STM32F103VE EvoPrimer

Migration from Primer2

Application Note AN60

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Contents

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1. Introduction

The EvoPrimer for STM32F Performance Line is the new development package based on Raisonance's versatile, innovative Open4 platform and an STM32F103VE Target Board.

The EvoPrimer is an enhancement of the STM32-Primer2. It supports various Target Boards, including the STM32F103VE which is the same micro-controller implemented in the Primer2.

1.1 Purpose of this manual

This manual provides a description of the differences between the Primer2 and the EvoPrimer for STM32F103VE designs, and how to migrate an application from Primer2 to EvoPrimer for STM32F103VE.

1.2 Scope of this manual

This manual is only applicable to EvoPrimer for STM32F103VE Performance Line. Other versions of EvoPrimer for STM32 are not applicable, due to the important differences between the micro-controller hardware and software (STM32F107VE for example).

Further information can be found in:

- STM32-Primer2-Manual,
- STM32E-EvoPrimer-Manual.

These manuals are available on the Ride7 help page.

Visit the Circle community web site at www.stm32circle.com for more resources and software tool downloads.

1.3 Additional help or information

Please visit the Raisonance website: *http://www.raisonance.com/* and the forum *http://www.raisonance.com/Forum/punbb/* or contact Raisonance.

Address: Raisonance S.A.S.

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                38330 Montbonnot Saint Martin

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Telephone: +33 4 76 61 02 30

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Email: ***support@raisonance.com***

If you find any errors or omissions, or if you have suggestions for improving this manual, please let us know by email.

2. Hardware differences

STM32 Primer2, which preceded EvoPrimer for STM32F103VE, was based on a single piece of hardware that allowed users to work exclusively with the STM32F103VE incorporated into its design. The EvoPrimers have a modular design that allows users to work with different target processors - among these is the STM32F103VE.

The EvoPrimer is composed of two major hardware elements:

- a Base platform,
- an STM32F103VE Target Board.

The Target Board is equipped with the same STM32F103VE microcontroller as the Primer2, and the EvoPrimer (Base + Target Board) provides the same features as the Primer2.

However, the EvoPrimer enhancements have resulted in a few differences between the 2 platforms, which are be explained in this manual.

2.1 Base features

- USB debug/programming connection (SWD for STM32)
- QVGA (320x240) backlit color LCD, with touch screen capability
- Joystick/push button (mechanical)
- 4 push buttons (based on touchscreen capability)
- Micro SD card connector
- Audio circuit with Microphone/Loudspeaker/Jack
- 3D MEMS accelerometer
- Li-Ion battery with charge management circuitry
- Add-on connector (USART, SPI, I2C, ADC,...)

2.2 Target Board features

The STM32F103VE Target Board integrates the following hardware features:

- STM32F103VET6 microcontroller (512KB Flash, 64KB RAM),
- audio codec,
- USB device / host port,
- one CAN port.

2.3 Differences

2.3.1 LCD

A new LCD has been implemented, increasing resolution from 160x128 pixels to QVGA (320x240 pixels) and embedding a new controller (ILITEK ILI9325).

It can work in 8-bit parallel port mode (LCD DO-D7), or in SPI mode (LCD D0-D1). This mode is configured by the base micro-controller during initialization phase, after Target Board recognition, using the Target Board Code Identification made with 8 pull-up or pull-down resistors.

The mode used for the STM32F103VE Target Board is 8 bits parallel like Primer2.

2.3.2 LCD bus

In the Primer2, the LCD bus was misaligned with the micro-controller FSMC bus (LCD_D0 → FSMC_D4 / LCD_D7 → FSMC_D11).

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In the STM32F103VE Target Board, the LCD is also driven with 8 bits parallel data bus, but the LCD bus has been realigned on the 8-bit FSMC bus (LCD_D0 → FSMC_D0 / LCD_D7 → FSMC_D7).

So, the bus has been moved from PE.7 - PE.14 (Primer2) to PD.14 / PD.15 / PD.0 / PD.1 / PE.7 - PE.10

2.3.3 LCD backlight

In the Primer2, the backlight was active low. Now, it is active high, so it is not powered during the Primer power-on phase, in order to avoid spikes to the power supply.

The CAN port has moved, so the backlight command has been moved from PB8 to PD13.

2.3.4 Audio

The Primer2 used two I2S ports for audio (I2S2 for voice recording and I2S3 for audio playing). The CircleOS cannot record and play sounds simultaneously, so the design was simplified to use only one I2S port (I2S2) for both playing and recording.

This permits the SPI3 / I2S3 port to be liberated for the Extension Card and application software.

2.3.5 Joystick / button

The 12MHz audio codec clock is provided by the MCO output of the micro-controller. In consequence, the Push Button has been moved from PA8 to PE15.

The joystick pins have been also moved, to accommodate the new debug trace connector.

2.3.6 LEDs

In the Primer2 the LEDs were tied to ground. Now, they are classically pulled up to VCC.

2.3.7 Application LED's

Two supplementary red LED's are provided on the Target Board (on pins PE11-PE12).

2.3.8 CAN

Due to the LCD realignment, CAN has been moved from PD0-PD1 to PB8-PB9.

Note : As for Primer2, the CAN transceiver is not soldered.

2.3.9 Trace connector

A trace connector has been added (JP1). This connector gathered all signals needed for debug and trace functionality.

It allows to debug the card with another tool than the embedded Rlink, and also add ETM trace possibility.

2.3.10 Miscellaneous

MEMS_CS : the mems chip select is moved from PE2 to PA4, due to debug trace connector presence.

IRDA_CS : the IrDA chip select is now always set to ground.

2.4 Extension connector

The Base has a 20-pin HE14 female right-angle extension connector, that provides signals directly from/to the Target Board without any treatment by the base. Due to technical choices, some pins have their role changed.

Same damage could be done to the Extension Board or Target Board if attention is not focused on the following points :
   - **pin 1**: EvoPrimer provides 3V1 on pin 1,
   - **pin 19** was a Primer2 input for external power supply, in order to supply the Primer2; it is now an EvoPrimer output providing the base battery voltage, in order to supply the Extension Card.

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Table 1: Comparison of the signals used by both platforms

Pin	Printed name (*)	Primer2		EvoPrimer		Remark
		Pin	Name	Pin	Name	
1	V2V8	Vcc	VCC2V8	Vcc	VCC	EvoPrimer provides 3V1 instead of 2V8
2	GND	GND	GND	GND	GND	
3	SCL	PB.6	CX_I2CSCL	PB.6	CX_I2CSCL	
4	SDA	PB.7	CX_I2CSDA	PB.7	CX_I2CSDA	
5	MISO	PB.14	AUDIO_SPI_MISO	PB.4	SPI3_MISO	
6	SD	PB.15	AUDIO_I2S2_SD	PB.5	SPI3_MOSI / I2S3_SD	SPI2/I2S2 was available on Primer2 (shared with audio codec). SPI3 is now available shared with SWV trace debug output
7	SCK	PB.13	AUDIO_I2S2_SCK	PB.3	SWO	
8	WS	PB.12	AUDIO_I2S2_WS	PA.15	JTDI_I2S3_WS	
9	CANH		CX_CANH		CX_CANH	Transceiver outputs (not soldered) are located on the same connector pins, but do not use the same micro-controller pins : - Rx: PD0 → PB8, - Tx: PD1→ PB9
10	CANL		CX_CANL		CX_CANL	
11	ADC1	PC.4	CX_ADC1	PC.4	CX_ADC1	
12	ADC2	PC.5	CX_ADC2	PC.5	CX_ADC2	
13	A_TIM	PB.0	CX_ADC_TIM	PB.0	CX_ADC_TIM	
14	CTS	PA.0	CX_USART_CTS	PA.0	CX_USART_CTS	
15	RTS	PA.1	CX_USART_RTS	PA.1	CX_USART_RTS	
16	TX	PA.2	CX_USART_TX	PA.2	CX_USART_TX	
17	CK	PA.4	CX_USART_CK	N/A	P_BUTTON	UART clock is replaced by Push Button that may allow Extension Board to wake up the Base.
18	RX	PA.3	CX_USART_RX	PA.3	CX_USART_RX	
19	VEXT		VCC_EXT.	N/A	VBAT	Primer2 took an external power supply, whereas EvoPrimer provides the base battery voltage.
20	GND	VSS	GND	VSS	GND	Ground

(*) : name printed on the Extension Card

2.5 Summary

Table 2: STM32 pins reaffection

Functionality	Primer2 pin	EvoPrimer pin	Remark
Button	PA8	PE15	Used for codec 12MHz clock (MCO pin)
Joystick L/R/U/D	PE.3 to PE.6	PD.8 to PD.11	Reserved for debug trace
CAN Rx	PD.0	PB.8	8-bit LCD aligned to FSMC bus
CAN Tx	PD.1	PB.9op	
Backlight command	PB.8	PD.13	Used by CAN after 8-bit LCD aligned to FSMC bus
IRDA_CS	PD.8	N/A	Always to ground
MEM_CS	PE.2	PA.4	Reserved for debug trace
LCD D0-D7	PE.7 to PE.14	PD.14 / PD.15 / PD.0 / PD.1 / PE.7 to PE.10	8-bit LCD aligned to FSMC bus
Application LEDs	N/A	PE.11 / PE.12	Supplementary LED's

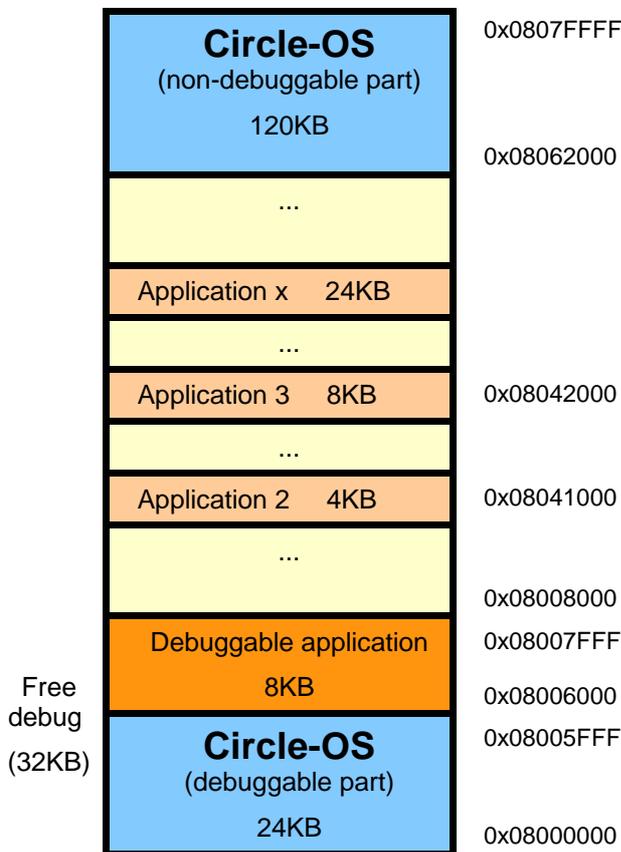RAISONANCE

3. Software differences

3.1 Memory map

More area has been reserved for CircleOS at the beginning of the Flash (48KB vs 24KB), and Ride7 allows debugging up to 64 KB for free.

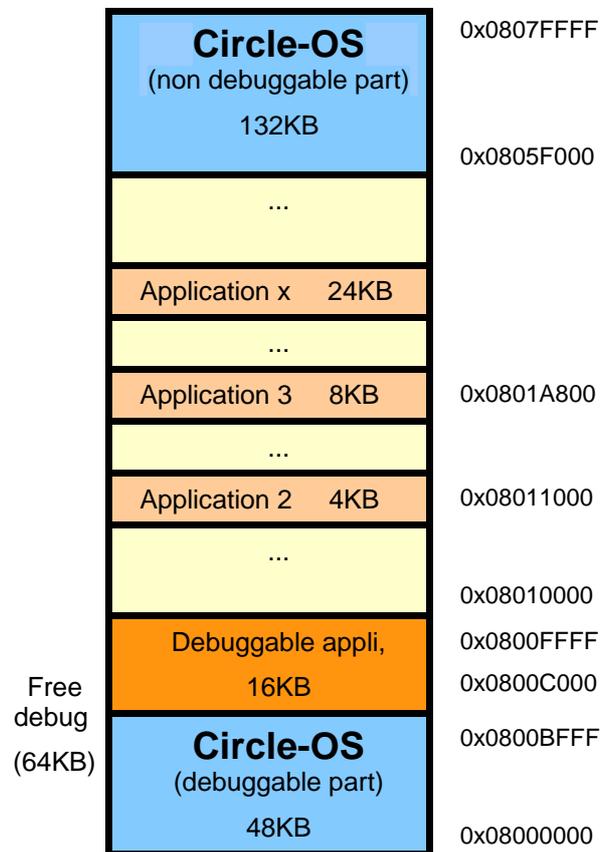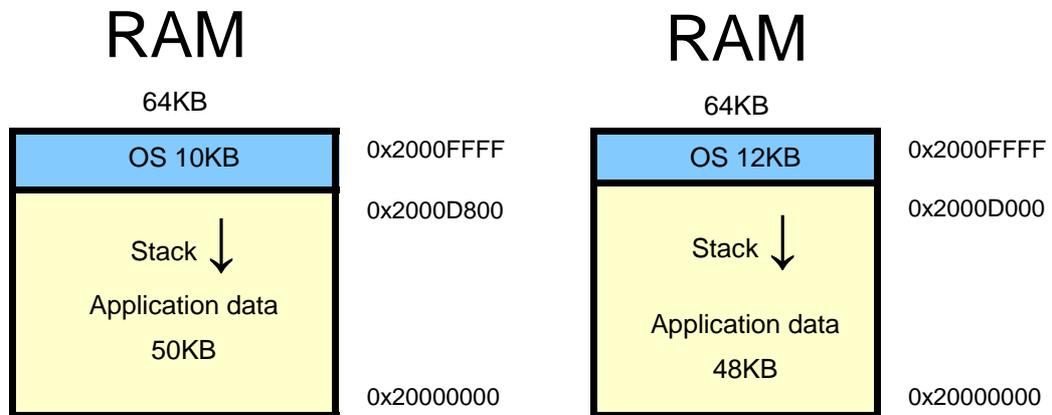### 3.1.1 Primer2 vs EvoPrimer flash memory map

PRIMER 2   **EvoPrimer**

PRIMER 2		EvoPrimer	
FLASH 512KB		**FLASH** 512KB	
Circle-OS (non-debuggable part) 120KB	0x0807FFFF	**Circle-OS** (non debuggable part) 132KB	0x0807FFFF
	0x08062000		0x0805F000
...		...	
Application x 24KB		Application x 24KB	
...		...	
Application 3 8KB	0x08042000	Application 3 8KB	0x0801A800
...		...	
Application 2 4KB	0x08041000	Application 2 4KB	0x08011000
...	0x08008000	...	0x08010000
Debuggable application 8KB	0x08007FFF / 0x08006000	Debuggable appli, 16KB	0x0800FFFF / 0x0800C000
Circle-OS (debuggable part) 24KB	0x08005FFF / 0x08000000	**Circle-OS** (debuggable part) 48KB	0x0800BFFF / 0x08000000

Free debug (32KB)

Free debug (64KB)

3.1.2 Primer vs EvoPrimer RAM memory map

PRIMER 2   **EvoPrimer**

RAM

64KB

OS 10KB	0x2000FFFF
	0x2000D800

Stack ↓

Application data

50KB

0x20000000

RAM

64KB

OS 12KB	0x2000FFFF
	0x2000D000

Stack ↓

Application data

48KB

0x20000000

3.2 LCD management

The new LCD has a resolution of 320 x 240 pixels, split into 2 areas :
- main area : 240 x 240 pixels available for applications and system menus,
- toolbar area : top 80 x 240 pixels only accessible by the toolbar functions.

3.2.1 Offset management

In order to maintain screen resolution compatibility, the new CircleOS manages a virtual offset, so applications developed for the Primer2 display in a 128 x 128 screen, that corresponds to a centered window in the useful 240 x 240 screen area.

By default, the offset is set before the application call. The new application for EvoPrimer must set the offset to zero, by calling the API function `LCD_SetOffset(OFFSET_OFF)`.

3.2.2 Touchscreen

For both platforms, the methodology of touchscreen acquisition was inspired from the **Cypress AN2173** application note.

But, due to LCD Primer2 hardware, the touchscreen was wired as follows:

xX = X+ (TOUCH_L = ADC channel 0),

vY = Y+ (TOUCH_U = ADC channel 1),

vT = Y- (TOUCH_D = ADC channel 2).

In the EvoPrimer, according to the application note, the touchscreen is wired as follows:

xX = X+ (TOUCH_L = ADC channel 0),

vT = Y+ (TOUCH_U = ADC channel 1),

vY = Y- (TOUCH_D = ADC channel 2).

The two ADC channels 0 and 1 are inverted.

So a specific handler has been implemented into the CircleOS, but this is transparent to the applications using the CircleOS API.

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3.3 Audio management

The new EvoPrimer uses only one I2S port for both recording and playing sounds, so a specific audio handler has been implemented into the CircleOS, but this is transparent to the applications using the CircleOS API.

4. Application migration

4.1 CircleOS

4.1.1 CircleOS compatibility

All CircleOS versions guarantee true ascending compatibility.

For example, for screen resolution compatibility, the new CircleOS manages a virtual offset, and applications developed for Primer2 display in a 128 x 128 screen, that corresponds to a centred windows in the 240 x 240 useful screen area.

CircleOS API are also guaranteed as ascending compatibility : all previous CircleOS API functions are always present and compatible.

4.1.2 CircleOS application compatibility

All Primer2 applications are binary compatible with EvoPrimer**.** The CircleOS API permits all Primer2 applications to run on the EvoPrimer for STM32F10VE *without any need to recompile*.

For proof, take a look at the applications provided with the CircleOS factory, developed for Primer2 (Maze, Breakout, Gobang, Square, Graphics, Drummer...).

A Primer2 binary (like "maze.o") can be loaded into a EvoPrimer, without any to need to recompile, thanks to the CircleMgr tool (or "add to circle.bat" batch command).

Issues can appear when an application makes :
- direct access to peripherals without using CircleOS API,
- use of a personalized toolbar (because of the icons change).

4.1.3 Migration procedure

When you want to port an Primer2 project into EvoPrimer project, you have to modify some Ride7 project parameters:

- <u>defines</u> : change the macro "**PRIMER2**" by the macro "**OPEN4**", in "*GCC Compiler/Defines*" parameter,

- <u>linker script</u> : a different linker scripted is provided for applications because the memory map has changed: "**Circle_App_OP4.ld"** instead of "**Circle_App.ld",**

- <u>CircleOS debug file</u> : replace the file "Primer2.elf" by "Evo_Circle_STM32E.elf" (select and suppress the old file, and then add the new one, located in {Ride}/lib/ARM/CircleOS directory),

- <u>FAT debug file</u> : replace the file "**FAT.elf**" by "**FAT_OP4.elf**", because the applications are not loaded at the same memory address.

4.2 Non-CircleOS

Applications developed without CircleOS do not profit from the portability offered by the CircleOS API.

As they access the peripherals directly, they must be adapted for any hardware modifications :
- new LCD controller,
- some microcontroller pins have changed roles.

See the two summary tables in section 2.5 Summary for pin affectation details.

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6. Glossary

Term	Description
Primer2	Complete, Fun Platform for Evaluation and Development
CircleOS	Embedded OS written by Raisonance
EvoPrimer	Enhancement of the STM32-Primer2, last born of the ST's Primer family

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7. Index

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8. History

Date	Modification
18 June 2010	Initial version.
09 Sept 2010	Memory maps update (CircleOS v4.1)
27 June 2011	Enhance application migration explanations

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