UM1851
User manual

STM32303E-EVAL demonstration firmware

Introduction

This user manual describes the demonstration firmware (STSW-STM32124) running on the STM32303E-EVAL evaluation board, which can be used to evaluate the capabilities of the STM32F303xE microcontroller and on-board peripherals.

This demonstration firmware contains many applications that can be easily reused, such as dual interface (I2C and RF) EEPROM application (ESL and DataLogger), infrared RC5 and SIRC receiver and transmitter, RTC calendar, file system FAT implementation on SD Card, wave player using STM32 I2S peripheral, temperature sensor interfacing and TFT LCD.

The demonstration firmware is provided with the demonstration programmed in the internal Flash memory. All the files needed by the demonstration are programmed in the MicroSD card. The demonstration is executed at each reset (board power-up, external reset, etc.).

Note: Before running the demonstration, check the configuration of all the evaluation board jumpers. For more details, refer to Section 1.9.12: STM32303E-EVAL board jumper configuration.

This demonstration firmware is available for download from the STMicroelectronics website: *www.st.com*.

Contents

List of tables

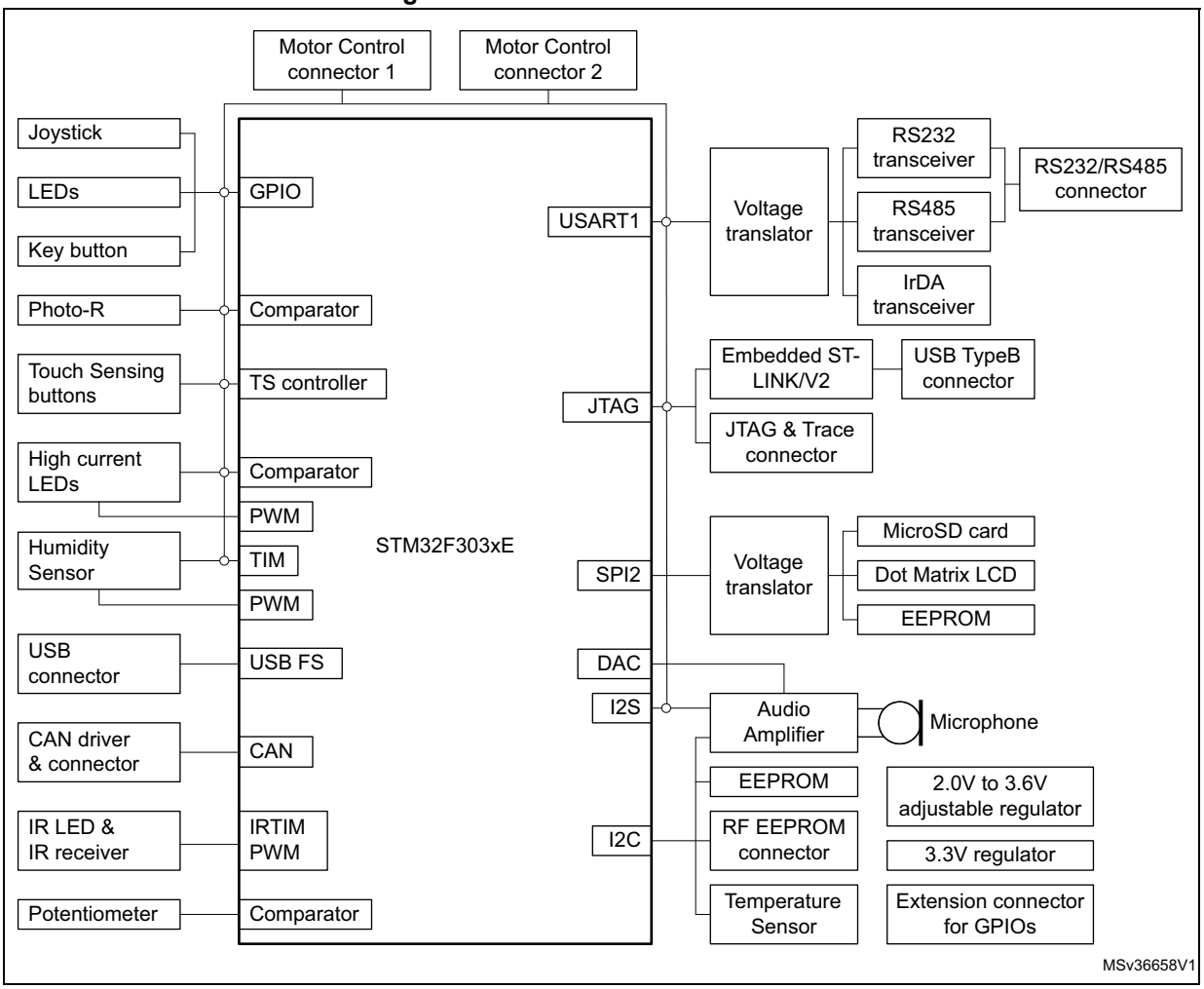
List of figures

1 Functional description of the evaluation board

The STM32303E-EVAL evaluation board provides a development and demonstration platform. It is designed to let the user try out the major functions of the STM32F303xE microcontroller.

Figure 1 summarizes the main functional blocks of the evaluation board.

Figure 1. Evaluation board overview



1.1 Power control

The evaluation board can be powered from an external 5 V supply, from the USB connector or from the ST-Link connector. All other required voltages are provided by on-board voltage regulators.

1.2 Clocking

Two clock sources are available on the STM32303E-EVAL evaluation board:

- 32 KHz crystal for embedded RTC
- 8 MHz crystal for the STM32F303xE main clock system

1.3 Reset control

The reset can be generated by hardware or software:

- Reset button: activates the RESET input when pressed
- JTAG reset

1.4 Debug JTAG interface

Software debug is done via the standard ARM® JTAG connection: 20-pin IDC (insulation displacement connector) for connection to the standard ARM host interface.

1.5 Serial wire debugger interface

The Serial Wire Debug Port (SWD-DP) provides a 2-pin (clock + data) interface to the AHP-AP port.

1.6 Embedded ST-LINK

An ST-LINK is integrated on the board as an embedded in-circuit debugger and programmer for the STM32F303xE microcontroller unit.

1.7 Display devices

1.7.1 LCD

A TFT color LCD module is mounted on the STM32303E-EVAL board. It is interfaced through the embedded SPI peripheral.

1.7.2 LEDs

Four general-purpose LEDs are available. They are used as a display.

1.8 Interfaces

1.8.1 RS232, RS485 and IrDA

RS232, RS485 and IrDA communications are performed through the following connectors:

- RS232 and RS485: a D-type 9-pin coonector (CN8)
- IrDA transceiver U10 is connected to the STM32F303xE USART1.

1.9 Miscellaneous peripherals

1.9.1 Joystick

The STM32303E-EVAL evaluation board features a four-direction joystick with a selection button at the center named SEL.

1.9.2 Push-button

The following push-button is available:

- KEY

1.9.3 Potentiometer

A successive approximation ADC channel (ADC12) is connected to an on-board variable resistor. The variable resistor provides a voltage in the range of 0V to 3.3 V.

1.9.4 Audio

The STM32303E-EVAL evaluation board supports stereo audio play, using an audio DAC CS42L52 connected to I2S2 port of STM32F303xE microcontroller.

1.9.5 MicroSD card

The STM32303E-EVAL evaluation board features a MicroSD card connector connected to the SPI peripheral.

1.9.6 RF EEPROM

RF EEPROM daughter board implemented on the module is the M24LR64-R. The daughter board can be connected on CN1 to the STM32F303xE via the I2C bus.

The I2C address of the RF EEPROM is 0b1010E2E1E0. The E0-E2 values are determined by the RF EEPROM daughter board.

1.9.7 IR LED and IR receiver

The IR receiver TSOP34836 is connected to PA9 on the STM32F303xE. The IR LED is driven by PB9 through transistors T4 and T5 on the board.

1.9.8 Brightness LED

The board features an amber high brightness LED and its power control circuits.

The brightness can be adjusted by a PWM signal issued by the STM32F303xE through PE13.

The LED supply current can be monitored by the STM32F303xE through PD14.

1.9.9 Humidity sensor

The board embeds a humidity sensor HS1101LF. The charge control signal is connected to the timer in STM32F303xE through PC8 and measured result of HS1101LF is connected with PB0.

1.9.10 Temperature sensor

The STM32303E-EVAL evaluation board includes a temperature sensor connected to the I2C2 peripheral.

1.9.11 Touchsensing buttons

The STM32303E-EVAL evaluation board supports two touchsensing buttons based on either RC charging or charge transfer technology. The charge transfer technology is enabled by default.

1.9.12 STM32303E-EVAL board jumper configuration

To be able to run the STM32303E-EVAL demonstration correctly, configure the following STM32303E-EVAL board jumpers as follows:

- JP1: fitted
- JP5: fitted in position 1<->2
- JP6: fitted in position 1<->2
- JP11: fitted
- JP12: fitted
- JP15: fitted in position 2<->3
- JP16: fitted in position 2<->3
- JP17: fitted in position 1<->2

Note: Set JP16 in BAT position to save time even if the evaluation board is powered off.

2 Running the demonstration

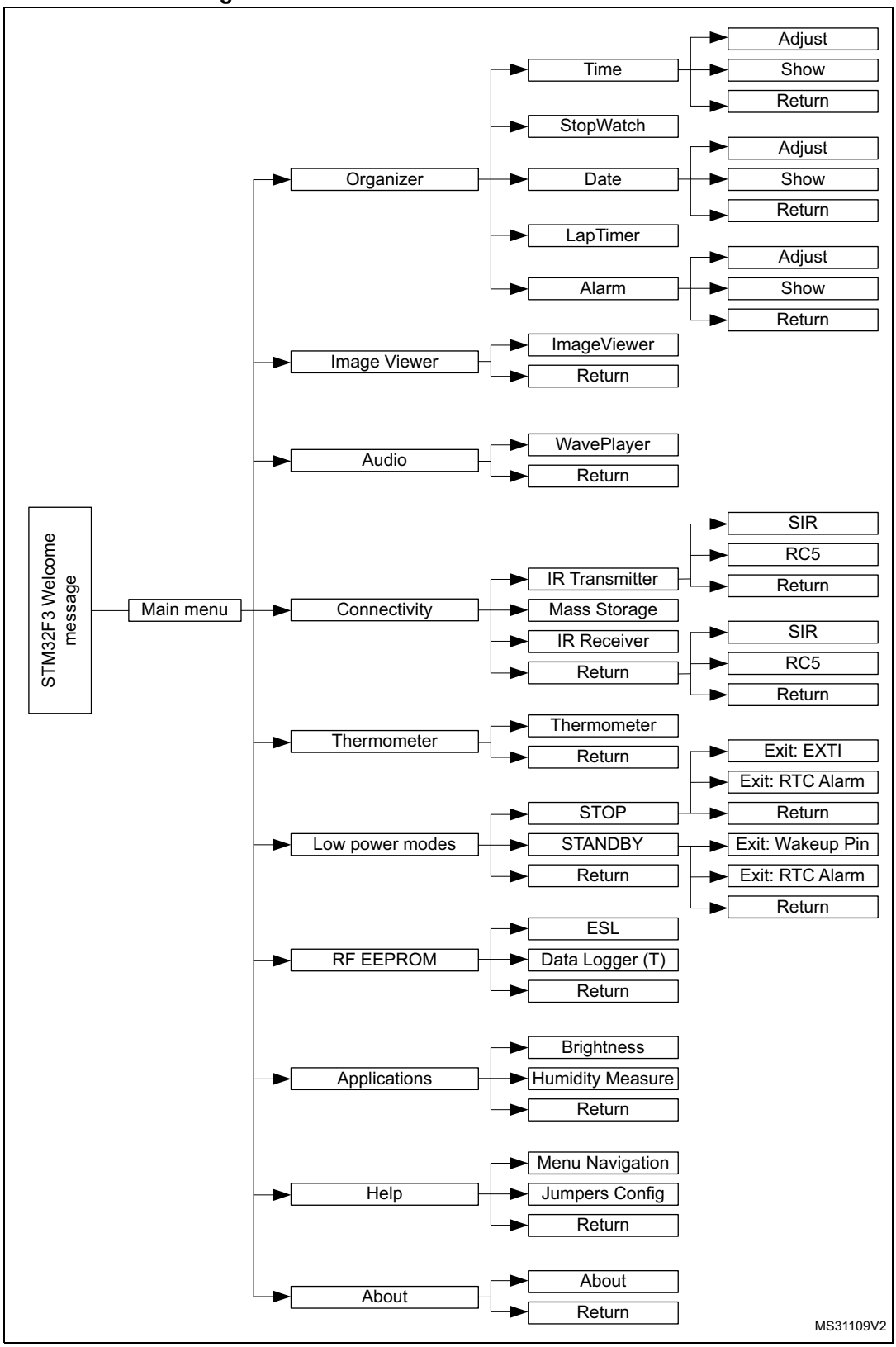
2.1 Menu

Figure 2 shows the menu architecture of the STM32303E-EVAL demonstration. The main menu is shown on the left-hand side. The UP, DOWN, RIGHT and LEFT joystick directions allow the user to navigate between items in the main menu and the submenus. To enter a submenu, press the SEL push-button.

The SEL push-button designates the action of vertically pressing the top of the joystick, as opposed to moving it horizontally UP, DOWN, RIGHT or LEFT.

To exit a submenu, select the return menu and press SEL.

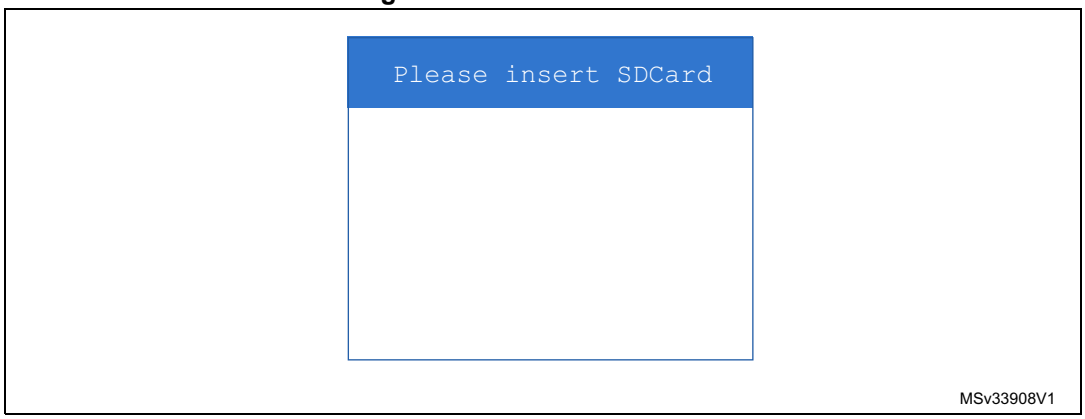
Figure 2. Structure of the demonstration menus



2.1.1 Demonstration startup

After a board reset, at demonstration startup, the system checks if a MicroSD memory card is already present in connector CN16. If no card is detected, the demonstration does not start and the message shown in *Figure 3* is displayed on the LCD screen.

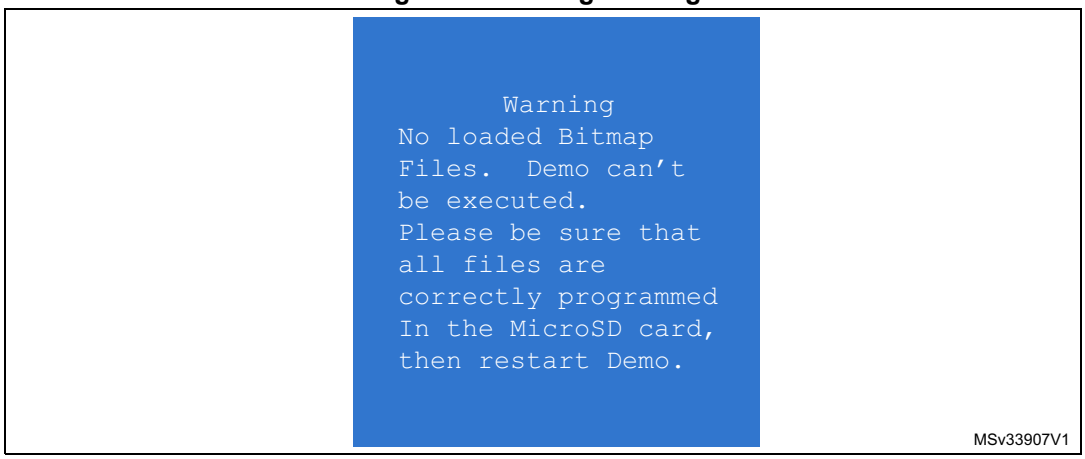
Figure 3. MicroSD card check



The demonstration continues only if a MicroSD card is inserted.

Then, the demonstration graphic icons and bitmap files are checked in the microSD card (see *Section 2.3.5: External memory organization*). All the icons have to be correctly programmed in the MicroSD card before starting the demonstration. If an icon is missing, the demonstration does not start and the message shown in *Figure 4* is displayed on the LCD screen.

Figure 4. Warning message



However, if the icons are correctly loaded in the MicroSD card memory, the welcome screen is displayed and the ST logo appears on the LCD (see *Figure 5*).

Figure 5. ST logo

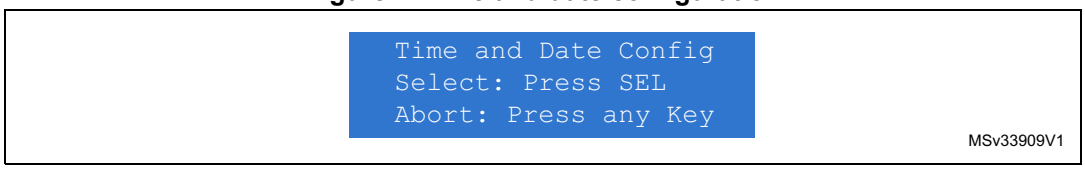
Then, after one second, an STM32F3 presentation slide is displayed on the LCD screen.

Figure 6. STM32F3 presentation slide

When the board is powered up for the first time, the user is prompted to set the time, year, month and day. The user may choose to ignore it by pressing any key except for the SEL push-button to abort the configuration sequence. To set the time and date, press SEL and follow the setting sequence.

The message shown in *Figure 7* appears on the LCD screen.

Figure 7. Time and date configuration



Note: If the user chooses to configure the time and date, the time adjust and date adjust menus are displayed. Otherwise, the main menu is displayed and the user can set the time parameters in the organizer menu. To set the time/date, use the joystick UP/DOWN and SEL push-buttons, please refer to Section 2.4.1: Organizer.

If the time configuration has already been done, then the number of elapsed days (higher than 1 day) from the last time the demonstration board was powered up, appears on the LCD screen. It is soon followed by the current date.

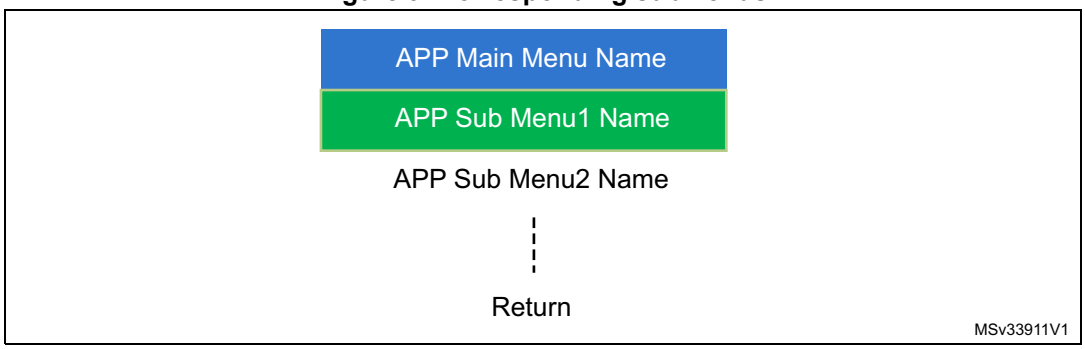
Once the time/date set, the main menu appears. The main menu is displayed in the form of a set of icons. It shows all the submenus in the same screen. The user can navigate using the UP, DOWN, RIGHT and LEFT joystick directions to select the required submenu. To enter a submenu, press the SEL joystick push-button, and the new submenu corresponding to the selected icon is displayed.

Figure 8. Main menu

1. The icons shown in *Figure 8* are taken from http://commons.wikimedia.org web site.

Once a submenu has been selected, the name of the application is listed at the top of the display and all the corresponding submenus are listed below as shown in *Figure 9*.

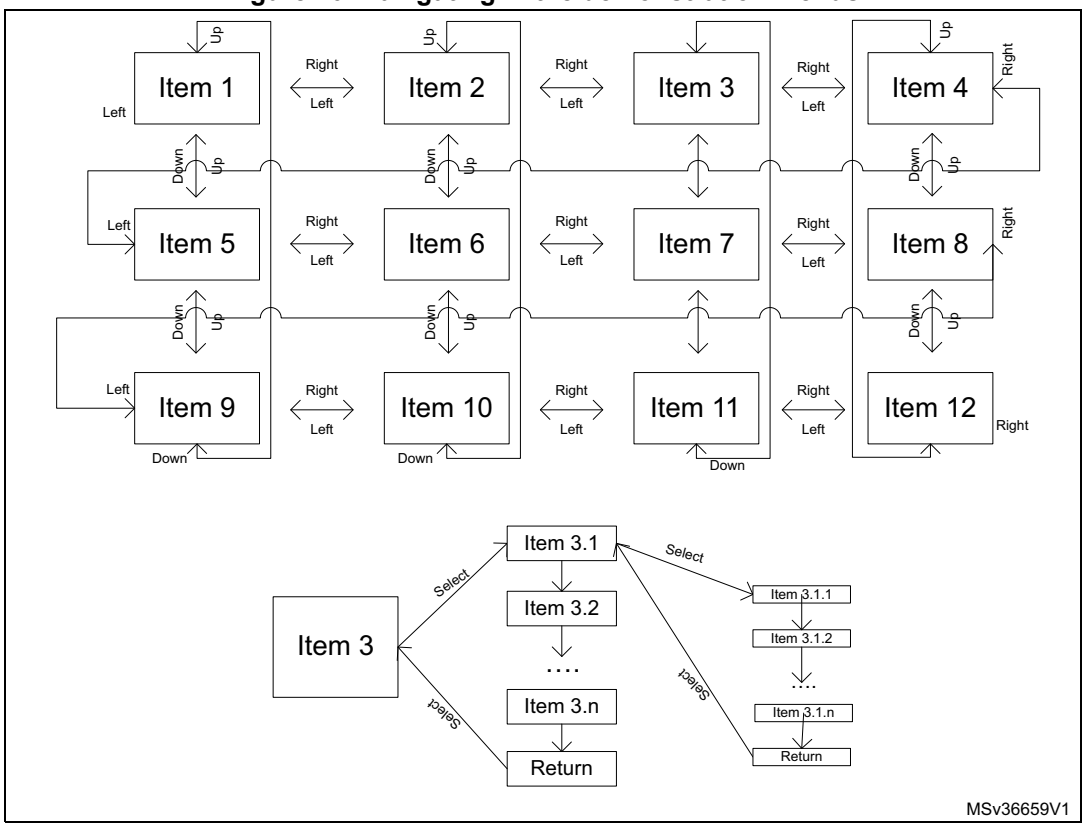
Figure 9. Corresponding submenus



2.1.2 Navigation

The demonstration menu is based on a circular navigation, submenu selection, item selection and back navigation as described in *Figure 10*.

Figure 10. Navigating in the demonstration menus



The user navigates using the joystick push-buttons located on the evaluation board: RIGHT, LEFT, SEL, UP and DOWN.

- The UP, DOWN, RIGHT and LEFT push-buttons are used to perform a circular navigation in the main menu and the current menu items.
- The SEL push-button selects the current item.
- The UP and DOWN push-buttons are used for vertical navigation in the submenus.
- To return to the upper menu, go to the return line and press SEL.

2.2 Clock sources

2.2.1 Clock control

The STM32F303xE internal clocks are derived from the HSE (clocked by the external 8 MHz crystal).

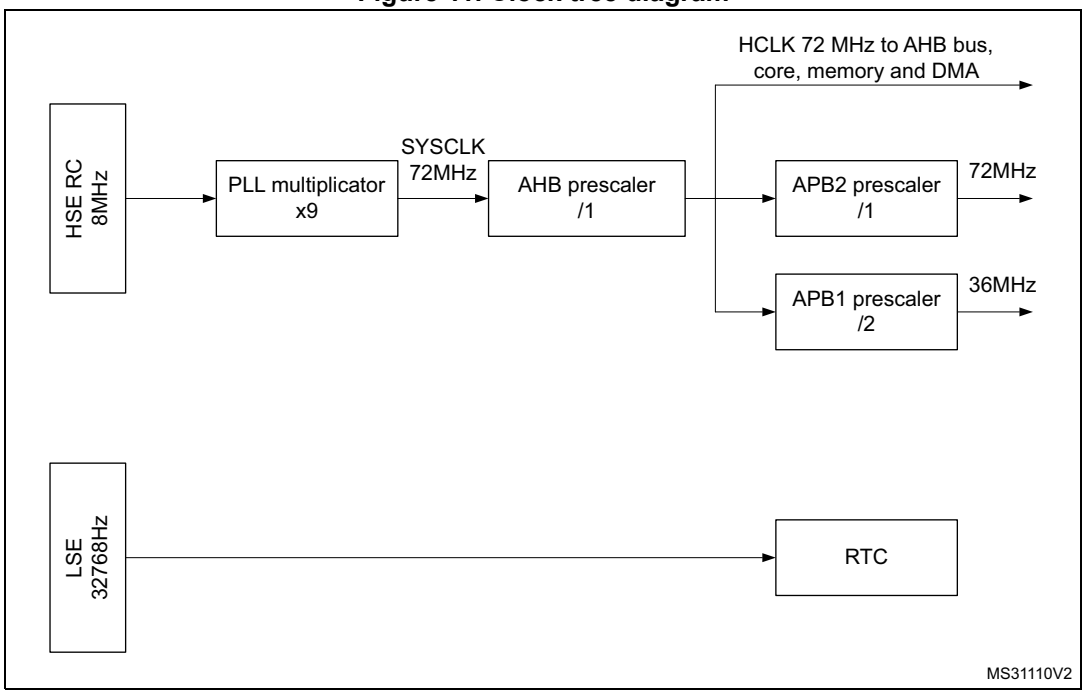
In this demonstration application, the various system clocks are configured as follows:

- System clock is set to 72 MHz: the PLL is used as the system clock source: 72 MHz.
- HCLK frequency is set to 72 MHz.
- Timer clock (TIMCLK) is set to 72 MHz.
- PCLK1 is set to 36 MHz.
- PCLK2 is set to 72 MHz.

Only the RTC is clocked by a 32 kHz external oscillator.

Figure 11 illustrates the clock tree organization for this demonstration.

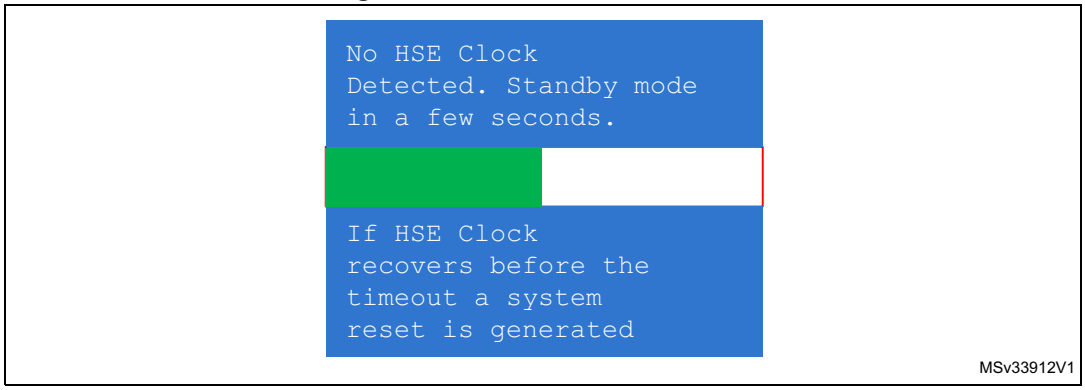
Figure 11. Clock tree diagram



2.2.2 Clock failure

At any demonstration level, if no clock is present on OSC_IN (broken or disconnected crystal), the message shown in *Figure 12* is displayed on the LCD screen.

Figure 12. No HSE clock detected

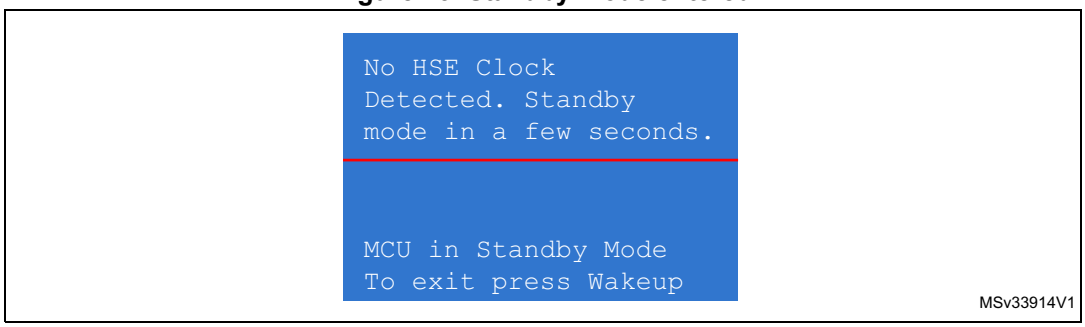


If the 8 MHz crystal is not reconnected in the next few seconds, the MCU enters Standby mode. If the 8 MHz crystal is reconnected within a few seconds, a system reset is generated.

Note: The clock security system (CSS) feeds the MCU with the HSI OSC used as an emergency clock if no clock is detected.

When a timeout occurs, the MCU enters Standby mode and the message shown in *Figure 13* is displayed on the LCD screen.

Figure 13. Standby mode entered



1. The demonstration does not restart as long as the 8 MHz crystal is not present.
2. By connecting the 8 MHz crystal oscillator after reset, the demonstration may not restart correctly. The crystal oscillator must be connected before starting the demonstration.

2.3 STM32F303xE resources

2.3.1 Peripherals

All used peripherals are described in *Table 1*.

Table 1. STM32F303xE demonstration peripherals

Used peripherals	Application
DMA	Wave player
EXTI	Menu navigation + joystick + push-button + low-power mode+ wave player + applications
GPIO	All applications + LEDs
I2C2	Temperature sensor (STTS751), dual interface EEPROM
I2S	Wave player
NVIC	All applications using interrupts
PWR	Low-power modes
RCC	All applications + demonstration kernel
RTC	Calendar (calendar, stop-watch, lap timer, alarm)
SPI3	MicroSD + Color LCD
SysTick	Generate 10 ms time base
TIM1	IR receiver
TIM2	LED toggling
TIM4	Applications (Humidity_Measure)
TIM16 and TIM17	IR transmitter
USB	Mass Storage

2.3.2 Interrupts

Table 2 shows all the enabled interrupts.

Table 2. STM32F303xE demonstration interrupts

Interrupts	Priority	Used for
EXTI9_5	Priority: 3 Subpriority: 0	MicroSD Card detection, Menu navigation
EXTI15_10	Priority: 3 Subpriority: 0	Menu navigation
I2C2 Error	Priority: 0 Subpriority: 0	SMBus Alert interrupt
NMI	Priority: -2	CSS interrupt
RTC	Priority: 1 Subpriority: 1	Calendar, date update, and alarm generation
SysTick	Priority: 3 Subpriority: 3	System timing
Tamper	Priority: 0 Subpriority: 0	Tamper generation
TIM1	Priority: 1 Subpriority: 1	IR receiver interrupt
TIM2	Priority: 3 Subpriority: 3	LED toggling interrupt
TIM3	Priority: 0 Subpriority: 0	IR receiver
TIM4	Priority: 1 Subpriority: 0	Applications (Humidity_Measure)
TIM16	Priority: 0 Subpriority: 0	IR Transmitter
USB	Priority: 0 Subpriority: 0	Mass storage

2.3.3 External interrupts

Table 3 shows all the external interrupts used by the demonstration.

Table 3. STM32F303xE demonstration external interrupts

External interrupts	Used for
EXTI line 5	KEY button (interrupt mode, rising edge) Joystick DOWN (interrupt mode, falling edge) Joystick LEFT (interrupt mode, falling edge)
EXTI line 6	MicroSD Card detect (interrupt mode, rising edge) KEY button (interrupt mode, rising edge) Joystick RIGHT (interrupt mode, falling edge)
EXTI line 7	Joystick UP((interrupt mode, falling edge)
EXTI line 13	Joystick SEL (interrupt mode, falling edge)
EXTI line 17	RTC alarm (interrupt mode, rising edge)

2.3.4 Internal memory size

Figure 14. Internal Flash memory organization

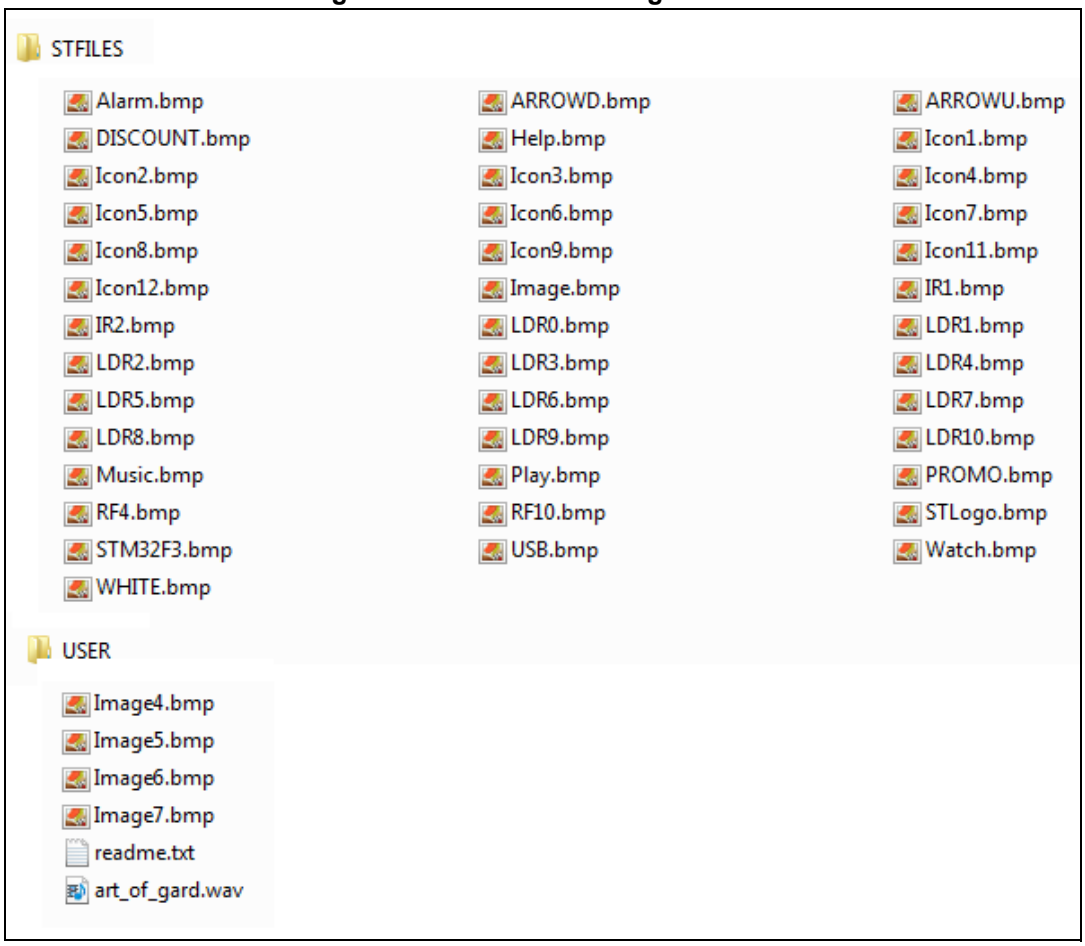
2.3.5 External memory organization

The STM32303E-EVAL demonstration is based on an embedded free FAT file system, FatFs. The file system is needed to read all media information from the on-board MicroSD card memory. The MicroSD card memory is organized in three subdirectories:

- STFILES: this directory contains all the required demonstration media files (icons). User files located in this folder cannot be handled by the demo; only default files are managed.
- USER: this is a user folder. The user can add own files to be played inside the demonstration menus (pictures and waves). This folder is used only by the Image viewer and wave player submenus. For more details on the various files properties, please refer to *Section 2.4.2: Image viewer submenu* and *Section 2.4.3: Audio features*.

Caution: The STFILES directory and its internal files are mandatory for the demonstration startup. FatFs is a generic FAT file system module for small embedded systems. The FatFs is written in compliance with ANSI C and completely separated from the disk I/O layer. For more details, refer to http://elm-chan.org web site.

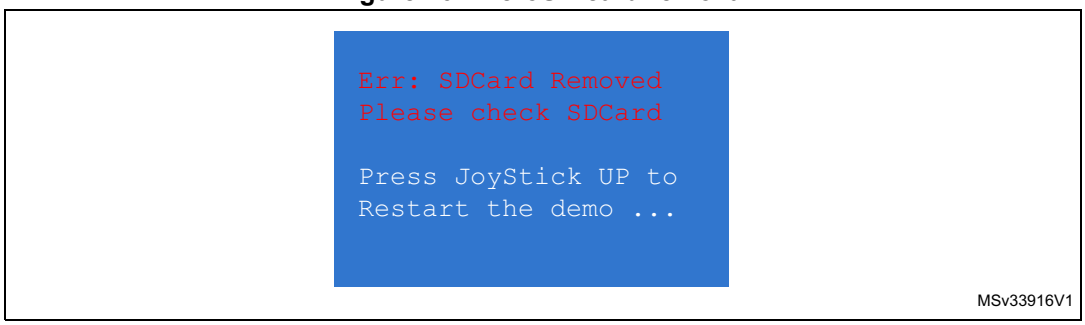
Figure 15. MicroSD card organization



Note: The user can add 16-bit bitmap images (320x240) and wave files in the USER folder.

At any demonstration level, if the MicroSD card is removed, the demonstration stops and the message shown in Figure 16 is displayed on the LCD screen.

Figure 16. MicroSD card removal



2.4 Demonstration applications

The following section provides a detailed description of each part of the demonstration.

Note: In the demonstration, the core runs at HCLK = 72 MHz.

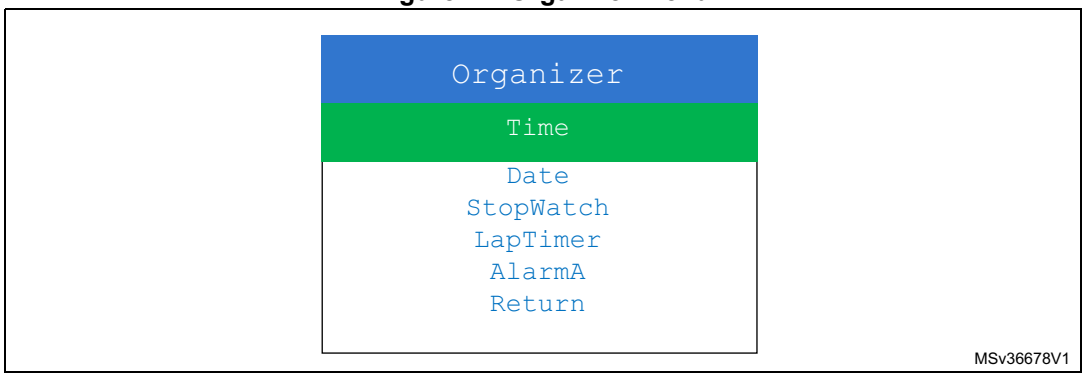
Four LEDs (LD1, LD2, LD3 and LD4) flash throughout the demonstration at a frequency depending on the core clock.

2.4.1 Organizer

The STM32F303xE features a real-time clock (RTC) which is an independent BCD timer/counter. The RTC provides a time-of-day clock/calendar, two programmable alarm interrupts, and a periodic programmable wakeup flag with interrupt capability.

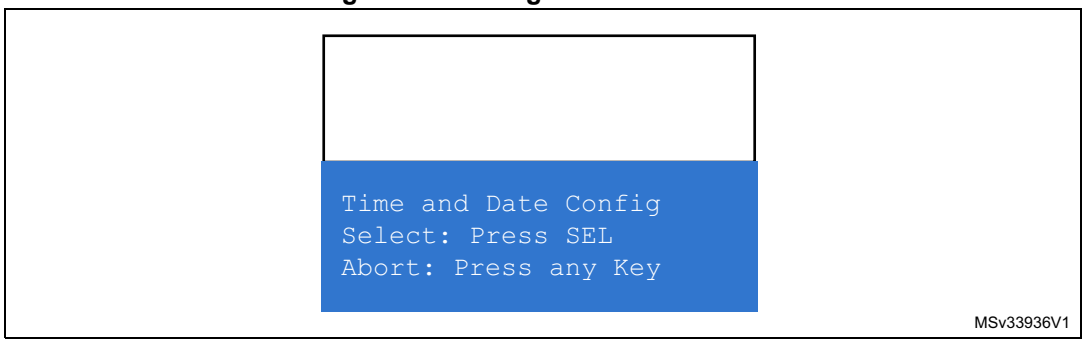
This submenu is used to configure/show the time and date, run stop-watch and lap timer subdemonstration and generate alarm. *Figure 17* shows the organizer menu.

Figure 17. Organizer menu



In any submenu, if the time and date parameters have not yet been configured, the message shown in *Figure 18* is displayed on the LCD screen.

Figure 18. Setting the time and date



The user can optionally choose to set the time, year, month and day. Press any key (except for SEL) to ignore the prompt and abort the configuration sequence. Press on SEL and follow the setting sequence to set the time and date.

Time submenu

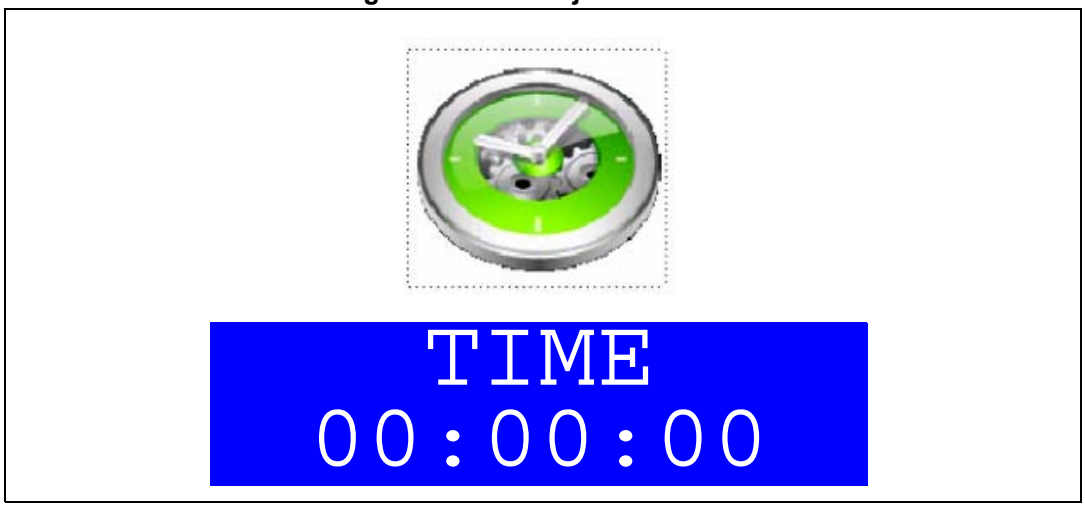
This submenu is divided into two items that allow the user to display or set the current time.

- **Time adjust:** after the evaluation board is powered up, select this submenu to change the default time (00:00:00) to the current time. Once Time adjust has been selected,

the first digit of the hour field can be changed. Press the UP button to display the current value plus one. Press the DOWN button to display the previous digit value. After setting the digit value, press SEL, and the cursor automatically jumps to the next digit. When all the time digits have been set, the Time submenu appears. Some digit values are limited to a range of values depending on the field (hour, minutes or seconds). The following message (with the default time or the current time) is displayed on the LCD when this submenu is selected.

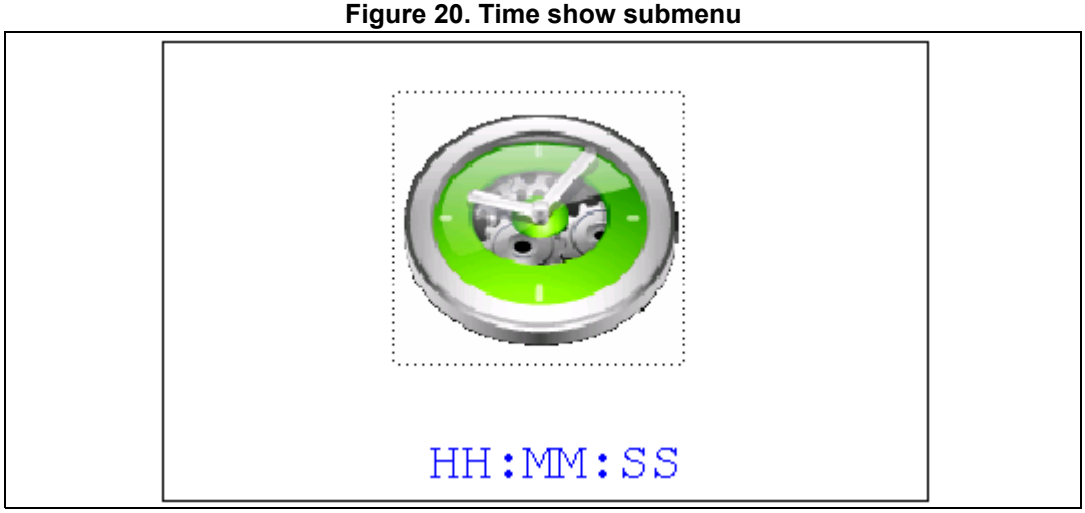
- Set JP16 in BAT position to save time even if the evaluation board is powered off

Figure 19. Time adjust submenu



- **Time show:** this item displays the current time. If time and date have not been configured before, a message is displayed, prompting the user to set the time and date or to exit to the upper submenu. When this submenu is selected, the message shown in *Figure 20* appears on the LCD. In the example, the time has not been set yet.

Figure 20. Time show submenu



To exit the Time show submenu, press the SEL push-button. To exit the Time submenu, select the return line and press the SEL push-button.

Date submenu

This submenu is divided into two items that allow the user to display or set the current date.

- **Date adjust:** select this item after each power-up in order to set the current date. If the time and date have not been configured before, a message is displayed, prompting the user to set the time and date or to exit to the upper submenu.

  The user is requested to set the current date to be stored in the application memory. The date is displayed as Year, Month, Week Nbr, Day Nbr (number of the day in the year) with the selected day shown in the month. There is no default date since the user has to set the date at least once.

  Once the submenu has been selected, the user starts by setting the year, then the month and the day of the selected month. The month and the year are selected using the UP or DOWN push-button. For the day, the UP, DOWN, RIGHT and LEFT push-buttons can be used. Press the UP push-button to display the current value plus one; press the DOWN push-button to display the previous value. To confirm the selected month, press the SEL push-button. The display then jumps to the year configuration. The same procedure is applicable for the year configuration.

  After configuring the day, press the SEL push-button to store the entered value and exit to the Date submenu. The current date value is then shown and the user can change the setting if required. The messages shown in *Figure 21*, *Figure 22* and *Figure 23* are successively displayed on the LCD when this submenu is selected.

Figure 21. Setting the year

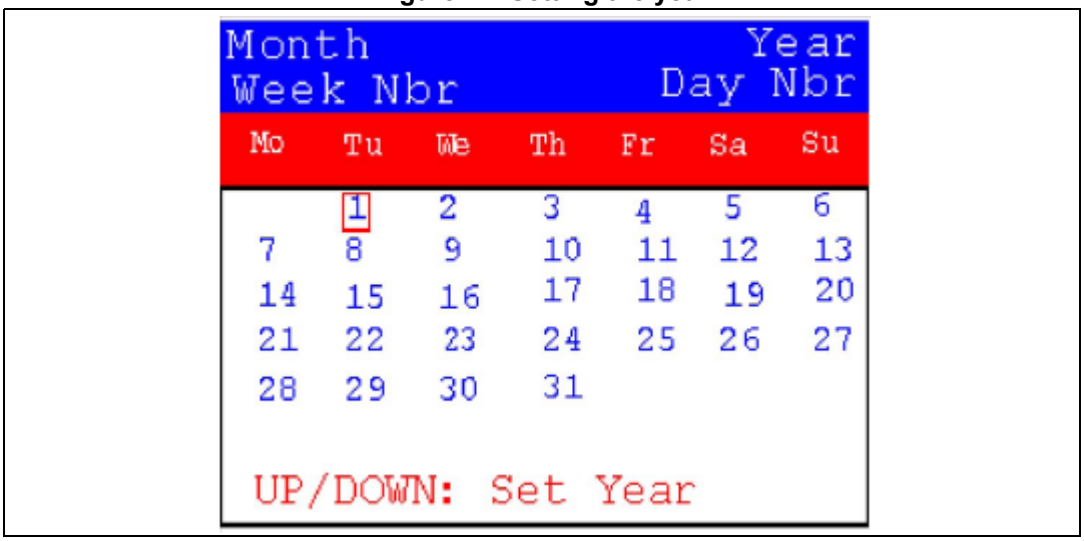


Figure 22. Setting the month

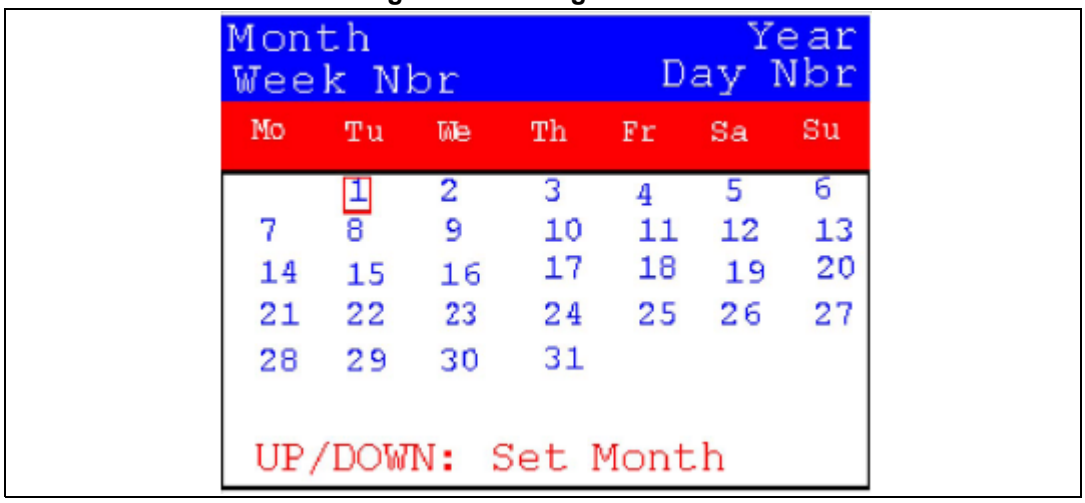
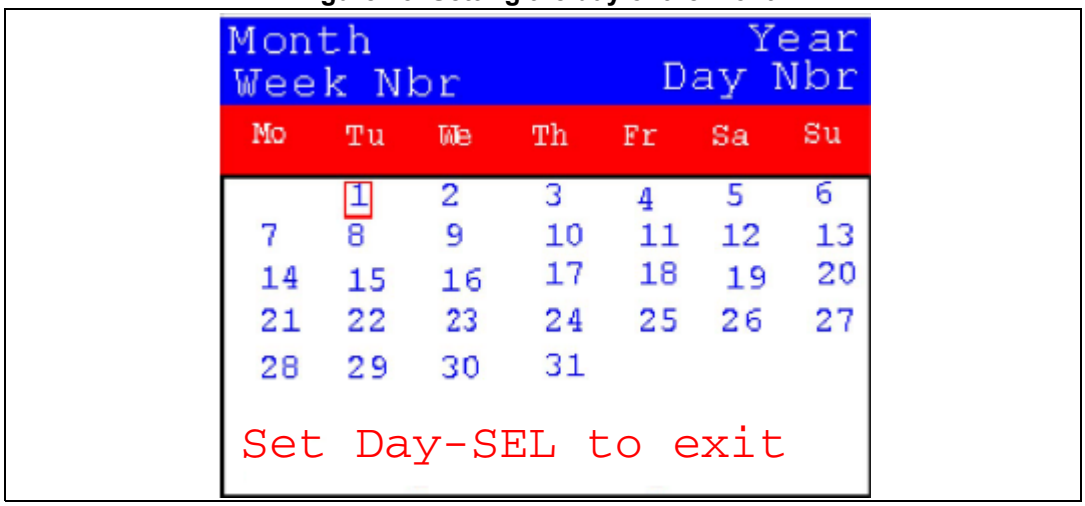


Figure 23. Setting the day of the month



- **Date show:** this item displays the current date. If the time and date have not been configured before, a message is displayed, prompting the user to set the time and date or to exit to the upper submenu. The message shown in *Figure 24* is displayed on the LCD when the submenu is selected (with the date already configured).

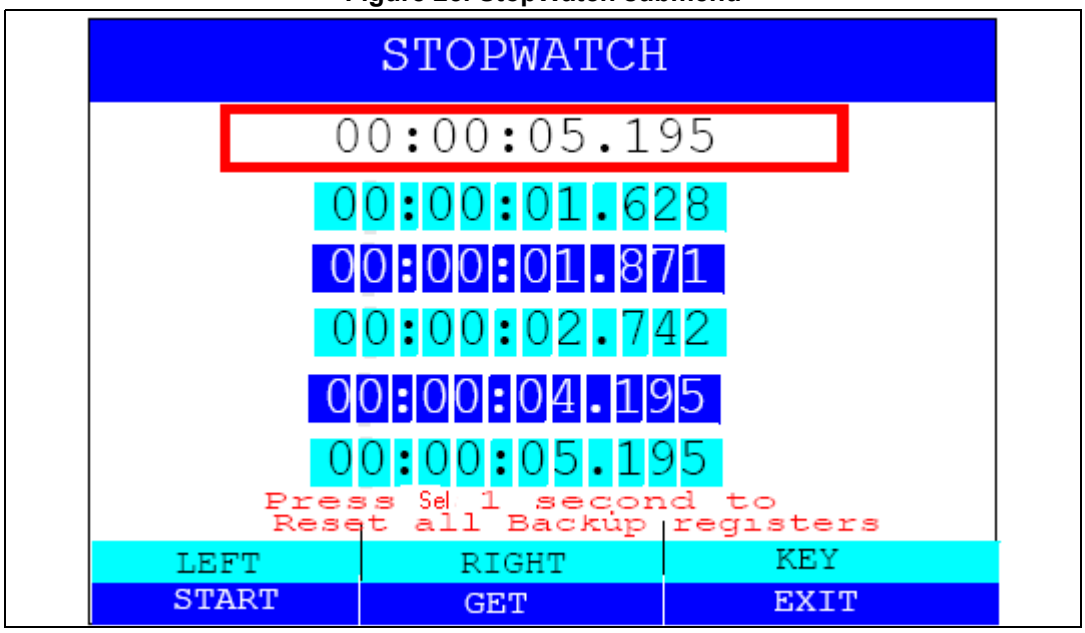
Figure 24. Exiting the date show submenu

To exit this submenu, press the SEL push-button. To exit the Date submenu, select the return line and press the SEL push-button.

Stopwatch submenu

This application simulates a precise chronometer with a provision for 5 record times. For this application an interactive human interface is developed using STM32303E-EVAL LCD and push-buttons to allow the user to use the stopwatch with real time display.

Figure 25. StopWatch submenu



After startup, a default 00:00:00:000 chronometer counter is displayed on the LCD, it correspond to [Hours]:[minutes]:[seconds]:[milliseconds].

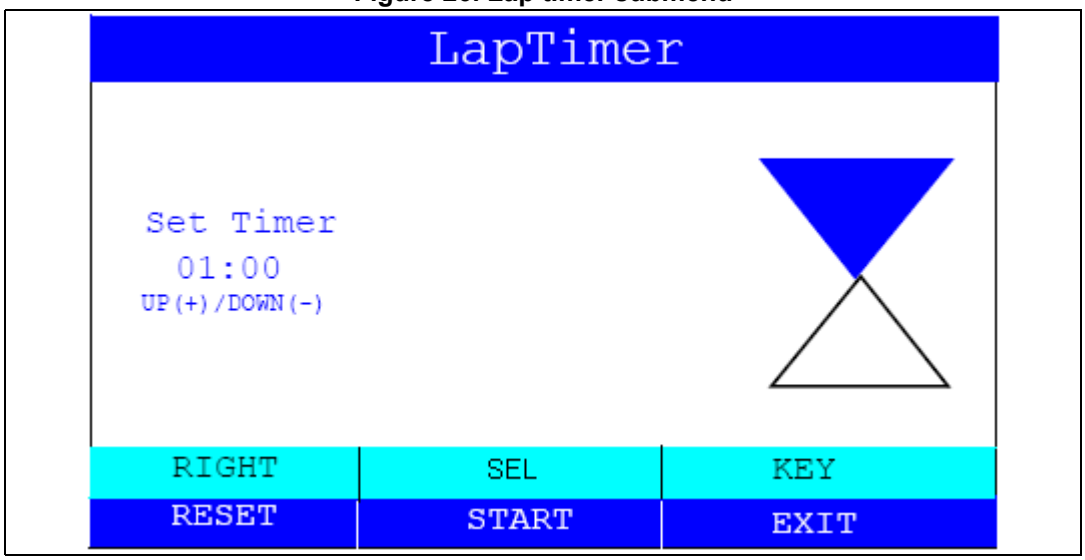
The user can control the chronometer features using the joystick LEFT and RIGHT push-buttons:

1. Press the joystick LEFT button to start the counter.
2. Press the joystick RIGHT button to save trials in the backup registers (max 5 actions).
3. Press the KEY button to exit.
4. Press and hold the SEL button for 1 sec to reset all the backup registers.

Lap timer

This application simulates a precise Hourglass, it measures the passage of a short period (subseconds, seconds or minutes) of time. For this application an interactive human interface is developed using the STM32303E-EVAL LCD and push-buttons to allow the user to use the lap timer with real time display. After startup, the Hourglass is filled and the default timer duration is set to one minute. Using the UP and DOWN push-buttons, the user can change the timer duration (the timer duration must be greater than 30 seconds and less than 2 minutes).

Figure 26. Lap timer submenu



The user can control the Hourglass features using the Joystick SEL, RIGHT, UP and DOWN buttons:

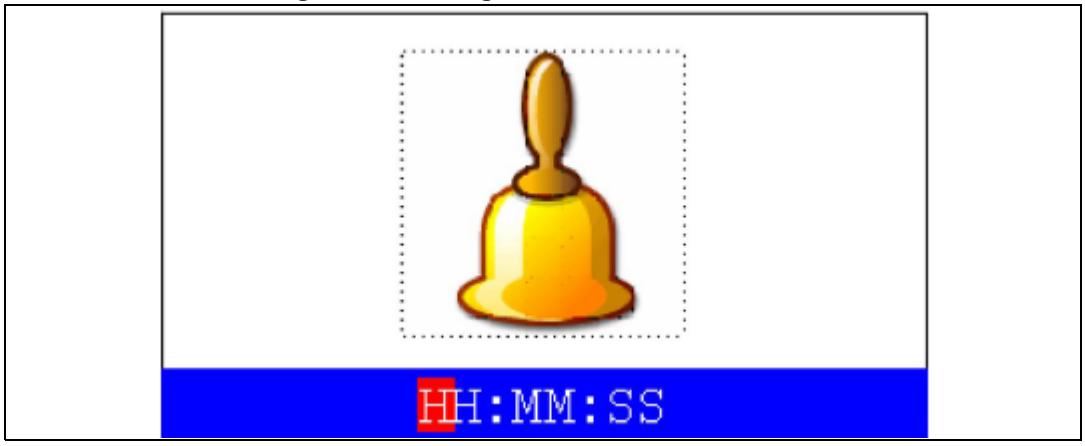
1. Press the joystick UP/DOWN button to adjust the timer (the UP and DOWN buttons are used only when the timer is reset).
2. Press the joystick SEL button to start the timer.
3. Press the joystick SEL button again to pause the timer.
4. Press the joystick RIGHT button to reset the timer.

Alarm submenu

Using this submenu, the user can configure the alarm activation time. When the alarm time value is reached, all the LEDs (LED1 to LED4) start flashing together, and continue for 3 seconds. This submenu is divided into two items that allow the user to display or set the current alarm.

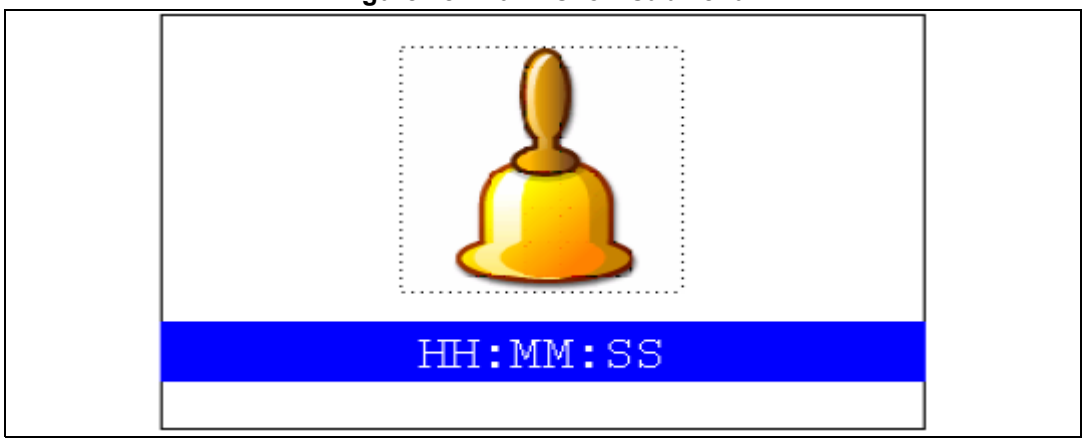
- **Alarm adjust:** the alarm time activation is set in the same way as the time is set in the Time adjust submenu. The following messages are successively displayed on the LCD when the submenu shown in *Figure 27* is selected. When adjusting the alarm, the current time is displayed.

Figure 27. Setting the alarm activation time



- **Alarm show:** this item displays the current alarm time. If the time and date have not been configured before, a message shown in *Figure 29* is displayed. Pressing SEL to go back to the alarm submenu. The message shown in *Figure 28* is displayed on the LCD when this submenu is selected.

Figure 28. Alarm show submenu



To exit the alarm show submenu, press the SEL push-button. To exit the alarm submenu, select to the Return line and press the SEL push-button.

Note: In the alarm adjust and alarm show menus, if the time and date have not yet been configured, the message shown in Figure 29 is displayed on the LCD screen.

Figure 29. Message displayed if time and date need setting

2.4.2 Image viewer submenu

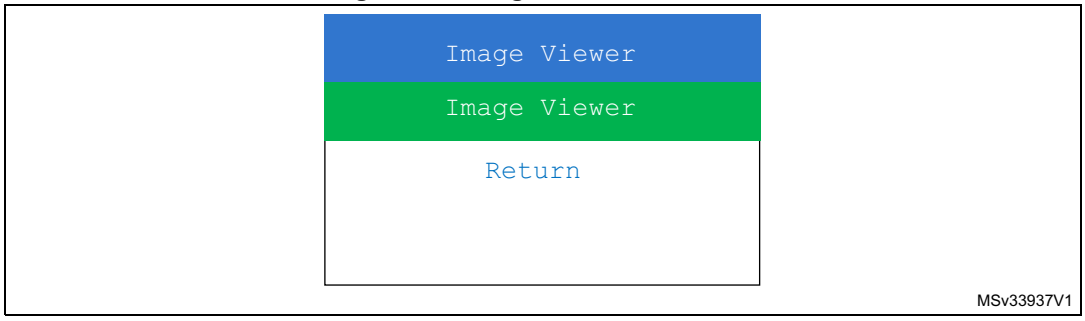
The Image viewer submenu is used to demonstrate the LCD control performance using the embedded SPI interface. The application is a successive display of stored images.

This application reads all bitmap pictures from the USER directory (see *Section 3.1: Programming the media files* and displays only the .BMP files having the following format:

- Bit depth: 16 bits (RGB)
- Size: 240x320

Select Image viewer to display the submenu shown in *Figure 30*.

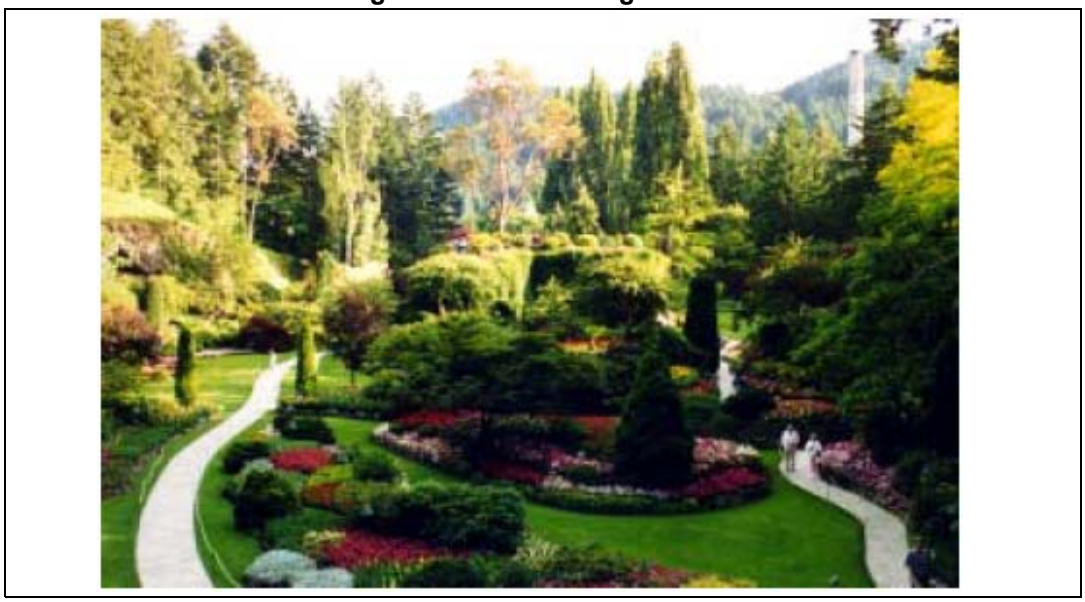
Figure 30. Image viewer submenu



When Image viewer is selected, a list box of images is displayed as shown in *Figure 31.*

Using the UP, DOWN and SEL push-button the user can select and view any image from the list box.

Figure 31. STM32 Image viewer



When Image viewer is selected, the corresponding image is displayed and then the user can use RIGHT and LEFT push-buttons to go to the next/previous image stored in the USER folder on the MicroSD card. If the KEY button is pressed, the Image viewer is stopped and the submenu shown in *Figure 30* is displayed.

The supported image size is 240x320. The defined number of images that are read from the MicroSD card is 4 images, selected in alphabetic order.

2.4.3 Audio features

Wave player submenu

The STM32303E-EVAL evaluation board supports stereo audio play using the audio Codec CS42L52 connected to I2S port and controlled by I2C2 interface.

In this demo, an audio wave file stored under the USER folder in the MicroSD card is opened using the FATFS file system and transferred to the internal SRAM block by block (512 bytes) using the SPI interface. The voice sampling period is read from the wave file header. An audio amplifier is connected to the DAC interface to play the stored wave files.

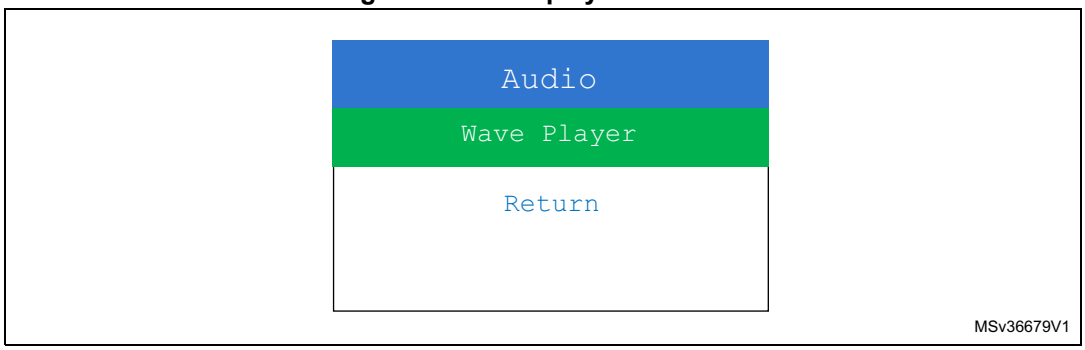
This application reads all wave files from “USER” directory (See *Section 3.1: Programming the media files*) and only displays WAV files with the following format:

- Audio Format: PCM (an uncompressed wave data format in which each value represents the amplitude of the signal at the time of sampling.)
- Sample rate: **may be 8000, 11025, 22050 or 44100 Hz.**
- Bits Per Sample: 16-bit (Audio sample data values in the range [0-65535]).
- Number of channels: 2(Stereo)

The maximum number of wave files that can be read from the MicroSD card is 25 files selected in alphabetic order.

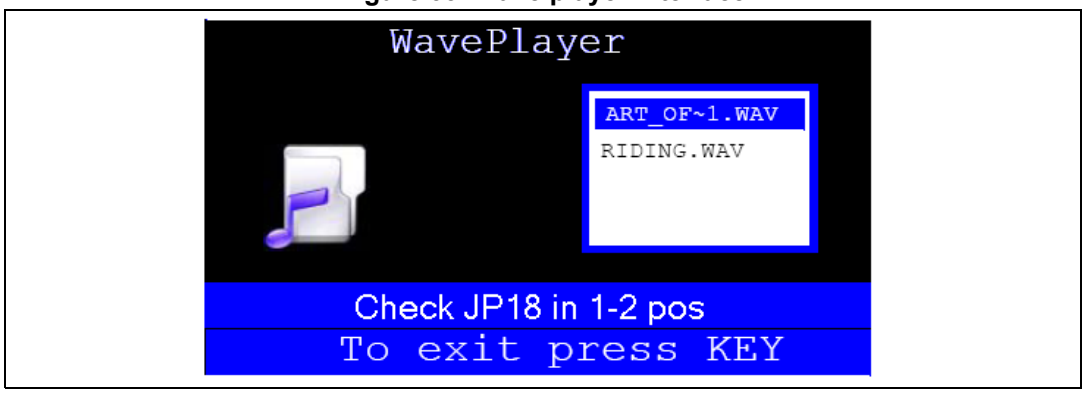
After selecting Wave player, the submenu shown in *Figure 32* is displayed.

Figure 32. Wave player submenu



When wave player is selected, the wave player file names are displayed in a list box as shown in *Figure 33*

Figure 33. Wave player interface



Using the UP, DOWN and SEL push-buttons, the user can select the wave file to be played.

Once the play command is prompted (SEL push-button), the submenu shown in *Figure 34.* is displayed.

Figure 34. Wave player playing submenu

At this application level, pressing:

- The SEL push-button pauses the audio stream
- The DOWN push-button decrements the audio stream
- The UP push-button increments the audio stream
- The KEY button exits the wave player submenu

When the audio stream is paused, the menu in *Figure 35* is displayed.

Figure 35. Pause submenu

To resume playing, press the SEL push-button. The menu shown in *Figure 34* is then displayed.

When the audio stream is stopped, the stream position is reset and the menu shown in *Figure 33* is displayed.

Note: The audio files provided with this package are based on a free music downloaded from the www.DanoSongs.com website.

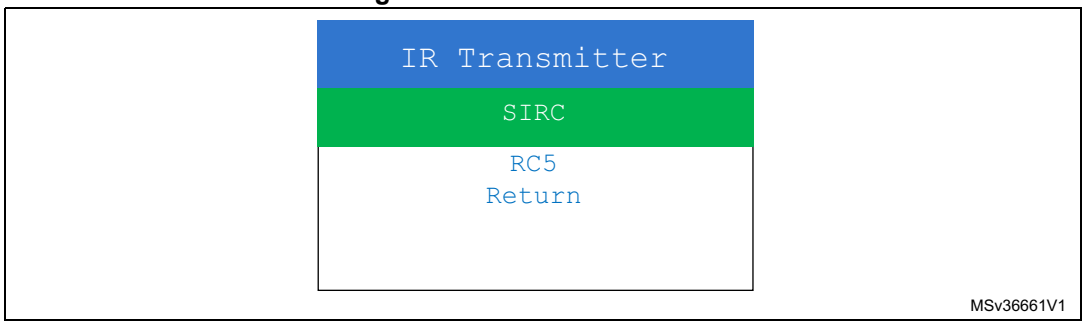
2.4.4 Connectivity submenu

IR Transmitter

On the STM32303E-EVAL an IR LED is driven by PB9 through transistors T4 and T5.

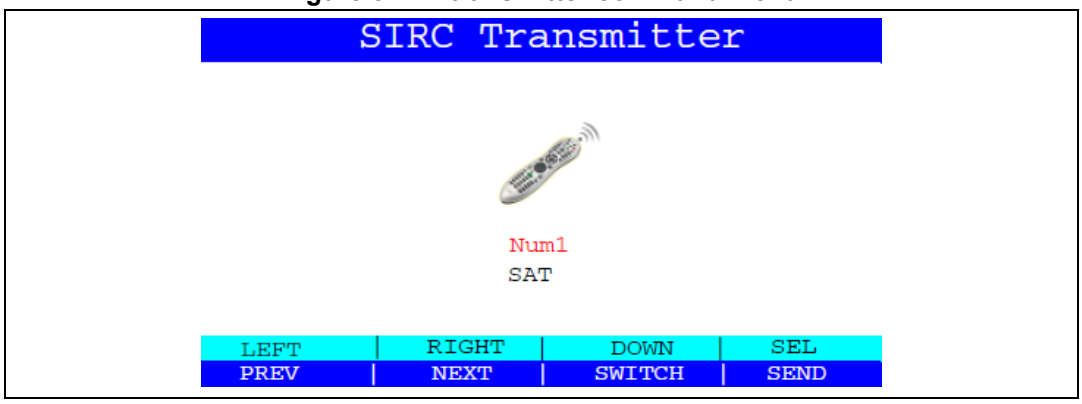
When the IR Transmitter submenu is selected, the message shown in *Figure 36* is displayed.

Figure 36. IR transmitter menu



When a protocol is selected in the list, the corresponding submenu such as the one shown in *Figure 37* is displayed.

Figure 37. IR transmitter command menu



The user can control the IR transmitter features using the Joystick LEFT, RIGHT, DOWN, UP and SEL buttons:

1. Press the joystick DOWN button to switch between device type and command.
2. Press the joystick LEFT button to go to the previously defined device/command.
3. Press the joystick RIGHT button to go to the next defined device/command.
4. Press the joystick SEL button to send the selected device command code.

When the Key is pressed, the IR transmitter demonstration is exited and the menu shown in *Figure 36* is displayed.

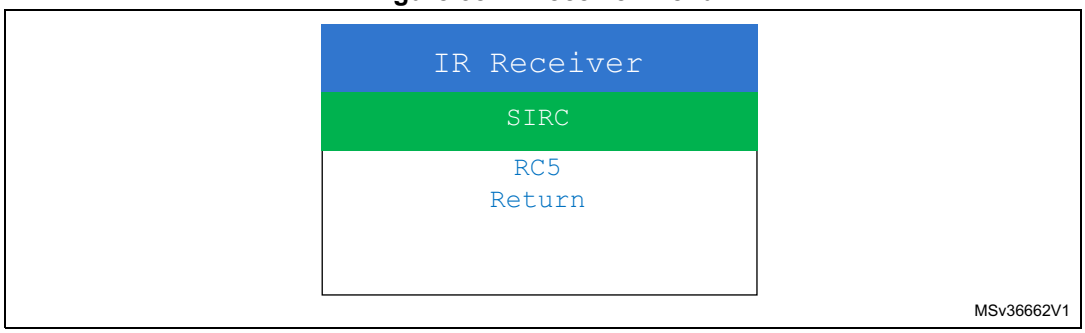
IR receiver

The IR receiver TSOP34836 is connected to PA9 of STM32F303xE on the STM32303E-EVAL board.

At the receiving end, a receiver detects the light pulses, which are processed to retrieve/decode the information they contain.

When the IR Receiver submenu is selected, the message shown in *Figure 38* is displayed.

Figure 38. IR receiver menu

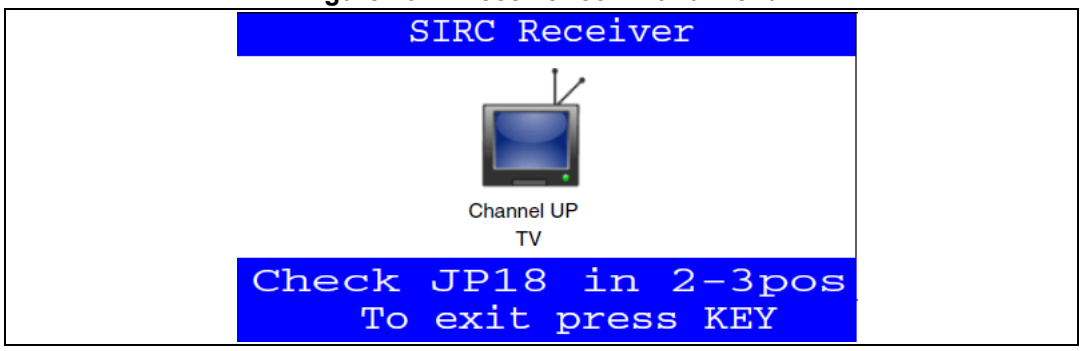


When a protocol is selected in the list, the corresponding submenu such as the one shown in *Figure 39* is displayed.

Figure 39. IR receiver application menu

When an IR frame is sent using a remote control or using the IR transmitter application running on another STM32303E-EVAL board, this IR frame is decoded using the IR receiver and if the protocol is compatible to the selected IR protocol the device and the command is displayed on the LCD screen *Figure 40*

Figure 40. IR receiver command menu

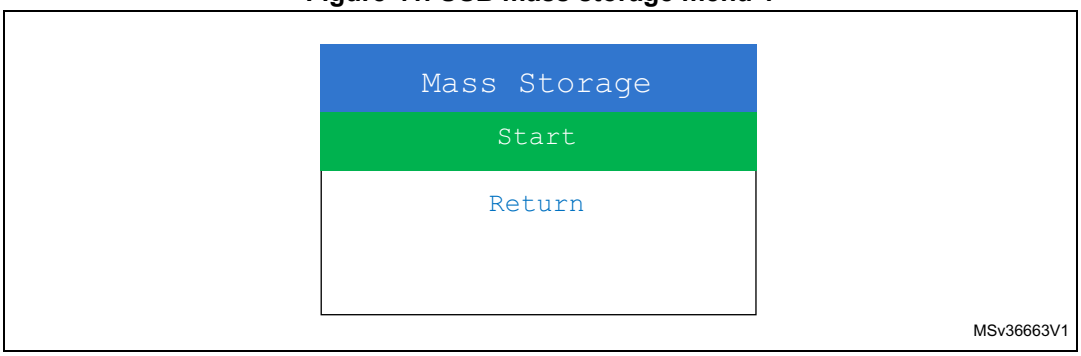


1. For more details on the IR receiver implementation, refer to application note AN3174: “implementing IR remote protocols receiver with the STM32F10x microcontrollers”. This application note provides a full description of the IR decoding.

USB mass storage

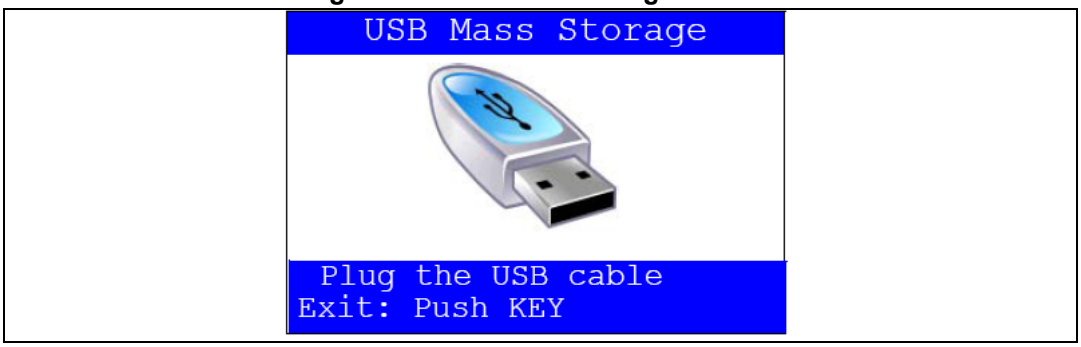
The STM32F303xE microcontroller features a USB (Universal Serial Bus) that provides a full-speed interface to a USB host PC.
The USB Mass Storage demonstration is used to configure the USB interface for a communication with the PC and to run the mass storage demonstration using a MicroSD card.

Figure 41. USB mass storage menu 1



If the SEL push-button is pressed when Start is selected, the message shown in *Figure 42* appears on the LCD screen until the cable is plugged in.

Figure 42. USB mass storage menu 2

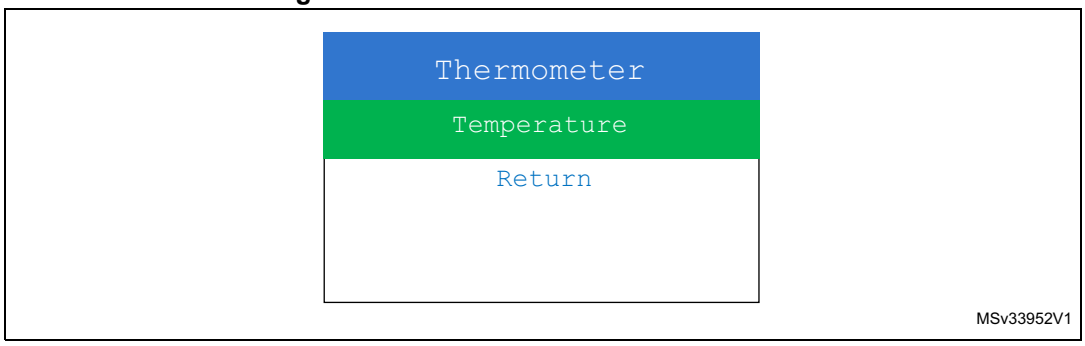


2.4.5 Thermometer

The STM32F303xE microcontroller has two embedded I^2C peripherals that can be connected to any device supporting the I^2C protocol including system management bus (SMBus) mode. STTS751 I^2C temperature sensor is mounted on the STM32303E-EVAL board and used to capture the external temperature (-40°C to +125°C).

When the Thermometer submenu is selected, the message shown in *Figure 43* is displayed on the LCD.

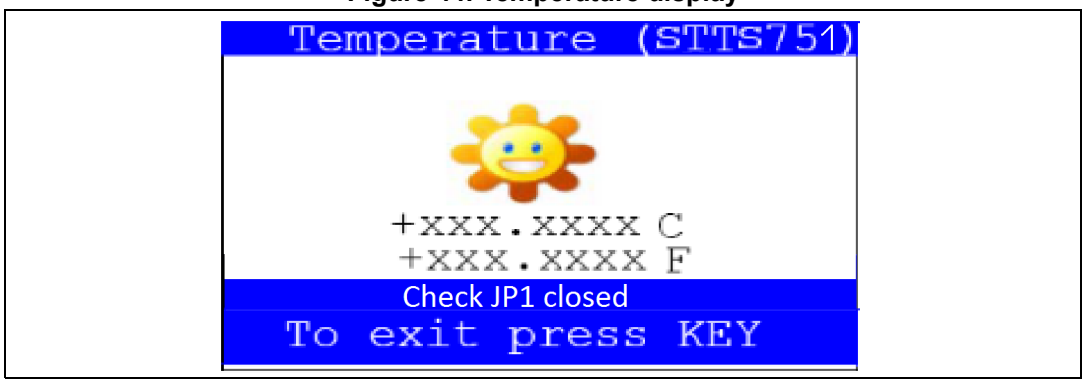
Figure 43. Thermometer submenu selected



Once the temperature submenu has been selected by pressing the SEL push-button, the temperature value is displayed in Celsius and Fahrenheit as shown in *Figure 44*.

Press KEY to return to the Thermometer submenu.

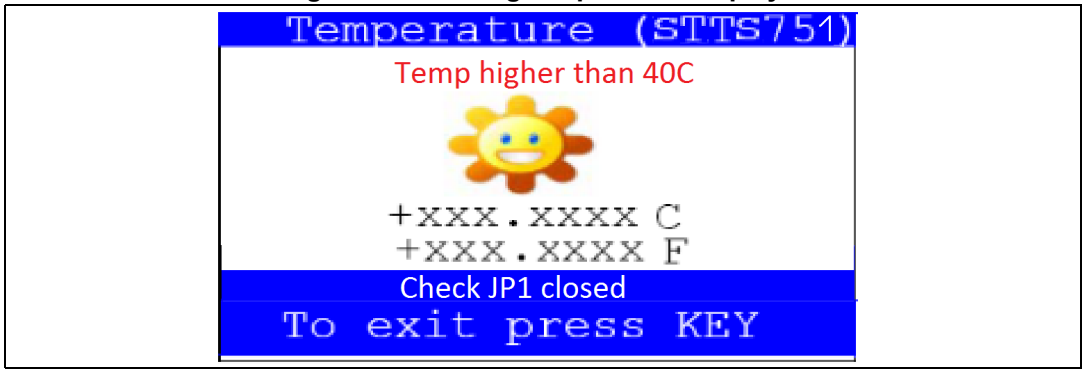
Figure 44. Temperature display



The temperature variations can be monitored easily using the STM32 I2C SMBus feature. This is managed by the SMBus Alert, which generates a dedicated interrupt informing the system that the temperature is out of the selected range. This can be very useful when a higher temperature needs an emergency action, as is the case in critical systems (motor control, medical...).

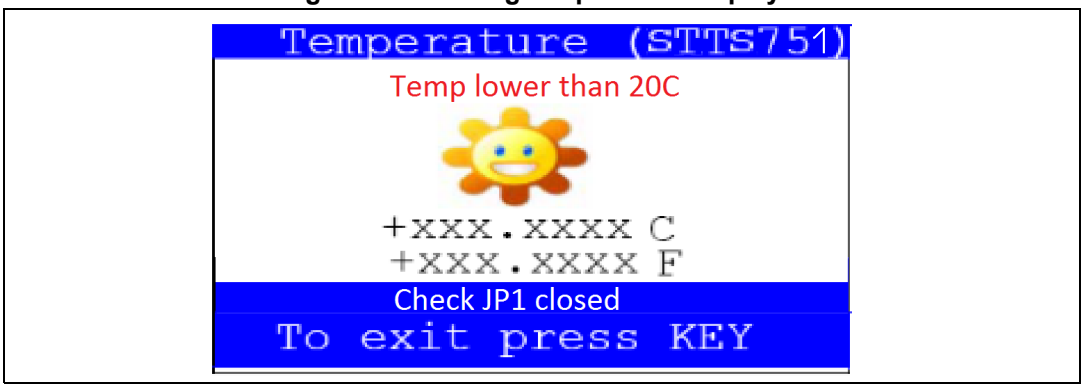
If the temperature exceeds the high limit (TEMPERATURE_HIGH: high limit temperature), the SMBus alert interrupt is generated and the warning message shown in *Figure 45* is displayed on the LCD screen.

Figure 45. Warning temperature display 1



If the temperature exceeds the low limit (TEMPERATURE_LOW: Low limit temperature), the SMBus alert interrupt is generated and the warning message shown in *Figure 46* is displayed on the LCD screen.

Figure 46. Warning temperature display 2



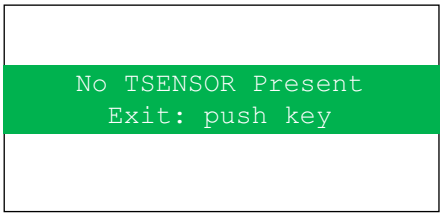
The user can configure the HIGH and LOW using dedicated define values in the code. By default, the STM32303E-EVAL demonstration sets them to the value defined in the thermometer.c file:

```
#define TEMPERATURE_LOW 0x14 /* 20°C */
#define TEMPERATURE_HIGH 0x28 /* 40°C */
```

Press KEY to return to the thermometer submenu.

Note: Any hardware problem with the temperature sensor is detected by a test. In such case, the message shown in Figure 47 is displayed.

Figure 47. Temperature sensor error



MSv36677V1

2.4.6 Low-power modes

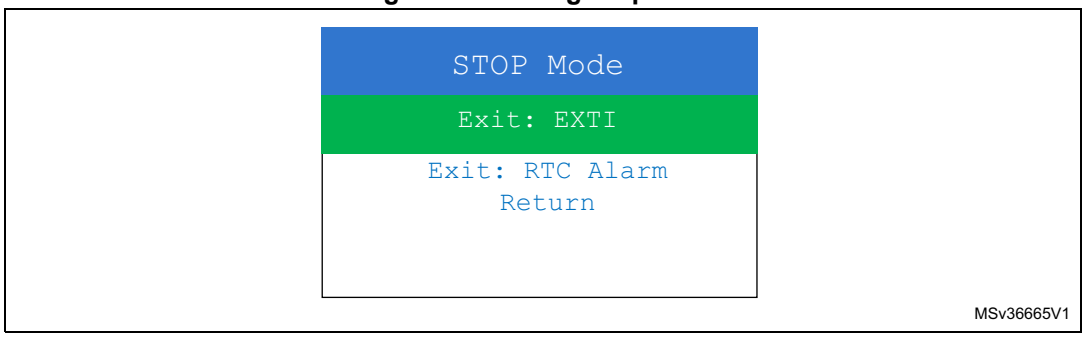
The STM32F303xE microcontroller provides different operating modes in which the power consumption is reduced. The purpose of this menu is to show the behavior of the microcontroller in different low-power modes. Stop and Standby modes are taken as examples.

Stop mode menu

This menu allows the user to put the STM32F303xE in Stop mode. The firmware performs the specific instruction sequence needed to enter Stop mode.

In this application, the STM32F303xE can exit Stop mode in two ways as shown in *Figure 48*.

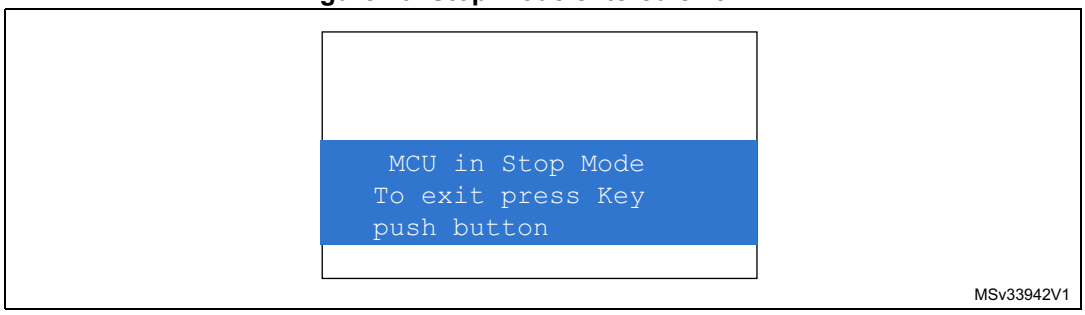
Figure 48. Exiting Stop mode



- In the first case, The EXTI KEY button is used to make the MCU exit Stop mode.

  Once the **Stop mode** submenu has been selected, the four LEDs continue blinking until the “SEL” push-button is pressed, and the system enters Stop mode. When the MCU is in Stop mode, the message shown in *Figure 49* is displayed on the LCD.

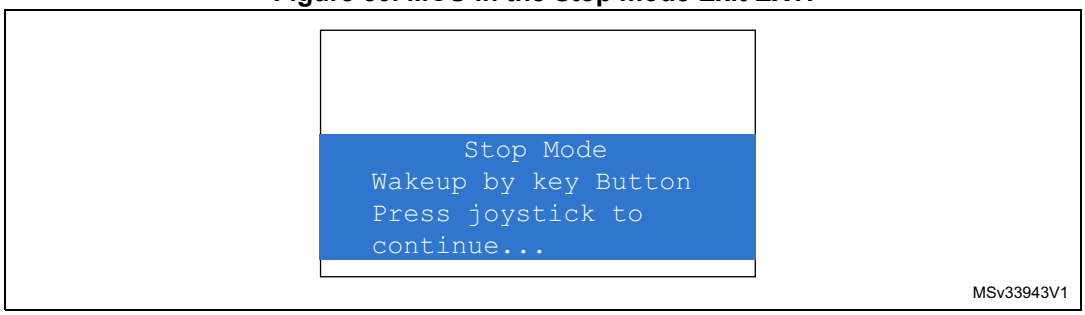
Figure 49. Stop mode entered exit EXTI



The MCU remains in the Stop mode until the KEY push-button is pressed and the message shown in *Figure 50* is displayed on the LCD screen.

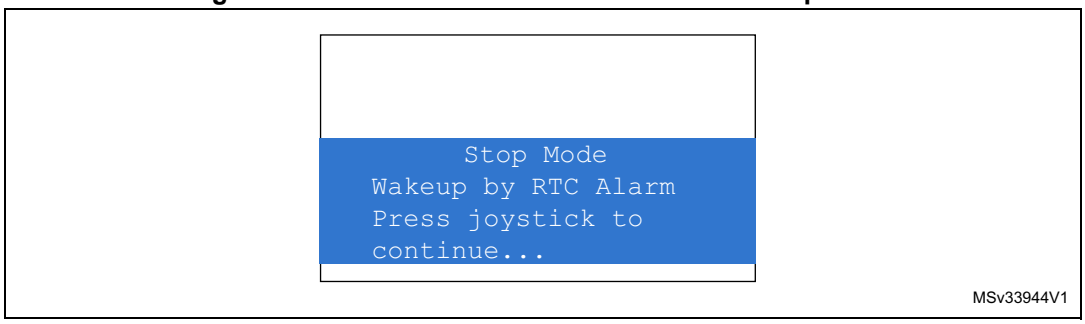
Once the KEY push-button has been pressed, the MCU exits the Stop mode. The system clock is then set to 72 MHz and the application resumes the execution.

Figure 50. MCU in the Stop mode Exit EXTI



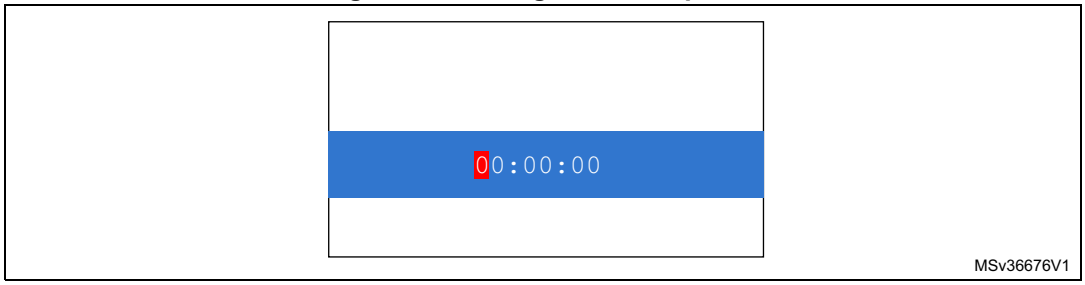
Note: If an RTC alarm is generated while the MCU is in Stop mode and the message shown in Figure 49 is displayed (which means that the KEY push-button needs to be pressed to exit Stop mode), the RTC alarm causes the MCU to exit Stop mode. The message shown in Figure 51 is then displayed.

Figure 51. RTC alarm causes the MCU to exit Stop mode



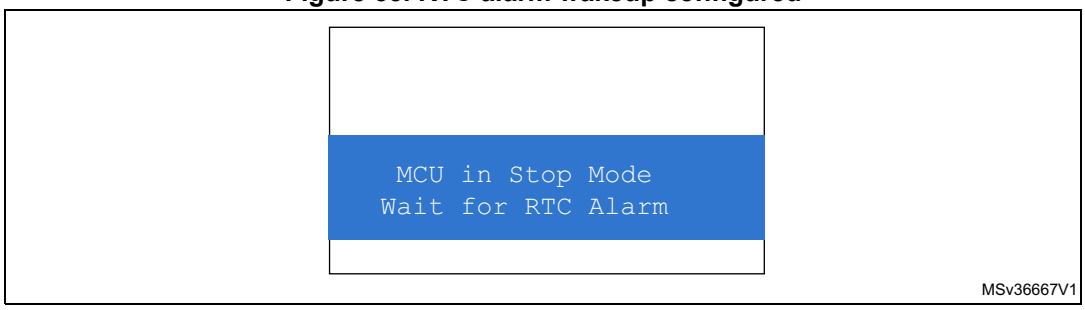
- In the second case, the RTC alarm wakes up the MCU from Stop mode after the programmed time has elapsed. When selecting this submenu, the user has to set the alarm to the time when the MCU has to exit Stop mode. *Figure 52* shows how to set the wakeup time.

Figure 52. Setting the wakeup time



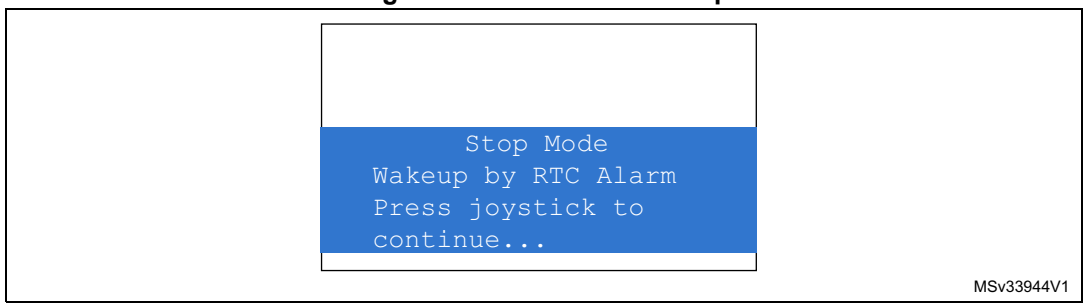
Once the alarm has been configured, the four LEDs stop blinking and the system enters Stop mode. The message shown in *Figure 53* is displayed on the LCD.

Figure 53. RTC alarm wakeup configured



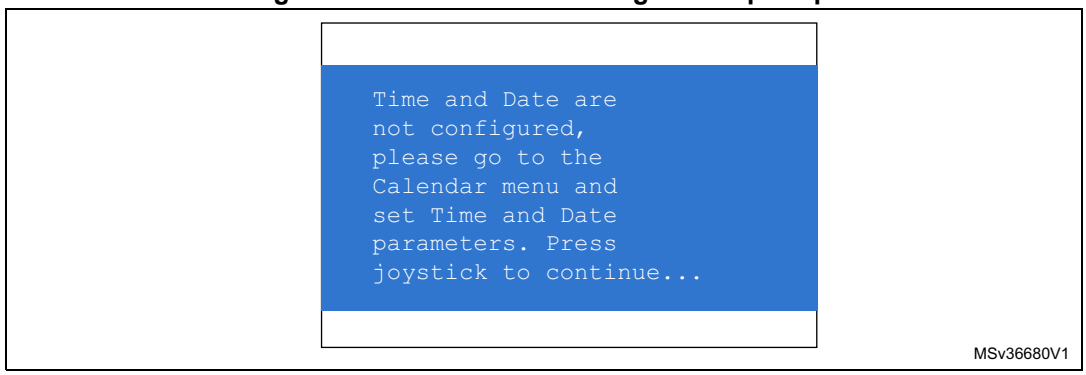
After the programmed time has elapsed, the system exits Stop mode. The system clock is then set to 72 MHz and the application resumes execution. The message shown in *Figure 54* is displayed on the LCD screen.

Figure 54. RTC alarm wakeup



Note: If the time and date have not been set, the message shown in Figure 55 is displayed on the LCD screen.

Figure 55. Time and date configuration prompt

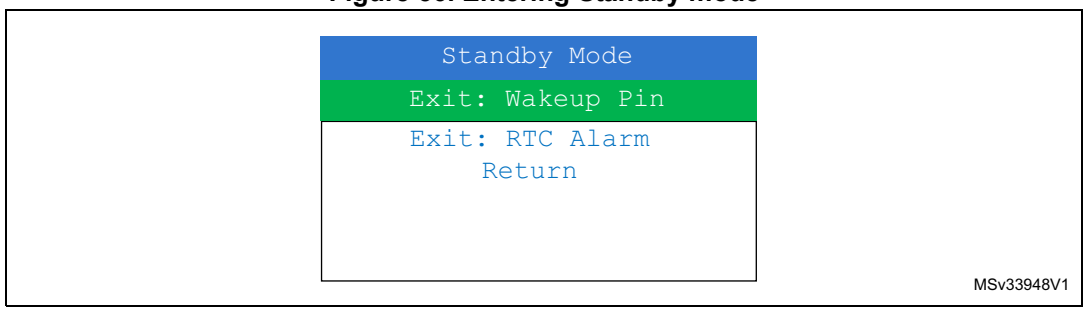


Standby mode menu

This menu allows the user to put the STM32F303xE in Standby mode. The software runs the specific instruction sequence needed by the STM32F303xE to enter Standby mode.

In this application, the STM32F303xE can be made to exit Standby mode in two ways as shown in *Figure 56*.

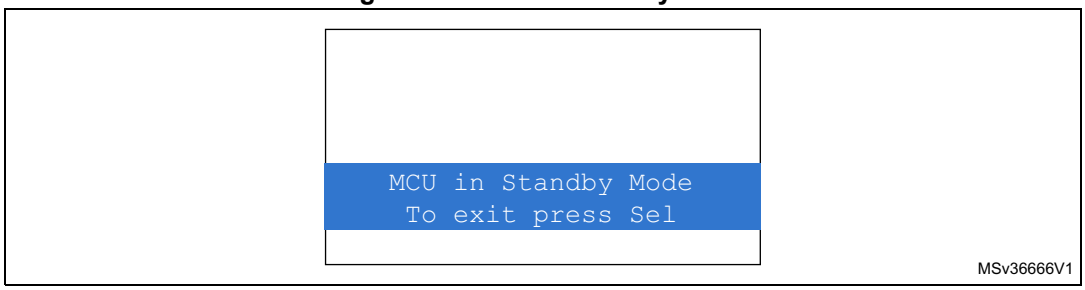
Figure 56. Entering Standby mode



- In the first case, the wakeup push-button is used to wake up the MCU from Standby mode.

  Once the **Standby mode** submenu has been selected, the four LEDs continue blinking until the “SEL” push-button is pressed, and the system enters Standby mode. When the MCU is in Standby mode, the message shown in *Figure 57* is displayed on the LCD

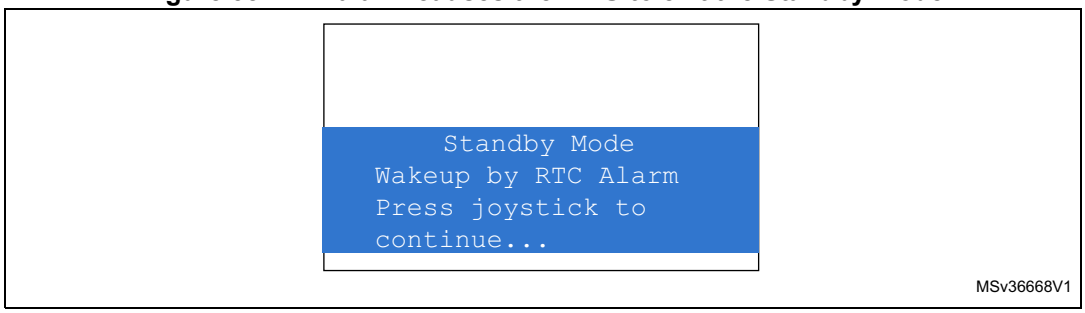
Figure 57. MCU in Standby mode



The MCU remains in Standby mode until the SEL push-button is pressed. Once the Wakeup push-button has been pressed, the MCU exits Standby mode and the system reset signal is generated.

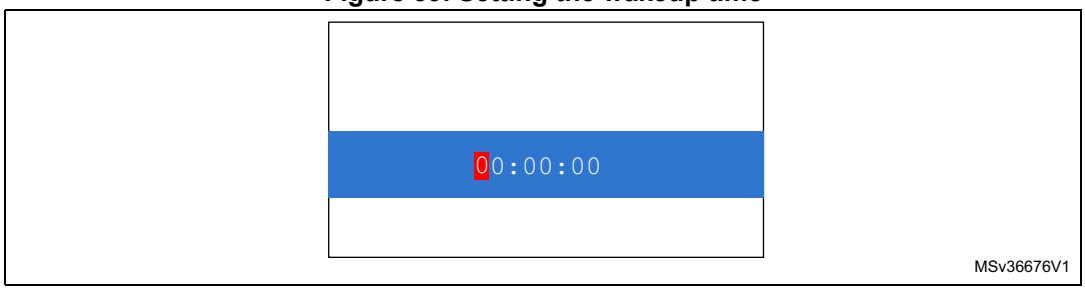
Note: If an RTC alarm is generated while the MCU is in Standby mode (which means that the SEL push-button needs to be pressed to exit Standby mode), the RTC alarm causes the MCU to exit Standby mode and a system reset signal is generated. The message shown in Figure 58 is displayed.

Figure 58. RTC alarm causes the MCU to exit the Standby mode



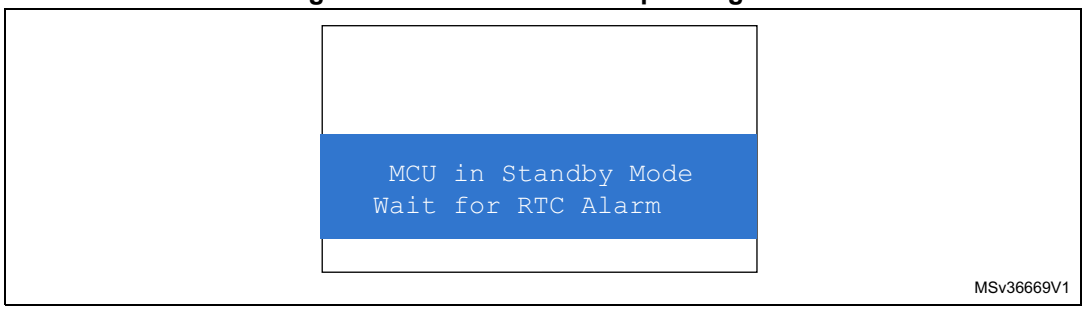
- In the second case, the RTC alarm wakes up the MCU from the Standby mode after the programmed time has elapsed. When selecting this submenu, the user has to set the alarm to the time when the MCU is to exit the Standby mode. *Figure 59* shows how to set the wakeup time.

Figure 59. Setting the wakeup time



Once the alarm has been configured, the LEDs stop blinking and the system enters Standby mode. The message shown in *Figure 60* is then displayed on the LCD.

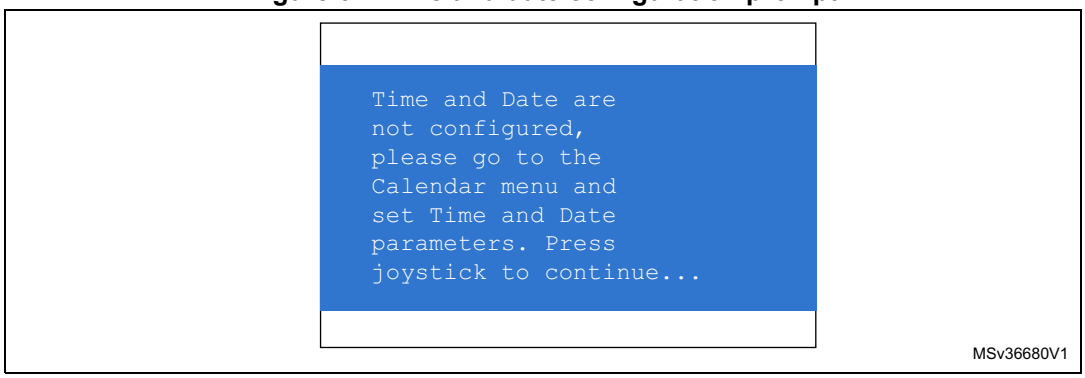
Figure 60. RTC alarm wakeup configured



After the programmed timing has elapsed, the system exits Standby mode and a system reset signal is generated.

Note: if the time and date have not been set, the message shown in Figure 61 is displayed on the LCD screen.

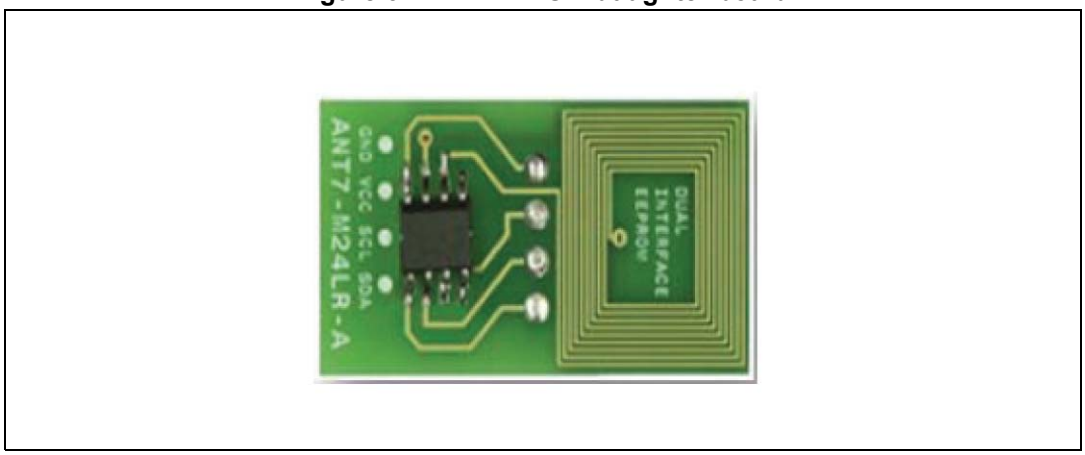
Figure 61. Time and date configuration prompt



2.4.7 RF EEPROM

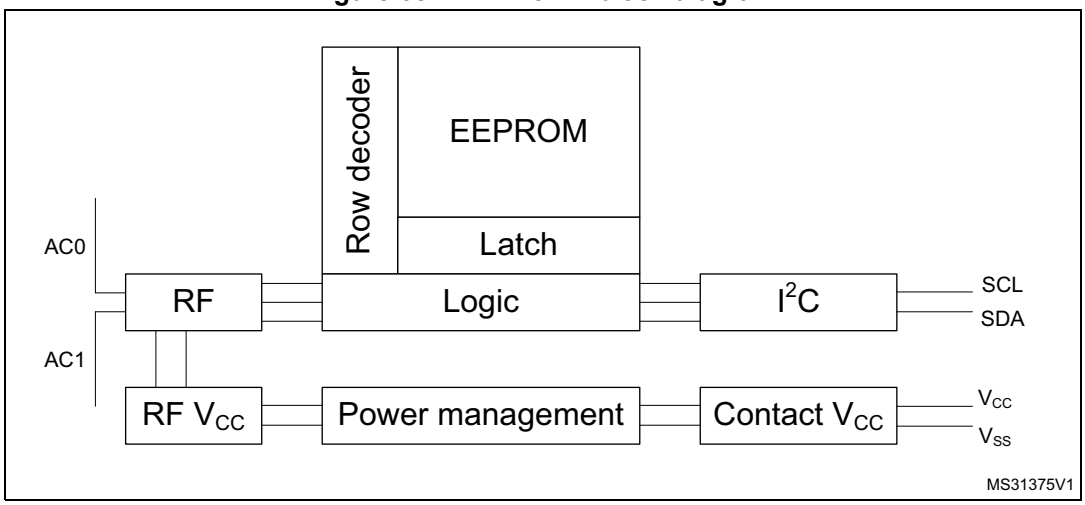
The STM32F303xE microcontroller has two embedded I^2C peripherals that can be connected to any device supporting the I^2C protocol. An RF EEPROM daughter board can be connected to STM32303E-EVAL via the I^2C interface.

Figure 62. RF EEPROM daughter board



The M24LR64-R device is a dual-interface, electrically erasable programmable memory (EEPROM). It features an I^2C interface and can be operated from a V_{CC} power supply. It is also a contactless memory powered by the received carrier electromagnetic wave. The M24LR64-R is organized as 8192 × 8 bits in I^2C mode and as 2048 × 32 bits in ISO 15693 and ISO 18000-3 mode 1 RF modes.

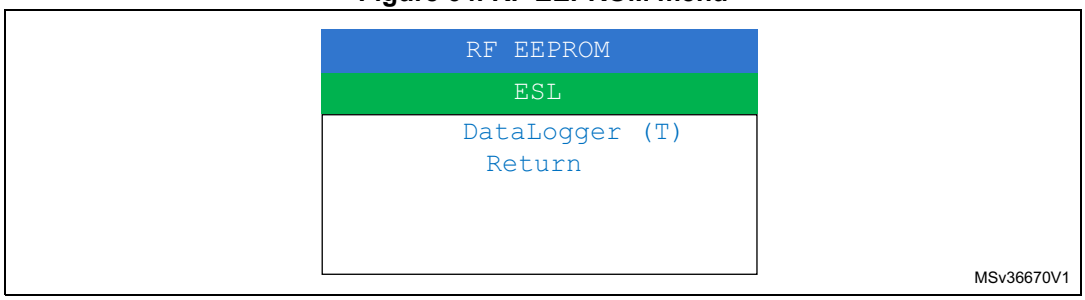
Figure 63. M24LR64-R block diagram



Note: For more details on the M24LR64 EEPROM, please refer to the datasheet.

Select the RF EEPROM menu by pressing SEL from the main menu, two RF EEPROM applications can be selected as shown in *Figure 64*.

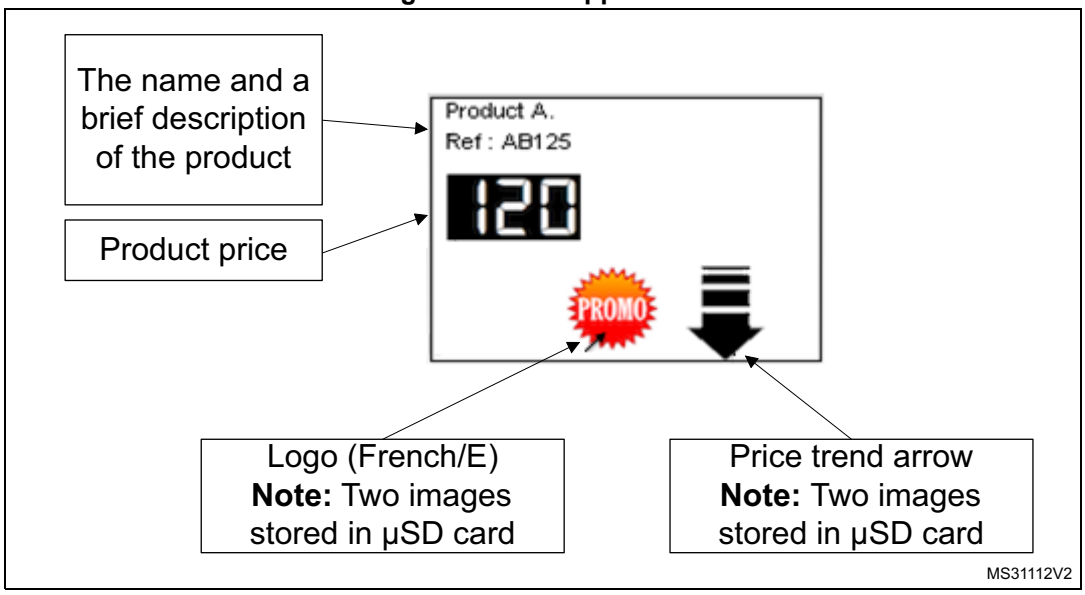
Figure 64. RF EEPROM menu



ESL application

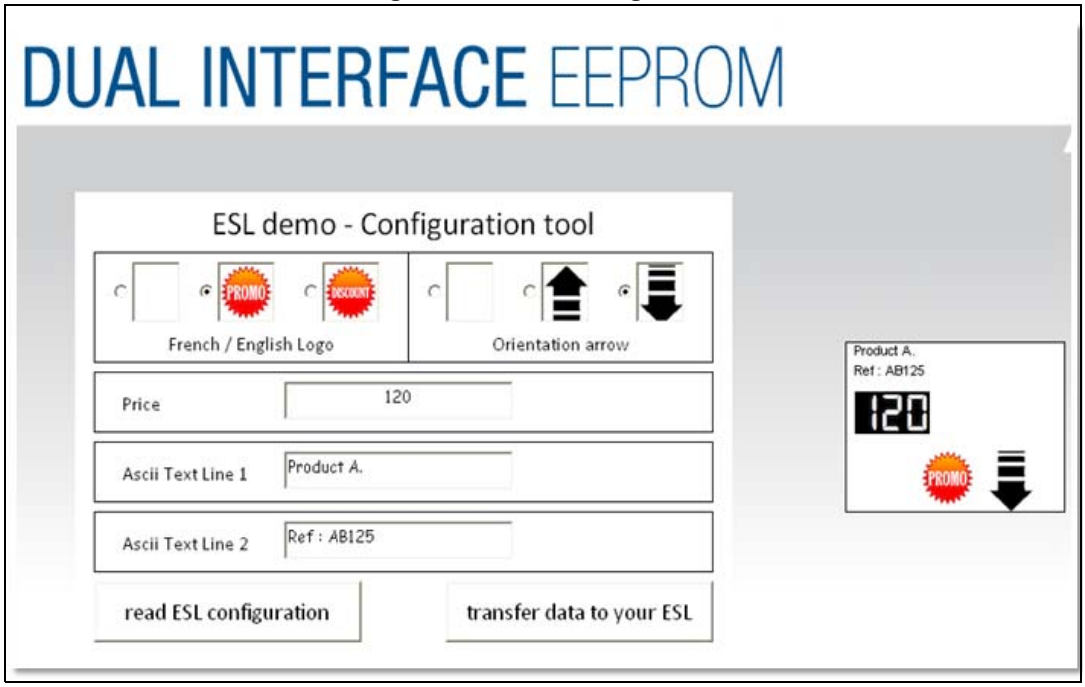
The Electronic Shelf Labeling (ESL) application consists of reading the content of the RF EEPROM (using I2C interface of the M24LR64 dual interface EEPROM) and displaying the information on the LCD screen as shown in *Figure 65*.

Figure 65. ESL application



All this information (product name, price, logo, price trend...) are programmed in the M24LR64 dual interface EEPROM via the RF interface and can be updated any time using the CR95HF demonstration board with the associated PC software (**M24LRxx_Application_Software)**.

Figure 66. ESL setting menu



Using this PC software application, several parameters can be set to configure the ESL device and update the LCD display:

Logo: Check the french (PROMO) or english (DISCOUNT) to indicate that a special price is proposed. Check the blank logo if no special price is applied.

Price trend arrow: Check the up or down arrow to indicate if the price has been increased or decreased, or the blank arrow if no indication is required.

Product price

ASCII Text line 1 and Line 2: Display the name and a brief description of the product.

*Note: For more details about this PC Software please refer to the user manual **UM0853**.*

Using this PC software, the M24LR64 dual interface EEPROM is organized as shown in *Table 4*.

Table 4. M24LR64 memory organization (ESL application)

RF block address	bits [31:24]	bits [23:16]	bits [15:8]	bits [7:0]
0x0000	-	Arrow	Icon	-
0x0001	Contains 0xXYYYYYYY X = number of digits in price (max 7) YYYYYYY = price value including decimal separator (.) coded in hexadecimal. For instance 0x512A99FF means 5 digits and price is 12.99			
0x0002	Contains the ASCII codes of the string chain called ASCII TEXT LINE1 in M24LR64 ESL demonstration software. The maximum size of this text line is 20 characters.			
0x0003				
0x0004				
0x0005				
0x0006				
0x0007	Contains the ASCII codes of the string chain called ASCII TEXT LINE2 in M24LR64 ESL demonstration software. The maximum size of this text line is 20 characters.			
0x0008				
0x0009				
0x000A				
0x000B				
0x000C	XXXX XX is the checksum of bytes from address 0x0000 to 0x000B. YY = Reserved ZZ = Reserved			

DataLogger application

This RF EEPROM application demonstrates a practical application of the M24LR64. It allows to record and store 64 Kbits of temperature data using the M24LR64-R Dual interface EEPROM (I2C and RF). The DataLogger microcontroller is an STM32F303xE. It communicates with the M24LR64-R using its serial interface and controls an STTS751 digital temperature sensor.

Figure 67. Communication block diagram

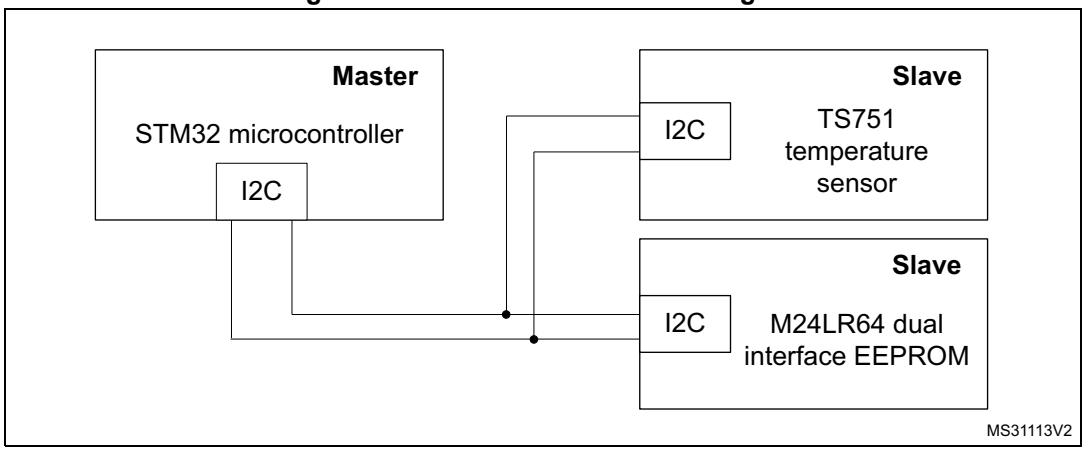
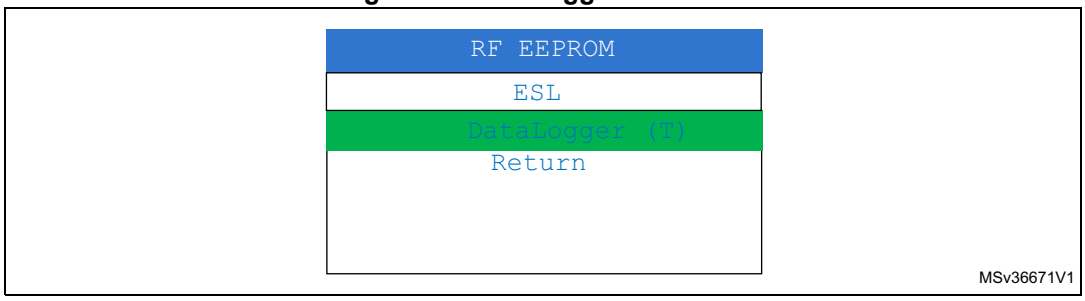


Figure 68. DataLogger submenu



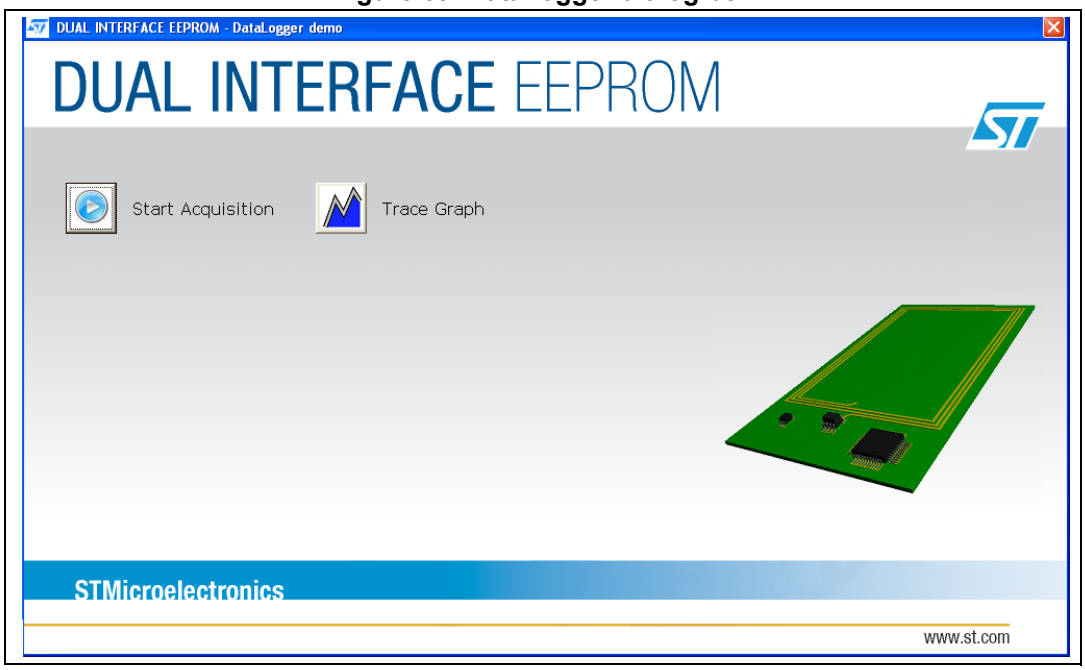
An on-board demonstration firmware stored in the STM32F303xE memory consist to select, control the temperature acquisition through a RFID reader connected by a USB cable to a PC.

For more details about this application please refer to the application note AN3109 “**Developing your M24LR64-R DataLogger application for temperature acquisition**“.

How to run the application:

1. From the STM32303E-EVAL evaluation board side, select the DataLogger submenu and then press SEL push-button.

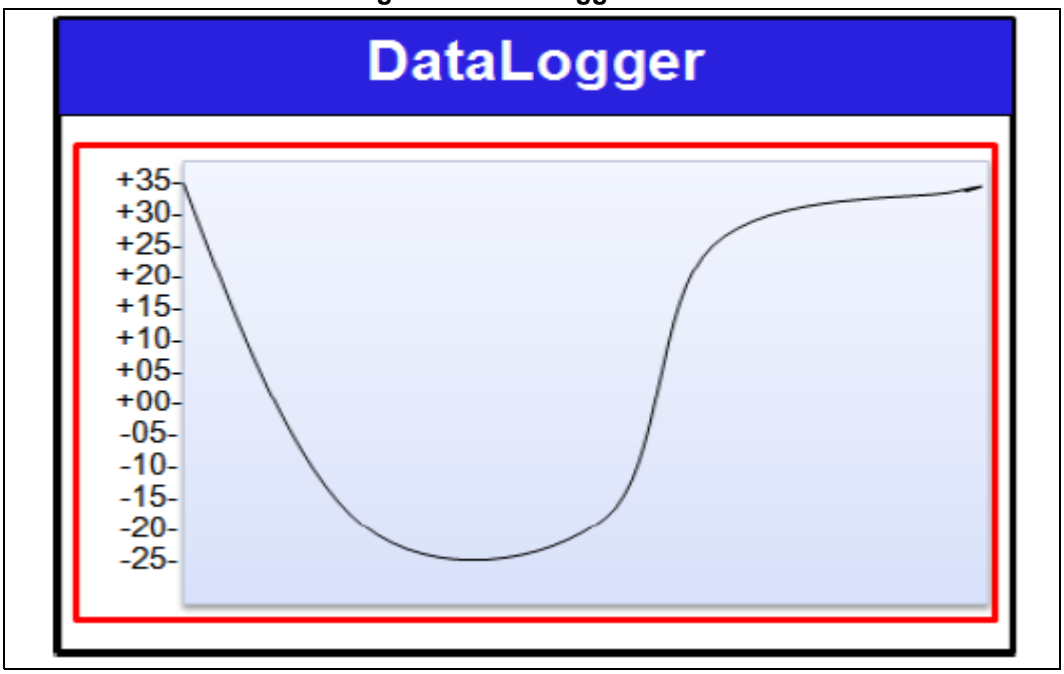
Figure 69. DataLogger dialog box



2. From the PC software side, choose “DataLogger“ application and then follow the steps described on the user manual **UM0925.**

When the application starts, the data is stored in the dual interface EEPROM and the temperature data is displayed in a real time as a graph on the TFT-LCD display on the evaluation board and also on the PC software interface.

Figure 70. DataLogger curve



Reference documents:

- M24LR64-R datasheet
- M24LR64-R tool driver install guide user manual (UM0863)
- User manual UM0925: Using the M24LR64-R DataLogger reference design
- Application note (AN3057): How to manage M24LR64-R data transfers from the I²C bus or an RF channel
- Application note (AN3109): Communication peripheral FIFO emulation with DMA and DMA timeout in STM32F10x microcontrollers

2.4.8 Humidity measurement application

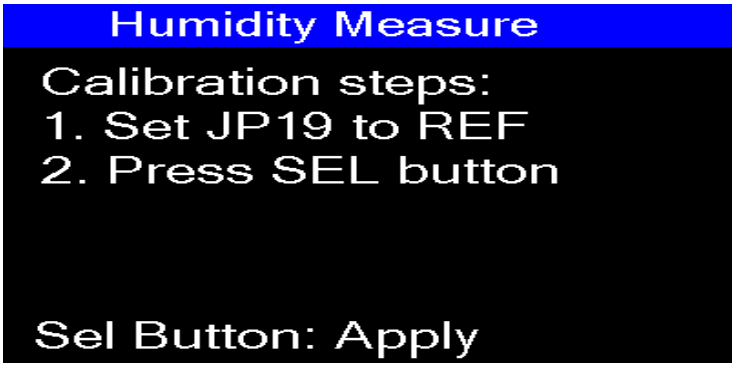
Before humidity measurements can be performed, a 2-step calibration is required:

1. In the first step, the capacitance offset error is evaluated and saved in backup registers, this phase is performed with JP19 installed in 2-3 (REF) position.

   The message shown in *Figure 71* is displayed.

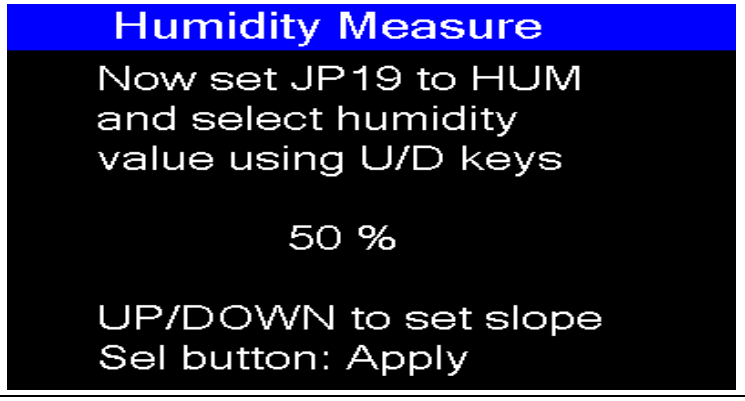
   The user must press SEL and follow the next step.

Figure 71. Humidity calibration 1



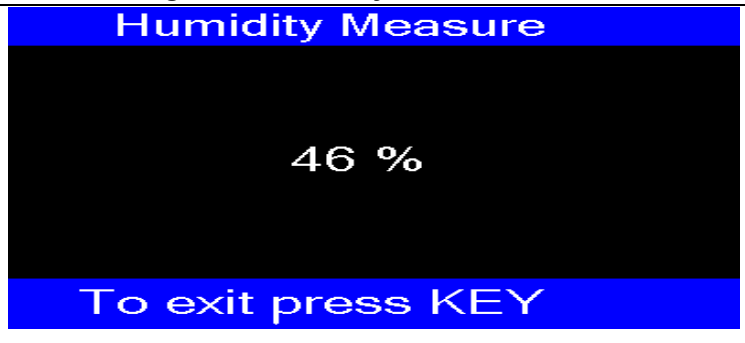
2. In the second step, the humidity measurement accuracy can be improved by entering the actual humidity reference at calibration time if it is known. After setting the JP19 to HUM position, select a reference humidity value using UP/DOWN buttons as indicated on *Figure 72* then press the SEL button. Otherwise, let the estimated humidity value unchanged and press the SEL button.

Figure 72. Humidity calibration 2



The humidity measure is displayed on the TFT-LCD. The figure below shows an example of the message displayed.

Figure 73. Humidity measurement



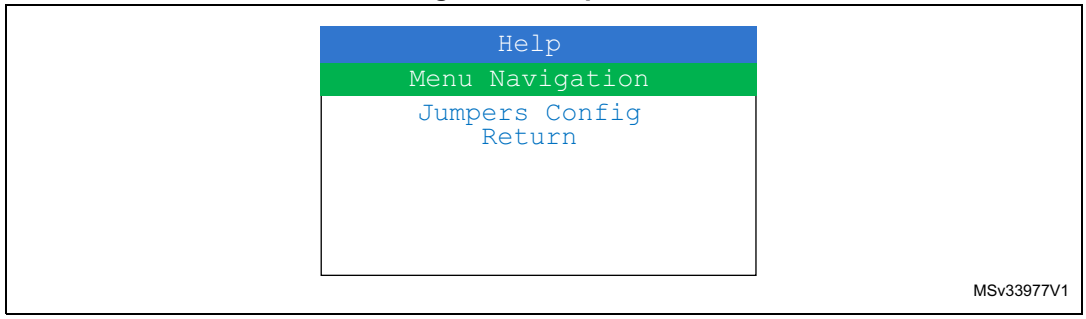
1. To run the calibration phase again, power-off the evaluation board and set the jumper JP16 in V_{DD} position. If jumper JP16 is fitted in BAT position, the calibration phase is executed only once.

2.4.9 Help

This submenu provides help for configuring the jumpers on the STM32303E-EVAL evaluation board and navigating between the menus and submenus available in the demonstration firmware.

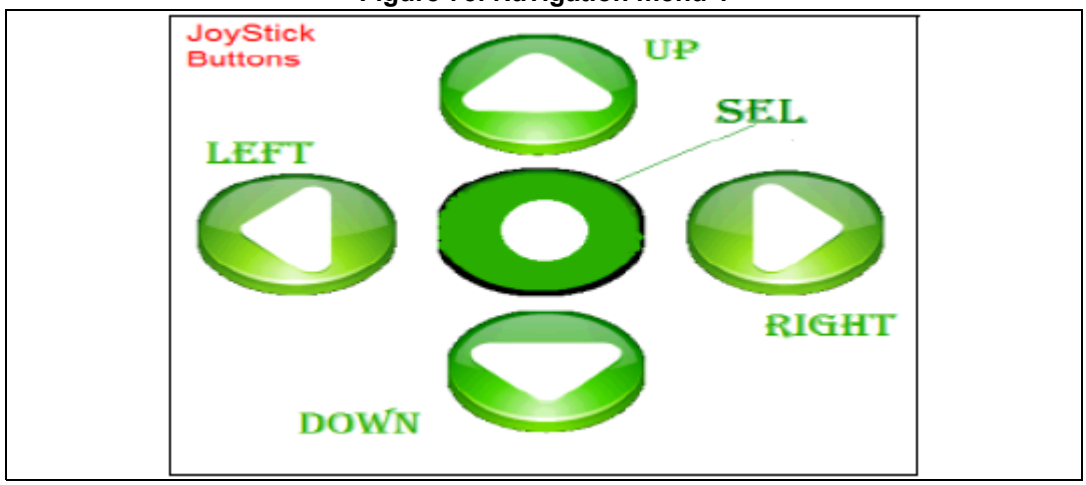
Select the Help menu by pressing SEL from the main menu. The message shown in *Figure 74* is then displayed on the LCD screen.

Figure 74. Help menu



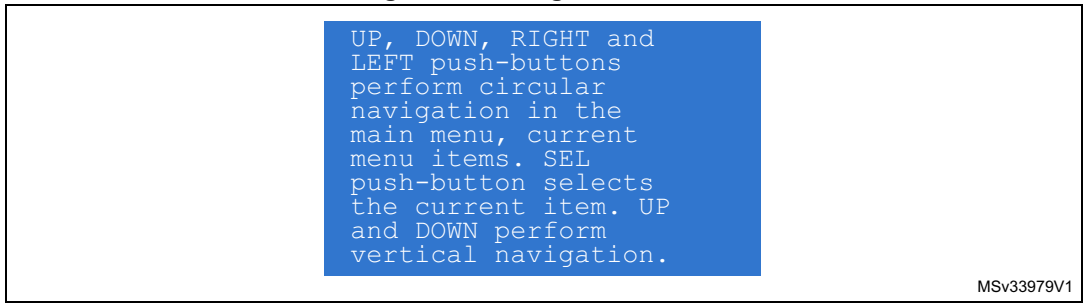
If the Menu Navigation submenu is selected, the message shown in *Figure 75* is displayed:

Figure 75. Navigation menu 1



When any joystick button is pressed, the second navigation interface is displayed as shown in *Figure 76.*

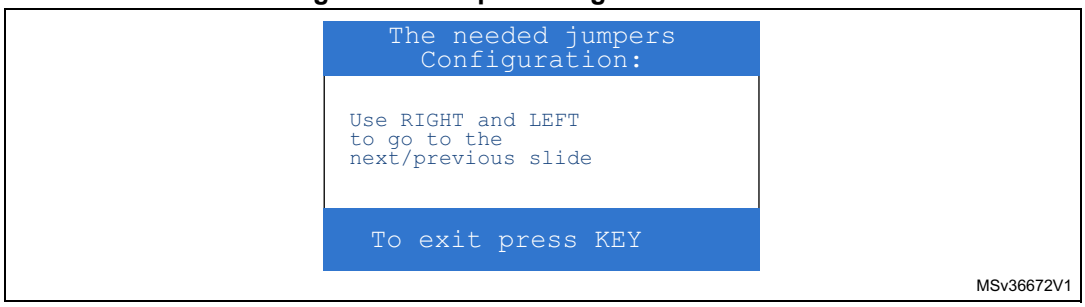
Figure 76. Navigation menu 2



Once the joystick push-button has been pressed again, the MCU exits the navigation submenu and the message shown in *Figure 74* is displayed on the LCD screen.

- If the jumpers config submenu is selected, the message shown in *Figure 77* is displayed.

Figure 77. Jumper configuration menu 1



Press RIGHT and LEFT to go to the next/previous slide and UP to exit. The following messages shown in *Figure 78*, *Figure 79 and Figure 80* are displayed sequentially on the LCD screen.

Figure 78. Jumper configuration menu 2

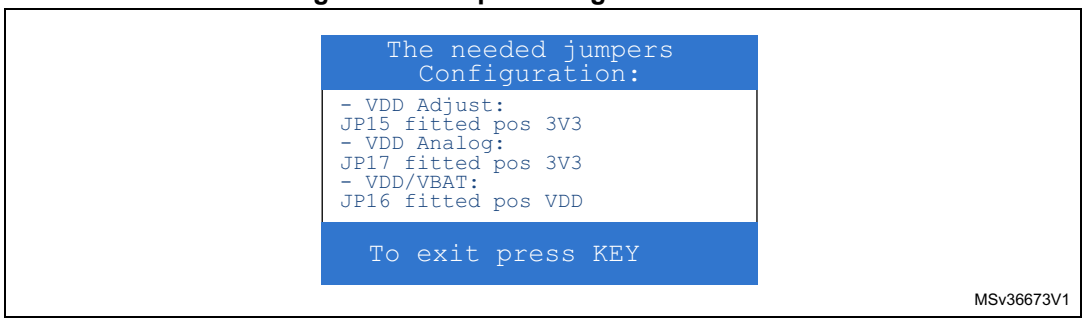


Figure 79. Jumper configuration menu 3

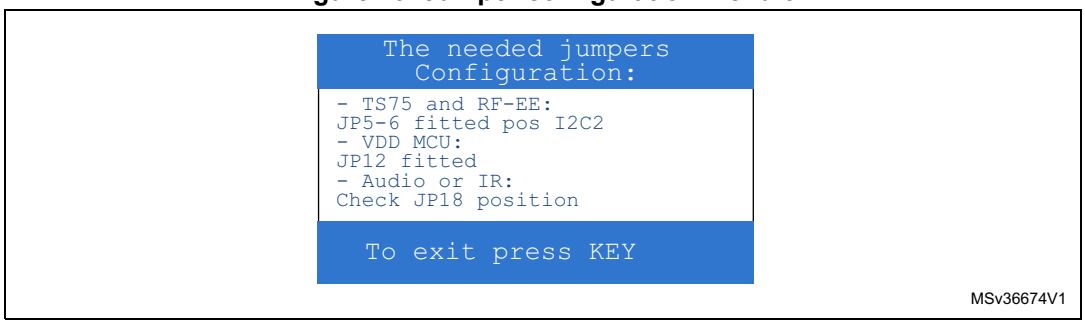
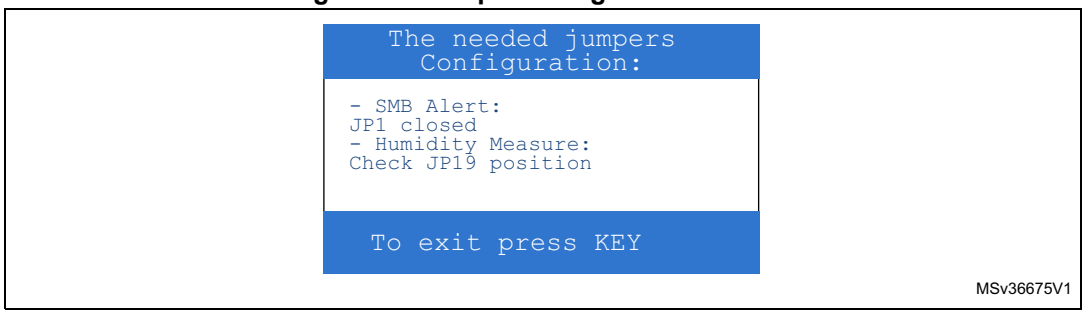


Figure 80. Jumper configuration menu 4



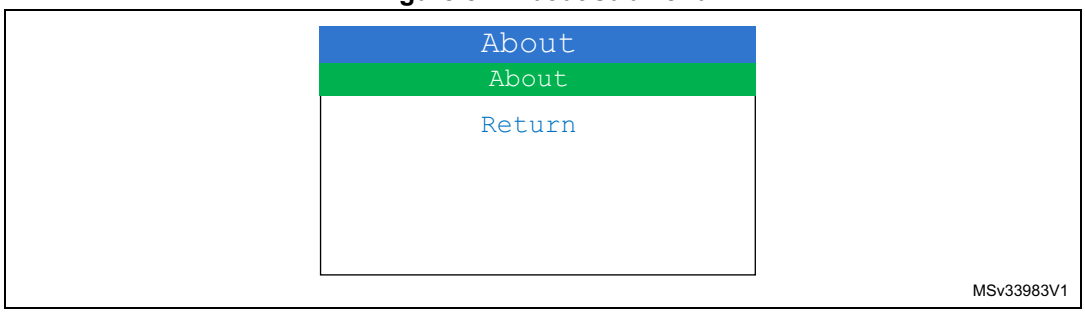
1. Set JP16 in BAT position to save time even if the evaluation board is powered off. By default, JP16 is set in position V_{DD}.

Once the KEY push-button has been pressed, the MCU exits the jumper configuration submenu and the message shown in *Figure 74* is displayed on the LCD screen.

2.4.10 About submenu

This submenu shows the version of the STM32303E_EVAL demonstration firmware. When the About submenu is selected, the message shown in *Figure 81* is displayed on the LCD screen.

Figure 81. About submenu



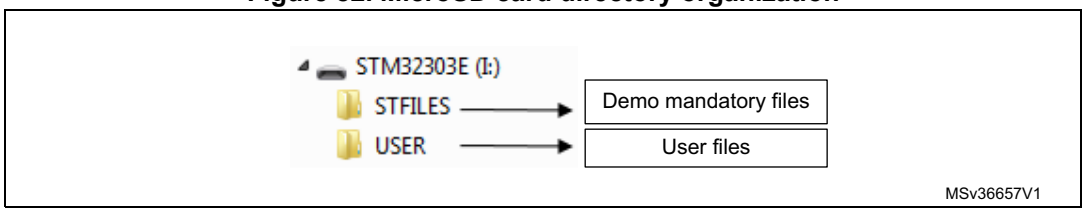
Pressing KEY a message is displayed, showing the STM32303E-EVAL demonstration version on the LCD screen.

3 STM32303E-EVAL demonstration programming

3.1 Programming the media files

The STM32303E-EVAL board is provided with a MicroSD card memory pre programmed with the audio and image resources used by the demonstration. However, the user can load own image (*.bmp) and audio (*.wav) files in the USER directory, providing that these file formats are supported by the demonstration. For more details, please refer to *Section 2.4.2: Image viewer submenu* and *Section 2.4.3: Audio features*.

Figure 82. MicroSD card directory organization



4 Revision history

Table 5. Document revision history

Date	Revision	Changes
15-Jan-2015	1	Initial release.