Capacitance
12.5pF	20pF (18~22pF)
20pF	36pF (33~39pF)
32pF	62pF (56~62pF)

❖ Xtal Capacitor Value Calculation Example

● C1/C2 Capacitor Selection Example-1

If $CL = 12.5$ pF (get from Xtal manufacture specification),

$Cp = 1\sim 2$ pF, then $C11//C22 = 10.5 \sim 11.5$ pF

$$\frac{C11 * C22}{C11 + C22} = 10.5 \sim 11.5 \text{ pF}$$

$C11$ and $C22$ are symmetric, we can get $C11 = C22 = 21 \sim 23$ pF.

Then $C1 = C11 - C_{XOUT} = 19\text{pF} \sim 22.1\text{pF} \rightarrow 20\text{pF}$

$C2 = C22 - C_{XIN} = 18.6\text{pF} \sim 20.8\text{pF} \rightarrow 20\text{pF}$

● C1/C2 Capacitor Selection Example-2

If $CL = 20$ pF (get from Xtal manufacture specification),

$Cp = 1\sim 2$ pF, then $C11//C22 = 18 \sim 19$ pF

$$\frac{C11 * C22}{C11 + C22} = 18 \sim 19 \text{ pF}$$

$C11$ and $C22$ are symmetric, we can get $C11 = C22 = 36 \sim 38$ pF.

Then $C1 = C11 - C_{XOUT} = 34\text{pF} \sim 37.1\text{pF} \rightarrow 36\text{pF}$

$C2 = C22 - C_{XIN} = 33.6\text{pF} \sim 35.8\text{pF} \rightarrow 36\text{pF}$

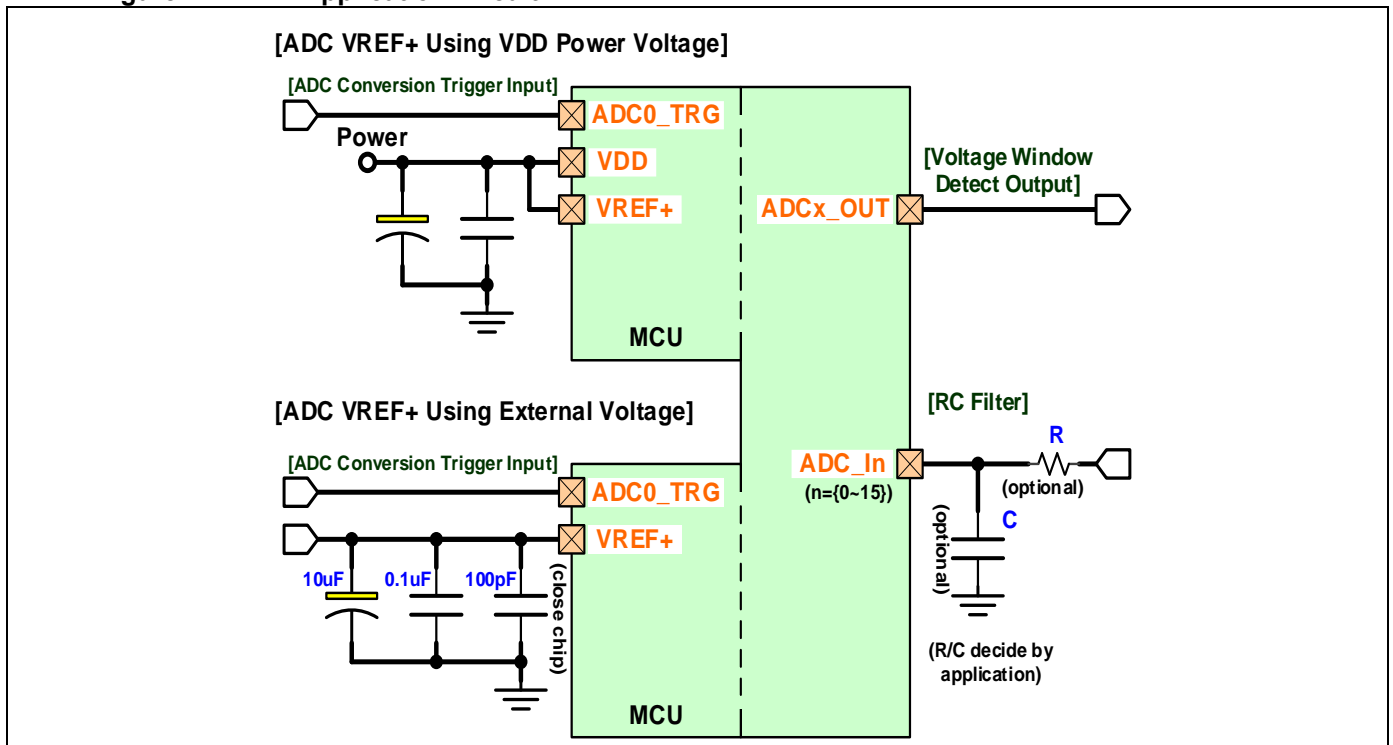
7.4. ADC Application Circuit

The ADC reference voltage source can be from (1) VDD power by connecting +VREF pin to VDD pin directly (2) external quiet reference voltage source.

When uses the VDD power as the ADC reference voltage, it must connect +VREF pin trace to the point which is at current flow behind the power capacitor(s). When uses the external reference voltage source as the ADC reference voltage, it must add some decoupling and bypass capacitors, as shown in following figure.

An optional ADCx_TRG pin is able to input the trigger signal for ADC input conversion and an optional ADCx_OUT pin is used to output the internal ADC window detection status.

Figure 7-4. ADC Application Circuit

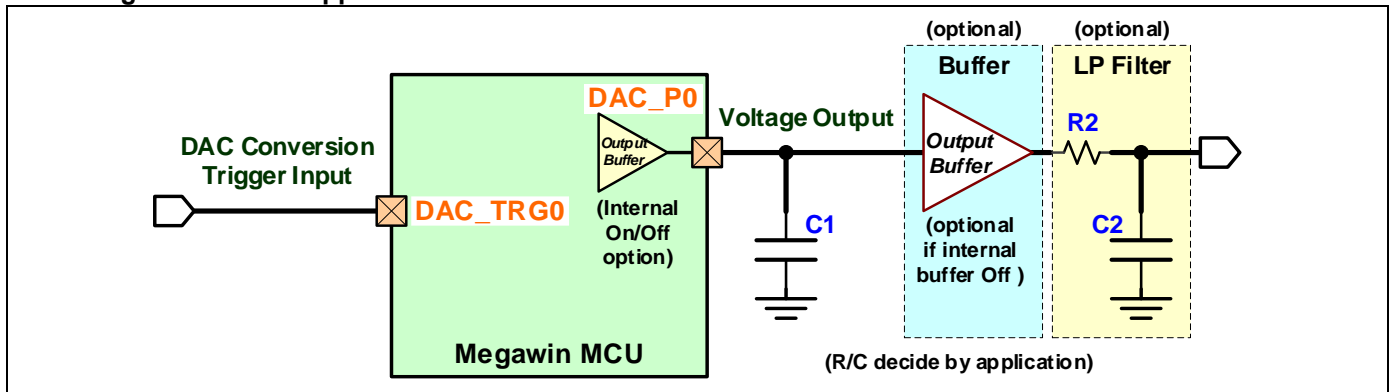


7.5. DAC Application Circuit

The DAC is built-in an internal output buffer which output resistive load is minimum 7.5Kohm. A capacitor (C1) is suggested and used to keep more stable output voltage. When the internal output buffer is enabled, the DAC output range is 0.2 volt to VDD-0.2 volt.

The external output buffer is suggested necessary if the output resistive load is over the 7.5Kohm. An external low-pass filter (R2/C2) is suggestion to be implemented in the application circuit for more better outputting performance. An optional DAC_TRG0 pin is able to input the trigger signal for DAC output conversion.

Figure 7-5. DAC Application Circuit

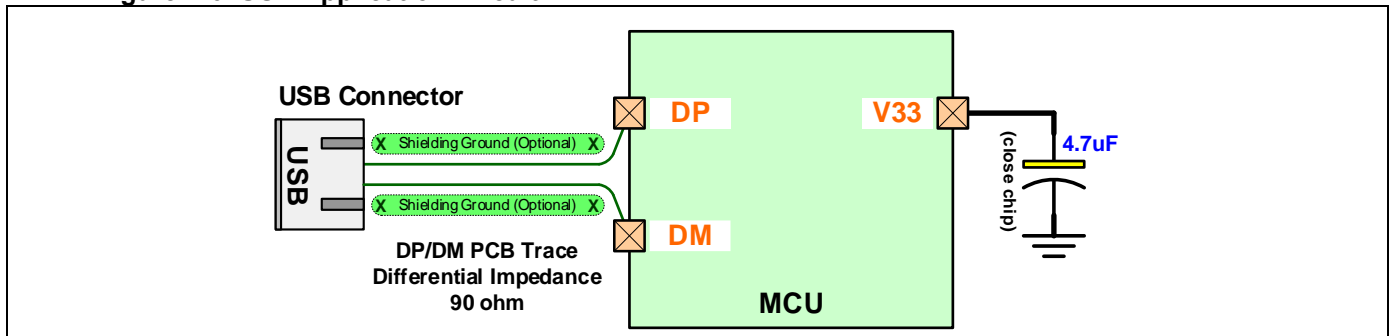


7.6. USB Application Circuit

For the USB series chip, it implements a USB device and an internal 3.3V regulator is built-in for the USB transceiver (XCVR). One external decoupling and bypass 4.7uF capacitor is necessary on V33 power pin for the internal 3.3V regulator output.

The DP and DM pins are a couple of differential signals to connect the USB host through the USB connector and cable without external serial resistors. On application PCB, the DP and DM signals' trace layout are necessary to rout with differential impedance 90 ohm to get better USB Eye-pattern for USB data transaction.



Figure 7-6. USB Application Circuit

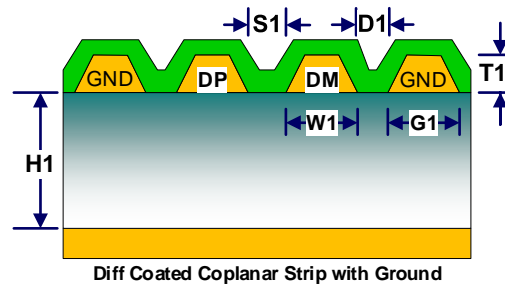
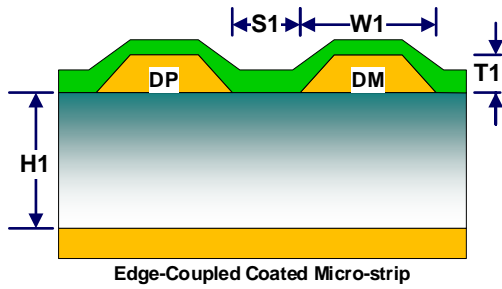


The DP and DM signals' trace layout is suggested by the structure of 'Edge-Coupled Coated Micro-strip' or "Diff Coated Coplanar Strip with Ground" as following figure. The following table and figure are the DP and DM signals' layout suggestion reference on 2-layer 1.6mm FR4 PCB.

Figure 7-7. USB PCB Layout Suggestion on 2-layer 1.6mm FR4 PCB

USB PCB Layout Suggestion on 2-layer 1.6mm FR4 PCB

Signals	PCB Impedance (ohm)	Trace Rule (mil)						PCB Structure
		Signal Trace Width <W1>	Space between Traces <S1>	Space to Ground <D1>	Ground Width <G1>	Trace Thickness <T1>	Substrate Height <H1>	
USB differential signal without ground shield	90.55	15	5			1.58	63	
USB differential signal with ground shield	89.72	12	6	7	16			



8. Electrical Characteristics

8.1. Parameter Glossary

Table 8-1. Parameter Glossary

Symbol	Definition	Descriptions
Abbreviations for electrical characteristics		
Min	Minimum value	Unless otherwise specified, the value is guaranteed in worst conditions of ambient temperature, supply voltage by referring sample testing mean value.
Max	Maximum value	Unless otherwise specified, the value is guaranteed in worst conditions of ambient temperature, supply voltage by referring sample testing mean value.
Typ	Typical value	Unless otherwise specified, the value is based on TA=25 °C, VDD=5V.
VDD	Power supply voltage	The voltage range is specified in characteristics table or conditions column.
VSS	Power reference voltage	Unless otherwise specified, all voltages are referred to VSS.
TA	Ambient temperature	The temperature range is specified in characteristics table or conditions column.
T_{PC}	Peripheral clock cycle time	The peripheral input clock source may select APB, SYS or other clock. This clock frequency needs lower than 1/2 of the module process clock frequency.

8.2. Absolute Maximum Rating

Table 8-2. Absolute Maximum Rating

Parameter	Rating	Unit
Ambient temperature under bias	-40 ~ +105	°C
Storage temperature	-65 ~ + 150	°C
Voltage on any Port I/O Pin or RST with respect to VSS	-0.5 ~ VDD + 0.5	Volt
Voltage on VDD with respect to VSS	-0.5 ~ +6.0	Volt
Maximum total current through VDD and VSS	200	mA
Maximum output current sunk by any I/O pin	40	mA

Note: stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the devices at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure to maximum rating conditions for extended periods may affect device reliability.

8.3. DC Characteristics

Table 8-3. DC Characteristics

VDD=5.0V±10%, VSS=0V, TA = 25 °C and execute NOP for each CPU cycle (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Current Consumption						
I _{OP1}	ON(normal) mode operating current	TL1 (APB=AHB=32KHz) dhystone		0.10		mA
I _{OP2}		TL2 (APB=AHB=12MHz) dhystone		3.5		mA
I _{OP3}		TL3 (APB=AHB=24MHz) dhystone + IP		7.9		mA
I _{OP4}		TL4 (APB=AHB=24MHz - XTAL) dhystone + IP		8.7		mA
I _{OP5}		TL5 (APB=AHB=24MHz - EXTCK) dhystone + IP		7.7		mA
I _{OP6}		TL6 (APB=AHB=48MHz) dhystone + all IP		14.0		mA
I _{SLP0}	SLEEP mode operating current (IWDT Enable)	SL0 (ILRCO on: IWDT Disable, APB=AHB=32KHz)		108		uA
I _{SLP1}		SL1 (IHRCO on: APB=6MHz,AHB=3MHz)		872		uA
I _{SLP2}		SL2 (IHRCO on: APB=AHB=12MHz)		1198		uA
I _{SLP3}		SL3 (XTAL=12MHz: APB/AHB=6MHz/3MHz)		1690		uA
I _{SLP4}		SL4 (ILRCO on: APB=AHB=32KHz) with Low Power SLEEP mode		39		uA
I _{STP0}	STOP mode operating current (LVR/BOD0/BOD1 Disabled)	ST0 (ILRCO off)		1.67		uA
I _{STP1}		ST1 (IWDT Enable, ILRCO=32KHz)		4.10		uA
I _{STP2}		ST2 (RTC Enable, ILRCO=32KHz)		4.00		uA
Wakeup Time						
t _{WK_SLP0}	Wakeup from SLEEP mode (Normal SLEEP mode)	IHRCO/ILRCO on, wakeup by RTC event (APB Clock= IHRCO clock)		5	6	T _{PC}
t _{WK_SLP1}	Wakeup from SLEEP mode (Low Power SLEEP mode)	IHRCO/ILRCO on, wakeup by RTC event (APB Clock= IHRCO clock)	20			us
t _{WK_STP0}	Wakeup from STOP mode	ILRCO on, wakeup by RTC event	20			us
BOD Characteristics						
V _{LVR}	LVR detection level (VR0)	TA = -40°C to +105°C		1.28		Volt
V _{BOD0}	BOD0 detection level (VR0)	TA = -40°C to +105°C	1.40		1.45	Volt
I _{BOD0+LVR}	BOD0 and LVR Current Consumption	TA = 25°C			3.5	uA
V _{BOD10}	BOD1 detection level for 2.0V	TA = -40°C to +105°C	1.8(*1)	2.0	2.2(*1)	Volt
V _{BOD11}	BOD1 detection level for 2.4V	TA = -40°C to +105°C	2.22(*1)	2.4	2.62(*1)	Volt
V _{BOD12}	BOD1 detection level for 3.7V	TA = -40°C to +105°C	3.50	3.7	3.90	Volt
V _{BOD13}	BOD1 detection level for 4.2V	TA = -40°C to +105°C	3.89(*1)	4.2	4.59(*1)	Volt
I _{BOD1}	BOD1 Current Consumption	TA = 25°C			9.0	uA
V _{BOD2}	BOD2 detection level for 1.7V	TA = -40°C to +105°C	1.65	1.70	1.75	Volt
I _{BOD2}	BOD2 Current Consumption	TA = 25°C			9.0	uA
Operating Condition						
V _{PSR}	Power-on Slope Rate	TA = -40°C to +105°C	0.05			V/ms
V _{OP1}	CPU Operating Speed 0–48MHz	TA = -40°C to +105°C	2.7		5.5	Volt

MG32F02U128/U064

V _{OP2}	CPU Operating Speed 0–12MHz	TA = -40°C to +105°C	1.8	5.5	Volt
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(*1) Data based on characterization results, not tested in production.

T_{PC}: APB clock cycle time, IP: internal peripheral modules, all IP: all test modules

TL3 ~ TL6: Measure current with IO toggle, SL4: Refer the wakeup time t_{WK_SLP1} as the low power SLEEP mode

Table 8-4. Current Measurement Condition Level Definition Table

Chip Power State	ON Mode						SLEEP Mode					STOP Mode			
Test Level	TL1	TL2	TL3	TL4	TL5	TL6	SL0	SL1	SL2	SL3	SL4	ST0	ST1	ST2	
Symbol	I _{OP1}	I _{OP2}	I _{OP3}	I _{OP4}	I _{OP5}	I _{OP6}	I _{SLP0}	I _{SLP1}	I _{SLP2}	I _{SLP3}	I _{SLP4}	I _{stp0}	I _{stp1}	I _{stp2}	
CPU State	Normal						Sleep					Deep Sleep			
CPU Code (*1)	dhystone	dhystone	dhystone + normal code			dhystone+heavy code	-	-	-	-	-	-	-	-	-
APB Clock	32KHz ILRCO	12MHz IHRCO	24MHz PLL/4	24MHz PLL/4	24MHz PLL/4	48MHz PLL/2	32KHz ILRCO	6MHz IHRCO/2	12MHz IHRCO	6MHz XTAL/2	32KHz ILRCO	-	32KHz ILRCO	32KHz ILRCO	
AHB/CPU Clock	32KHz APB	12MHz APB	24MHz APB	24MHz APB	24MHz APB	48MHz APB	32KHz APB	3MHz APB/2	12MHz APB	3MHz APB/2	32KHz APB	-	32KHz APB	32KHz APB	
ILRCO (32KHz)	V	V	V	V	V	V	V	V	V	V	V		V	V	
IHRCO (12MHz)		V	V			V		V	V						
XTAL (12MHz)				Medium						Medium					
EXTCK (12MHz)					V										
PLL			V	V	V	V									
LDO (*2)	Normal						Normal					Low Power			
LVR	V	V	V	V	V	V	V	V	V	V	V				
BOD0	V	V	V	V	V	V	V	V	V	V	V				
BOD1			V	V	V	V									
SLEEP Mode (*3)							Normal	Normal	Normal	Normal	Low Power				
ADC0			CK_APB	CK_APB	CK_APB	CK_APB									
CMP			CK_APB	CK_APB	CK_APB	CK_APB		CK_APB	CK_APB	CK_APB					
RTC			CK_UT	CK_UT	CK_UT	CK_UT								CK_UT	
IWDT	CK_ILRCO	CK_ILRCO	CK_ILRCO	CK_ILRCO	CK_ILRCO	CK_ILRCO		CK_ILRCO	CK_ILRCO	CK_ILRCO			CK_ILRCO		
WWDT			CK_APB	CK_APB	CK_APB	CK_APB									
TM00	CK_APB	CK_APB	CK_APB	CK_APB	CK_APB	CK_APB		CK_APB	CK_APB	CK_APB					
TM01						CK_APB									
TM10			CK_APB	CK_APB	CK_APB	CK_APB									
TM16						CK_APB									
TM20						CK_APB									
TM26						CK_APB									
TM36			CK_APB	CK_APB	CK_APB	CK_APB									
I2C0			CK_APB	CK_APB	CK_APB	CK_APB									
I2C1						CK_APB									
URT0			CK_APB	CK_APB	CK_APB	CK_APB									
URT1						CK_APB									
URT2						CK_APB									
SPI0						CK_APB									
IO Pins	all Push-Pull Low		IO Toggle				all Push-Pull Low					all Push-Pull Low			

Note: (*1) [CPU Code]
dhystone: CPU runs "Dhystone" benchmarks code.
normal code: Set CK_APB and CK_AHB frequency by table. The module clock divider can be /4, /8 or others.
heavy code: 1. Set CK_APB and CK_AHB frequency by table. The module clock set the highest frequency (module clock DIV=2).
 2. Let the module operates as busy as possible and fills full data through the buffer. (EX: transfer 4 bytes for one transaction)

(*2) Normal: PW_LDO_ON=0, Low Power: PW_LDO_STP=1

(*3) Normal: PW_WKSLP_MDS=0, Low Power: PW_WKSLP_MDS=1

8.4. IO Characteristics

Table 8-5. IO Characteristics

VSS=0V, TA = 25 °C and execute NOP for each CPU cycle (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
V _{IH}	Input High voltage	Except RSTN,XIN/XOUT pins	0.6			VDD
V _{IH_XOSC}	Input High voltage (XIN)	XIN pin GPIO mode	0.75			VDD
V _{IH_RST}	Input High voltage (RSTN)	RSTN pin reset/GPIO mode	0.75			VDD
V _{IL}	Input Low voltage	Except RSTN,XIN/XOUT pins			0.15	VDD
V _{IL_XOSC}	Input Low voltage (XIN)	XIN pin GPIO mode			0.2	VDD
V _{IL_RST}	Input Low voltage (RSTN)	RSTN pin reset/GPIO mode			0.2	VDD
VDD=5.0V						
I _{IH}	Input High Leakage current	V _{PIN} = VDD		0.02	0.1	uA
I _{IL}	Input Low Leakage current	V _{PIN} = 0.4V		0.01	0.1	uA
I _{H2L}	Logic 1 to 0 input transition current (quasi-bidirectional or input mode with on-chip pull-up resistor)	V _{PIN} = 2.2V (V _{IH} voltage)		250	500	uA
I _{OH1}	Output High current (push-pull output mode & Full level)	VDD=5.0V, V _{PIN} = 2.4V		38.5		mA
I _{OH2}	Output High current (push-pull output mode & 1/2 level)	VDD=5.0V, V _{PIN} = 2.4V		19.8		mA
I _{OH3}	Output High current (push-pull output mode & 1/4 level)	VDD=5.0V, V _{PIN} = 2.4V		10.1		mA
I _{OH4}	Output High current (push-pull output mode & 1/8 level)	VDD=5.0V, V _{PIN} = 2.4V		5.2		mA
I _{OL1}	Output Low current(Full level)	VDD=5.0V, V _{PIN} = 0.4V		30.4		mA
I _{OL2}	Output Low current(1/2 level)	VDD=5.0V, V _{PIN} = 0.4V		15.7		mA
I _{OL3}	Output Low current(1/4 level)	VDD=5.0V, V _{PIN} = 0.4V		8.0		mA
I _{OL4}	Output Low current(1/8 level)	VDD=5.0V, V _{PIN} = 0.4V		4.0		mA
R _{PU}	IO pin pull-high resistance	Except RSTN		13.3		Kohm
R _{RST}	Internal reset pull-high resistance	RSTN pin		250		Kohm
TR1	IO rising time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		13.7		ns
TR2	IO rising time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		28.9		ns
TR3	IO rising time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		5.58		ns
TR4	IO rising time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		26.8		ns
TR5	IO rising time (XOUT GPIO mode)	C load=30pF		5.60		ns
TR6	IO rising time (XIN GPIO mode)	C load=30pF		5.29		ns
TR7	IO rising time (RSTIN GPIO mode)	C load=30pF		7.36		ns
TF1	IO falling time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		13.7		ns
TF2	IO falling time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		16.45		ns
TF3	IO falling time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		3.2		ns

MG32F02U128/U064

TF4	IO falling time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		9.65		ns
TF5	IO falling time (XOUT GPIO mode)	C load=30pF		3.1		ns
TF6	IO falling time (XIN GPIO mode)	C load=30pF		2.6		ns
TF7	IO falling time (RSTIN GPIO mode)	C load=30pF		3.0		ns
VDD=3.3V						
I_{IH}	Input High Leakage current	V _{PIN} = VDD		0.02	0.1	uA
I_{IL}	Input Low Leakage current	V _{PIN} = 0.4V		0.01	0.1	uA
I_{H2L}	Logic 1 to 0 input transition current (quasi-bidirectional or input mode with on-chip pull-up resistor)	V _{PIN} = 1.6V (V _{IH} voltage)		115	150	uA
I_{OH1}	Output High current (push-pull output mode & Full level)	VDD=3.3V, V _{PIN} = 2.4V		13		mA
I_{OH2}	Output High current (push-pull output mode & 1/2 level)	VDD=3.3V, V _{PIN} = 2.4V		6.5		mA
I_{OH3}	Output High current (push-pull output mode & 1/4 level)	VDD=3.3V, V _{PIN} = 2.4V		3.5		mA
I_{OH4}	Output High current (push-pull output mode & 1/8 level)	VDD=3.3V, V _{PIN} = 2.4V		1.7		mA
I_{OL1}	Output Low current(Full level)	VDD=3.3V, V _{PIN} = 0.4V		22		mA
I_{OL2}	Output Low current(1/2 level)	VDD=3.3V, V _{PIN} = 0.4V		11.3		mA
I_{OL3}	Output Low current(1/4 level)	VDD=3.3V, V _{PIN} = 0.4V		5.6		mA
I_{OL4}	Output Low current(1/8 level)	VDD=3.3V, V _{PIN} = 0.4V		2.8		mA
R_{PU}	IO pin pull-high resistance	Except RSTN		19.5		Kohm
R_{RST}	Internal reset pull-high resistance	RSTN pin		426		Kohm
TR1	IO rising time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		19.4		ns
TR2	IO rising time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		38.4		ns
TR3	IO rising time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		7.7		ns
TR4	IO rising time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		35.5		ns
TR5	IO rising time (XOUT GPIO mode)	C load=30pF		7.0		ns
TR6	IO rising time (XIN GPIO mode)	C load=30pF		7.3		ns
TR7	IO rising time (RSTIN GPIO mode)	C load=30pF		11.3		ns
TF1	IO falling time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		19.9		ns
TF2	IO falling time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		21.8		ns
TF3	IO falling time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		3.66		ns
TF4	IO falling time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		12.76		ns
TF5	IO falling time (XOUT GPIO mode)	C load=30pF		4.2		ns
TF6	IO falling time (XIN GPIO mode)	C load=30pF		3.1		ns
TF7	IO falling time (RSTIN GPIO mode)	C load=30pF		3.8		ns
VDD=1.8V						

I_{IH}	Input High Leakage current	V _{PIN} = VDD		0.02	0.1	uA
I_{IL}	Input Low Leakage current	V _{PIN} = 0.4V		0.01	0.1	uA
I_{H2L}	Logic 1 to 0 input transition current (quasi-bidirectional or input mode with on-chip pull-up resistor)	V _{PIN} = 1.1V (V _{IH} voltage)		27.1		uA
I_{OH1}	Output High current (push-pull output mode & Full level)	VDD=1.8V, V _{PIN} = 1.4V		3.3		mA
I_{OH2}	Output High current (push-pull output mode & 1/2 level)	VDD=1.8V, V _{PIN} = 1.4V		1.7		mA
I_{OH3}	Output High current (push-pull output mode & 1/4 level)	VDD=1.8V, V _{PIN} = 1.4V		0.9		mA
I_{OH4}	Output High current (push-pull output mode & 1/8 level)	VDD=1.8V, V _{PIN} = 1.4V		0.45		mA
I_{OL1}	Output Low current(Full level)	VDD=1.8V, V _{PIN} = 0.4V		10.7		mA
I_{OL2}	Output Low current(1/2 level)	VDD=1.8V, V _{PIN} = 0.4V		5.4		mA
I_{OL3}	Output Low current(1/4 level)	VDD=1.8V, V _{PIN} = 0.4V		2.7		mA
I_{OL4}	Output Low current(1/8 level)	VDD=1.8V, V _{PIN} = 0.4V		1.3		mA
R_{PU}	IO pin pull-high resistance	Except RSTN		45		Kohm
R_{RST}	Internal reset pull-high resistance	RSTN pin		1100		Kohm
TR1	IO rising time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		38.6		ns
TR2	IO rising time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		68		ns
TR3	IO rising time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		15.78		ns
TR4	IO rising time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		62.4		ns
TR5	IO rising time (XOUT GPIO mode)	C load=30pF		15.1		ns
TR6	IO rising time (XIN GPIO mode)	C load=30pF		15.9		ns
TR7	IO rising time (RSTIN GPIO mode)	C load=30pF		22.7		ns
TF1	IO falling time (Normal mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		40.8		ns
TF2	IO falling time (Normal mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		42.3		ns
TF3	IO falling time (High speed mode and IO output drive strength is Full level)	Except RSTN,XIN/XOUT pins C load=30pF		7.5		ns
TF4	IO falling time (High speed mode and IO output drive strength is 1/4 level)	Except RSTN,XIN/XOUT pins C load=30pF		40.5		ns
TF5	IO falling time (XOUT GPIO mode)	C load=30pF		6.1		ns
TF6	IO falling time (XIN GPIO mode)	C load=30pF		6.1		ns
TF7	IO falling time (RSTIN GPIO mode)	C load=30pF		7.9		ns

8.5. External Clock Characteristics

Table 8-6. External Clock Characteristics

VDD=1.8V ~ 5.5V, VSS=0V, TA = -40°C ~ +105°C (unless otherwise specified)

Symbol	Parameter	Conditions	Crystal		External Clock		Unit
			Min	Max	Min	Max	
f _{xosc}	Oscillator Frequency	VDD = 1.8V ~ 5.5V	4	25		36	MHz
		VDD = 1.8V ~ 5.5V	4	25		12	MHz
t _{xosc}	Clock Period		40		27.7		ns
t _{H_xosc}	High Time		0.4T	0.6T	0.4T	0.6T	t _{xosc}
t _{L_xosc}	Low Time		0.4T	0.6T	0.4T	0.6T	t _{xosc}
t _{r_xosc}	Rise Time					7	ns
t _{f_xosc}	Fall Time					7	ns
t _{START12M}	Start-up Time	Xtal = 12MHz, CL = 20pF		2			ms
t _{START32K}	Start-up Time	Xtal = 32KHz, CL = 12.5pF		0.8			s
R _{FB12M}	Feedback resistor value of crystal buffer	Xtal = 12MHz, CL = 20pF	90	160			KΩ

8.6. PLL Characteristics

Table 8-7. PLL Characteristics

Parameter	Conditions	Limits			Unit
		Min	Typ	Max	
Supply Voltage		1.35	1.50	1.65	Volt
Input Clock Frequency Range	TA = -40°C to +105°C	4.0 (*1)		8.5 (*1)	MHz
Output Clock Frequency Range	TA = -40°C to +105°C	68		180	MHz
PLL Locking Time	TA = -40°C to +105°C		14.3 (*2)		us
PLL Current Consumption	TA = +25°C, VDD=5.0V		0.30		mA
PLL Period Jitter (Peak-to-Peak)	TA = -40°C to +105°C		720	1000	ps

(*1) Data guaranteed by design, not tested in production.

(*2) Data based on characterization results, not tested in production.

8.7. IHRCO Characteristics

Table 8-8. IHRCO Characteristics

Parameter	Conditions	Limits			Unit
		Min	Typ	Max	
Supply Voltage		1.8	5.0	5.5	Volt
IHRCO0 Frequency	TA = +25°C		12		MHz
IHRCO1 Frequency	TA = +25°C		11.0592		MHz
IHRCO0 Frequency Deviation (factory calibrated)	TA = +25°C	-1.0		+1.0	%
	TA = -40°C to +105°C	-4.0(*1)		+3.0(*1)	%
IHRCO1 Frequency Deviation (factory calibrated)	TA = +25°C	-1.0		+1.0	%
	TA = -40°C to +105°C	-4.0(*1)		+3.0(*1)	%
IHRCO Start-up Time	TA = 25°C			5(*1)	us
IHRCO Current Consumption	TA = +25°C, VDD=5.0V		0.35		mA

(*1) Data based on characterization results, not tested in production.

8.8. ILRCO Characteristics

Table 8-9. ILRCO Characteristics

Parameter	Conditions	Limits			Unit
		Min	Typ	Max	
Supply Voltage		1.8	5.0	5.5	Volt
ILRCO Frequency	TA = +25°C		32		KHz
ILRCO Frequency Deviation (factory calibrated)	TA = +25°C, VDD=5.0V	-4		+4	%
	TA = -40°C to +105°C	-15(*1)		+15(*1)	%
ILRCO Current Consumption	TA = +25°C, VDD=5.0V			2	uA

(1) Data based on characterization results, not tested in production.

8.9. LDO Characteristics

Table 8-10. LDO Characteristics

VDD=5.0V±10%, VSS=0V, TA = -40°C ~ +105 °C

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDD	Supply Voltage	Normal Mode, IOU=20mA	1.8	5.0	5.5	V
General						
VR0	LDO Output Voltage (VR0 pin)	ON(Normal) mode		1.60		Volt
		Low power mode (VDD=1.8V~5.5V), TA = -40°C ~ +105 °C		1.35		Volt
IQ	Current	VDD=1.7V~5.0V, Temp.= 25°C		30		uA
		VDD=1.7V~5.0V, Temp.= -40°C ~ +105°C		50(*1)		uA
VDROP	Dropout Voltage (VDD-VR0)	IOU=40mA, VDD=2.0V~5.5V (VR0 =1.60V +/-5%)	530			mV
		IOU=30mA, VDD=1.9V~5.5V (VR0 =1.60V +/-5%)	420			mV
		IOU=20mA, VDD=1.8V~5.5V (VR0 =1.60V +/-5%)	310			mV
IOU	Max output current	VDD=5.0V	50			mA
		VDD=3.6V	50			mA
		VDD=2.0V	40			mA
		VDD=1.9V	30			mA
		VDD=1.8V	20			mA

(1) Data based on characterization results, not tested in production.

8.10. Flash Characteristics

Table 8-11. Flash Characteristics

VDD=5.0V±10%, VSS=0V, TA = -40°C ~ +105 °C

Parameter	Conditions	Limits			Unit
		Min	Typ	Max	
Supply Voltage		1.8		5.5	Volt
Flash Write (Erase/Program) Voltage		1.8		5.5	Volt
Flash Erase/Program Cycle		20000			Times
Flash Data Retention	TA = +25°C	100			Year

8.11. ADC Characteristics

Table 8-12. ADC Characteristics

VDDA=VDD=5.0V±10%, VSS=0V, TA = 25 °C, CLOAD=10pF, Gain=x1 (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDDA	Analog Supply Voltage		2.4	5.0	5.5	Volt
I _{ADC_ON}	Operation Current - normal			1200		µA
I _{ADC_OFF}	Operation Current - power-down			0.1		µA
ADC Static Parameters						
Bits	Resolution				12	bits
INL	Integral nonlinearity (INL)	VREF = 5V, VDD = 5V, 1.5Msps Conversion Rate (sampling clock = 36 MHz/24 clocks)		±7		LSB
INL	Integral nonlinearity (INL)	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 24 MHz/24 clocks)		±6		LSB
INL	Integral nonlinearity (INL)	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 30 MHz/30 clocks)		±6		LSB
DNL	Differential nonlinearity (DNL)	VREF = 5V, VDD = 5V, 1.5Msps Conversion Rate (sampling clock = 36 MHz/24 clocks)	-1	2.5		LSB
DNL	Differential nonlinearity (DNL)	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 36 MHz/24 clocks)	-1	2.5		LSB
DNL	Differential nonlinearity (DNL)	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 48 MHz/30 clocks)	-1	2.5		LSB
E _{OFFSET}	Offset error	VREF = 5V, VDD = 5V, 1.5Msps Conversion Rate (sampling clock = 36 MHz/24 clocks)		±4		LSB
E _{OFFSET}	Offset error	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 24 MHz/24 clocks)		±4		LSB
E _{OFFSET}	Offset error	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 30 MHz/30 clocks)		±4		LSB
E _{FS}	Full scale error	VREF = 5V, VDD = 5V,		±14		LSB

		1.5Msps Conversion Rate (sampling clock = 36 MHz/24 clocks)				
E_{FS}	Full scale error	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 24 MHz/24 clocks)		±10		LSB
E_{FS}	Full scale error	VREF = 5V, VDD = 5V, 1Msps Conversion Rate (sampling clock = 30 MHz/30 clocks)		±10		LSB
ADC Input and DC Characters						
V_{AIN}	ADC input voltage range (Single Ended)	gain = 1.0	0		Vref	Volt
C_{LOAD}	Input capacitance			5		pF
V_{XREF}	External ADC reference voltage		2.4		VDDA	Volt
VDD_{IREF}	Supply Voltage range for V _{IREF}		2.7		5.5	Volt
V_{IREF}	Internal ADC reference voltage	-40 °C < < 105 °C		2.40		Volt
	Internal ADC reference voltage spread over the temperature range	-40 °C < < 105 °C V _{IREF} =2.40V at 25°C		40		mV
V_{BUF}	Internal VBUF reference voltage	-40 °C < < 105 °C	1.38	1.40	1.42	Volt
	Internal VBUF reference voltage spread over the temperature range	-40 °C < < 105 °C V _{BUF} =1.40V at 25°C		30		mV
TADEN	ADC enable time			5		us
ADC Conversion Parameters						
F_s	Sampling clock				48	MHz
F_{Conv}	Conversion rate	VDDA = 5.5 ~ 4.0 V			1500	Ksps
		VDDA = 4.0 ~ 2.4 V			1000	Ksps
T_{Conv}	Conversion time in conversion clock (not including acquisition time)	ADC0_CONV_TIME=0		24		clocks
		ADC0_CONV_TIME=1		30		clocks

8.12. ADC PGA Characteristics

Table 8-13. ADC PGA Characteristics

VDDA=VDD=5.0V±10%, VSS=0V, TA = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDDA	Analog Supply Voltage		2.4	5.0	5.5	Volt
DC Characteristics						
V_{OS2}	input offset voltage	With Calibration Gain=x1	-6		10	mV
V_{CM_IN}	Input Common-mode Voltage	VDDA>3.0V,Gain=x1,as a unit gain buffer	0.03		VDDA/2+0.5	V
		VDDA<3.0V,Gain=x1,as a unit gain buffer	0.03		VDDA/2	V
IQ	Ground Current	VDDA=5.0V, VIN= VDDA/2; VOUT=VDDA/2, Gain=x1 (RFB=120KΩ current Not included when Gain=x1)		1150		uA
AC Characteristics						
SR	Slew rate (*1)	Normal Operation		3.5		V/us

MG32F02U128/U064

UGF	PGA Bandwidth Frequency (*2)	Normal Operation		10		MHz
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(*1) Data guaranteed by design, not tested in production.

(*2) The UGF will be divided by the GAIN setting. (ex: Ideal UGF will be 10MHz/4 when PGA gain=4)

8.13. Analog Comparator Characteristics

Table 8-14. Analog Comparator Characteristics

VDDA=VDD=5.0V±10%, VSS=0V, TA = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDDA	Analog Supply Voltage	-40°C ~ +105°C	2.0	5.0	5.5	Volt
I_{COMP0}	Operation Current - CMP0	High response time without IVREF (*1)		9		uA
		High response time with IVREF (*1)		210		uA
		Low response time		2		uA
I_{COMP1}	Operation Current - CMP1	High response time without IVREF (*1)		9		uA
		High response time with IVREF (*1)		210		uA
		Low response time		2		uA
Analog Comparator Core						
V_{OS}	Input Offset Voltage		-5	15		mV
V_{CM}	Input Common Mode Voltage		50		VDDA-50	mV
V_{HYS}	Comparator hysteresis Input voltage range 50mV ~ VDD-50mV	Disable Hysteresis		0		mV
		High response time		11		mV
		Low response time		9		mV
T_{RT}	Response time	High response time - Falling		230		ns
		High response time - Rising		200		ns
		Low response time - Falling		0.7		us
		Low response time - Rising		0.7		us
t_{PWON}	Power on Time (from power-down)	High response time		550		ns
		Low response time		15		us
RU	Unit Resistance			390		ohm

(*1) IVREF : Internal voltage reference circuit

8.14. Temperature Sensor Characteristics

Table 8-15. Temperature Characteristics

VDDA=VDD=5.0V±10%, VSS=0V, TA = 25 °C (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDDA	Analog Supply Voltage	calculate VREF	2.4	5.0	5.5	Volt
Temperature Conversion Parameters						
T _{RANG}	Temperature range		-40		125	°C
Slope _{AVG}	Linearity (curve slope)		2.4		2.7	mV/°C
V ₀	Voltage at 0 °C (*1)	TA = 0°C (± 5 °C)	710	750	780	mv
	Accuracy		-3	±2	+4	°C
t _{START}	Startup time		20	25	30	ms
I _{TEMP_ON}	Operation current			280		uA

(*1) Data based on characterization results, not tested in production.

8.15. DAC Characteristics

Table 8-16. DAC Characteristics

VDDA=VDD=5.0V±10%, VSS=0V, TA = 25 °C, TT case

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
VDDA	Analog Supply Voltage (VDDA)	VDD = 2.4V~5.5V	2.4		5.5	Volt
DAC Static Parameters						
	Resolution				12	bits
DNL	Differential nonlinearity (DNL)	DAC Buffer OFF		±2.25		LSB
DNL	Differential nonlinearity (DNL)	DAC Buffer ON		±2		LSB
INL	Integral nonlinearity (INL)	DAC Buffer OFF	-7		2	LSB
INL	Integral nonlinearity (INL)	DAC Buffer ON	-13		2	LSB
E _{OFFSET}	Offset error	DAC Buffer OFF	-1		6	LSB
E _{OFFSET}	Offset error	DAC Buffer ON	-1		30	LSB
E _{GAIN}	Gain error (Full scale error - Offset Error)	DAC Buffer OFF		±2		LSB
E _{GAIN}	Gain error (Full scale error - Offset Error)	DAC Buffer ON		±2		LSB
DAC DC Characters						
FSR	Full scale range	DAC Buffer ON	0.2		VDD-0.2	Volt
R _{LOAD}	Resistive load with buffer ON		7.5			Kohm
R _o	Resistive load with buffer OFF	VDD=2.4V	13			Kohm
		VDD=3.3V	17			Kohm
		VDD=5.5V	20			Kohm
C _{LOAD}	Capacitive load				50	pF
I _{DAC}	DAC operation current	DAC Buffer OFF	1.10	1.25	1.30	uA
		DAC Buffer ON	7.30	7.60	7.90	uA
I _{OFF}	DAC power-down current				1	uA
DAC Conversion Parameters						
F _s	Sampling Clock				1	MHz
F _{CONV}	Conversion Rate	C _{LOAD} ≤ 50 pF, R _{LOAD} ≥ 5 KΩ DAC output change from input			1	MspS

MG32F02U128/U064

		code i to i+1 LSB				
T_{SETTLING}	Settling Time	$C_{LOAD} \leq 50 \text{ pF}$, $R_{LOAD} \geq 5 \text{ K}\Omega$ DAC output change from input code i to i+1 LSB		540		ns
		$C_{LOAD} \leq 50 \text{ pF}$, $R_{LOAD} \geq 5 \text{ K}\Omega$ Input code transition between the lowest and the highest input codes when DAC output reaches final value +/- 1 LSB		2	4	us
T_{START}	Startup time after DAC ON				10	us

8.16. USB Characteristics

Table 8-17. USB Characteristics

V33=3.0V ~ 3.6V, VSS=0V, TA = 25 °C

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Supply Range						
V33	3.3V regulator output voltage	VDD = 3.6V~5.5V	3.1		3.6	Volt
Static Parameters						
R_{PU}	Pull-Up resistance on DP			1.24		Kohm
Receiver Parameters						
V_{DI}	Differential Input Sensitivity	DP – DM			0.2	Volt
V_{CM}	Differential Input Common Mode Range		0.8		2.5	Volt
Z_{INP}	Input impedance exclusive of pullup/pulldown		300			Kohm
I_{IH}	Input High Leakage current	DP/DM= 3~3.6V Pull-up/Pull-down Disabled		<1.0		uA
I_{IL}	Input Low Leakage current	DP/DM= 3~3.6V Pull-up/Pull-down Disabled		<1.0		uA
Transmitter Parameters						
V_{OH}	Output High voltage		2.8		3.6	Volt
V_{OL}	Output Low voltage		0		0.3	Volt
V_{CRS}	Output Cross Over point		1.3		2.0	Volt
Z_{DRV}	Driver Output Impedance			45		Ohm
T_R	Output Rising time		4		20	ns
T_F	Output Falling time		4		20	ns

8.17. UART Characteristics

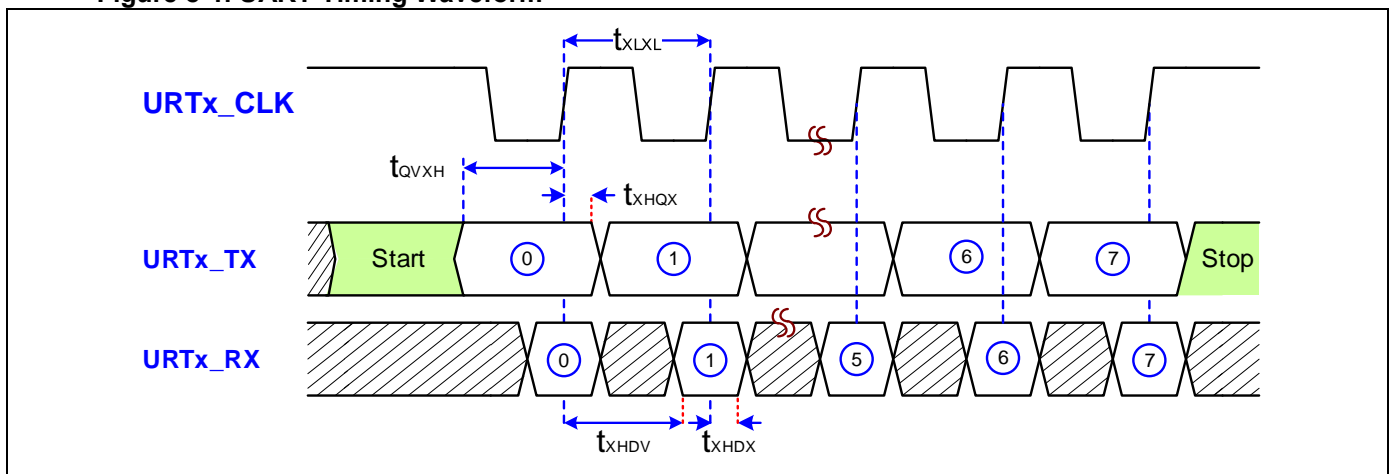
Table 8-18. UART Characteristics

VDD=5.0V±10%, VSS=0V, TA = -40°C ~ +105°C (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
UART Mode						
f _{CK}	Serial Port Clock Frequency				6	MHz
t _{LXL}	Serial Port Clock Cycle Time		4			T _{PC}
t _{QVXH}	Output Data Setup to Clock Rising Edge		T _{PC} -20			ns
t _{XHQX}	Output Data Hold after Clock Rising Edge		T _{PC} -10			ns
t _{XHDX}	Input Data Hold after Clock Rising Edge		0			ns
t _{XHDV}	Clock Rising Edge to Input Data Valid				T _{PC} -20	ns
SPI Master Mode (Synchronous Mode)						
f _{MCK}	SPI Output Clock Frequency	VDD=3.3V ~ 5.5V			18	MHz
		VDD=1.8V ~ 3.3V			16	MHz
t _{MCKH}	SPI Clock High Time		2			T _{PC}
t _{MCKL}	SPI Clock Low Time		2			T _{PC}
SPI Slave Mode (Synchronous Mode)						
f _{MCK}	SPI Input Clock Frequency	VDD=3.3V ~ 5.5V			12	MHz
		VDD=1.8V ~ 3.3V			12	MHz
t _{MCKH}	SPI Clock High Time		4			T _{PC}
t _{MCKL}	SPI Clock Low Time		4			T _{PC}

T_{PC} : APB clock or SYS clock cycle time

Figure 8-1. UART Timing Waveform



8.18. SPI Characteristics

Table 8-19. SPI Characteristics

VDD=5.0V±10%, VSS=0V, TA = -40°C ~ +105°C (unless otherwise specified)

Symbol	Parameter	Conditions	Limits			Unit
			Min	Typ	Max	
Master Mode						
f_{MCK}	SPI Clock Frequency	VDD=3.3V ~ 5.5V			22	MHz
		VDD=1.8V ~ 3.3V			16	MHz
t_{MCKH}	SPI Clock High Time		2			T_{PC}
t_{MCKL}	SPI Clock Low Time		2			T_{PC}
t_{MIS}	D _{IN} Valid to SPI Clock Shift Edge		2T_{PC} + 20			ns
t_{MIH}	SPI Clock Shift Edge to D _{IN} Change		0			ns
t_{MOH}	SPI Clock Shift Edge to D _{OUT} Change				10	ns
Slave Mode						
f_{SCK}	SPI Clock Frequency	VDD=3.3V ~ 5.5V			16	MHz
		VDD=1.8V ~ 3.3V			12	MHz
t_{SE}	NSS Falling to First SPI Clock Edge		2			T_{PC}
t_{SD}	Last SPI Clock Edge to NSS Rising		2			T_{PC}
t_{SEZ}	NSS Falling to D _{OUT} Valid				4	T_{PC}
t_{SDZ}	NSS Rising to D _{OUT} High-Z				4	T_{PC}
t_{CKH}	SPI Clock High Time		3			T_{PC}
t_{CKL}	SPI Clock Low Time		3			T_{PC}
t_{SIS}	D _{IN} Valid to SPI Clock Sample Edge		2			T_{PC}
t_{SIH}	SPI Clock Sample Edge to D _{IN} Change		2			T_{PC}
t_{SOH}	SPI Clock Shift Edge to D _{OUT} Change				4	T_{PC}
t_{SLH}	Last SPI Clock Edge to D _{OUT} Change (CPHA = 1 only)		1		2	T_{PC}

T_{PC} : APB clock or SYS clock cycle time

D_{IN} : SPI input data signal

D_{OUT} : SPI output data signal

Figure 8-2. SPI Master Timing Waveform

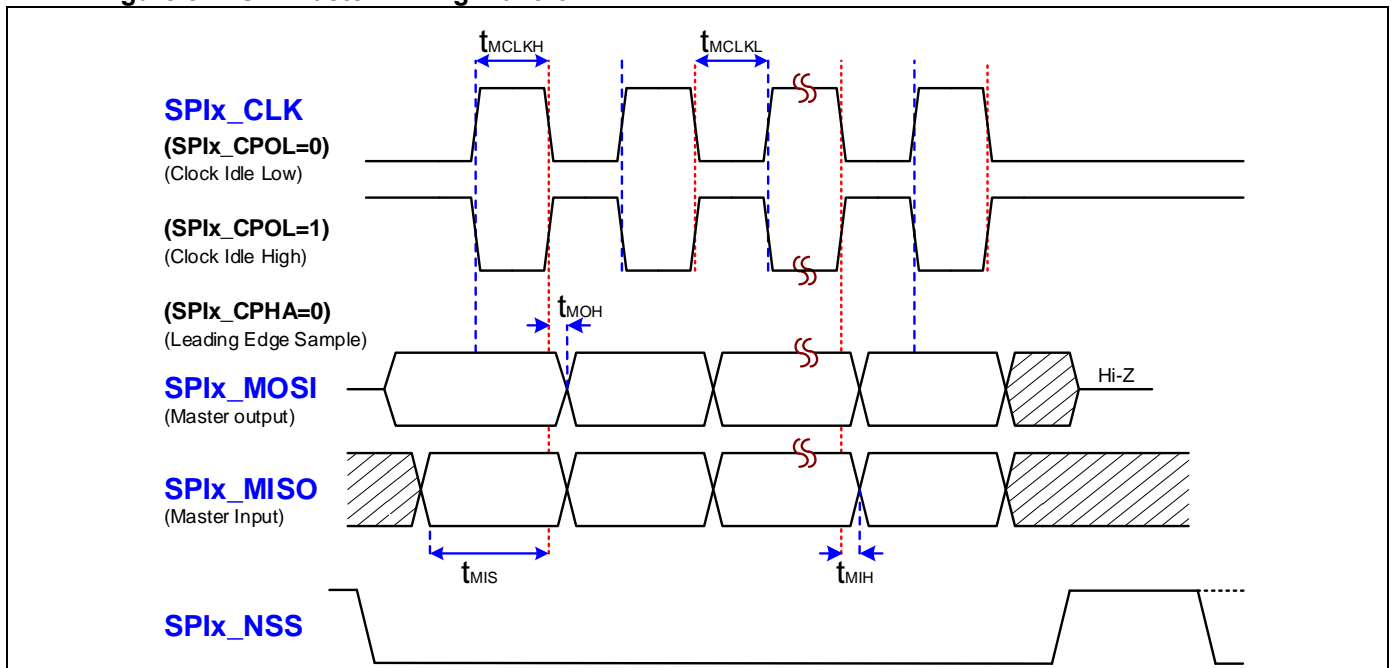
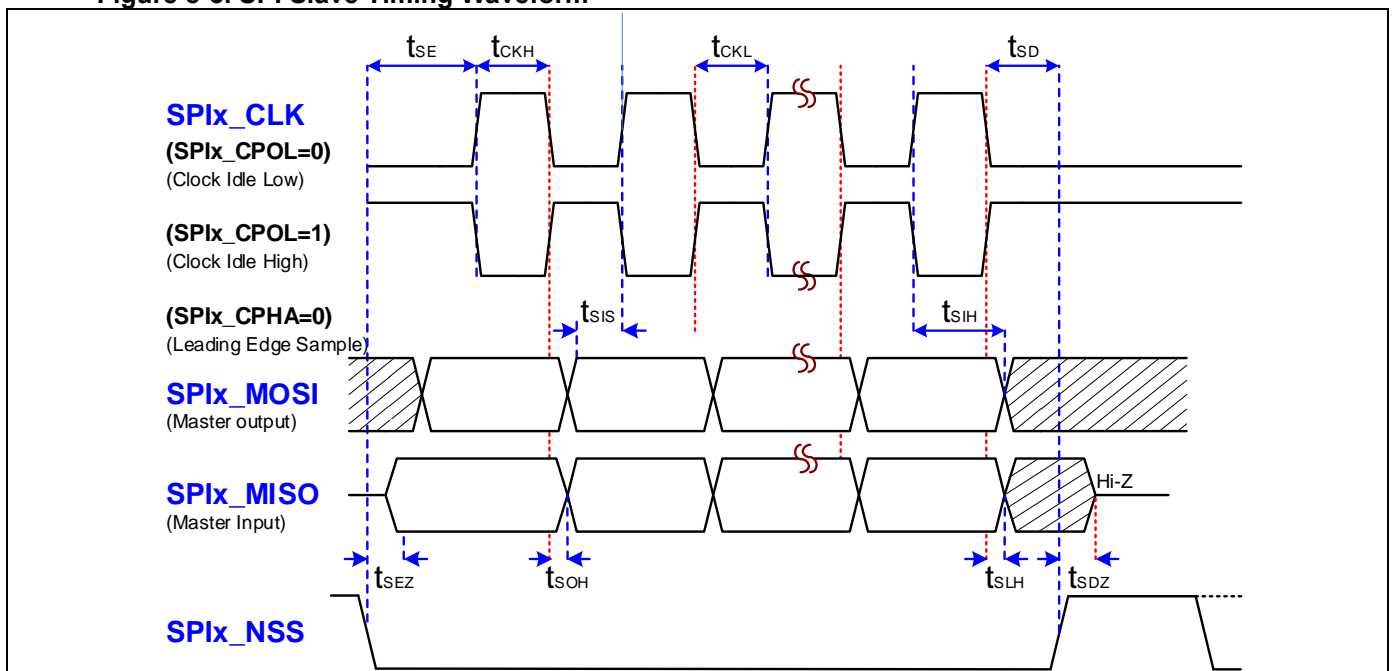


Figure 8-3. SPI Slave Timing Waveform



8.19. I2C Characteristics

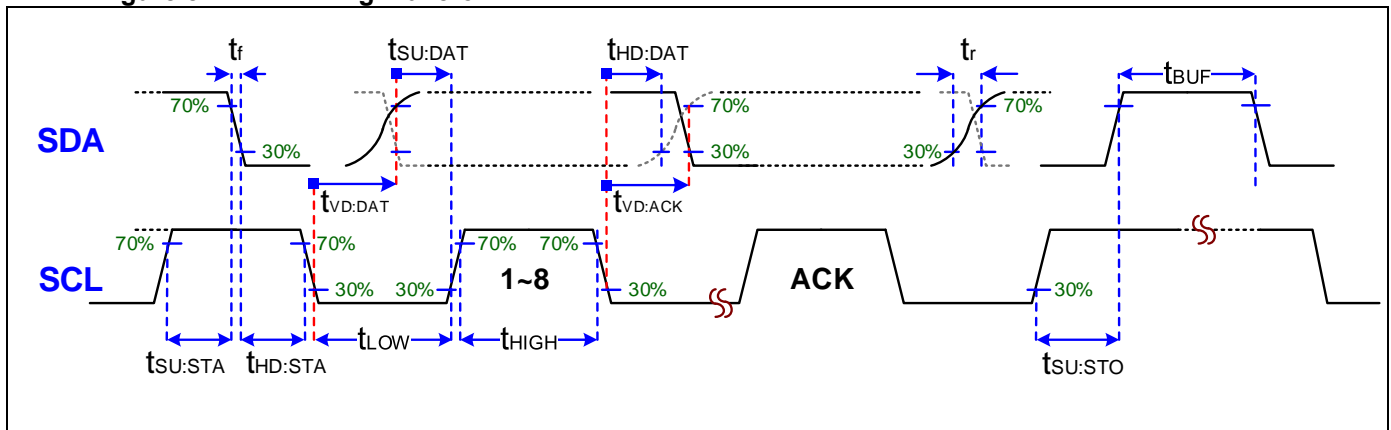
Table 8-20. I2C Characteristics

VDD=5.0V±10%, VSS=0V, TA = -40°C ~ +105°C (unless otherwise specified)

Symbol	Parameter	Conditions	Standard-mode		Fast-mode		Fast-mode Plus		Unit
			Min	Max	Min	Max	Min	Max	
f _{SCL}	SCL Clock Frequency		0	100	0	400	0	1000	KHz
t _{Low}	Low period of the SCL clock		4.7		1.3		0.5		us
t _{Low_M}	Low period of the SCL clock (Master Mode)		2		2		2		T _{PC}
t _{Low_S}	Low period of the SCL clock (Slave Mode)		4		4		4		T _{PC}
t _{High}	High period of the SCL clock		4.0		0.6		0.26		us
t _{High_M}	High period of the SCL clock (Master Mode)		3		3		3		T _{PC}
t _{High_S}	High period of the SCL clock (Slave Mode)		5		5		5		T _{PC}
t _{HD:STA}	Hold time for START condition		4.0		0.6		0.26		us
t _{SU:STA}	Setup time for START condition		4.7		0.6		0.26		us
t _{HD:DAT}	Data hold time		0		0		0		us
t _{SU:DAT}	Data setup time		250		100		50		ns
t _{SU:STO}	Setup time for STOP condition		4.0		0.6		0.26		us
t _{BUF}	Bus free time between a STOP and START		4.7		1.3		0.5		us
t _{VD:DAT}	Data valid time			3.45		0.9		0.45	us
t _{VD:ACK}	Data valid acknowledge time			3.45		0.9		0.45	us
t _r	Rise time of both SDA and SCL signals			1000		300		120	ns
t _f	Fall time of both SDA and SCL signals			300	20x (VDD/5.5V)	300	20x (VDD/5.5V)	120	ns
C _i	Capacitive load for each IO pin			10		10		10	pF

T_{PC} : APB clock or SYS clock cycle time

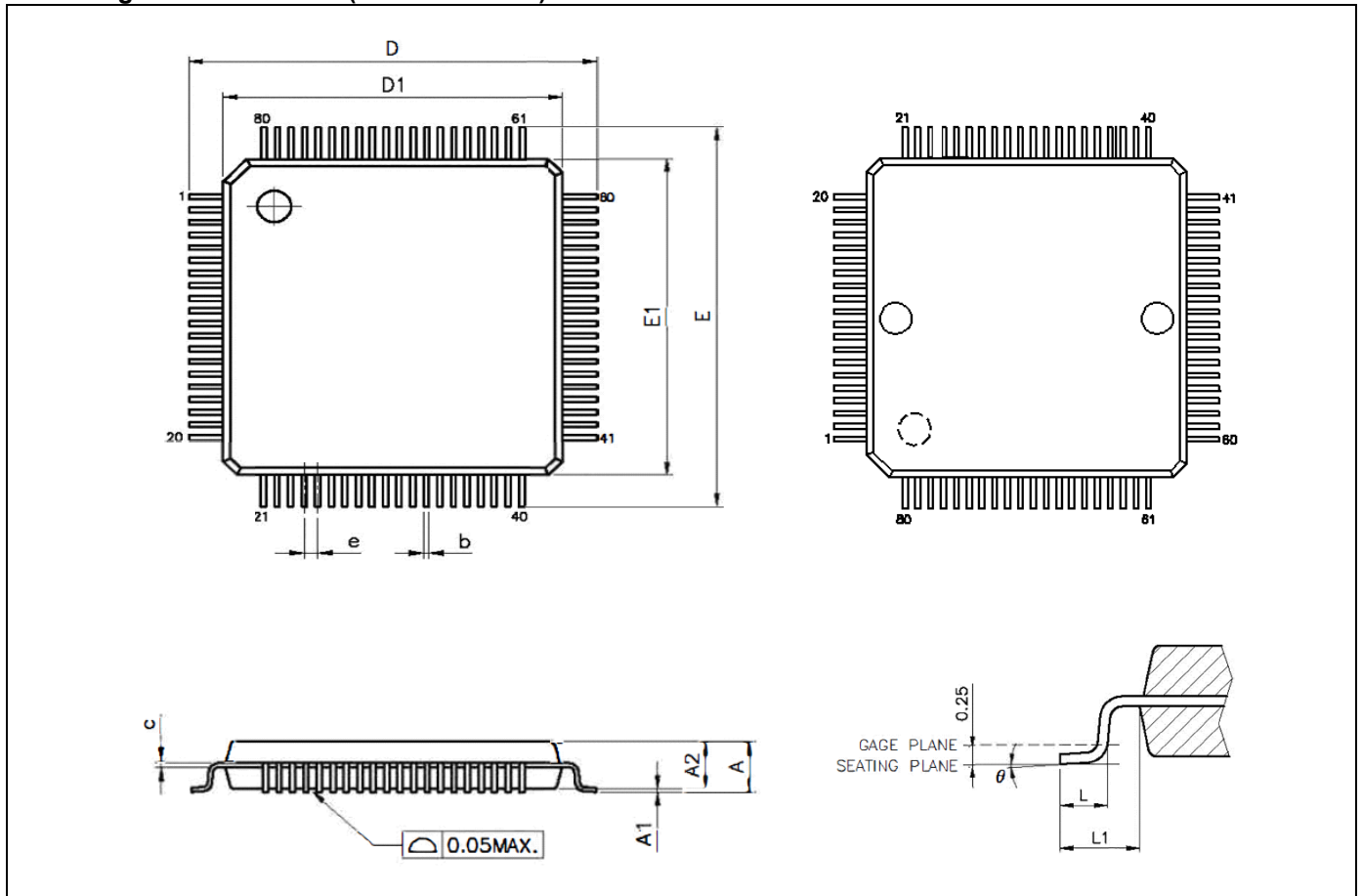
Figure 8-4. I2C Timing Waveform



9. Package Dimension

9.1. LQFP-80

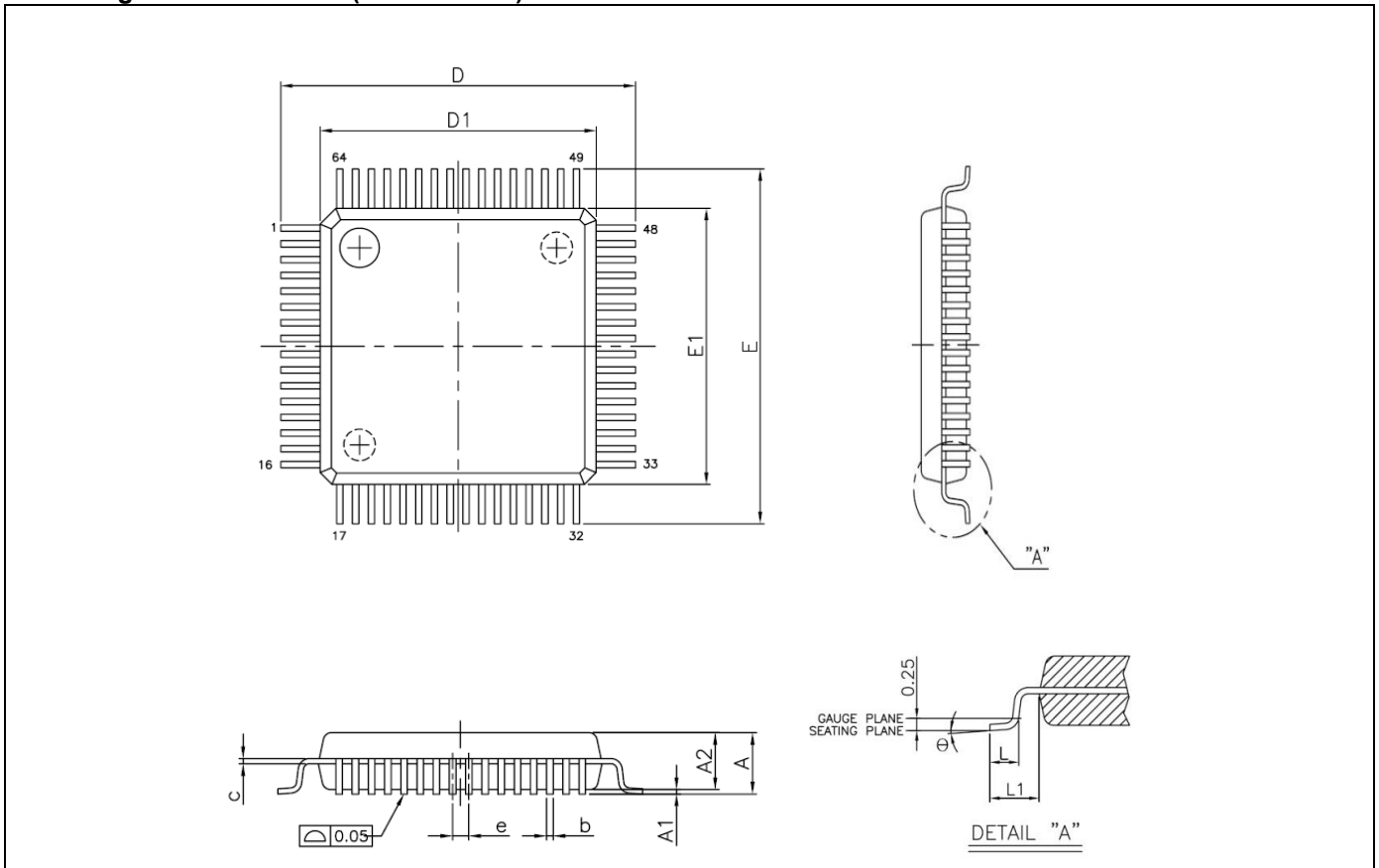
Figure 9-1. LQFP-80 (10mm X 10mm) ~ AD80



Unit	mm			inch		
Symbols	Min.	Nom.	Max.	Min.	Nom.	Max.
A	---	---	1.60	---	---	0.062
A1	0.05	---	0.15	0.001	---	0.005
A2	1.35	1.40	1.45	0.053	0.055	0.057
b	0.13	0.18	0.23	0.005	0.007	0.009
c	0.09	---	0.20	0.003	---	0.007
D	12.00 BSC			0.472 BSC		
D1	10.00 BSC			0.393 BSC		
E	12.00 BSC			0.472 BSC		
E1	10.00 BSC			0.393 BSC		
e	0.40 BSC			0.015 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00 REF			0.039 REF		
θ	0°	3.5°	7°	0°	3.5°	7°

9.2. LQFP-64

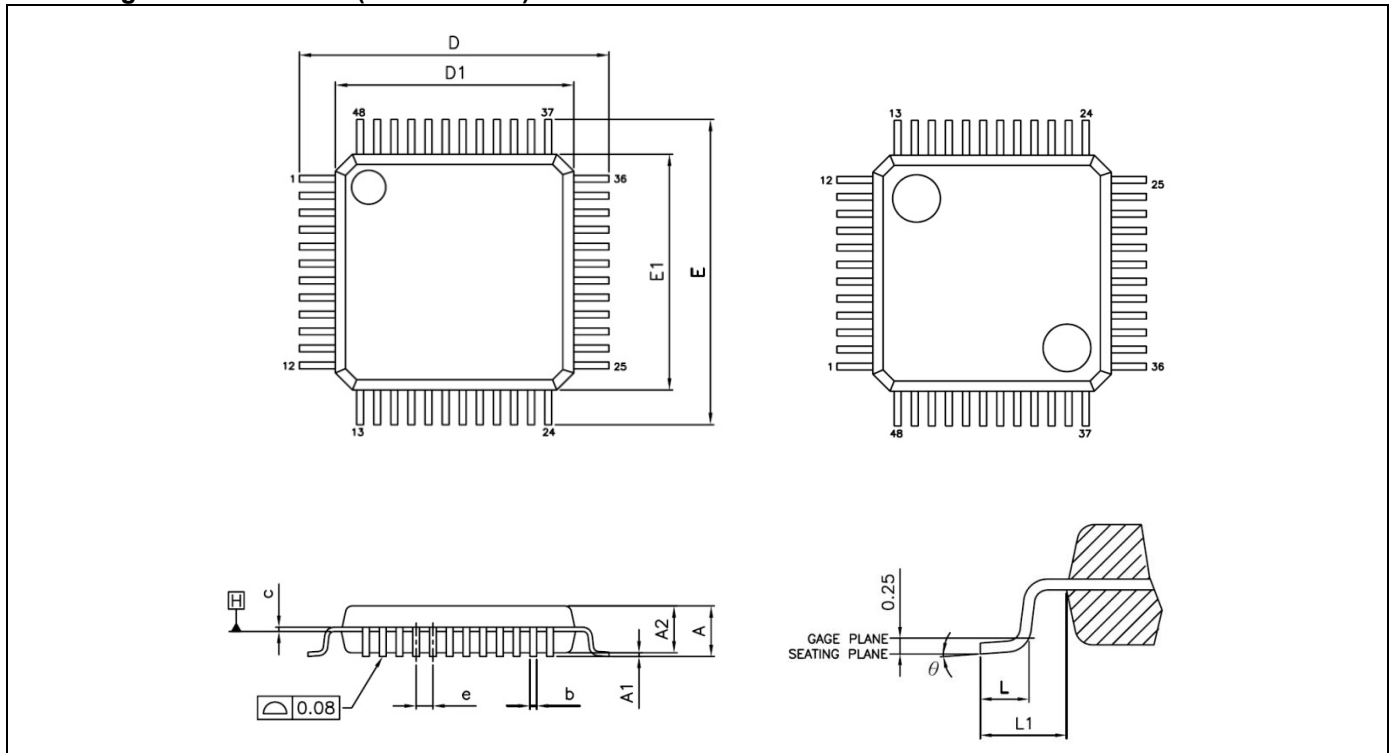
Figure 9-2. LQFP-64 (7mm X 7mm) ~ AD64



Unit	mm			inch		
Symbols	Min.	Nom.	Max.	Min.	Nom.	Max.
A	---	---	1.60	---	---	0.062
A1	0.05	---	0.15	0.001	---	0.005
A2	1.35	1.40	1.45	0.053	0.055	0.057
b	0.13	0.18	0.23	0.005	0.007	0.009
c	0.09	---	0.20	0.003	---	0.007
D	9.00 BSC			0.354 BSC		
D1	7.00 BSC			0.275 BSC		
e	0.40 BSC			0.015 BSC		
E	9.00 BSC			0.354 BSC		
E1	7.00 BSC			0.275 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00 REF			0.039 REF		
θ	0°	3.5°	7°	0°	3.5°	7°

9.3. LQFP-48

Figure 9-3. LQFP-48 (7mm X 7mm) ~ AD48



Unit	mm			inch		
Symbols	Min.	Nom.	Max.	Min.	Nom.	Max.
A	---	---	1.60	---	---	0.062
A1	0.05	---	0.15	0.001	---	0.005
A2	1.35	1.40	1.45	0.053	0.055	0.057
b	0.17	0.22	0.27	0.006	0.008	0.010
c	0.09	---	0.20	0.003	---	0.007
D	9.00 BSC			0.354 BSC		
D1	7.00 BSC			0.275 BSC		
E	9.00 BSC			0.354 BSC		
E1	7.00 BSC			0.275 BSC		
e	0.50 BSC			0.019 BSC		
L	0.45	0.60	0.75	0.018	0.024	0.030
L1	1.00 REF			0.039 REF		
e	0°	3.5°	7°	0°	3.5°	7°

10. Revision History

Revision V1.21 (2022_0624)		Chapter
1	Remove PD4/5/6 GPIO pin function in Pin Description chapter.	4
Revision V1.20 (2022_0621)		Chapter
1	Add the figure of "Figure 8-1. UART Timing Waveform" and add "Symbol" column in the table of "Table 8-17. UART Characteristics" in the section of "8.16. UART Characteristics".	8.16
2	Add the figures of "Figure 8-2. SPI Master Timing Waveform" and "Figure 8-3. SPI Slave Timing Waveform" in the section of "8.17. SPI Characteristics". Add "Symbol" column in the table of "Table 8-18. I2C Characteristics".	8.17
3	Add the figure of "Figure 8-4. I2C Timing Waveform" in the section of "8.18. I2C Characteristics".	8.18
Revision V1.10 (2022_0308)		Chapter
1	Remove SDT function in General Description chapter and the section of "6.12. APX".	1 6.12
2	Add the descriptions of VR0 pin in the section of "7.1. Power Supply Circuit".	7.1
Revision V1.00 (2022_0211)		Chapter
1	Correct the "SPI" descriptions from three modules to four modules for SPI communication in Features chapter.	
2	Update the "I _{OP6} " parameters in the table of "Table 8-3. DC Characteristic".	8.3
3	Add the table of "Table 8-4. Current Measurement Condition Level Definition Table".	8.3
4	Update the "TR1~TR7" and "TF1~TF7" parameters in the table of "Table 8-5. IO Characteristics".	8.4
5	Update the "VR0" and "VDROP" parameters in the table of "Table 8-10. LDO Characteristics".	8.9
Revision V0.72 (2021_1215)		Chapter
1	Update the "SPI" descriptions in Features chapter.	
2	Update the table of "Table 2-1. Chip Selection Table".	2
3	Correct the wrong word "Code" to "Cold" in the descriptions of the section "6.3.3. Chip Reset Levels".	6.3.3
4	Update the descriptions of the section "6.23.1. Introduction".	6.23.1
5	Correct the wrong word "Slop" to "Slope" in the table of "Table 8-3. DC Characteristics".	8.3
6	Change "Cycle-to-Cycle Jitter" to "Period Jitter" in the table of "Table 8-6. PLL Characteristics".	8.6
7	Update the "SPI Clock Frequency" parameters of slave mode in the table of "Table 8-18. SPI Characteristics".	8.18
8	Update the diagram of package dimension for each package in Package Dimension chapter.	9
Revision V0.71 (2021_0623)		Chapter
1	Update the table of "Table 2-1. Chip Selection Table".	2
Revision V0.70 (2021_0609)		Chapter
1	Support EMB bus 8-bit data width.	6.7

2	Update the description of the section of “6.15.3. CMP Control Block”.	6.15.3
3	Update the Conditions description of “Current Consumption” in the table of “Table 8-3. DC Characteristics”.	8.3
4	Update the $I_{SLP0}/I_{SLP1}/I_{SLP2}$ parameters in the table of “Table 8-3. DC Characteristics”.	8.3
5	Add the $I_{SLP3}/I_{SLP4}/t_{WK_SLP1}$ parameters in the table of “Table 8-3. DC Characteristics”.	8.3
6	Merge the I_{DAC}/I_{BUF} parameters in the table of “Table 8-15. DAC Characteristics”.	8.15
Revision V0.60 (2021_0426)		Chapter
1	Update the descriptions of the section of “6.23.1 Introduction”.	6.23.1
2	Update ‘Internal VBUF reference voltage’ parameter in the table “Table 8-11. ADC Characteristics”.	8.11
Revision V0.50 (2021_0322)		Chapter
1	Add ‘Wakeup Time’ characteristics in the table of “Table 8-3. DC Characteristics”.	8.3
Revision V0.40 (2021_0129)		Chapter
1	Separate the series Data Sheet for MG32F02A128/A064 chips.	
2	Update the descriptions of the section of “7.2. Reset Circuit” and “7.5. DAC Application Circuit” in Application Notes chapter.	7.2 7.5
Revision V0.30 (2021_0127)		Chapter
1	Update the parameters’ value in Electrical Characteristics chapter.	8
2	Add the information of ‘Dimensions in inch’ for each package in Package Dimension chapter.	9
Revision V0.20 (2020_0928)		Chapter
1	Add (*1) comment for the section of Operating in Feature chapter.	
2	Update the section of Part Number List in Order Information chapter.	2
Revision V0.10 (2020_0401)		Chapter
1	Preliminary version	

11. Disclaimers

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