

E404X Migration Guide

Preliminary pre-release version 2022-03-14

This is an preliminary pre-release migration guide and the contents are subject to change.

This guide assists in the transition from the E Series E402/E404 to the E404X.

Software Differences

USER FIRMWARE BINARY SIZE

One major advantage of the E404X is that user firmware binaries can be up to 256 Kbytes, instead of 128 Kbytes on Gen 2 devices including the E Series.

FLASH FILE SYSTEM

On the E404X and Gen 3 devices, there is a flash file system (2 MB) for storing user data. This is not available on Gen 2 devices.

COMBINED AND RESUMABLE OTA

On the E404X and Gen 3 devices, over-the-air (OTA) updates have two features that can improve the speed and reliability of OTA updates:

- Combined OTA can combine Device OS and user firmware updates into a single binary that requires only one download and one reboot to install.
- Resumable OTA allows an update to resume from the point it stopped, instead of starting over from the beginning if interrupted.

SLEEP MODES

- In general, the E404X will use less power in all modes.
- In HIBERNATE mode, the RTC (real time clock) does not run on the E404X, so you cannot wake by time from HIBERNATE mode (formerly known as SLEEP_MODE_DEEP).
- However, you can wake by time from ULTRA_LOW_POWER mode, and it uses less power than the E Series HIBERNATE mode.
- On Gen 2 devices, you can only wake from HIBERNATE with a rising signal on WKP (A7). The E404X can wake from HIBERNATE on any pin, rising or falling.
- On Gen 2 (STM32F205) devices, if you try to go into HIBERNATE mode with WKP already high, the device will go into sleep and will not wake up by time or pin change, essentially rendering it unable to wake until reset manually. This problem does not occur on the E404X and Gen 3 devices.

RTC (REAL-TIME CLOCK)

- The E Series module has the ability to use an external lithium coin cell or supercap to power the RTC when the MCU is unpowered. This feature does not exist on the E404X.
- The RTC on the E404X s is not really a real-time clock. It's basically just a counter, and some advanced wakeup features are not possible on the E404X and Gen 3 devices. These features were not enabled by Device OS on Gen 2 devices, either, so this is generally not an issue.
- On the E404X and Gen 3 devices, in HIBERNATE sleep mode the RTC does not run, so it is not possible to wake by time, and the system clock will not be set until you connect to the cloud again. ULTRA_LOW_POWER is recommended instead.

Hardware differences

MCU

The microcontroller is different in E Series and E404X:

Measure	E Series	E404X
MCU	STM32F205	nRF52840
Manufacturer	ST Microelectronics	Nordic Semiconductor
Processor	ARM Cortex M3	ARM Cortex M4F
Speed	120 MHz	64 MHz
RAM	128 KB	256 KB
Flash (MCU)	1 MB	1 MB
Flash (external)		4 MB ¹
Hardware floating point		✓

- ¹Most of this space is reserved by the system and only a portion if it is available to user applications as a flash file system.
- Not all RAM is available to user applications. The Device OS firmware uses a portion of it.

BLE (BLUETOOTH LE)

- Bluetooth LE (BLE 5.0) is supported on the E404X but not E Series (Gen 2).

NO 5V TOLERANCE!

On Gen 2 devices (STM32F205), most pins are 5V tolerant. This is not the case for the E404X and Gen 3 (nRF52840). You must not exceed 3.3V on any GPIO pin, including ports such as serial, I2C, and SPI.

PINS NO LONGER AVAILABLE FOR GPIO

Pin	Pin Name	Reason
28	B5	NC on E404X
29	B4	NC on E404X
35	D7	SWD debugging SWDIO
36	D6	SWD debugging SWDCLK
38	D4	SWD debugging SWO
39	D3	NC on E404X

You will need to use different pins if you are currently using these pins.

SPI

- On the E404X, there are only two SPI ports SPI (A pins) and SPI1 (C pins)
- E Series SPI1 on the D pins does not exist on the E404X.
- E Series SPI2 on the C pins is SPI1 on the E404X

The following are all SPI-related pins on the E Series and E404X:

Pin	E Series Pin Name	E Series SPI	E404X Pin Name	E404X SPI
21	A5	SPI (MOSI)	A5	SPI (MOSI)
22	A4	SPI (MISO)	A4	SPI (MISO)
23	A3	SPI (SCK)	A3	SPI (SCK)
24	A2	SPI (SS)	A2	SPI (SS)
37	D5	SPI1 (SS)	D5	SPI1 (SS)
38	D4	SPI1 (SCK)	SWO	
39	D3	SPI1 (MISO)	NC	
40	D2	SPI1 (MOSI)	D2	
46	C3	SPI2 (SCK)	C3	SPI1 (SCK)
47	C2	SPI2 (MISO)	C2	SPI1 (MISO)
48	C1	SPI2 (MOSI)	C1	SPI1 (MOSI)

The following SPI data rates are available:

	E Series SPI	E Series SPI1	E404X SPI & SPI1
Maximum rate	30 MHz	15 MHz	32 MHz
Default rate	15 MHz	15 MHz	16 MHz
Clock	60 MHz	30 MHz	64 MHz

- Available clock divisors: 2, 4 (default), 8, 16, 32, 64, 128, 256
- On the E404X, SPI_MODE_SLAVE is only supported on SPI1 and is limited to 8 MHz

I2C

- On the E Series, only one of `Wire` and `Wire1` can be used at the same time. Both I2C ports be used at the same time on the E404X.

Pin	E Series Pin Name	E Series I2C	E404X Pin Name	E404X I2C
41	D1	Wire (SCL)	D1	Wire (SCL)
42	D0	Wire (SDA)	D0	Wire (SDA)
44	C5	Wire1 (SCL)	C5	Wire1 (SCL)
45	C4	Wire1 (SDA)	C4	Wire1 (SDA)

SERIAL (UART)

The primary UART serial (`Serial1`) is on the TX and RX pins on both the E Series and E404X. There is no hardware flow control on this port on E Series, but it can be enabled on the E404X on pins D0 (CTS) and D1 (RTS).

The E Series has additional serial ports `Serial2`, `Serial4`, and `Serial5`. These are not available on the E404X.

	E Series	E404X
Buffer size	64 bytes	configurable ¹
7-bit mode	✓	
8-bit mode	✓	✓
9-bit mode	✓	
Half duplex	✓	
LIN bus	✓	

¹Default buffer size is 64 bytes but you can configure a larger buffer if desired, limited by available RAM.

²CTS/RTS flow control optional on `Serial1`.

Pin	E Series Pin Name	E Series Serial	E404X Pin Name	E404X Serial
16	TX	Serial1 (TX)	TX	Serial1 (TX)
17	RX	Serial1 (RX)	RX	Serial1 (RX)
41	D1		D1	Serial1 (CTS)
42	D0		D0	Serial1 (RTS)
46	C3	USART4_TX	C3	
47	C2	USART4_RX	C2	
48	C1	USART5_TX	C1	
49	C0	USART5_RX	C0	
52	RGBB	Serial2 (RX)	RGBB	
53	RGBG	Serial2 (TX)	RGBG	

Baud rate support

Baud Rate	E Series	E404X
1200	✓	✓
2400	✓	✓
4800	✓	✓
9600	✓	✓
19200	✓	✓
28800		✓
38400	✓	✓
57600	✓	✓
76800		✓
115200	✓	✓
230400	✓	✓
250000		✓
460800		✓
921600		✓
1000000		✓

Serial configurations

Constant	Description	E Series	E404X
SERIAL_8N1	8 data bits, no parity, 1 stop bit (default)	✓	✓
SERIAL_8N2	8 data bits, no parity, 2 stop bits	✓	
SERIAL_8E1	8 data bits, even parity, 1 stop bit	✓	✓
SERIAL_8E2	8 data bits, even parity, 2 stop bits	✓	
SERIAL_8O1	8 data bits, odd parity, 1 stop bit	✓	
SERIAL_8O2	8 data bits, odd parity, 2 stop bits	✓	
SERIAL_9N1	9 data bits, no parity, 1 stop bit	✓	

SERIAL_9N2	9 data bits, no parity, 2 stop bits	✓
SERIAL_7O1	7 data bits, odd parity, 1 stop bit	✓
SERIAL_7O2	7 data bits, odd parity, 1 stop bit	✓
SERIAL_7E1	7 data bits, even parity, 1 stop bit	✓
SERIAL_7E2	7 data bits, even parity, 1 stop bit	✓
LIN_MASTER_13B	8 data bits, no parity, 1 stop bit, LIN Master mode with 13-bit break generation	✓
LIN_SLAVE_10B	8 data bits, no parity, 1 stop bit, LIN Slave mode with 10-bit break detection	✓
LIN_SLAVE_11B	8 data bits, no parity, 1 stop bit, LIN Slave mode with 11-bit break detection	✓

- Using an I2C or SPI UART like the SC16IS750 is also a good way to add support for other bit length, parity, and stop bit options on Gen 3 devices.

ANALOG INPUT (ADC)

For analog to digital conversion (ADC) using `analogRead()`, there are fewer ADC inputs on the E404X:

Pin	E Series Pin Name	E Series ADC	E404X Pin Name	E404X ADC
19	WKP / A7	✓	A7 / WKP	✓
20	DAC / A6	✓	A6	✓
21	A5	✓	A5	✓
22	A4	✓	A4	✓
23	A3	✓	A3	✓
24	A2	✓	A2	✓
25	A1	✓	A1	✓
26	A0	✓	A0	✓
28	B5	✓	NC	
29	B4	✓	NC	
30	B3	✓	B3	
31	B2	✓	B2	

If additional ADC ports are needed, an external I2C and SPI ADC can be added to your base board.

PWM (PULSE-WIDTH MODULATION)

The pins that support PWM are different on the E Series and E404X.

Pin	E Series Pin Name	E Series PWM	E404X Pin Name	E404X PWM
16	TX	✓	TX	✓
17	RX	✓	RX	✓
19	WKP / A7	✓	A7 / WKP	
21	A5	✓	A5	✓
22	A4	✓	A4	✓
23	A3		A3	✓
24	A2		A2	✓
30	B3	✓	B3	✓
31	B2	✓	B2	✓

32	B1	✓	B1	
33	B0	✓	B0	
39	D3	✓	NC	
40	D2	✓	D2	✓
41	D1	✓	D1	✓
42	D0	✓	D0	✓
44	C5	✓	C5	
45	C4	✓	C4	
49	C0		C0	✓

- PWM on the same timer (such as TIM3 or PMM3) must share the same frequency, but can have different duty cycles.
- E404X pin B2 uses PWM0 which is used by the RGB LED. You can have a different duty cycle but should not change the frequency if you are using the RGB LED.

DIGITAL TO ANALOG CONVERTER (DAC)

The E Series supports DAC one A3 and A6 (DAC). There is no DAC on the E404X or Gen 3 devices.

If you need a DAC, it's easy to add one via I2C or SPI on your base board.

Pin	E Series Pin Name	E Series DAC	E404X Pin Name	E404X DAC
20	DAC / A6	✓	A6	
23	A3	✓	A3	

WKP (A7)

	E Series	E404X
Module Pin	30	30
Pin Name	WKP	WKP
	A7	A7
Analog Input	✓	✓
PWM	✓	

On Gen 2 devices (STM32), only the WKP pin rising can wake from HIBERNATE sleep mode.

This restriction does not exist on the E404X and Gen 3 devices; any pin can be used to wake from all sleep modes, rising or falling.

CAN (CONTROLLER AREA NETWORK)

The E series supported CAN on pins D1/D2 or C4/C5. There is no CAN on the E404X or Gen 3 devices (except the Tracker).

- The Tracker SoM includes CAN via a MCP25625 CAN interface with integrated transceiver.
- Both the MCP2515 and MCP25625 work with [the library](#) used on the Tracker and can be used to add CAN to the E404X.

Pin	E Series Pin Name	E Series CAN	E404X Pin Name	E404X CAN
40	D2	CAN2_RX	D2	
41	D1	CAN2_TX	D1	

44	C5	CAN1_RX	C5
45	C4	CAN1_TX	C4

I2S (SOUND)

- The E Series theoretically had I2S sound available on pins D1 and D2, however there has never been support for it in Device OS.
- I2S is available on Gen 3 devices including the P404X on any GPIO pins using a 3rd-party library.

INTERRUPTS

There are many limitations for interrupts on the E Series (STM32F205). All pins can be used for interrupts on the E404X Gen 3 devices, however you can only attach interrupts to 8 pins at a time.

SWD

Unlike the E Series module, the E404X SWD pins are dedicated and cannot be used for GPIO.

Pin	E Series Pin Name	E Series SWD	E404X Pin Name	E404X SWD
35	D7	SWDIO	SWDIO	SWDIO
36	D6	SWCLK	SWDCLK	SWCLK
38	D4		SWO	SWO

JTAG

The E404X does not support full JTAG. Some pins are shared with SWD; the E404X SWD pins are dedicated and cannot be used for GPIO.

Pin D5 (module pin 37), however, is available for GPIO as it is not NC and not used by SWD.

Pin	E Series Pin Name	E Series JTAG	E404X Pin Name	E404X JTAG
35	D7	JTAG TMS	SWDIO	
36	D6	JTAG TCK	SWDCLK	
37	D5	JTAG TDI	D5	
38	D4	JTAG TDO	SWO	
39	D3	JTAG RST	NC	

USB

The following USB feature differences exist:

USB Feature	E Series	E404X
Secondary USB serial emulation	USBSerial1	✓
USB keyboard emulation		✓
USB mouse emulation		✓

PIN FUNCTIONS REMOVED

The following pins were used on the E Series but are not available on the E404X. You should not connect anything to these pins.

Pin		Description
Pin	Name	
10	VDDA	Power input for ADC. Normally connected to 3V3. Must always be within 300 mV of 3V3.
11	VBAT	Battery for internal real-time clock, backup registers, and SRAM. Supply 1.65VDC to 3.6 VDC at 19 μ A..
28	B5	B5 Analog in, GPIO
29	B4	B4 Analog in, GPIO
39	D3	D3 GPIO, SPI1

PIN FUNCTIONS ADDED

No pin functions have been added to previously unused (NC) pins.

FULL MODULE PIN COMPARISON

Software

THIRD-PARTY LIBRARIES

Most third-party libraries are believed to be compatible. The exceptions include:

- Libraries that use peripherals that are not present (such as DAC)
- Libraries for MCU-specific features (such as ADC DMA)
- Libraries that are hardcoded to support only certain platforms by their PLATFORM_ID

Since the E404X uses the same MCU as Gen 3 devices (Boron, B Series SoM, Tracker SoM), most libraries intended for those platforms will work with no changes or minimal changes.

Version History

Revision	Date	Author	Comments
pre	2022-01-25	RK	Pre-release
	2022-03-14	RK	Minor edits; no functional changes