



Holtek HT32 Family

Holtek 32-bit Flash MCU
HT32F1655
HT32F1656
介紹及其應用



32位元產品開發處
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Content

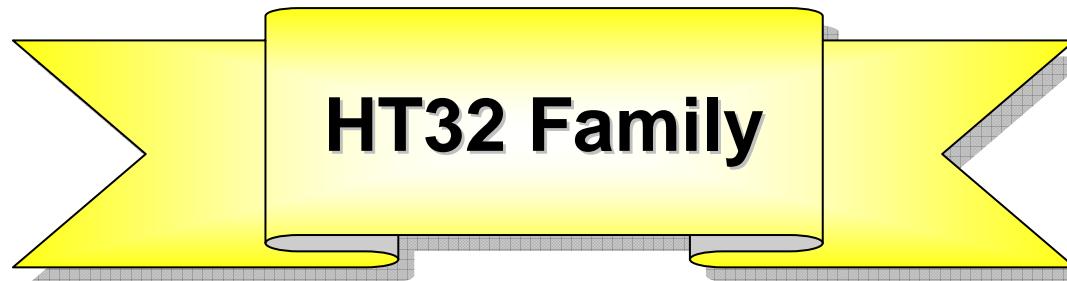
- HT32 Family: HT32F1655 / 1656
- Development Tools
- Flash Programming
- Applications

LAN / WiFi
Networking

LCD Data
Transmission

3 Phase
Motor Control

HT32 Family : Product Line



General Purpose

HT32F1251(B) / 52 / 53

HT32F1755 / 65

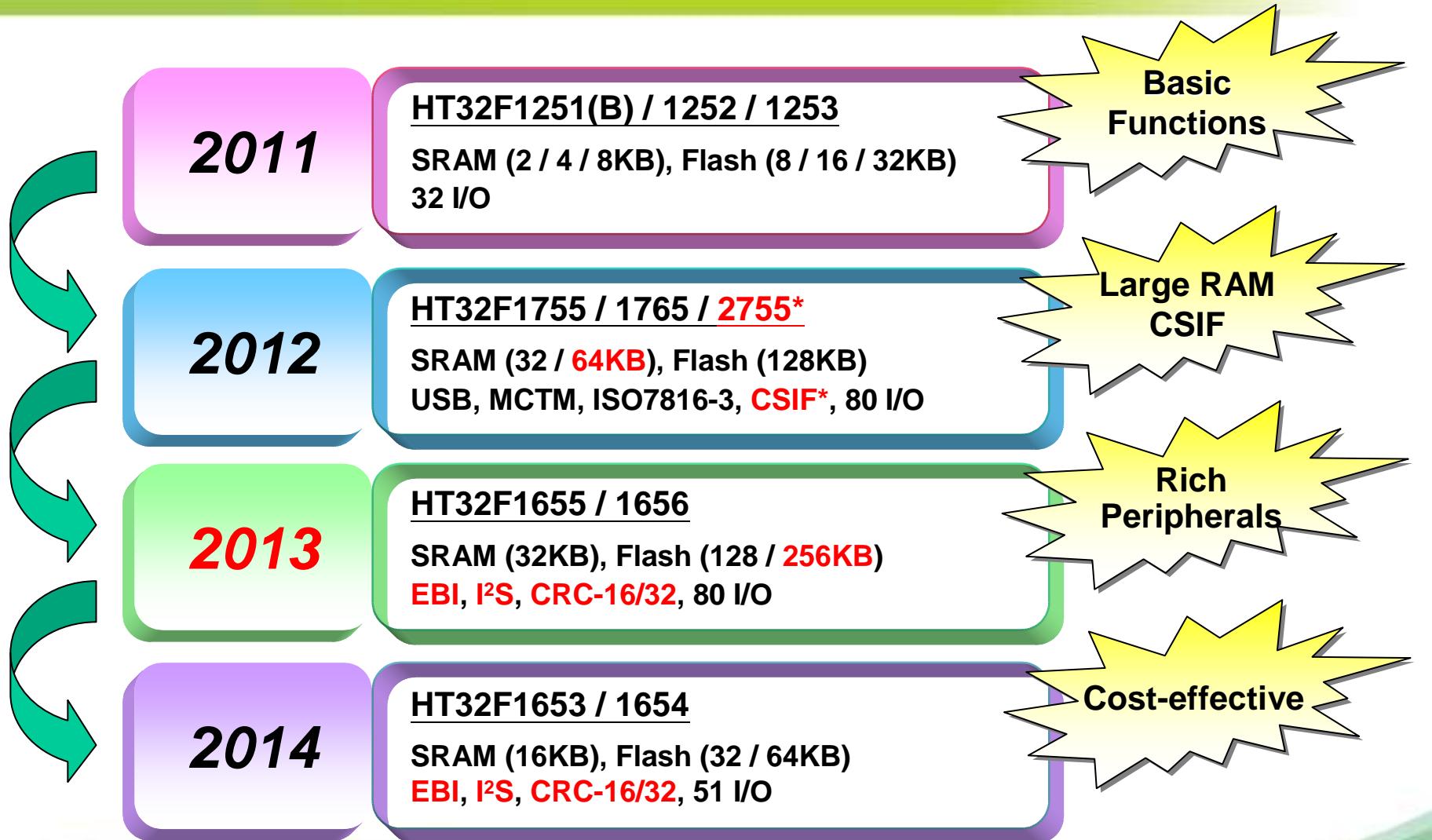
HT32F1655 / 56

HT32F1653 / 54

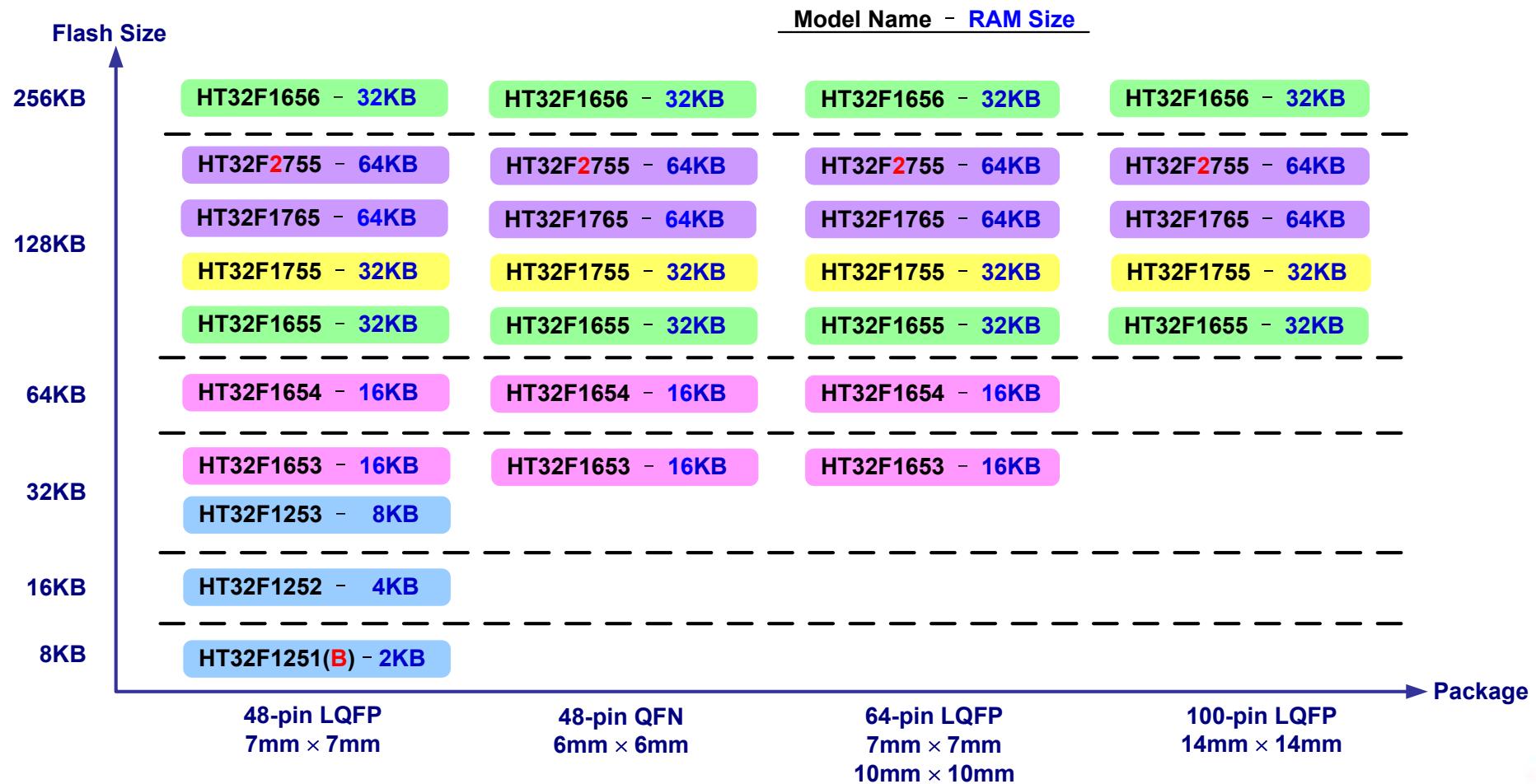
Special Purpose

HT32F2755

HT32 Family : Roadmap



HT32 Family : Category



HT32 Family : Selection Guide

Part No.	Flash (Bytes)	SRAM (Bytes)	ADC	PDMA	USB 2.0 FS	EBI	I ² S	CRC	CSIF	Timer	PWM	RTC	I/O	Others	Package	
HT32F1251B	8K	2K	12-bit x 8ch	---	---	---	---	---	---	16-bitx2	16-bit x8	---	30	USART x 1 SPI x 1 I ² C x 1 WDT x 1	48LQFP	
HT32F1251	8K	2K												32		
HT32F1252	16K	4K												32		
HT32F1253	32K	8K												32		
HT32F1755	128K	32K	12-bit x 8ch	12ch	√	---	---	---	---	16-bitx3 32-bitx2	16-bit x12	√	33 46 80	USART x 2 SPI x 2 I ² C x 2 WDT x 1	48QFN 48/64/100 LQFP	
HT32F1765	128K	64K														
HT32F2755	128K	64K														
HT32F1655	128K	32K	12-bit x 16ch	8ch	√	√	√	√	---	16-bitx4 32-bitx2	16-bit x16	√	35 49 80	USART x 2 UART x 2 SPI x 2 I ² C x 2 WDT x 1	48QFN 48/64/100 LQFP	
HT32F1656	256K	32K														

* HT32F1653/54 is under development

System Clock = 72MHz

V_{DD} = 2.7V ~ 3.6V

HT32 Family : Applications

- LCD Data Transmission
- Motor Control – FOC / SVPWM
- Wireless – BT / ZigBee / 2.4G RF
- Network – LAN / WiFi
- Security – Biometrics / Smart Card
- Barcode Scanner



- PC and Gaming Peripherals
- Medical Equipments
- Intelligent Toys
- Home Appliances
- Smart Meters
- Consumer Products

HT32F1655 / 1656 : What's New?

- **EBI (External Bus Interface)**

- High Speed Bus, up to **36MB/S**
- With programmable timing and interfaces
- Supports a wide range of devices such as SRAM / NOR Flash / LCD

- **I²S (Inter-IC Sound)**

- Master or Slave mode
- Mono or Stereo
- 8 / 16 / 24 / 32-bit sample size
- 8 × 32-bit Tx & Rx FIFO with PDMA supported

- **CRC (Cyclic Redundancy Check)**

- CCITT CRC-16 and Ethernet (**IEEE-802.3**) CRC-32
- 1 AHB clock cycle for 8-bit data and 4 AHB clock cycles for 32-bit data
- Supports PDMA to complete CRC computation for a block of memory

HT32F1655 / 1656 : Spec Summary

Function	1251B	1251 / 1252 / 1253	1755 / 1765			2755	1655 / 1656					
Flash (KB)	8	8	16	32	128			128				
SRAM (KB)	2	2	4	8	32	64	64	32				
ADC	8 channels			8 channels			16 channels					
Timer	GPTM × 2			BFTM × 2 GPTM × 2 MCTM × 1			BFTM × 2 GPTM × 2 MCTM × 2					
QEI	1			2			4					
RTC	—	√		√			√					
I ² C	1			2			2					
SPI	1			2			2					
USART	1			2			2					
UART	—			—			2					
USB	—			1			1					
SCI (ISO7816-3)	—			1			1					
PDMA	—			12 channels			8 channels					
CSIF	—			—	√		—					
EBI	—			—			√					
I ² S	—			—			√					
CRC	—			—			√					
I/O Ports	32			33 / 47 / 80			35 / 49 / 80					
Package	48LQFP			48QFN 48 / 64 / 100LQFP			48QFN 48 / 64 / 100LQFP					

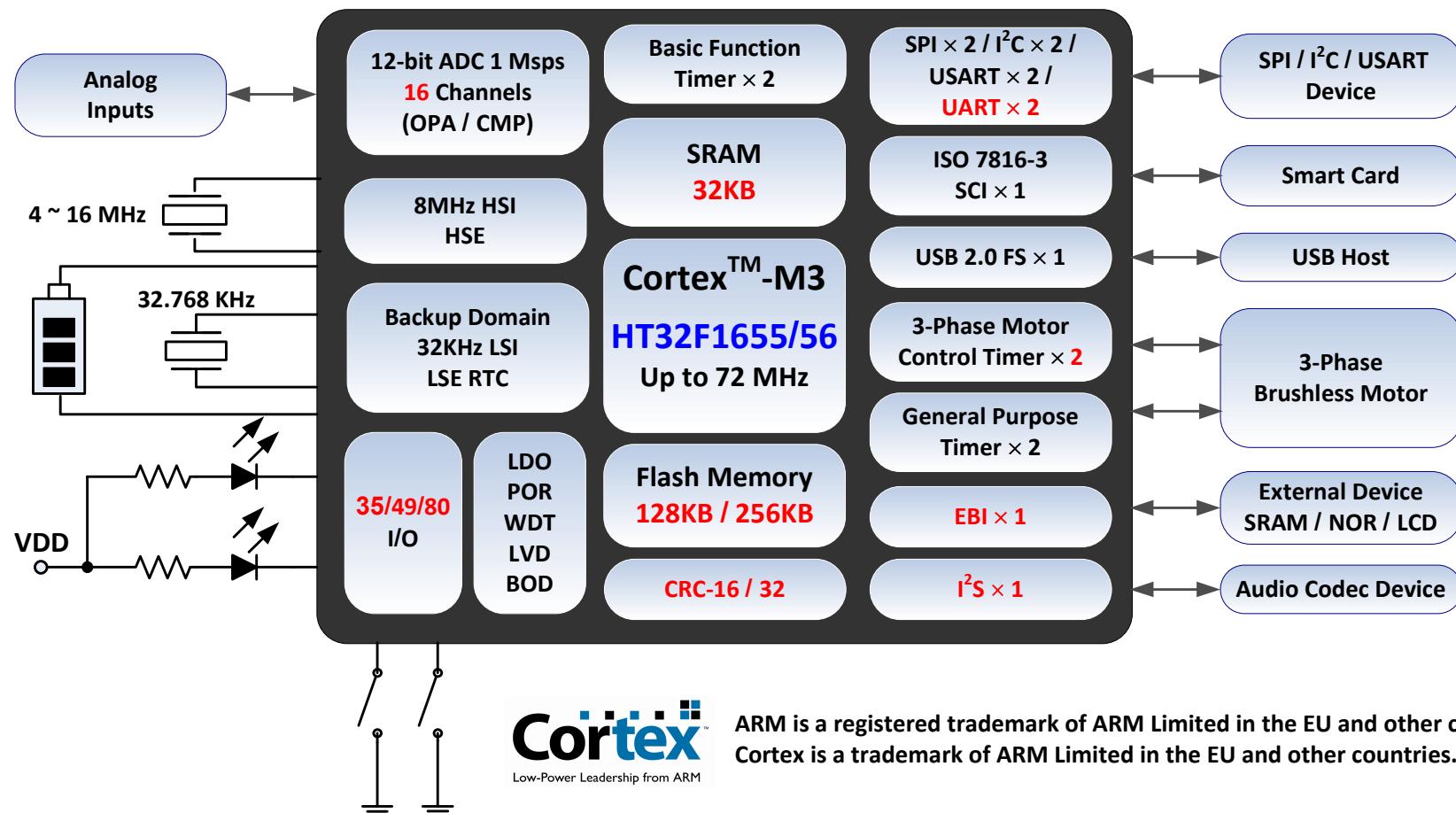
HT32F1655 / 1656 : Flash MCU Range

Part No.	Flash (Bytes)	SRAM (Bytes)	ADC	PDMA	USB 2.0 FS	EBI	I ² S	CRC	Interrupt		Timer	PWM	RTC	I/O	Others	Package
									Ext.	Int.						
HT32F1655	128K	32K	12-bit x16	8 ch	√	√	√	16/32	16	24	16-bitx4 32-bitx2	16-bit x16	√	35 49 80	USARTx2 UARTx2 SPIx2 I ² Cx2 WDTx1	48QFN/LQFP 64/100LQFP
HT32F1656	256K															

System Clock = 72MHz
V_{DD} = 2.7V ~ 3.6V



HT32F1655 / 1656 : Block Diagram



Cortex
Low-Power Leadership from ARM

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HT32F1655 / 1656 : Feature -1

Function	Spec/Number	Description
CPU Core	Cortex-M3 r2p0	JTAG / Serial Wire Debug, MPU Optimal blend of 16 / 32-bit instructions
Operating Voltage	2.7V ~ 3.6V	
System Clock	72MHz	Max. generated from HSE / HSI by PLL
Flash	128K / 256K Bytes	1655 : 128KB 1656 : 256KB
SRAM	32K Bytes	
Oscillators	High-Speed External High-Speed Internal RC Low-Speed External Low-Speed Internal RC	HSE : 4MHz ~ 16MHz (Clock Stop Detection) HSI : 8MHz ± 5% @ -40°C ~ +85°C LSE : 32.768KHz LSI : 32KHz ± 10% @ 25°C
PDMA	1	8 channels
USB	1	USB 2.0 Full Speed Device
SCI	1	ISO-7816-3 Smart Card Interface
EBI	1	36MB/s High Speed Bus with programmable timing and interfaces to support a wide range of devices such as SRAM / NOR / LCD
I ² S	1	Audio Interface, Master or Slave mode, Mono or Stereo
CRC	1	CCITT CRC-16 and Ethernet (IEEE-802.3) CRC-32 Support PDMA to complete CRC computation for a block of memory

HT32F1655 / 1656 : Feature -2

Function	Spec/Number	Description
Basic Function Timer (BFTM)	2	<ul style="list-style-type: none"> – 32-bit compare counter – One shot / Repetitive interrupt mode
General Purpose Timer (GPTM)	2	<ul style="list-style-type: none"> – Input capture – Output compare – PWM generation (Edge and Center-aligned mode) – Single Pulse Mode output – QEI & Hall sensor interface
Motor Control Timer (MCTM)	2	<p>Similar to GPTM but with extra motor functions:</p> <ul style="list-style-type: none"> – Complementary outputs with programmable dead time insertion – Programmable polarity – Programmable idle state – Break protection – Supports 3-phase motor control
USART	2	<p>Supports SPI Master Mode, up to 9 MHz With FIFO, Baud Rate up to 4.5 Mbps</p>
UART	2	With FIFO, Baud Rate up to 4.5 Mbps
SPI	2	Master Up to 36 MHz / Slave Up to 18 MHz
I ² C	2	Master / Slave Standard / Fast mode (100 / 400 KHz)
ADC	12-bit x 16 channels	Max. 1 Msps with 12-bit SAR ADC
Op Amp / Comparator	2	
RTC	1	
Watchdog	1	

HT32F1655 / 1656 : Feature -3

Function	Spec/Number	Description
LVD	✓	8 levels : 2.7V ~ 3.5V, 0.1V per level
BOD	✓	2.6V
POR	✓	Power On Reset : 1.36V
Internal LDO	1	$V_{IN} = 2.7V \sim 3.6V$ Normal mode: $V_{OUT} = 1.8V / 200mA$ Low-power mode: $V_{OUT} = 1.8V / 100mA$
Operating Mode	Run, Sleep, Power-down Deep Sleep Mode1, 2	Run : Typ. 74mA @ $V_{DD} = 3.3V$ Deep Sleep 2 : Typ. 22μA @ $V_{DD} = 3.3V$
Backup Registers	32-bit×10	General data storage in Backup Domain
ESD / Latch Up	ESD HBM : 4KV ESD MM : 300V Latch up : ±400mA	HBM : Human Body Mode MM : Machine Mode
Operating Temperature	-40°C ~ +85°C	
I/O Ports	35 / 49 / 80	Max. Port A ~ E [15:0] ; Can be configured with alternative functions (AFIO)
Package	48QFN 48 / 64 / 100LQFP	

HT32F1655 / 1656 : Power Saving Mode

$V_{DD} = 3.3V @ 72MHz, T_A = 25^\circ C$

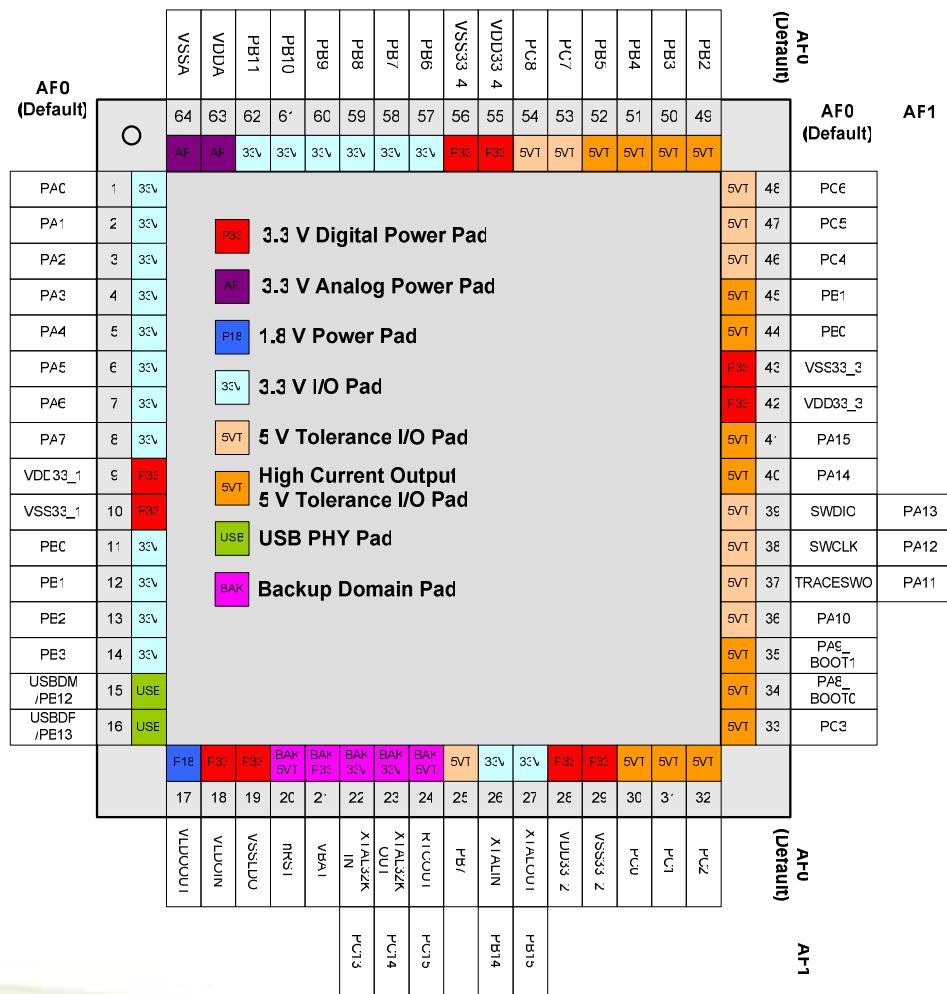
Mode	Status	Typ.
Run 1	CM3 on, All Peripherals on	74mA
Run 2	CM3 on, All Peripherals off	32mA
Sleep 1	CM3 off, All Peripherals on	55mA
Sleep 2	CM3 off, All Peripherals off	10mA
Deep Sleep 1	RTC on, 1.8V LDO on	65µA
Deep Sleep 2	RTC on, 1.8V LDO off , DMOS on	22µA
Power Down 1 (Power Supply)	RTC off, 1.8V LDO off, $V_{DD33} = V_{BAT} = 3.3V$	3µA
Power Down 2 (Battery Supply)	RTC off, 1.8V LDO off, V_{DD33} not present, $V_{BAT} = 3.3V$	2.7µA

HT32F1655 / 1656 : Pin Assignment -1

48LQFP : 7 mm x 7 mm

48QFN : 6 mm × 6 mm

HT32F1655 / 1656 : Pin Assignment -2



64LQFP : 7 mm × 7 mm

64LQFP : 10 mm × 10 mm

HT32F1655 / 1656 : Pin Assignment -3

		AF0 (Default)	AF1 (Default)	AF1 (Default)	AF1 (Default)	AF1 (Default)
	O	VSSA	VDD3_4	VDD3_4	VDD3_2	VDD3_2
PA0	1	33V				
PA1	2	33V				
PA2	3	33V				
PA3	4	33V				
PA4	5	33V				
PA5	6	33V				
PA6	7	33V				
PA7	8	33V				
PE8	9	33V				
PE9	10	33V				
PE10	11	33V				
PE11	12	33V				
PE12	13	33V				
VDD3_1	14	P03				
VSS3_1	15	P03				
PC9	16	33V				
PC10	17	33V				
PC11	18	33V				
PC12	19	33V				
PC6	20	33V				
PE12	21	33V				
USBDM	22	USE				
USBDF	23	USE				
PE13	24	33V				
NC	25					
		P16 P03 P03 BAK_SV1 BAK_P03 BAK_33V BAK_EV1	P03 P03 EV1 EV1 EV1 EV1 EV1	EV1 EV1 EV1 EV1 EV1 EV1 EV1	EV1 EV1 EV1 EV1 EV1 EV1 EV1	P03 P03 P03 P03 P03 P03 P03
		26 27 28 29 30 31 32 33 34	35 36 37 38 39 40 41 42 43	44 45 46 47 48 49 50 51 52	53 54 55 56 57 58 59 50 51	P04 P05 P06 P07 P08 P09 P010 P011
		VDDOUT	VDDIN	VSSDIO	XIAL32KOUT	XIAL32KIN
		mRSI			PC14	PC13
		VBA				

100LQFP : 14 mm × 14 mm

HT32F1655 / 1656 : Competitive Advantages

Cutting-edge Core
ARM V7 Cortex-M3 at
72MHz

Large Memory Size
Flash : **128 / 256KB**
SRAM : **32KB**

Advanced Peripherals
ADC : **1 Msps, 12-bit**
EBI, I²S, CRC-16/32

Rich Choice of Tools
Coocox : **Free**
Keil
IAR

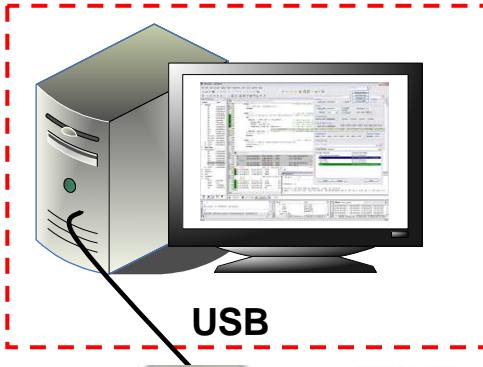
Reliable Software
CMSIS -- compliant
MISRA C -- compliant
RTOS / Middleware

Solution Provider
LCD Transmission
WiFi, Ethernet
Wireless Comm.



Development Tools : Overview

IDE



- Compiler
- Debugger
- Flash Loader



ICE



Interface between IDE & Board
e-Link32, uLink2, JLink

Board



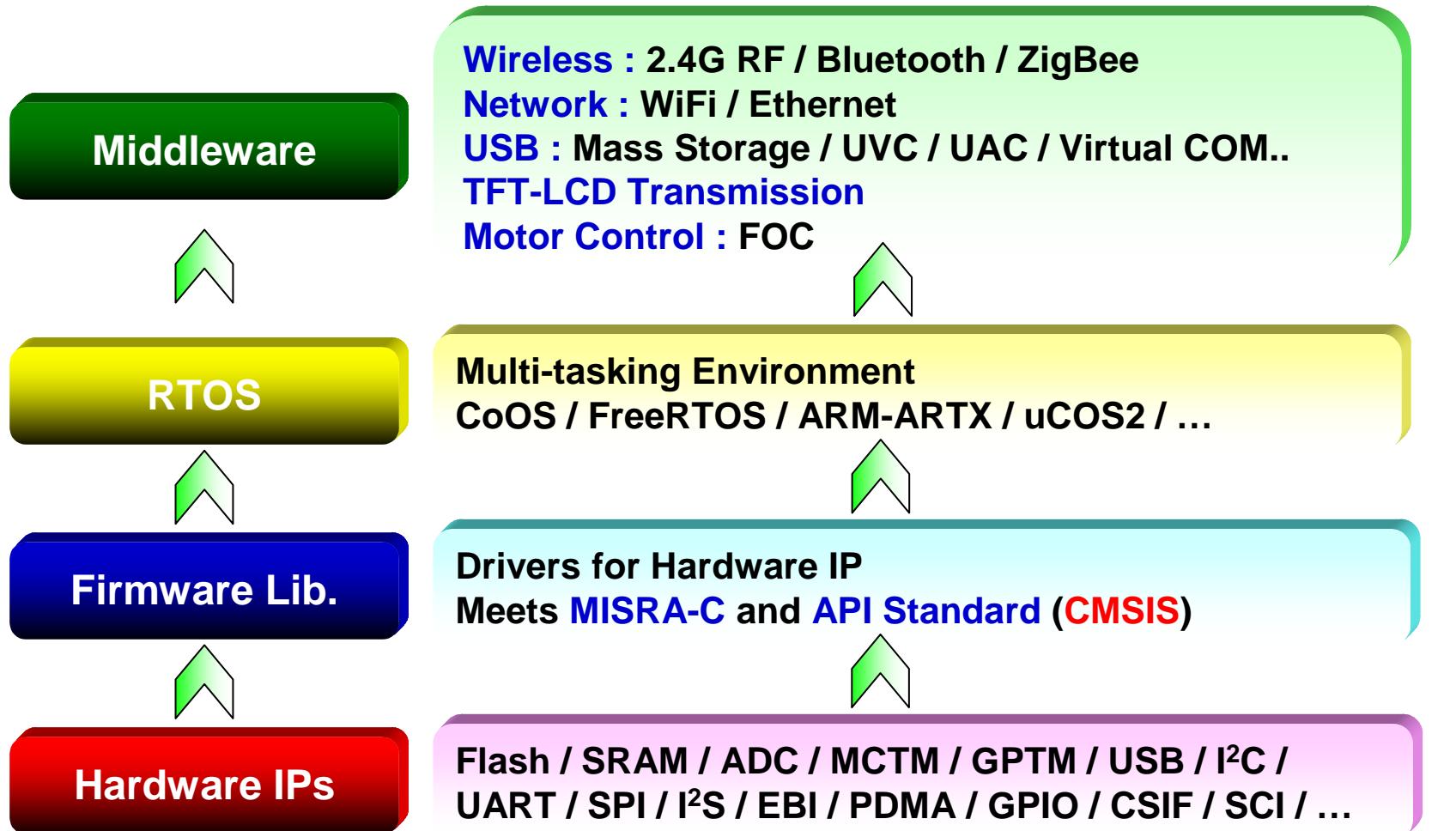
Firmware Library

Drivers to Control H/W IPs

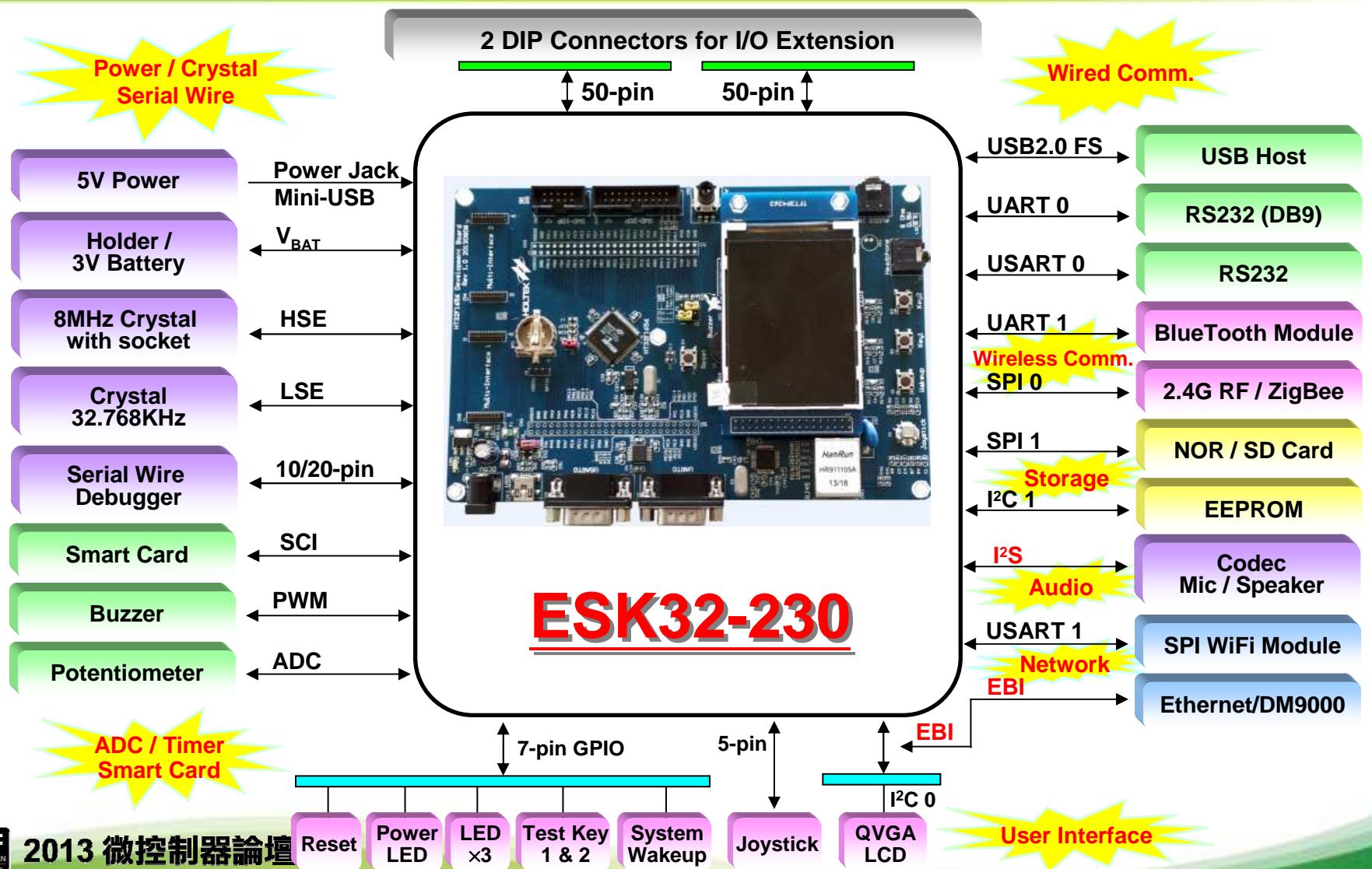
RTOS

Multi-tasking Environment

Development Tools : Software Stack



Development Tools : Development Board



Development Tools : Documents

	Item	Description
IC	Datasheet User's Manual	IC Brief Description IC Detailed Description
F/W	Programmer's Guide	F/W library Guide in CHM format
Tools	DVB User's Manual e-Link32 User's Manual Quick Start Guide	Development Board Description e-Link32 Installation Guide IAR / Keil Installation Guide
IAP / ISP	IAP / ISP User's Manual	IAP / ISP PC UI Manual
App	Application Notes	USB Applications (HID / INT / BULK / ISO ...)

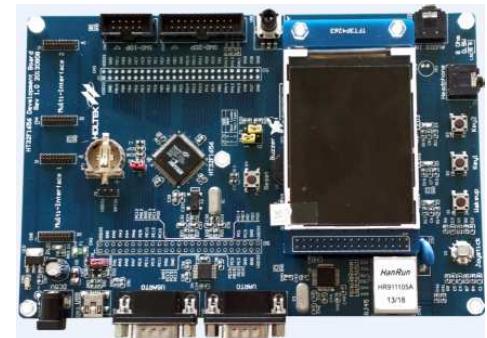
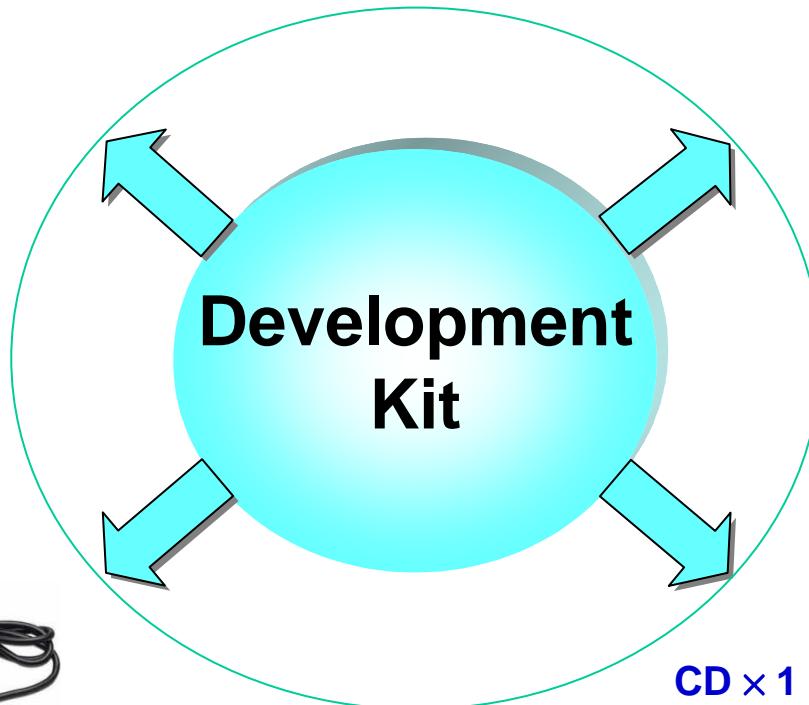
Development Tools : Kit Package



**USB Debug Adaptor
e-Link32**



USB Cable × 2
➤ 5V Power Input
➤ e-Link32 communication



**Development Board
ESK32-230**



- CD × 1**
- IDE (Keil & IAR Evaluation)
 - Firmware Library & RTOS
 - IAP / ISP UI
 - Schematics
 - Documents

Flash Programming : Overview

MCU	Firmware	Interface	Software	Target
Writer	Unmounted	No	Socket	HOPE3000
ICP	Mounted	No	Serial Wire	IDE
ISP	Mounted	BootLoader	UART / USB	IAP/ISP UI
IAP	Mounted	User's AP	Various	IAP/ISP UI
				End User

Flash Programming : Writer

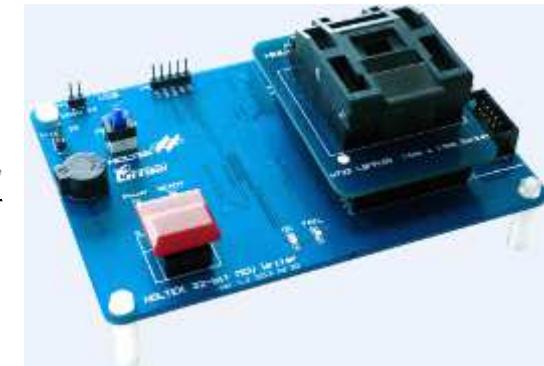
HT32 Series MCU Writer

- For Mass Production
- 1:1 or 1:4 Programming via socket
- Two operation modes
 - On-line Mode : Connect with PC via USB
 - Off-line Mode : Stand alone one button operation
- 5 seconds only for programming 128KB Flash ROM

1:4 Writer



1:1 Writer



Flash Programming : ISP / IAP

ISP (In-System Programming)

- Program through the **Boot Loader** by the IC vendor
- **Mass Erase** before updating the Firmware
- Triggered by setting **BOOT0** and **BOOT1** Pins to low

IAP (In-Application Programming)

- Program through **the application** by the developers
- Programmed range can be **user-defined**
- Triggered by the application or while the main application **does not exist or crash**
- Example Source code is provided

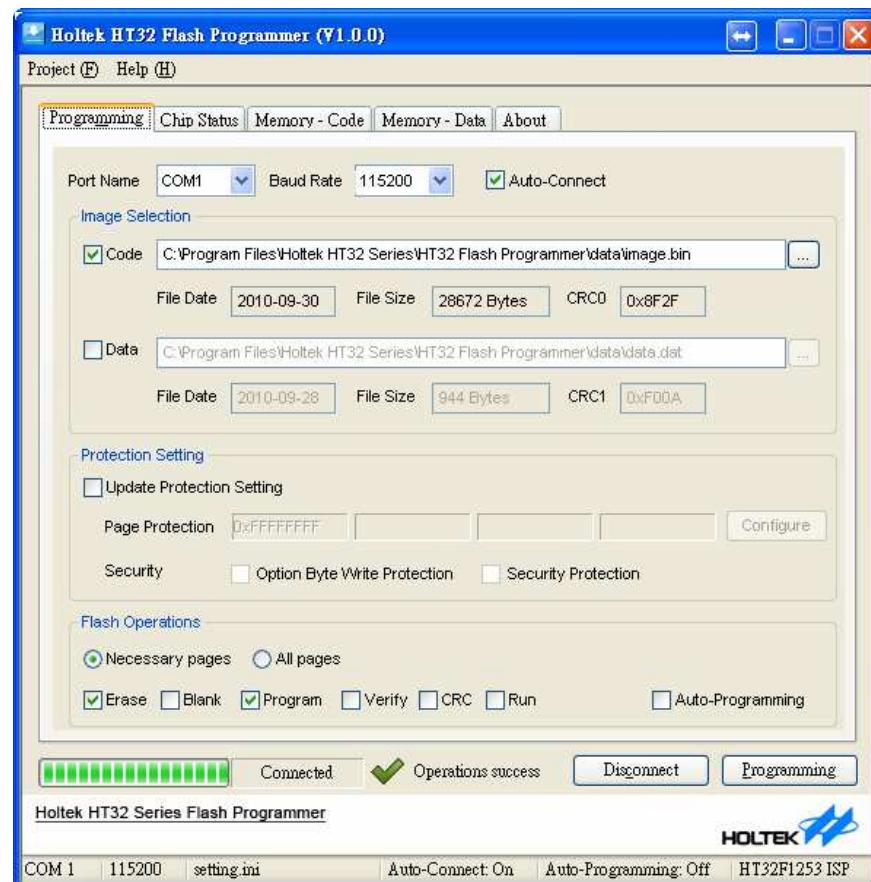
Flash Programming : PC UI

ISP / IAP Standard UI

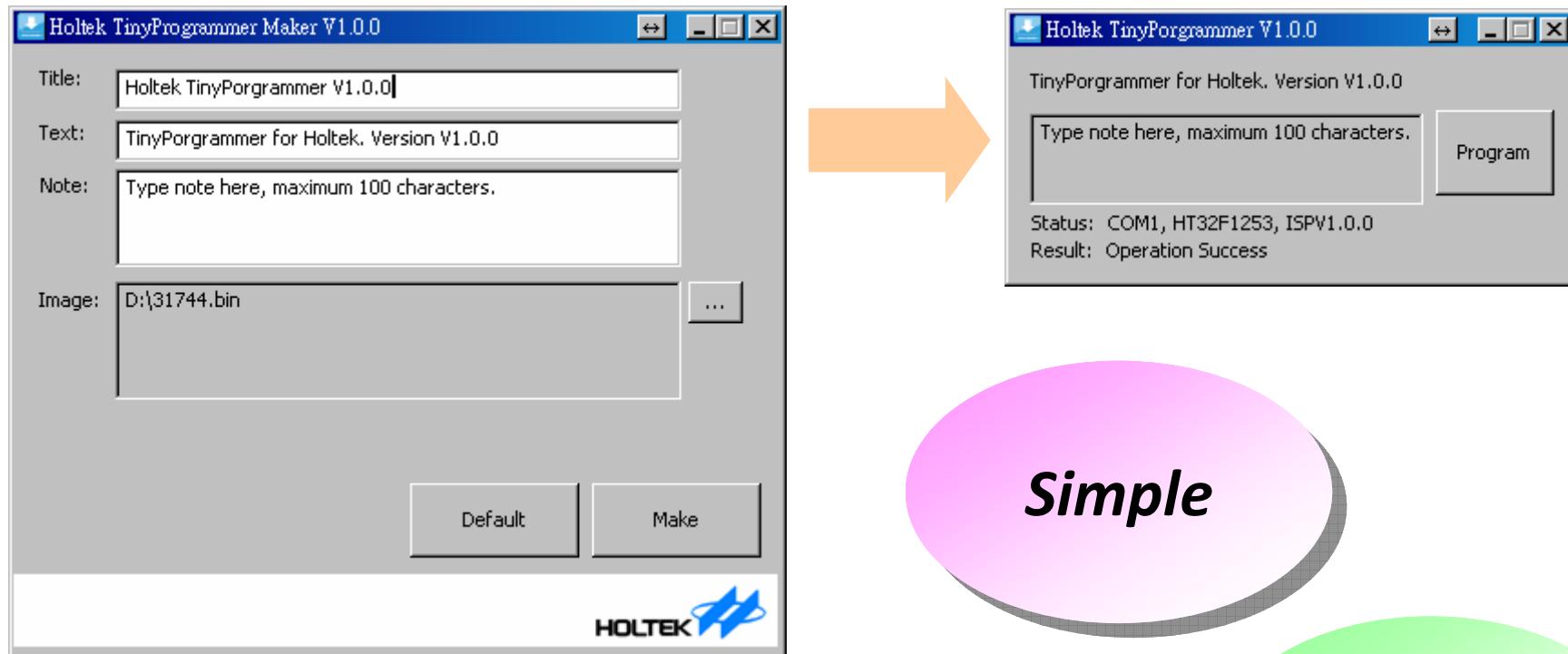
- Setting
- Programming Firmware
- Checking Status
- Reading Memory
- Interface : **RS232 / USB**

SDK

- For customized UI
- “**ISPCmd.dll**” DLL API
- Example code in VC++



Flash Programming : TinyProgrammer



Simple

Encryption

Customize

Holtek HT32 Family

■ Applications

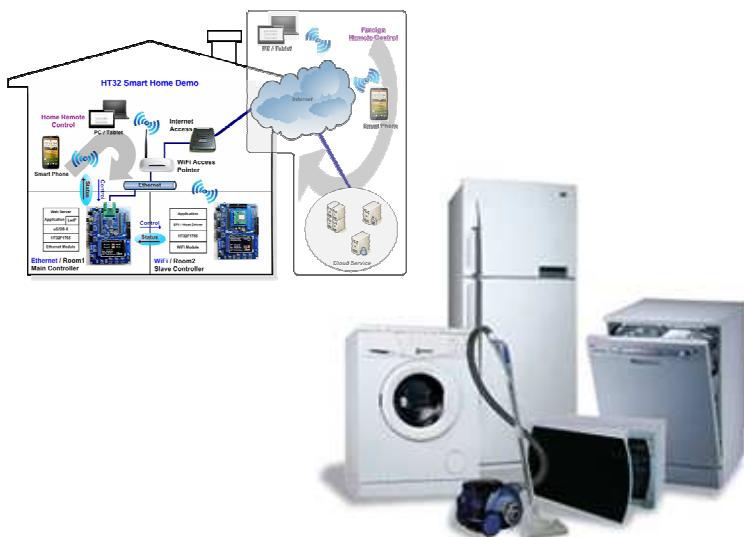
LAN / WiFi
Networking

LCD Data
Transmission

3 Phase
Motor Control

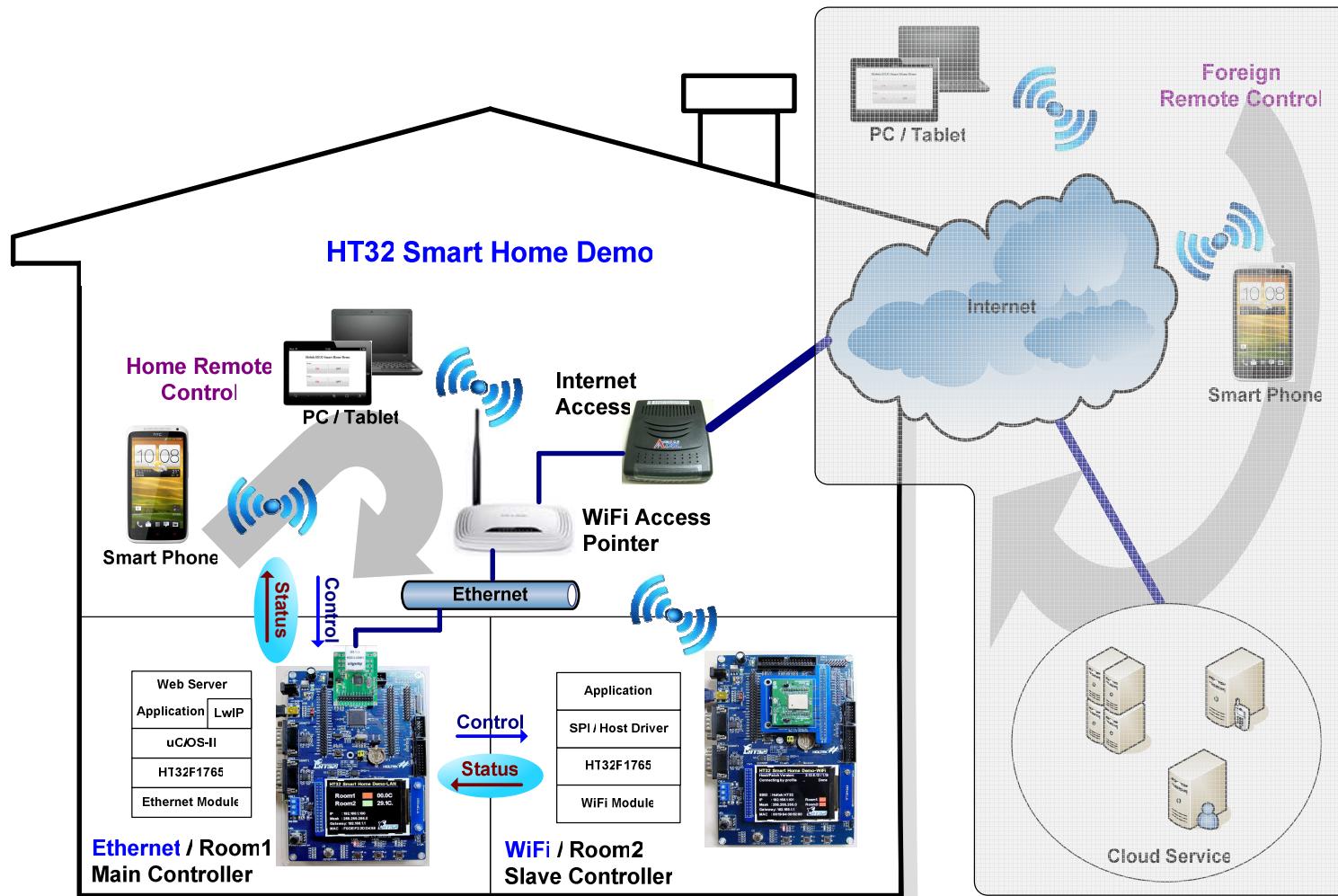
LAN/WiFi Networking : Applications

LAN / WiFi Networking

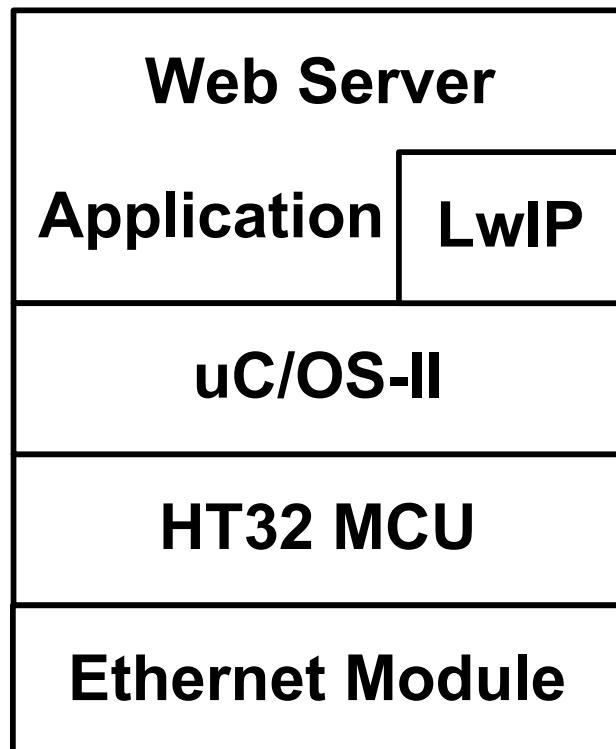


- Smart Home
- Home Automation
- Internet of Things (IoT)
- Machine to Machine (M2M)
- Cloud Control
- Intelligence White Goods
- Household Appliances
- Network to UART Bridge

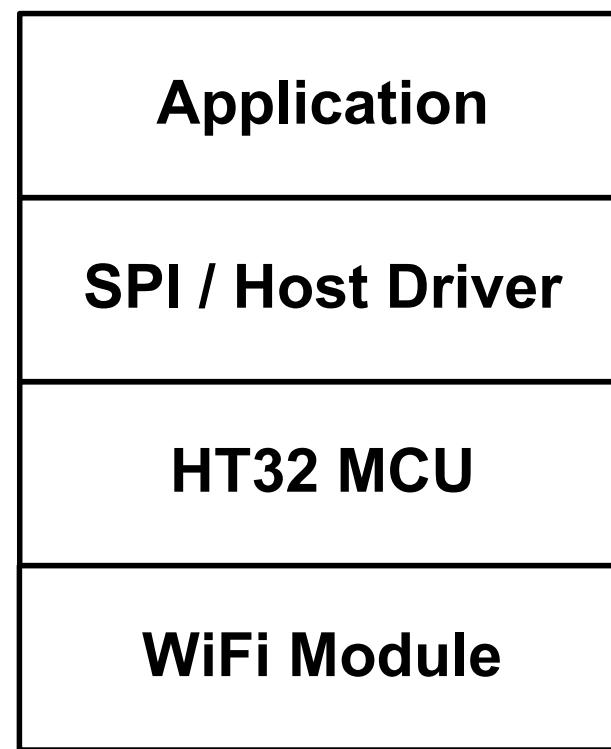
LAN/WiFi Networking : System Architecture



LAN/WiFi Networking : Block Diagram

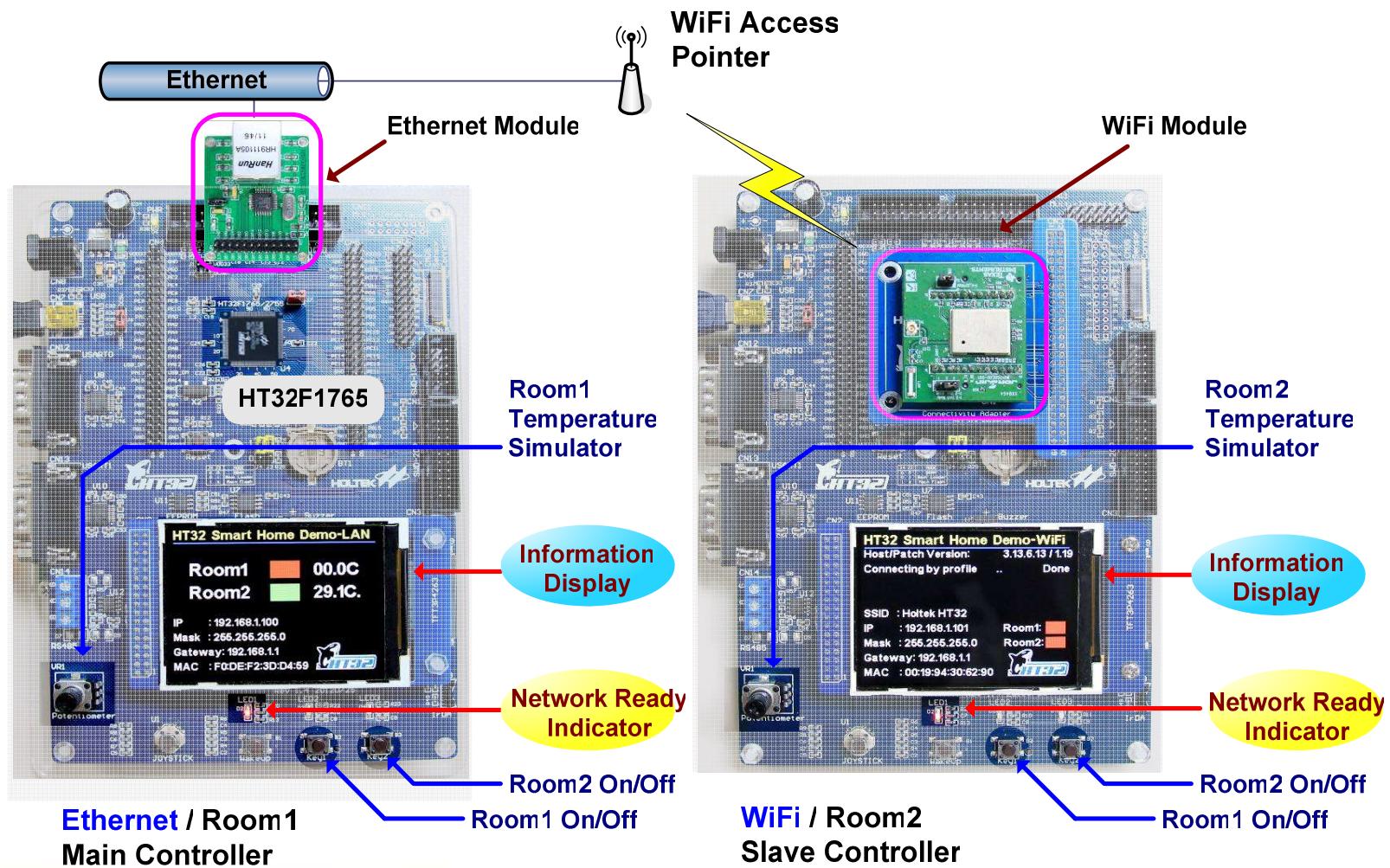


LAN



WiFi

LAN/WiFi Networking : Demo kit



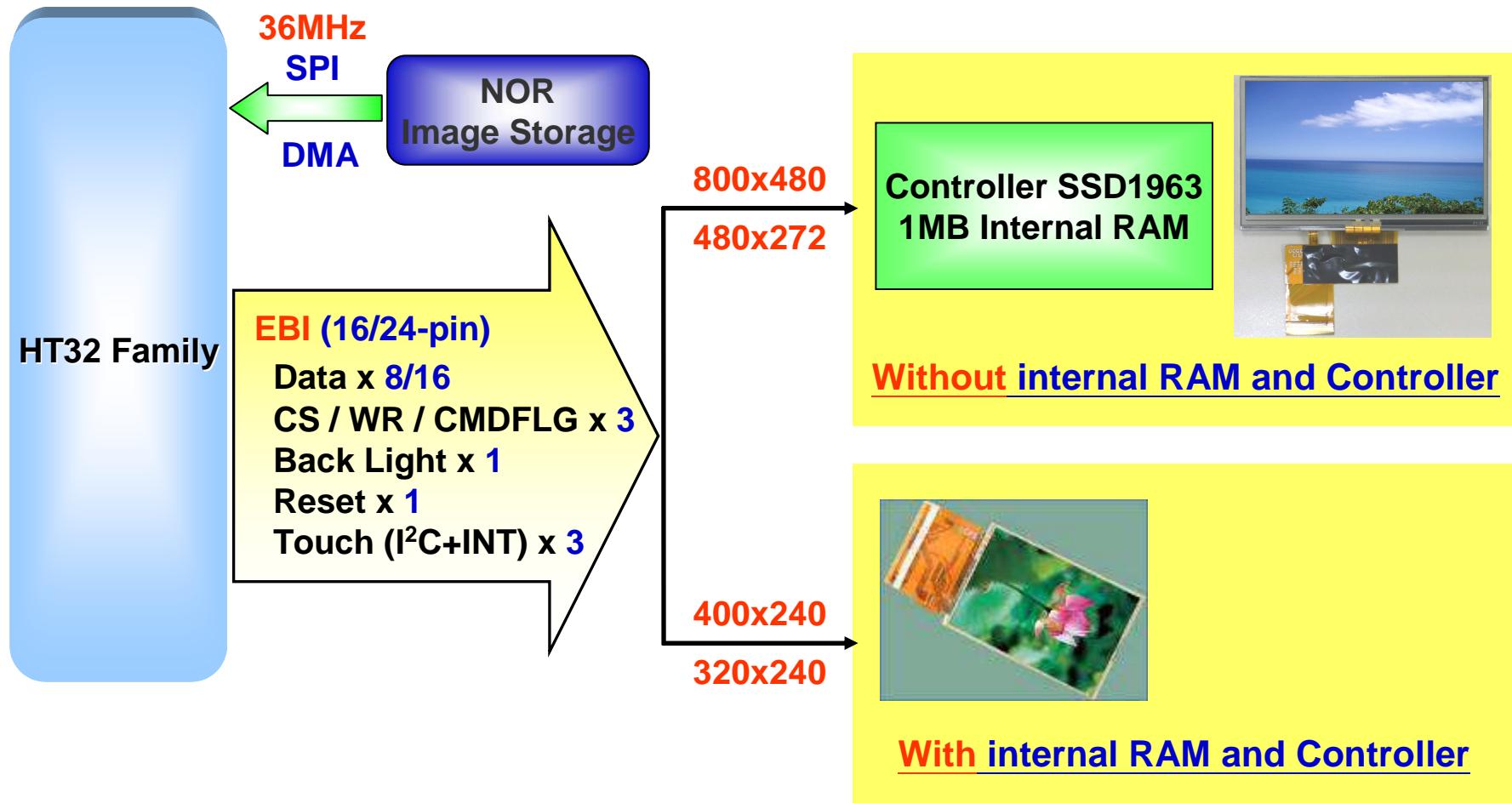
LCD Transmission : Applications

LCD Data Transmission

- White Goods
- Household Appliances
- User Interface



LCD Transmission : System Architecture



LCD Transmission : Features

■ Environment

- 8-bit Mode : 48 / 64-pin LQFP
- 16-bit Mode : 100-pin LQFP

■ Display Speed

Resolution	8-bit / 16-bit Mode
5.0" ~ 7.0" (480×800)	11.0 Frames/s
3.5" ~ 4.7" (272×480)	32.4 Frames/s
2.8" ~ 3.2" (240×400)	44.1 Frames/s
2.0" ~ 3.5" (240×320)	55.1 Frames/s

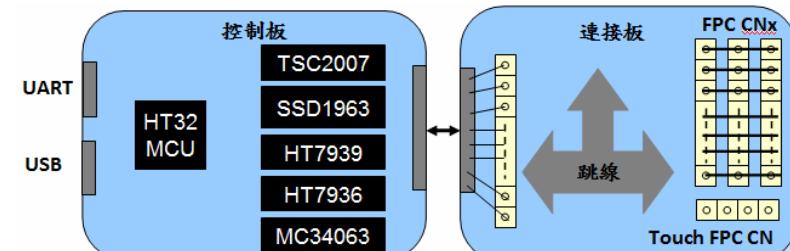
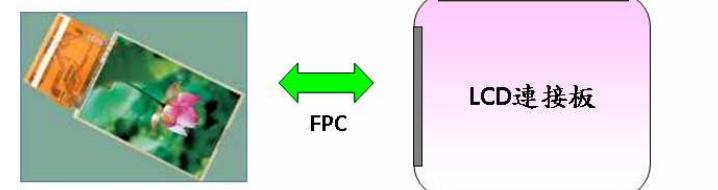
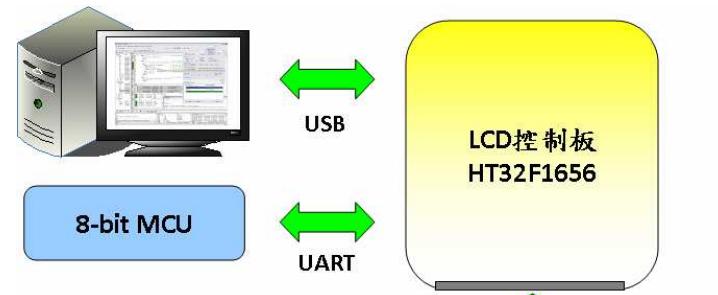
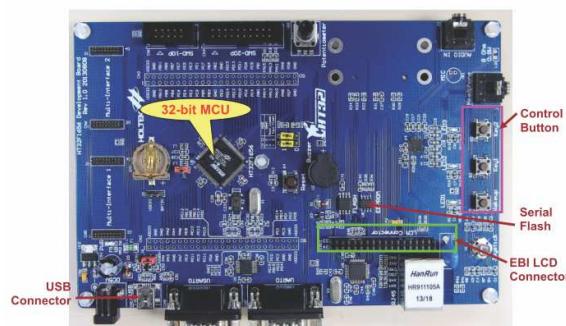
HT32F1655/1656 with EBI

LCD Transmission : Demo Kit

HT32F175x



HT32F165x



HT32 LCD Platform

3 Phase Motor Control : Applications

3 Phase Motor Control

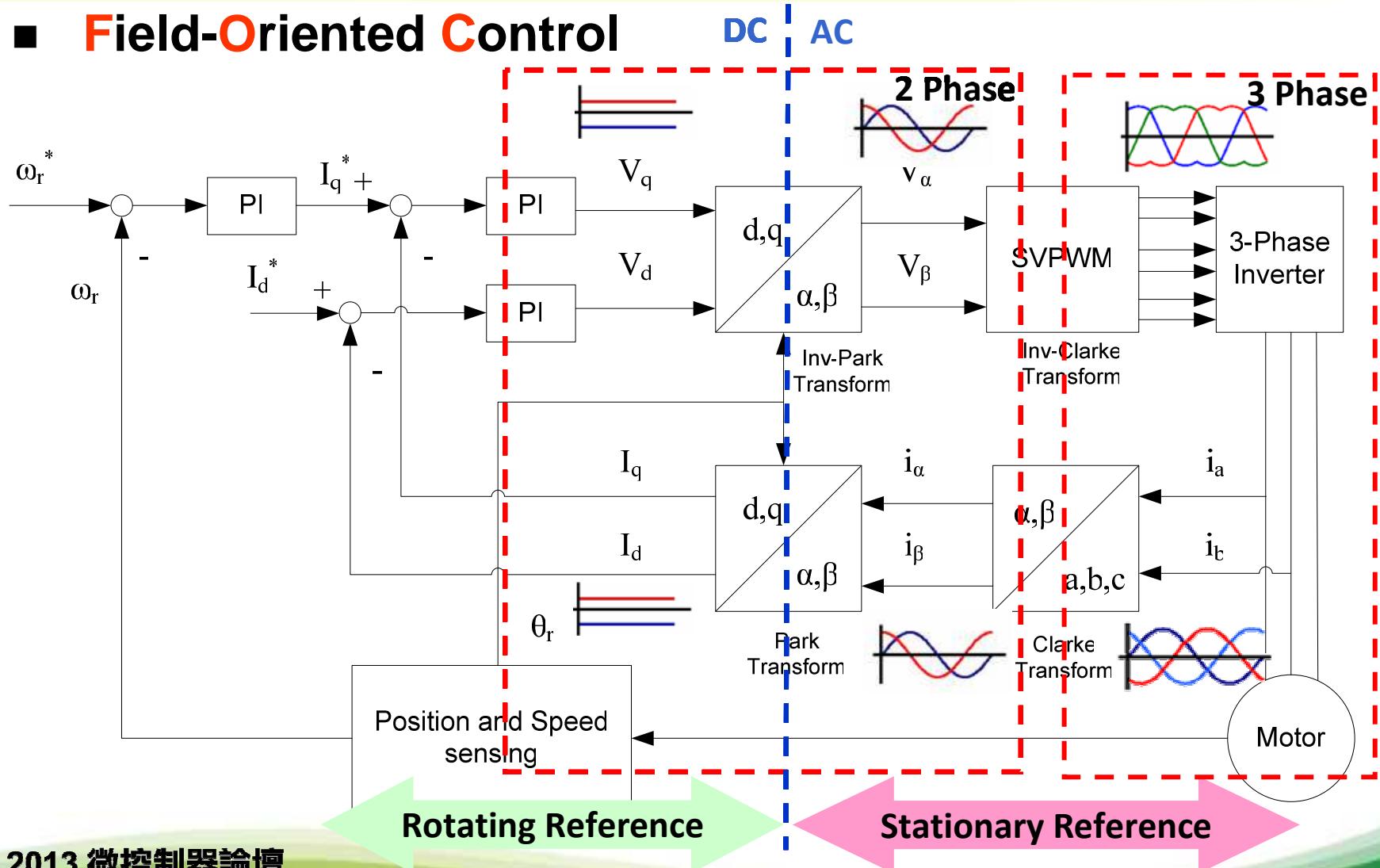
- Motor Control
- Industrial Control
- White Goods
- Other Products



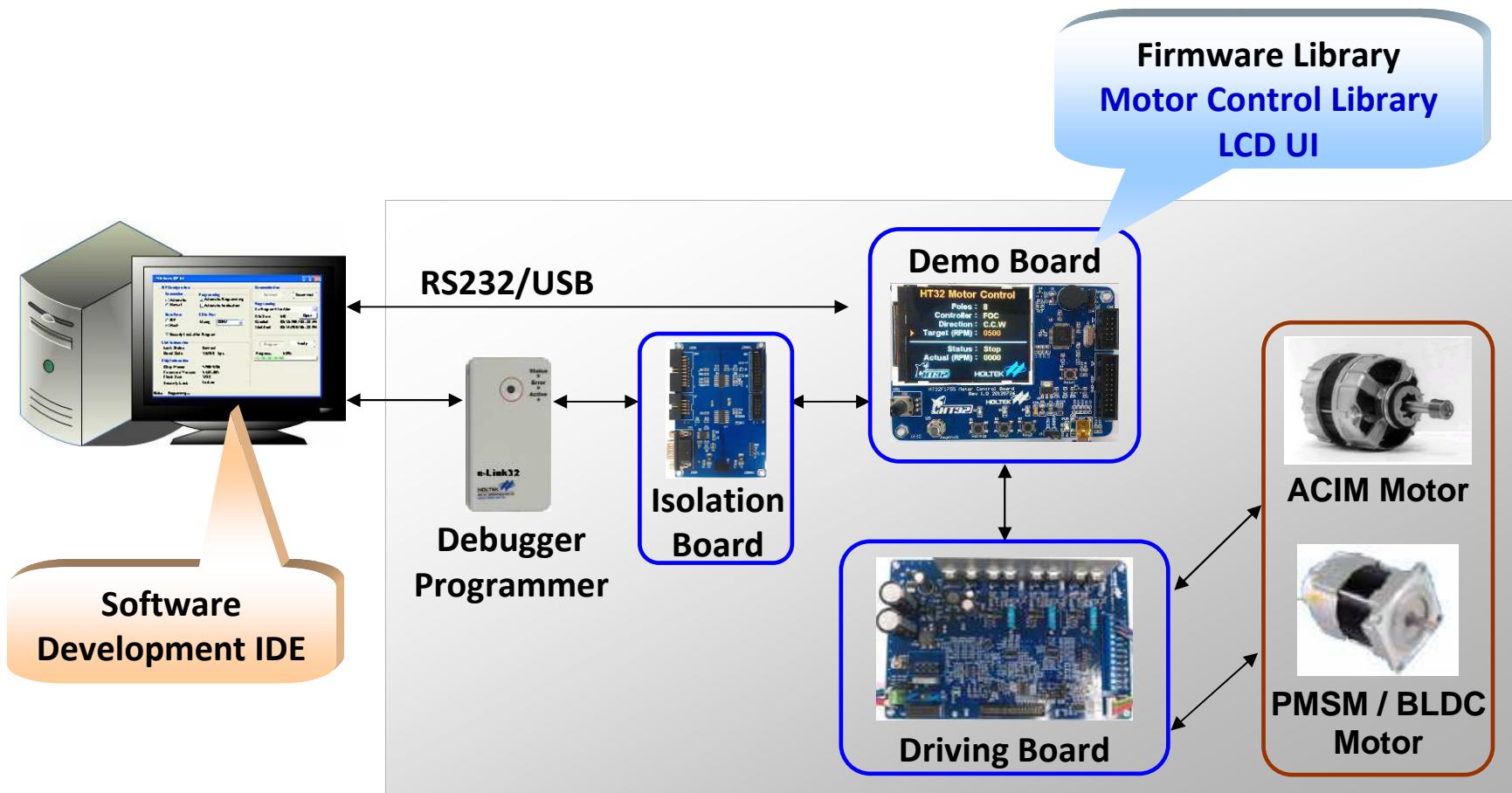
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3 Phase Motor Control : FOC

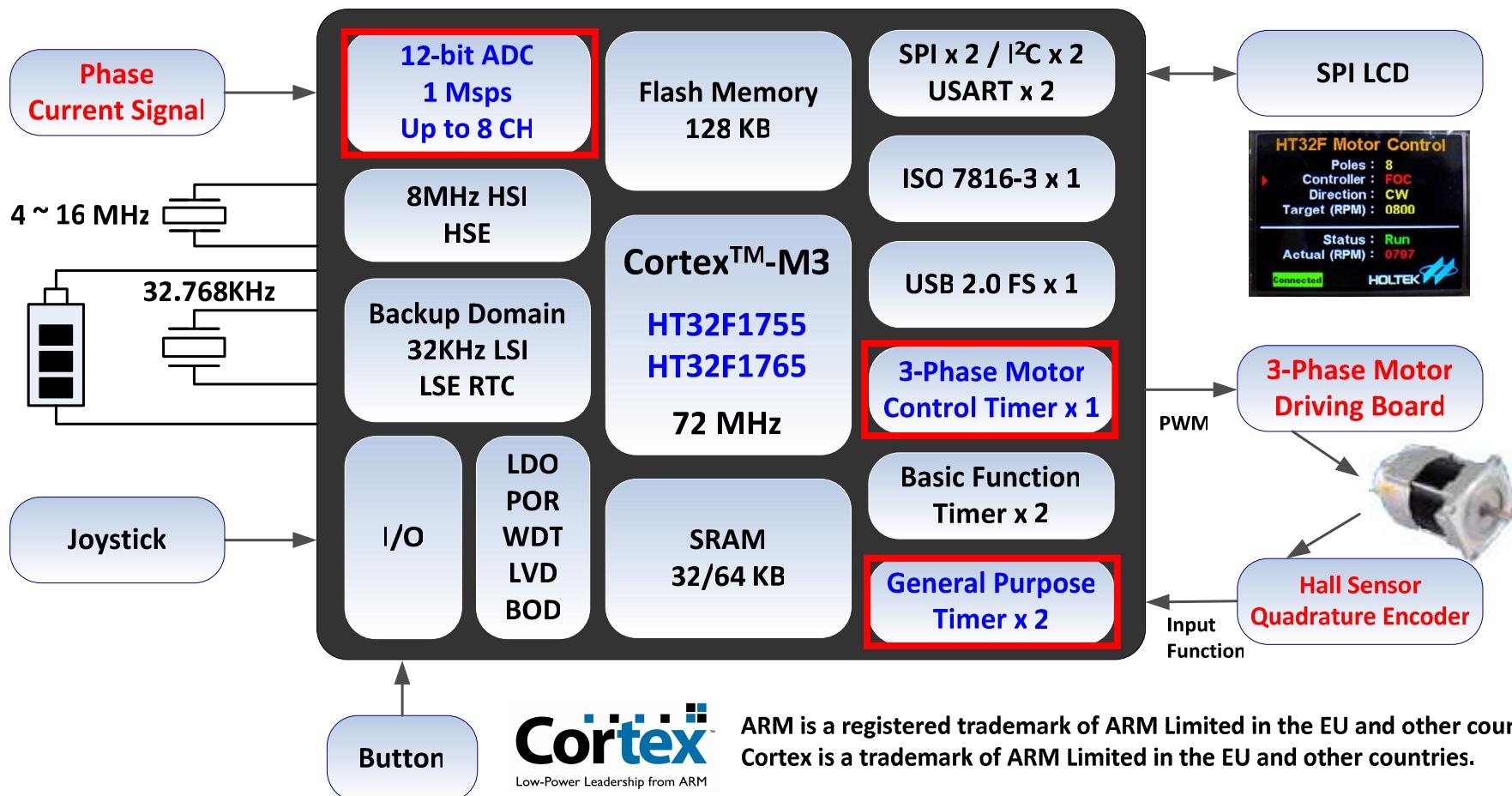
■ Field-Oriented Control



3 Phase Motor Control : System Architecture



3 Phase Motor Control : Block Diagram



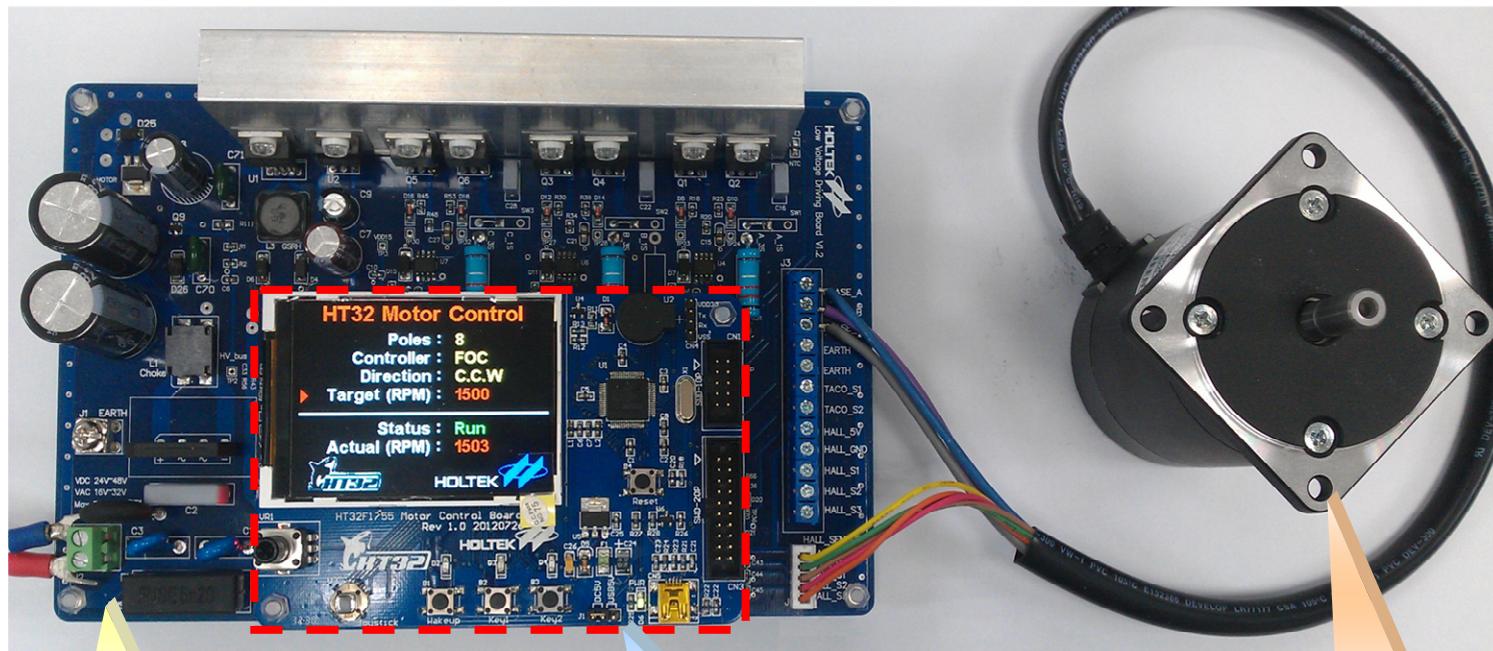
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3 Phase Motor Control : Feature

Algorithm	FOC (Field-Oriented Control) SVPWM (Space Vector PWM) Hall-Sensored & Sensorless
Motor (BLDC)	Voltage : 24V ~ 48V Power : 30W ~ 200W RPM : 3000 ~ 30000
Communication	USB & RS232
Peripheral	VR : Adjust speed Buttons : Start / Stop / Parameter
UI	PC : Control via USB / RS232 LCD : Local control through VR/Buttons

3 Phase Motor Control : Demo Kit



Driving Board
48V, 200W

HT32F1755
Demo Board

24V BLDC
Motor

Holtek HT32 Family

HT32F125X

Basic Functions

HT32F1755/1765

Larger SRAM (32KB/64KB)

HT32F1655/1656

Larger Flash (256KB)
Rich Peripherals
EBI、I²S、CRC-16/32

HT32F2755

Large SRAM (64KB)
CMOS Sensor Interface



Move Forward to the 32-bit MCU – HT32 Family

- High Performance
- Easy to Development

