

Ultra Low Power ARM Cortex M0P-based 32-bit MCU with 256KB FLASH , 16KB SRAM , hardware DIV/SQRT calculator , 9 timers , 3 versatile communication interfaces , 1 RTC with calendar , one 12-bit SAR ADC with differential pair inputs , one 12-bit R2R DAC , and 1 temperature sensor.

■ Features

● 32-bit ARM Cortex-M0+ Core

- ✓ Processor version: r0p1
- ✓ Maximum operating frequency: 48 MHz
- ✓ Nested Vectored Interrupt Controller (NVIC)
- ✓ 24-bit System timer (Sys Tick): System timer for OS task management
- ✓ Compatible with Cortex-M3 bit band operation

● On-chip Memory

- ✓ Flash memory
 - Up to 256 Kbyte
 - Read cycle:0 wait-cycle @ CPU clock = 20MHz
 - Security function for code protection
- ✓ SRAM
 - Up to 16Kbyte
 - With 4Kbyte retention area in ultra-low power modes

● Power Supply

- ✓ Wide Range : 2.0V to 3.6V

● Clock and Reset

- ✓ Clocks
 - Main clock : up to 48MHz
 - Sub clock : 32.768 kHz
 - On-chip HCR clock : 40 MHz ($\pm 1\%$ frequency accuracy after trimming)
 - On-chip LCR clock : 100 kHz
 - PLL clock
- ✓ Resets
 - External Pin Reset
 - Power on reset
 - Software reset
 - Watchdog timer reset
 - Low-voltage detection reset
 - Clock supervisor reset

- ✓ Clock Supervisor (CSV)
 - The Clock Supervisor monitors the failure of external clocks. If an external clock failure (clock stop) is detected, a reset is asserted; If an external frequency anomaly is detected, an interrupt or a reset is asserted.

● Debug

- ✓ 2-line Serial Wire Debug Port (SW-DP)
- ✓ Micro Trace Buffer (MTB)

● Low-voltage Detector (LVD)

- ✓ LVD1: generating an interrupt in low voltage condition
- ✓ LVD2: resetting the system in low voltage condition
- ✓ each LVD has 10 configurable detection voltage levels

● Flexible Low Power Modes

- ✓ Run Mode : 4.9mA @48MHz (VCC=2.5V; Temp.=25°C)
- ✓ Sleep Mode : 3.5mA @ 40MHz (VCC=2.5V; Temp.=25°C)
- ✓ Timer Mode : 13.5uA @ 32kHz (VCC=2.5V; Temp.=25°C)
- ✓ RTC Mode : 13uA @ 32kHz (VCC=2.5V; Temp.=25°C)
- ✓ Stop Mode : 12uA (VCC=2.5V; Temp.=25°C)
- ✓ Hibernate-RTC Mode : 1.1uA (VCC=2.5V; Temp.=25°C)
- ✓ Hibernate Mode : 0.9uA (VCC=2.5V; Temp.=25°C)
- ✓ Shut Down Mode : 7nA (VCC=2.5V; Temp.=25°C)

● Versatile Serial Communication Interfaces

- ✓ 3 channels; Each channel can be configured as:
 - UART
 - LIN
 - SPI
 - I2C
- ✓ 64-byte receiver FIFO and 64-byte transmitter FIFO
- ✓ UART
 - Full duplex
 - 5~9 bits data length with NRZ or inverted NRZ signals
 - Hardware flow control
 - Support multiple slaves
- ✓ LIN
 - support protocol Rev.2.1
 - Full duplex double buffer
 - Master and Slave mode
 - LIN break field generation
 - LIN break delimiter generation

- Various error detection functions
- ✓ SPI
 - Master or Slave function
 - Support Chip Selection
 - Overrun error detection function
 - 5 ~ 16 bits data length
- ✓ I2C
 - Standard-mode (Max: 100 kbps)
 - Fast-mode (Max: 400kbps)
- **I2C Slave**
 - ✓ Slave function of I2C and wake-up function from Hibernate modes.
- **Base Timer (4 channels)**
 - ✓ Each channel can be configured as:
 - 16-bit PWM timer
 - 16-bit PPG timer
 - 16/32-bit reload timer
 - 16/32-bit PWC timer
- **Dual Timers (two 32/16-bit Down Counters)**
 - ✓ The Dual Timer consists of two programmable 32/16-bit down counters. Each supports:
 - Free-run counting
 - Auto-Reload counting
 - One-shot counting
- **Heterogeneous Timers**
 - ✓ The heterogeneous timer consists of the following blocks.
 - 16-bit free-run timer (3 channels)
 - Input capture (4 channels)
 - Output compare (6 channels)
 - A/D activating compare (3 channels)
 - Waveform generator (3 channels)
 - PPG (3 channels)
 - ✓ The following function can be used to achieve the motor control.
 - PWM signal output function
 - DC chopper waveform output function
 - Complementary outputs with dead time insertion
 - Input captures
 - A/D converter triggers
 - Emergency stop function

- **Position Detection Counter (PDC)**

- ✓ detection of three external event inputs
- ✓ 16-bit position counter
- ✓ 16-bit revolution counter
- ✓ two 16-bit compare registers

- **Real-time Clock (RTC)**

- ✓ RTC counts Year/Month/Day/Hour/Minute/Second/Day of the week.
 - generate an interrupt at a specific time, or generate an interrupt in a specific year, in a specific month, on a specific day, at a specific hour or at a specific minute.
 - count leap years automatically

- **Watchdog Timers**

- ✓ watchdog timers can generate interrupts or a reset when a time-out value is reached.
 - one software watchdog
 - one hardware watchdog which works automatically after MCU is powered on

- **Hardware DIV and SQRT Calculator (DIVSQRT)**

- ✓ ARM Cortex-M0+ processor does not have integer divide and square root operating instructions. The DIVSQRT supports 32/32 signed (SDIV) and unsigned (UDIV) divide calculations, and unsigned integer square root calculation. The divide operations compatible with ARMv7-M instruction set architecture.
- ✓ DIVSQRT module also supports MOD operation; the quotient and remainder are available at the same time through read different registers.
- ✓ Calculation takes 1 ~ 9 CPU clock cycles depending on the value of operands.

- **External Interrupts**

- ✓ eight external interrupt inputs
- ✓ one non-maskable interrupt (NMI) input

- **GPIOs (4 ports with total 26 pins)**

- ✓ Each GPIO pin can be configured as:
 - High-Impedance (both input and output are disabled)
 - Input with internal pull-up or pull-down resistor
 - Input without pull-up/pull-down resistor
 - Open-drain output with internal pull-up resistor
 - Open-drain output with internal pull-down resistor
 - Push-Pull output
- ✓ Most of GPIO pins are 5V-input tolerant

- **A/D Converter**

- ✓ 12-bit SAR A/D Converter

- ✓ 8 analog single-end input channels, or 4 differential input channels
- ✓ Conversion rate : 1Mbps (typical)
- ✓ Integral linearity error : ± 1.5 LSB (typical)
- ✓ Differential linearity error : ± 1.0 LSB (typical)
- ✓ Scanning conversion mode
- ✓ 16-depth FIFO of conversion results

- **D/A Converter**

- ✓ 12-bit R2R D/A Converter with 1 analog output channel

- **Temperature Sensor**

- ✓ sensor gain : 10mV/°C
- ✓ analog output is internally connected to A/DC

■ Lineup Overview

Table1: HK32M0PxxE Lineup table

Device Name	HK32M0P32E
On-chip FLASH	256 Kbytes
On-chip SRAM	16 Kbytes
Pin count	32 (Evaluation Chip is 64)
Package	LQFP32; QFN32 (Evaluation Chip is LQFP64)
CPU	Cortex-M0+ (up to 48MHz)
Operating Voltage	2.0V to 3.6V
Operating Temperature	-40°C to 85°C (ambient temperature)
LVD	2 units
ADC	1 unit with 8 input channels; 12-bit resolution
DAC	1 unit with 1 output channel; 12-bit resolution
Temperature Sensor	1 unit
GPIO	4 ports with total 26 pins
High Speed Internal CR	1 unit (40MHz with $\pm 1\%$ freq. accuracy after trimming)
Low Speed Internal CR	1 unit (100kHz)
DIV/SQRT Calculator	1 unit
Timers	9 units
Watchdog	2 units (hardware and software types)
Position Detection Counter	1 unit
RTC	1 unit with calendar
Versatile Serial Comm. Interface	3 channels (UART, LIN, SPI and I2C)
External Interrupts	8 inputs plus 1 NMI input
Hibernate Mode Wakeups	4 inputs plus external reset wakeup
Debug	2-line Serial Wire debug port; Micro Trace Buffer (MTB)

Pin Assignment

Figure1: LQFP32 Pin Assignment

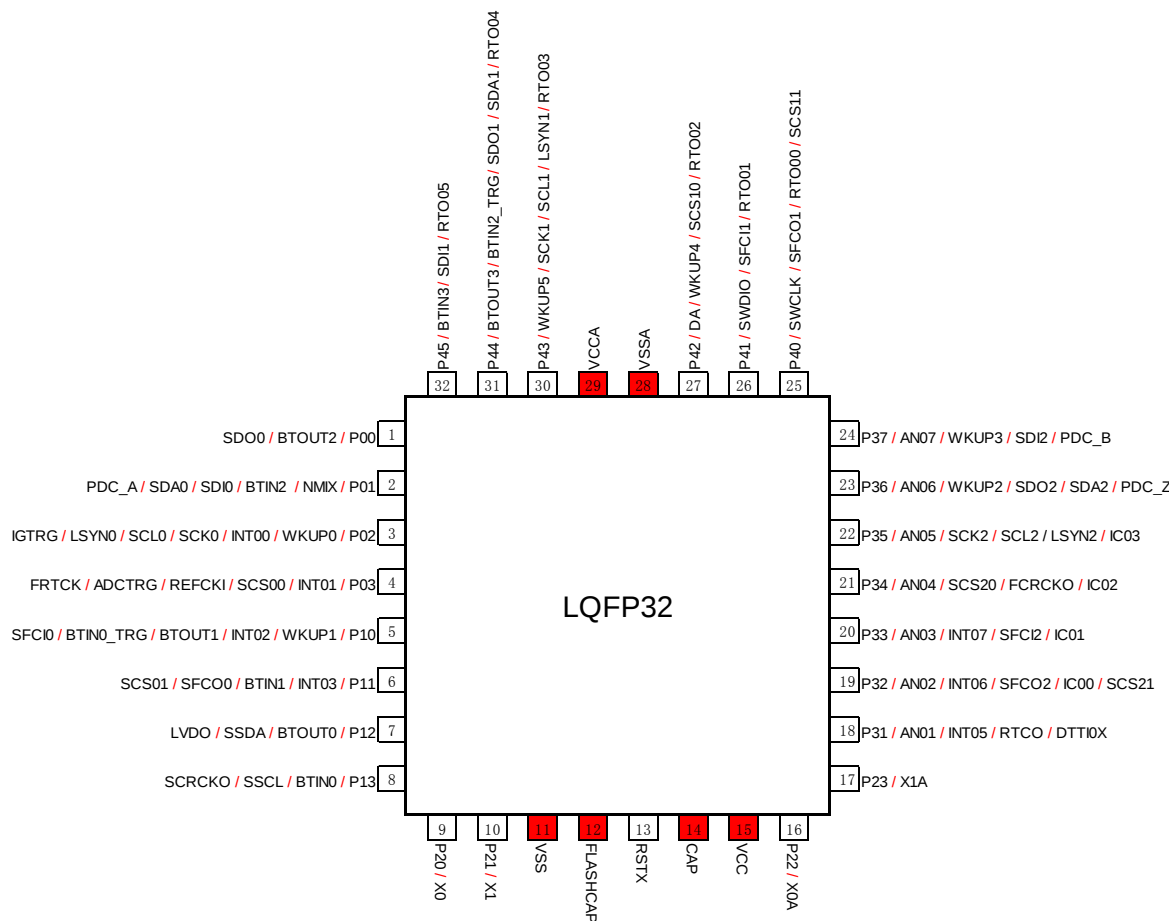
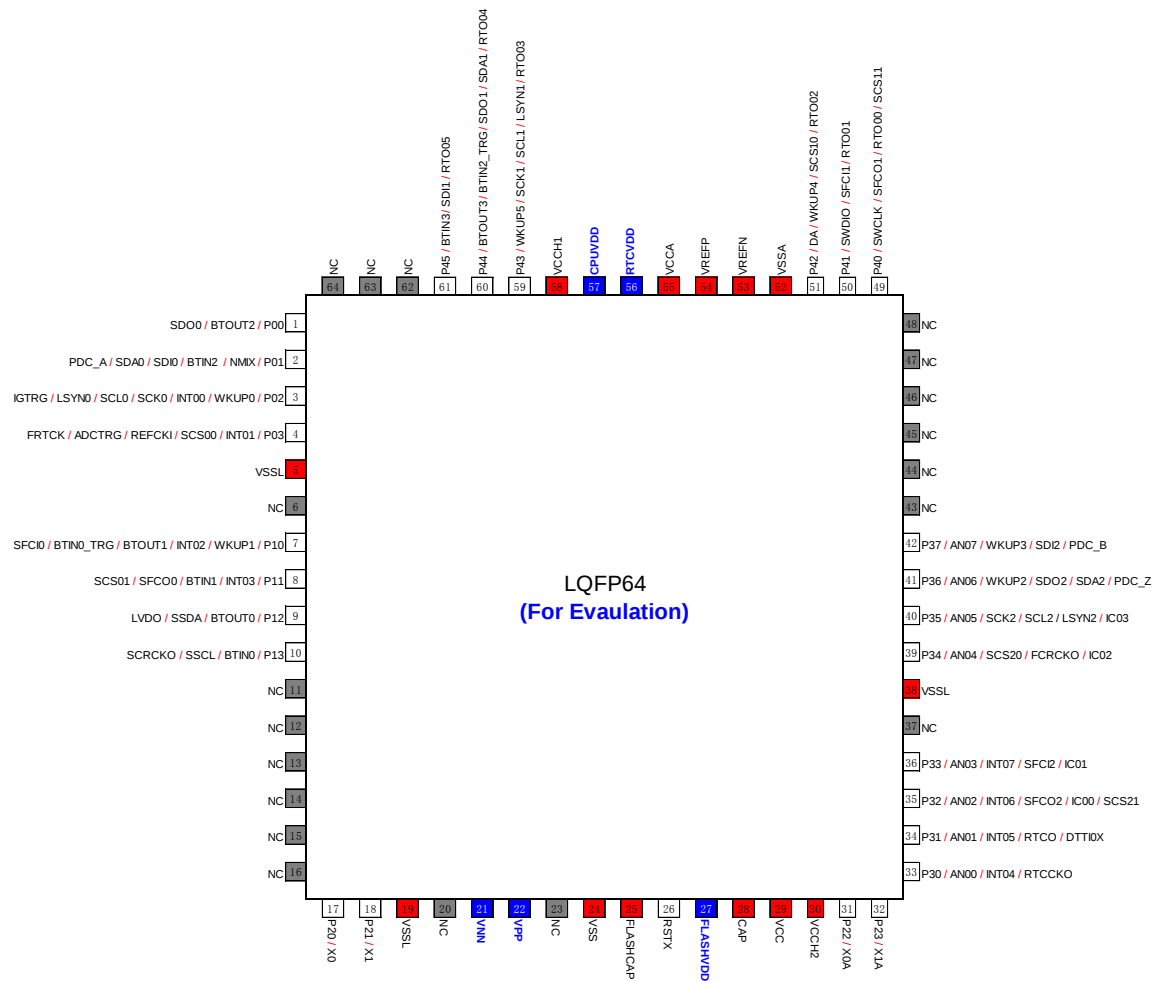


Figure2: LQFP64 Pin Assignment



Caution 1: Evaluation pins (in blue in above figure) must be kept open !!! Otherwise, chip would possibly be damaged!!!

Note 1: VNN (pin no. 21) and VPP (pin no. 22) pins are without ESD capability; But evaluation board has the ESD protection circuits on them.

■ Pin Function List

Table2: HK32M0PxxE Lineup table

Pin No	Type	5VT *1	Pin Function	Description
1	I/O	Yes	P00	GPIO
			BTOUT2	Base timer channel 2 output
			SDO0	UART or SPI channel 0 output
2	I/O	Yes	P01	GPIO
			NMIX	Non-maskable interrupt input
			BTIN2	Base timer channel 2 input
			SDI0	UART or SPI channel 0 input
			SDA0	I2C channel 0 SDA inout
			PDC_A	Position detection counter input A
3	I/O	Yes	P02	GPIO
			WKUP0	Hibernate mode wake up input 0
			INT00	External interrupt input 0
			SCK0	SPI channel 0 clock inout
			SCL0	I2C channel 0 SCL inout
			LSYN0	LIN ch.0 sync. field indication signal output
			IGTRG	heterogeneous timer IGBT mode trigger input
4	I/O	Yes	P03	GPIO
			INT01	External interrupt input 1
			SCS00	SPI ch. 0 chip selection input(slave) or output 0(master)
			REFCKI	High speed CR trimming reference clock input
			ADCTRG	A/DC external trigger input
			FRTCK	heterogeneous timer clock input
5	I/O	Yes	P10	GPIO
			WKUP1	Hibernate mode wake up input 1

			INT02	External interrupt input 2
			BTOUT1	Base timer channel 1 output
			BTIN0_TRG	Base timer channel 0 external trigger input
			SFCIO	UART ch.0 flow control input
6	I/O	Yes	P11	GPIO
			INT03	External interrupt input 3
			BTIN1	Base timer channel 1 input
			SFCO0	UART ch.0 flow control output
			SCS01	SPI ch. 0 chip selection output 1
7	I/O	Yes	P12	GPIO
			BTOUT0	Base timer channel 0 output
			SSDA	I2C Slave SDA inout
			LVDO	LVD interrupt output
8	I/O	Yes	P13	GPIO
			BTIN0	Base timer channel 0 input
			SSCL	I2C Slave SCL inout
			SCRCKO	Low speed CR 100kHz clock output
9	I/O	No	P20	GPIO
			X0	Main oscillator input
10	I/O	No	P21	GPIO
			X1	Main oscillator inout
11	GND	-	VSS	Ground
12	PWR	-	CAP	External capacitor pin (connect to 4.7uF capacitor)
13	I	Yes	RSTX	External reset input with internal pull-up resistor
14	PWR	-	VCC	External power supply
15	I/O	No	P22	GPIO
			X0A	sub oscillator input
16	I/O	No	P23	GPIO
			X1A	sub oscillator inout

17	I/O	No	P30	GPIO
			AN00	A/DC analog input channel 0
			INT04	External interrupt input 4
			RTCKO	RTC clock output
18	I/O	No	P31	GPIO
			AN01	A/DC analog input channel 1
			INT05	External interrupt input 5
			RTCO	RTC second signal output
			DTTIOX	heterogeneous timer emergency stop input
19	I/O	No	P32	GPIO
			AN02	A/DC analog input channel 2
			INT06	External interrupt input 6
			SFCO2	UART ch.2 flow control output
			IC00	Input capture ch.0 input
			SCS21	SPI ch.2 chip selection output 1
20	I/O	No	P33	GPIO
			AN03	A/DC analog input channel 3
			INT07	External interrupt input 7
			SFCI2	UART ch.2 flow control input
			IC01	Input capture ch.1 input
21	I/O	No	P34	GPIO
			AN04	A/DC analog input channel 4
			SCS20	SPI ch. 2 chip selection input(slave) or output 0(master)
			FCRCKO	High speed CR clock output
			IC02	Input capture ch.2 input
22	I/O	No	P35	GPIO
			AN05	A/DC analog input channel 5
			SCK2	SPI ch.2 clock inout
			SCL2	I2C ch.2 SCL inout

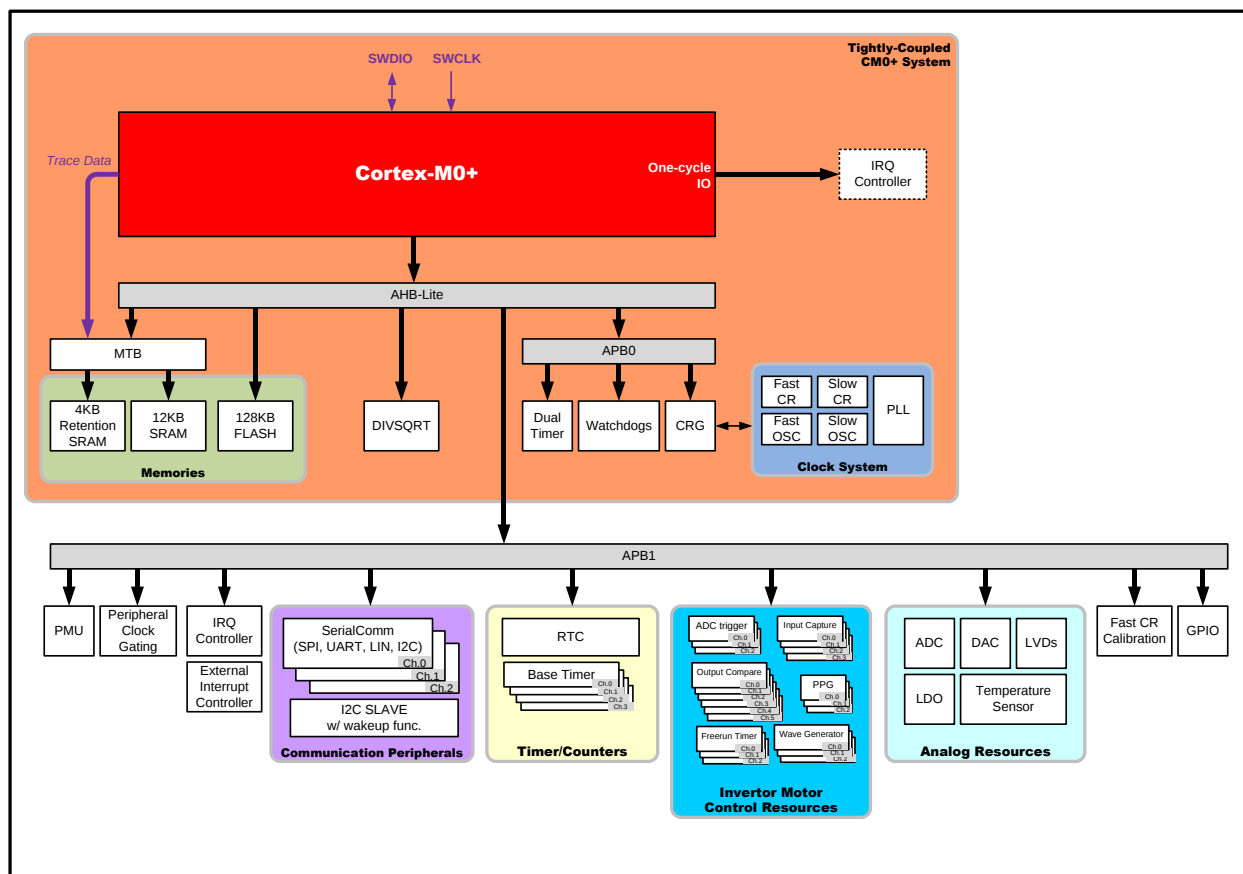
23	I/O	No	LSYN2	LIN ch.2 sync. field indication signal output
			IC03	Input capture ch.3 input
			P36	GPIO
			AN06	A/DC analog input channel 6
			WKUP2	Hibernate mode wake up input 2
			SDO2	UART or SPI channel 2 output
			SDA2	I2C ch.2 SDA inout
24	I/O	No	PDC_Z	Position detection counter input Z
			P37	GPIO
			AN07	A/DC analog input channel 7
			WKUP3	Hibernate mode wake up input 3
			SDI2	UART or SPI channel 2 input
25	I/O	Yes	PDC_B	Position detection counter input B
			P40	GPIO
			SWCLK	Serial Wire debug port clock input
			SFCO1	UART ch.1 flow control output
			RTO00	heterogeneous timer output 0
26	I/O	Yes	SCS11	SPI ch.1 chip selection output 1
			P41	GPIO
			SWDIO	Serial Wire debug port data inout
			SFCI1	UART ch.1 flow control input
27	I/O	No	RTO01	heterogeneous timer output 1
			P42	GPIO
			DAO	D/AC analog output
			WKUP4	Hibernate mode wake up input 4
			SCS10	SPI ch. 1 chip selection input(slave) or output 0(master)
28	GND	-	RTO02	heterogeneous timer output 2
			VSSA	A/DC ground
29	PWR	-	VCCA	A/DC power supply

30	I/O	Yes	P43	GPIO
			WKUP5	Hibernate mode wake up input 5
			SCK1	SPI ch.1 clock inout
			SCL1	I2C ch.1 SCL inout
			LSYN1	LIN ch.1 sync. field indication signal output
			RTO03	heterogeneous timer output 3
31	I/O	Yes	P44	GPIO
			BTOUT3	Base Timer channel 3 output
			BTIN2_TRG	Base timer channel 2 external trigger input
			SDO1	UART or SPI channel 1 output
			SDA1	I2C ch.1 SDA inout
			RTO04	heterogeneous timer output 4
32	I/O	Yes	P45	GPIO
			BTIN3	Base timer channel 3 input
			SDI1	UART or SPI channel 1 input
			RTO05	heterogeneous timer output 5

*1 : 5VT means 5V-input tolerant.

■ Block Diagram

Figure2: HK32M0P32E Pin Assignment



Memory Map

Figure3: HK32M0P32E Memory Map

0xFFFFFFF	Reserved (bus-error)		
0xF8020000			
0xF801FFFF	Reserved (bus-error)		
0xF8000180			
0xF800017F	one-cycle IO		
0xF8000100			
0xF80000FF	Reserved (bus-error)		
0xF8000000			
0xF0002000	Reserved (bus-error)		
0xF0001000	Reserved		
0xF0000FFF	CM0+ Coresight-MTB(SFR)		
0xF0000000	CM0+ Private Peripherals		
0xE0000000			
	Reserved (bus-error)		
0x44000000			
0x43FFFFFF	32 Mbytes Bit band alias 0x40000000 ~ 0x40100000		
0x42000000			
0x41FFFFFF	Reserved (bus-error)		
0x40070000			
0x4006FFFF	Reserved		
0x40063000			
0x40062FFF	DIVSQRT		
0x40062000			
0x40061FFF	Reserved		
0x40061000			
0x40060FFF	Reserved		
0x40050000			
0x4004FFFF	Reserved		
0x40040000			
0x4003FFFF	AHB2APB Bridge		
0x40020000			
0x40016000	Reserved		
0x40015000	Dual timer		
0x40013000	Reserved		
0x40012000	SW-Watchdog		
0x40011000	HW-Watchdog		
0x40010000	CRG		
0x40001000	Reserved		
0x40000000	FLASH Controller		
	Reserved		
0x24000000			
	32 Mbytes Bit band alias 0x20000000 ~ 0x20100000		
0x22000000			
0x20100000	Reserved (bus-error)		
0x20082000	Reserved		
0x20080000	Reserved		
0x20004000	Reserved		
	SRAM(16KB)		
0x20000000			
0x00800000	Reserved (bus-error)		
	Reserved		
0x00020000			
	FLASH(128KB)		
0x00000000			

	0x4003FFFF	Reserved
	0x4003E000	Reserved
	0x4003DFFF	Reserved
	0x4003D000	Reserved
	0x4003CFFF	Reserved
	0x4003C000	LVD Controller
	0x4003BFFF	Temp. Sensor
	0x4003A000	D/AC
	0x40039FFF	A/DC
	0x40038000	Reserved
	0x40037FFF	Reserved
	0x40037000	Reserved
	0x40036FFF	Reserved
	0x40036000	Reserved
	0x40035FFF	Reserved
	0x40035000	RTC
	0x40034FFF	PDC
	0x40034000	HFT-PPG
	0x40033FFF	Base Timer
	0x40033000	HFT
	0x40032FFF	Reserved
	0x40032000	Reserved
	0x40031FFF	I2C Slave
	0x40031000	Serial Comm. Interface
	0x40030FFF	Reserved
	0x40030000	Interrupt Controller
	0x4002FFFF	External Interrupts
	0x4002E000	GPIO
	0x4002DFFF	Reserved
	0x4002D000	Reserved
	0x4002CFFF	On-chip CRs
	0x4002C000	Peripheral Clock Gating
	0x4002BFFF	Reserved
	0x4002B000	Reserved
	0x4002AFFF	Reserved
	0x4002A000	Reserved
	0x40029FFF	Reserved
	0x40029000	PMU
	0x40028FFF	
	0x40028000	
	0x40027FFF	
	0x40027000	
	0x40026FFF	
	0x40026000	
	0x40025FFF	
	0x40025000	
	0x40024FFF	
	0x40024000	
	0x40023FFF	
	0x40023000	
	0x40022FFF	
	0x40022000	
	0x40021FFF	
	0x40021000	
	0x40020FFF	
	0x40020000	