UM0949
User manual

STMT/8L-EV1
STM8L evaluation board with touch-sensing library

Introduction

The STM8L evaluation board with the touch-sensing library enables designers, who are familiar with the standard STM8Lxxx microcontrollers, to create higher-end look-and-feel user interfaces by replacing conventional electromechanical switches with touch-sensing controls. Designers can thus combine touch-sensing functions with traditional MCU features such as communication, LED control, beeper, LCD control, and so on.

The touch-sensing firmware library is part of the application firmware.

Maturity, robustness, flexibility, and outstanding performance make the STM8L evaluation board with the touch-sensing library a simple and robust solution. In addition, its low time-to-market period facilitates the development of numerous applications including mobile phones, cooking appliances and printers, to name a few.

In development mode, designers can debug, modify, adapt, or integrate the touch-sensing library in the application firmware using the ST MCU toolset with the ST Visual Develop (STVD) IDE interface.

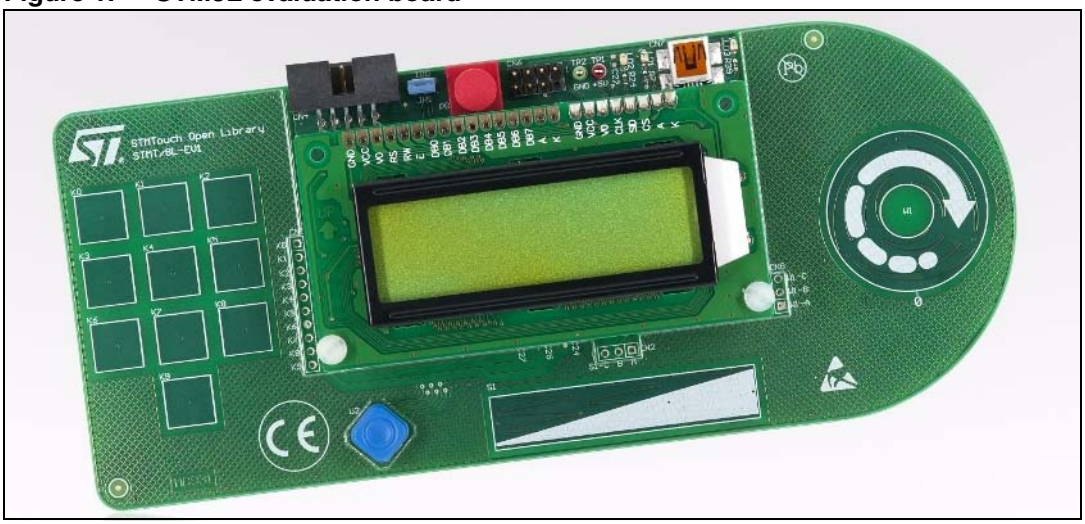
Evaluation firmware

Evaluation firmware is preloaded in the board's STM8L15x device for easy demonstration of the device peripherals in stand-alone mode. To download the latest version and for more information refer to the STMT/8L-EV1 demonstration software available on www.st.com.

Order code

To order the STM8L evaluation board with the touch-sensing library, use the order code STMT/8L-EV1.

Figure 1. STM8L evaluation board



Contents

1 Overview

1.1 Contents

The STM8L evaluation board package contains an MB931 board.

Note: This document, the STM8 touch-sensing library, STM8 toolset, STM8L15xxx standard library, and all related documentation are available at www.st.com/touch-sensing-library

1.2 Features

1.2.1 Touch-sensing library

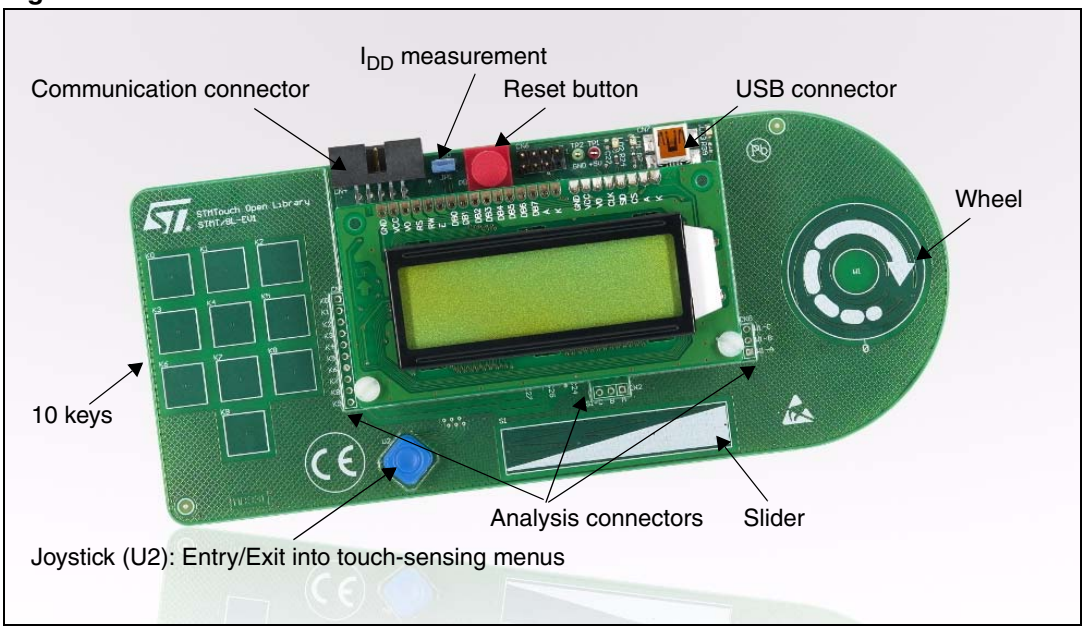
- Robust and proven charge-transfer acquisition principle
- Excellent immunity against conductive noise
- Supports up to 16 capacitive sensing channels
- Low BOM with only 1 I/O per channel + 1 I/O per acquisition group for sampling capacitors
- Up to 8-bit resolution wheel/slider using 3 channels
- Fast acquisition time (2 ms typical for touchkey, 7 ms typical for a wheel/slider)
- Advanced processing featuring:
  - Autocalibration
  - Debounce filtering
  - Environment control system (ECS)
  - Detection exclusion system (DxS)
- Free C source code library

1.2.2 STM8L evaluation board

- Uses an STM8L microcontroller (STM8L151C6) in a 48-pin LQFP package.
- Preprogrammed with evaluation firmware that manages:
  - 10 touchkeys made of a simple copper surface
  - 1 slider consisting of three interlaced electrodes
  - 1 wheel consisting of three interlaced electrodes
- Analysis connectors: All electrodes and signals are available through three connectors (CN1, CN2, and CN8) for analysis and monitoring.
- Communication connector: The board provides a connector (CN4) for interfacing with the UART, SPI, or I2C of the microcontroller.
- Embedded ST-Link interface to quickly program and debug the firmware. This interface is accessible through the USB connector (CN7).

Figure 2 shows the main features of the STM8L evaluation board.

Figure 2. Main features



1.3 User interface

The STM8L evaluation board user interface is composed of:

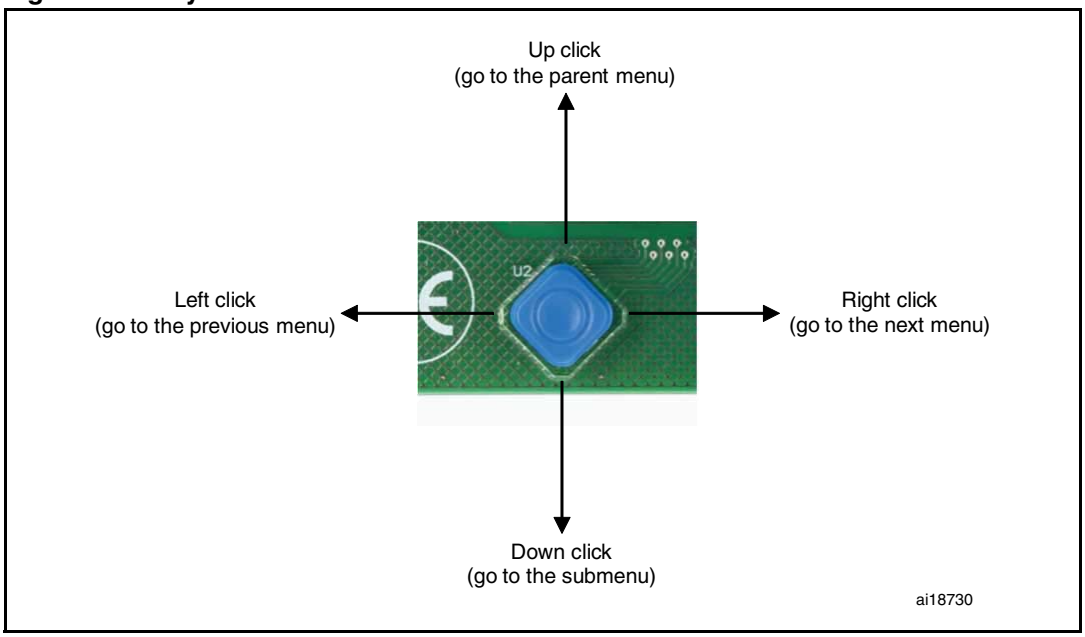
- An LCD screen
- A joystick

The user interface can:

- Display touchkeys, slider, and wheel values and states (via display submenus).
- Modify the main touch-sensing library parameters, such as, debounce filter, detection timeout, low power mode, detection exclusion system setting, etc. (via parameter setting submenus).
- The joystick (U2) is used to navigate into the different menus that appear on the LCD screen:
  - Click right: go to the next menu
  - Click left: go to the previous menu
  - Click up: go to the parent menu
  - Click down: go to the sub-menu

See *Figure 3: Joystick*.

Figure 3. Joystick



2 Analysis and development features

2.1 STM8L evaluation board options

2.1.1 Power supply

The evaluation board is powered to 3.3 V (supplied via the USB connector providing 5 V). Without being connected to the USB connector, the board can be supplied by an external power supply via the Test point TP1 (5V) and TP2 (GND).

2.1.2 Analysis connectors (CN1, CN2, and CN8)

Application designers can use connectors CN1, CN2, and CN8 to analyze electrodes and driven shield signals on the evaluation board.

Note: The user should take into account possible probe capacitance disturbance and should consider recalibrating the device before use.

Table 1. CN1, CN2, and CN8 connector pin descriptions

CN1 pin	Description	CN2 pin	Description	CN8 pin	Description
1	Key 0 electrode	1	Slider electrode A	1	Wheel electrode C
2	Key 1 electrode	2	Slider electrode B	2	Wheel electrode B
3	Key 2 electrode	3	Slider electrode C	3	Wheel electrode A
4	Key 3 electrode				
5	Key 4 electrode				
6	Key 5 electrode				
7	Key 6 electrode				
8	Key 7 electrode				
9	Key 8 electrode				
10	Key 9 electrode				

2.1.3 Communication connector (CN4)

The communication connector, CN4, provides the I2C, SPI, and UART pins of the microcontroller. The user can use these pins to develop his own communication protocol.

Table 2. CN4 connector pin description

Pin number	Description	Pin number	Description
1	VDD_3V3	2	VSS
3	SPI_MOSI	4	NCHG
5	SPI_MISO	6	I2C_SDA
7	SPI_SCK-UART_RX	8	I2C_SCL
9	SPI_NSS-UART_TX	10	VSS

2.2 Dielectric

A 1.5 mm acrylic front panel, with a dielectric constant of 3, is placed on top of the electrodes. It is glued using a standard 3M 467MP adhesive. You may also find some STMT/8L-EV1 evaluation boards with a top layer silkscreen which improves the overall look and feel of the solution.

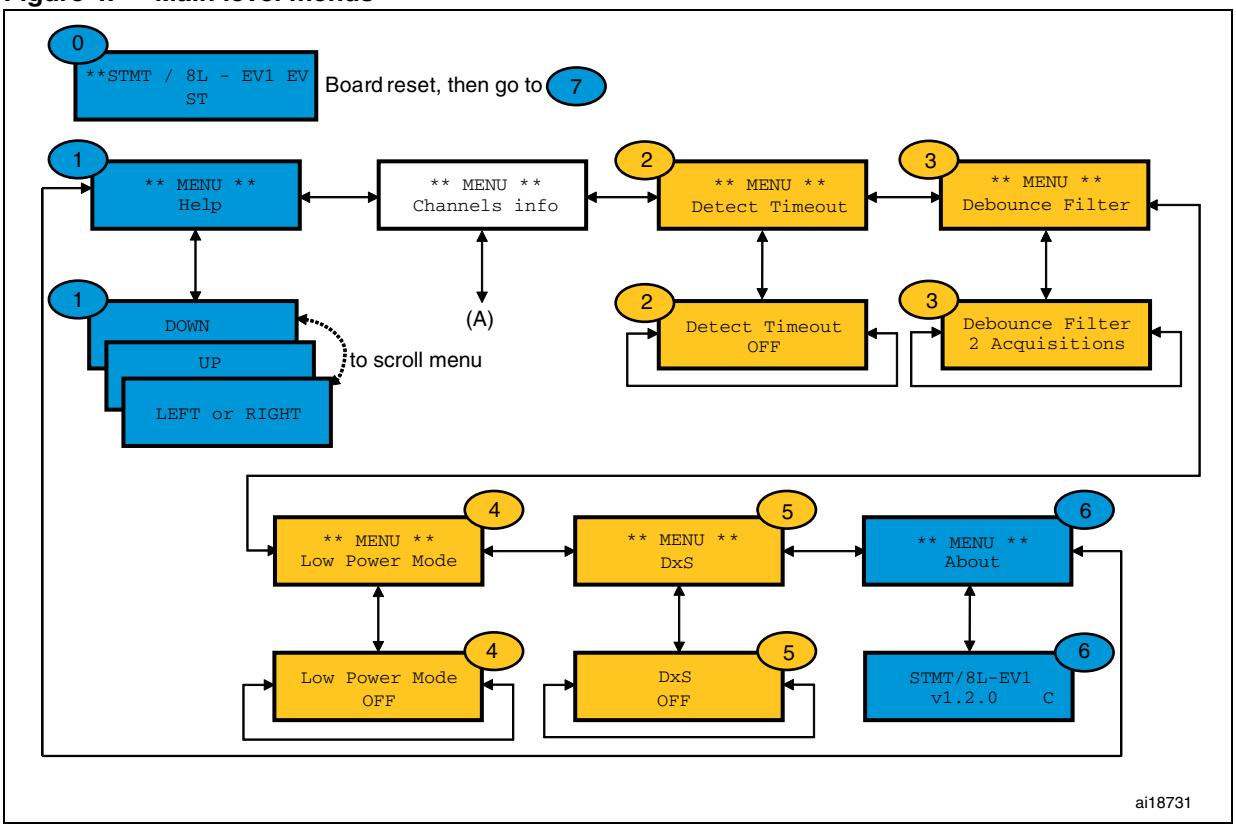
3 Getting started

Once the STM8L evaluation board is connected to the USB connector, it is ready to use. The evaluation firmware enables the user to quickly evaluate the main features of the touch-sensing library by using the different touch electrodes (touchkeys, wheel and slider), the LCD screen and the joystick button.

3.1 Main level menus

Figure 4 shows the main level menus. The channels information menus (A) are described in more detail in *Figure 5*. Menus depicted in blue (0, 1, 6, and 7) and yellow (2, 3, 4, and 5) are explained in *Table 3: Menu explication*. The blue menus display information and the yellow menus are used to change settings.

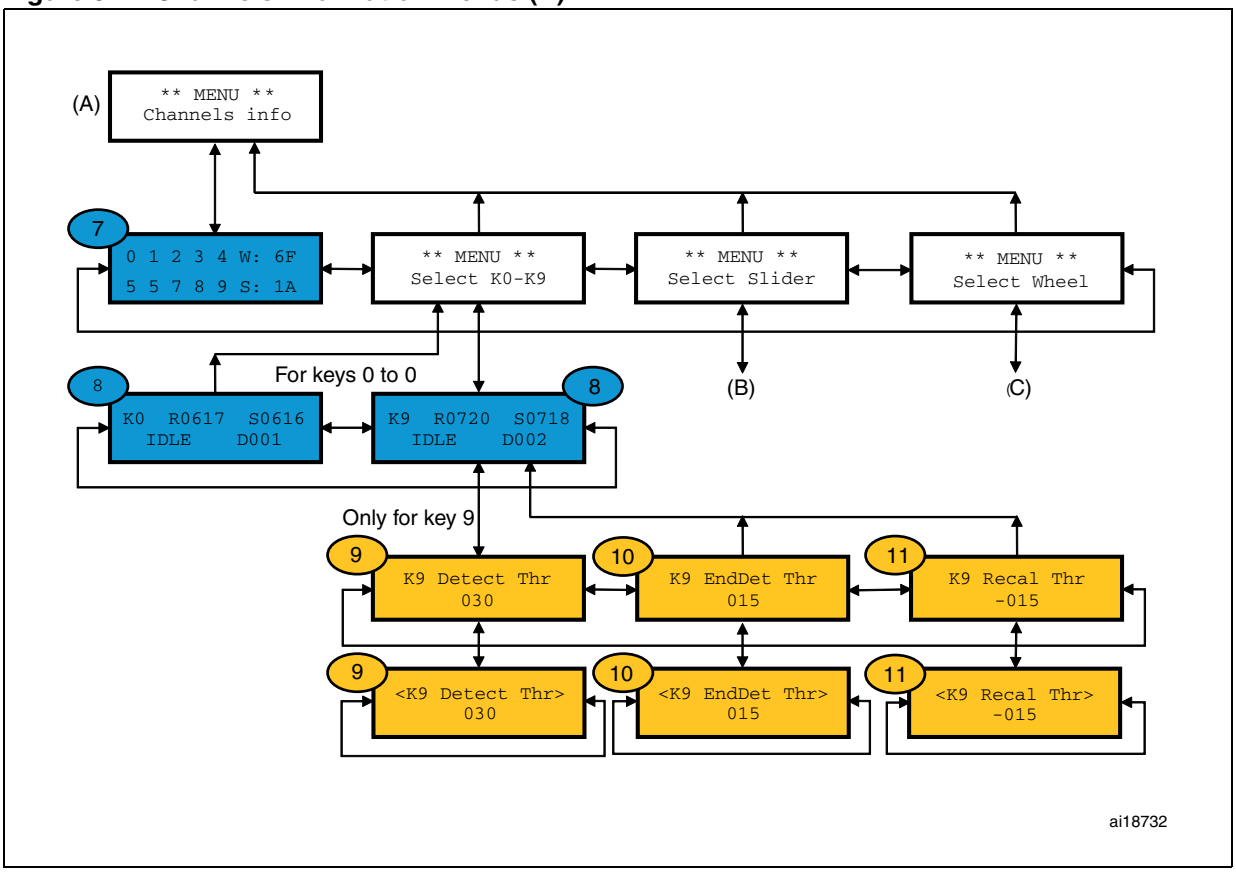
Figure 4. Main level menus



3.2 Channels information menus

Figure 5 shows the channels information menus. The slider and wheel menus (B and C respectively) are described in more detail in *Figure 6*. Menus depicted in blue (7 and 8) and yellow (9, 10, and 11) are explained in *Table 3: Menu explication*.

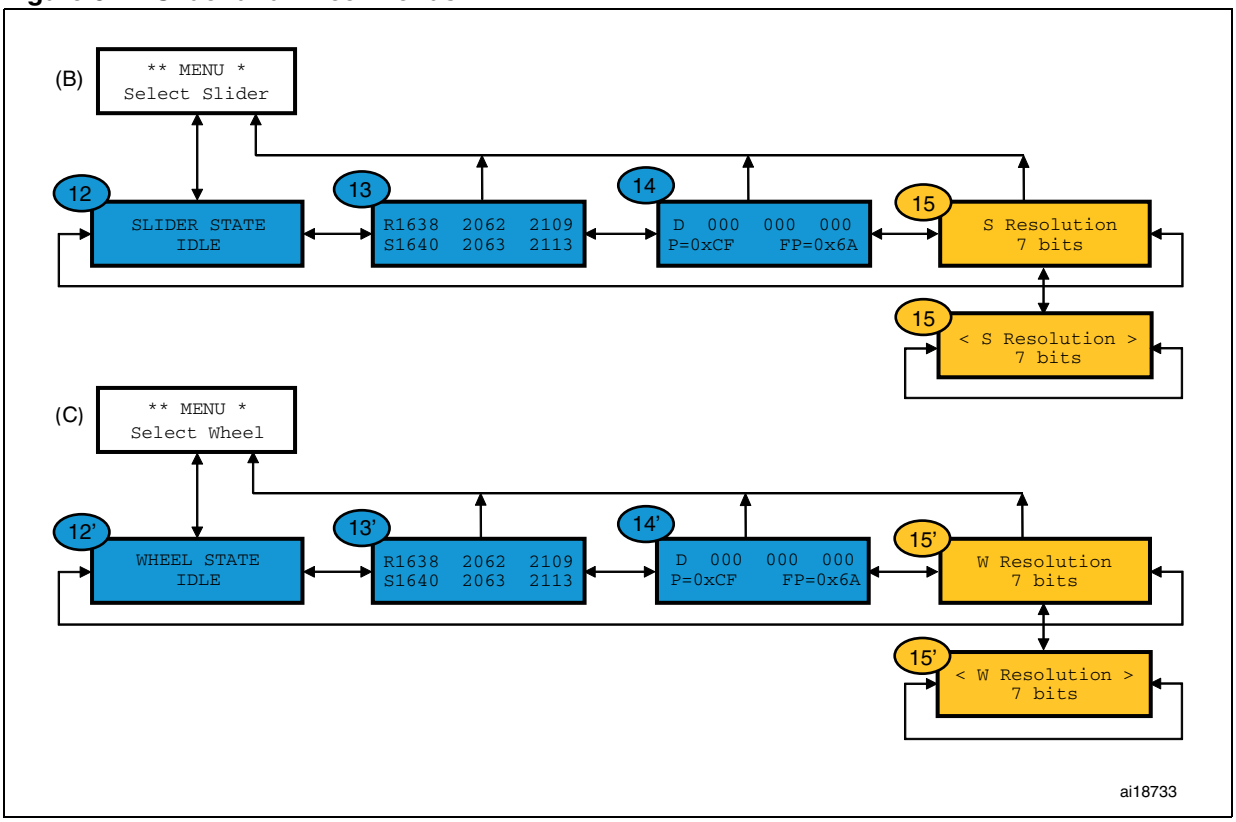
Figure 5. Channels information menus (A)



3.3 Slider and wheel menus

Figure 6 shows the slider (A) and wheel (B) menus. Menus depicted in blue (12, 12', 13, 13', 14, and 14') and yellow (15 and 15') are explained in *Table 3: Menu explication*.

Figure 6. Slider and wheel menus



3.4 Menu explication

Table 3. Menu explication

Number of menu	Name of menu	Explication of menu
0	Introduction	Displays the evaluation board firmware name then automatically jumps to menu 7 (Summary).
1	Help	Displays a brief explanation of how to navigate into the menus. The text is scrolled automatically by clicking “down”, “up”, “left or right”.
2	Detect Timeout	The Detection Timeout feature automatically recalibrates the keys after a fixed duration of continuous touch detection. This prevents the keys from becoming “stuck-on” due to foreign objects (including water or steam) or other sudden influences (like moving the device from the hand to the pocket). After recalibration, the keys continue to operate normally even if they are partially or fully obstructed. Infinite timeout (detection timeout is OFF) is useful in applications where a prolonged detection can occur and where the output must reflect the detection regardless of its duration. The default setting is OFF. Possible settings include: 1 to 20 s with 1 s step.
3	Debounce Filter	The Debounce Filter feature reduces the effects of low frequency noise on key states. This mechanism requires a specified number of measurements that qualify as detections. The measurements must occur consecutively otherwise a detection is not reported. Similarly, the end of a touch (loss of signal) also has to be confirmed over several measurements. This process acts as a type of debounce mechanism against noise. The default setting is 2. Possible settings include: 1 to 9.
4	Low Power Mode	An example of low power management is provided with this evaluation board. When activated, the device enters halt mode for a configurable period of time after each complete acquisition loop. The system does not allow entry into low power mode simultaneous with entry into detection or calibration. Please note that Low Power Mode does not affect the system timings like environment control system (ECS) or detection timeout. Warning: navigation of the menus is slowed down when an important value (> 64 ms) is set. The default setting is OFF. Possible settings include: 1 ms/2 ms/4 ms/ 8 ms/16 ms/32 ms/64 ms/128 ms/256 ms/512 ms
5	Detection exclusion system (DxS)	The DxS feature prevents multiple keys from responding to a single touch. This can happen with closely spaced keys. Once a key is considered to have been touched, all other keys are locked in an untouched state. To unlock these keys, the touched key must first return to an untouched state. The default setting is OFF. Possible settings include: All keys, wheel and slider/keys only/keys 0 to 8 only.
6	About	Displays the firmware version. The letter after the version indicates which compiler was used: “C” for Cosmic, “R” for Raisonance and “I” for IAR.

Table 3. Menu explication (continued)

Number of menu	Name of menu	Explication of menu
7	Summary	Displays the activity of all the keys, and the slider and wheel. When a key is touched, an arrow is added to the right of the key number (from 0 to 9). The number after the “W:” and “S:” characters are respectively the wheel and slider position in hexadecimal format. *Note: This display appears just after the introduction display when the board is reset.*
8	Reference, signal, delta, and state of selected key (keys 0 to 9)	Displays the reference (R), signal (S), delta (D) and the state of the selected key. The joystick (left or right button) is used to change keys. The states of the keys are: pre calibration, calibration, idle, predetected, detected, postdetected, disabled, and error.
9	Key 9 detection threshold	This feature allows the detection threshold of key 9 to be changed. To prevent bad behavior of the system, the end of detection threshold value is automatically decreased to allow a minimum difference of 1 between the two values. The default setting is 30. The minimum value is 2 and the maximum value is 127. All values in between 2 and 127 can be set.
10	Key 9 end detection threshold	This feature allows the end of detection threshold of key 9 to be changed. To prevent bad behavior of the system, the detection threshold value is automatically increased to allow a minimum difference of 1 between the two values. The default setting is 15. The minimum value is 1 and the maximum value is 126. All values in between 1 and 126 can be set.
11	Key 9 recalibration threshold	This feature allows the recalibration threshold of key 9 to be changed. The default setting is -15. The minimum value is -1 and the maximum value is -128. All values in between -1 and -128 can be set.
12, 12’	Slider/Wheel state	Displays the Slider/Wheel state (pre calibration, calibration, idle, predetected, detected, postdetected, disabled, and error).
13, 13’	Slider/Wheel reference and signal	Displays the Slider/Wheel reference (values after the “R” on the first line) and signal (values after the “S” on the second line) for the three channels.
14, 14’	Slider/Wheel delta, position, and filtered position	Displays the Slider/Wheel delta (after the “D” on the first line) for the three channels, position (after the letter “P”) and filtered position (after the letters “FP”) values in hexadecimal format.
15, 15’	Slider/Wheel resolution	This feature allows the Slider/Wheel resolution to be changed. The default setting is 7 bits. Possible settings include: 0 to 7 bits.

4 Advanced evaluation using a debugging environment

4.1 Running the evaluation firmware in debug mode

Designers can easily run the evaluation firmware in debug mode using either ST or third-party toolsets (Raisonance, Cosmic, or IAR).

There is no need to use another hardware tool thanks to the ST-Link interface embedded on the board and accessibled through the USB connector.

Software tools to be downloaded separately include:

- ST MCU toolset with ST Visual Develop (STVD) IDE and ST Visual Programmer (STVP) programming interface

  Note: the STVD toolset supports both Raisonance and Cosmic compilers.
- A C compiler of your choice:
  - STM8 Cosmic C compiler (www.cosmic-software.com)
  - Raisonance C compiler (www.raisonance.com)
  - IAR C compiler (www.iar.com)

In debug mode, designers can perform an in-depth evaluation of the firmware and visualize touch-sensing parameters. Designers can even customize the touch-sensing library to their specific needs by creating their own application firmware.

For further information about STMicroelectronics software, STM8 microcontrollers, or debugging tools, please read the associated documentation or ask your local ST support team for a training session. More information is available at: *www.st.com/touch-sensing-library.*

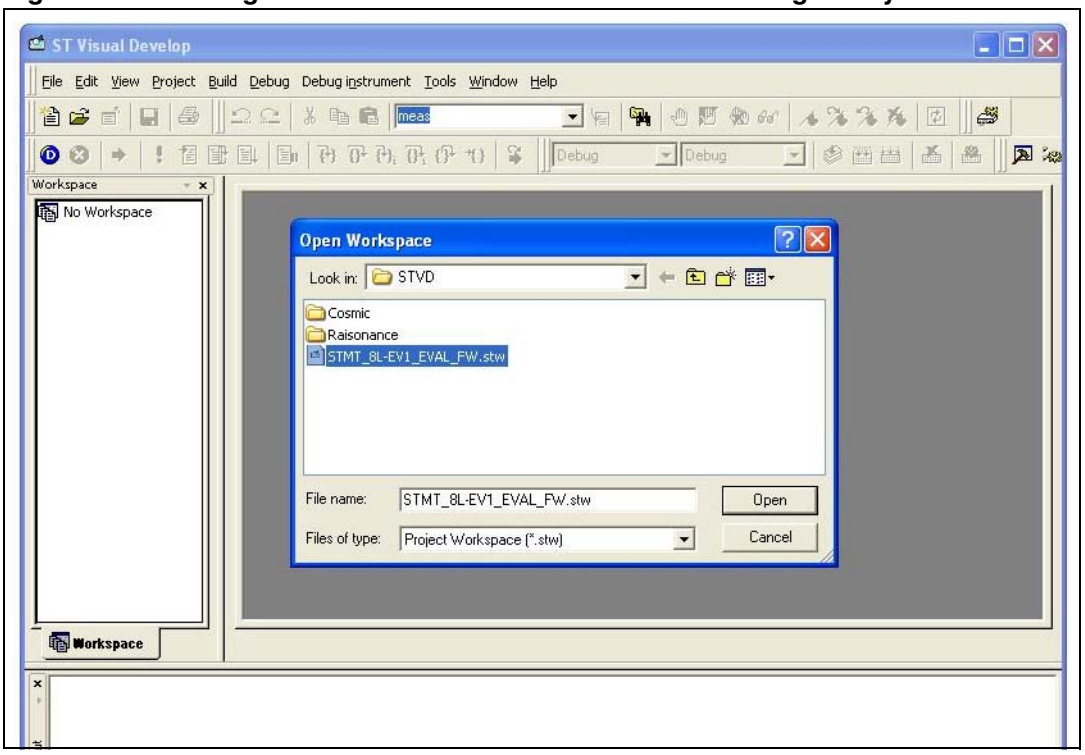
4.2 Debugging the application using STVD

This section describes the steps necessary to set up a platform for evaluating and developing touch-sensing firmware using ST Visual Develop (STVD).

Note: For links to tools and downloads, please refer to ST's microcontroller web site at www.st.com/mcu/.

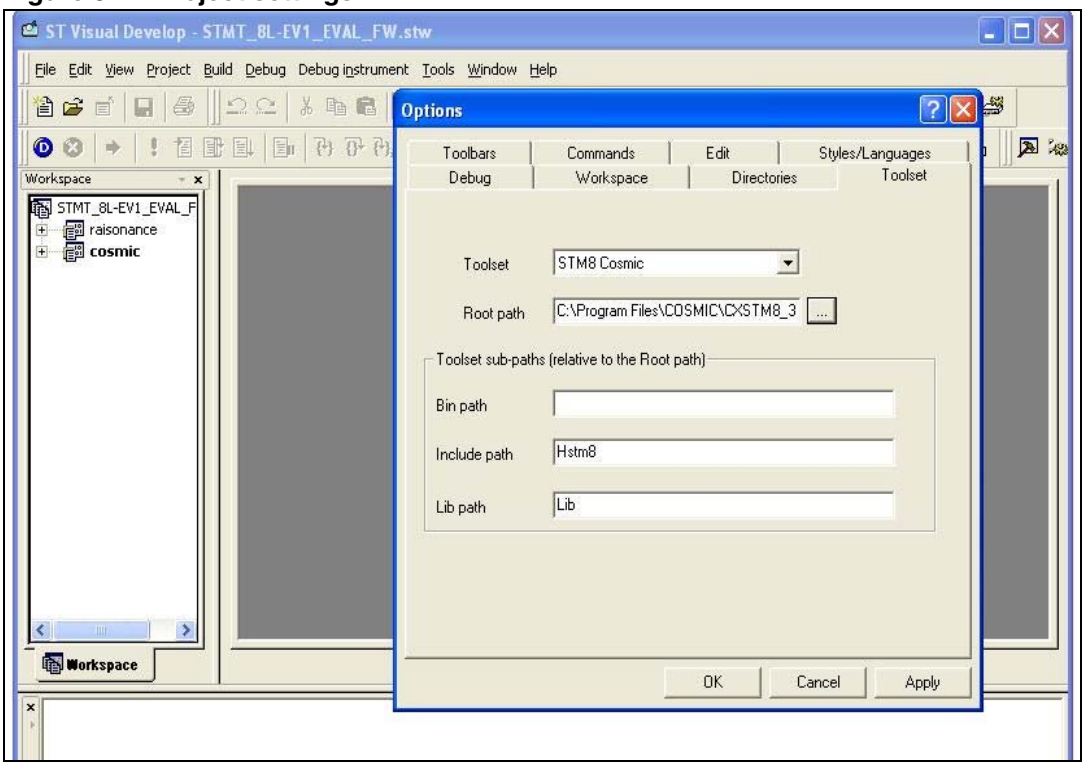
1. Download and install the ST MCU toolset with ST Visual Develop (STVD) IDE and ST Visual Programmer (STVP) programming interface (single download).
2. Download and install the STM8 Cosmic C compiler or the Raisonance C compiler.
3. Connect the USB cable between your PC and the STM8L evaluation board. The evaluation board is powered.
4. Download the STM8L evaluation board firmware and the latest STM8 touch-sensing library from *www.st.com/touch-sensing-library;*
5. Launch the STVD integrated development environment.
6. Load the STM8L evaluation board firmware (*Figure 7*) as follows:
   In the File menu, click **Open workspace** and **Select/Open** the file:
   <Installation path>\STMT_8L-EV1 Evaluation Board Firmware Package\Projects\STVD

Figure 7. Loading the STM8L evaluation board touch sensing library



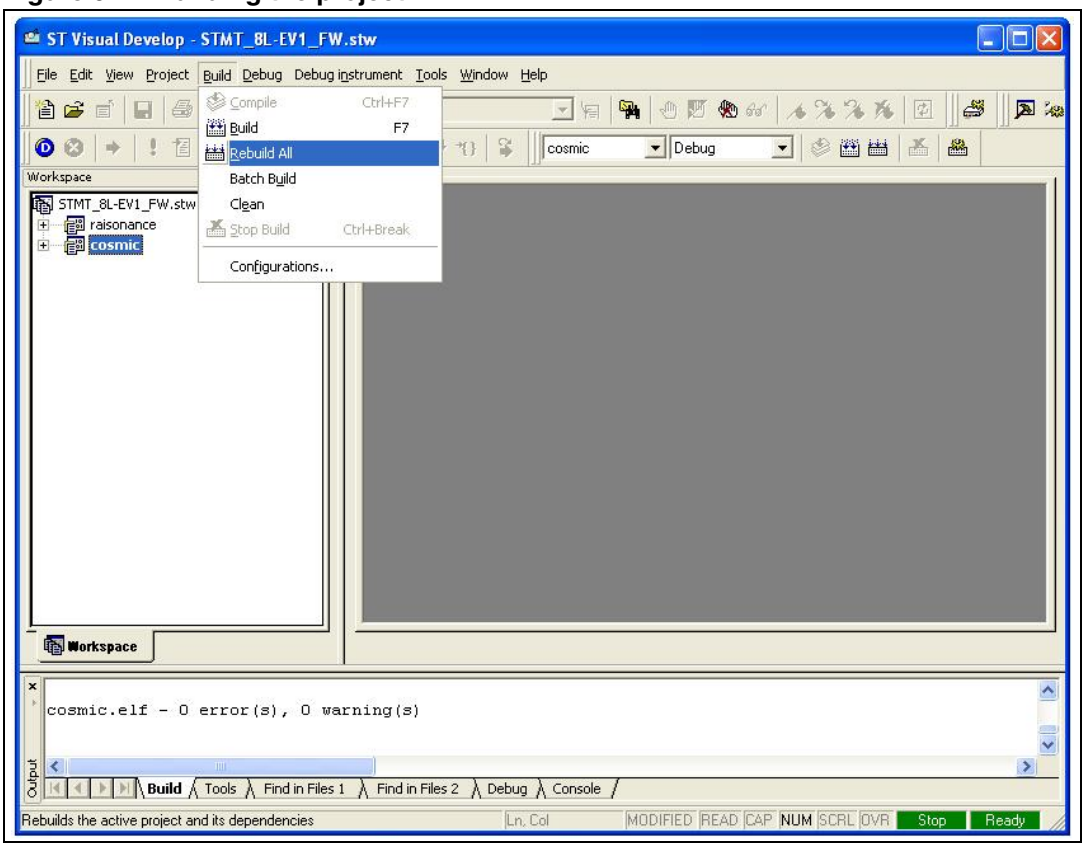
7. In the Project menu, select **Tools>Options>Toolset** to define the C Cosmic location directory as shown in *Figure 8*.

Figure 8. Project settings



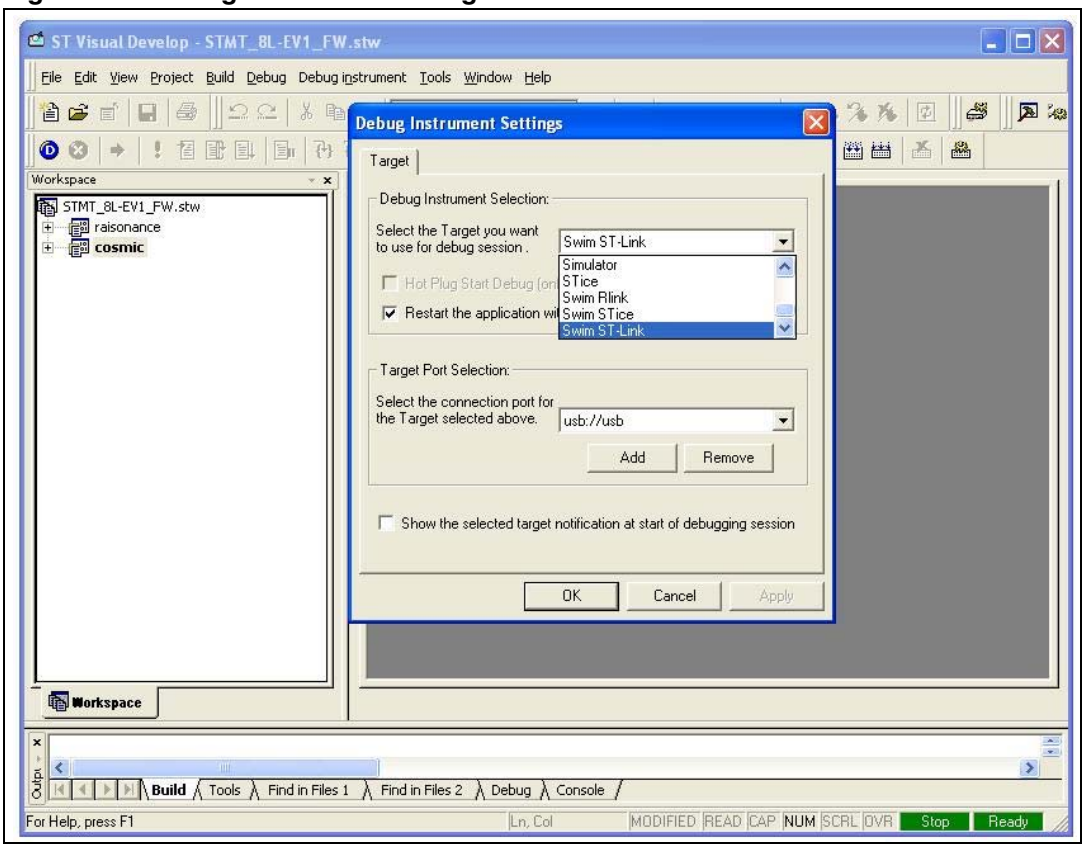
8. Build the project (*Figure 9*) by compiling and linking the source code as follows:
   a) Select Cosmic active project and **Rebuild all** in the Build menu.
   b) When this process is completed, check there are no errors and no warning messages in the Output window.

Figure 9. Building the project



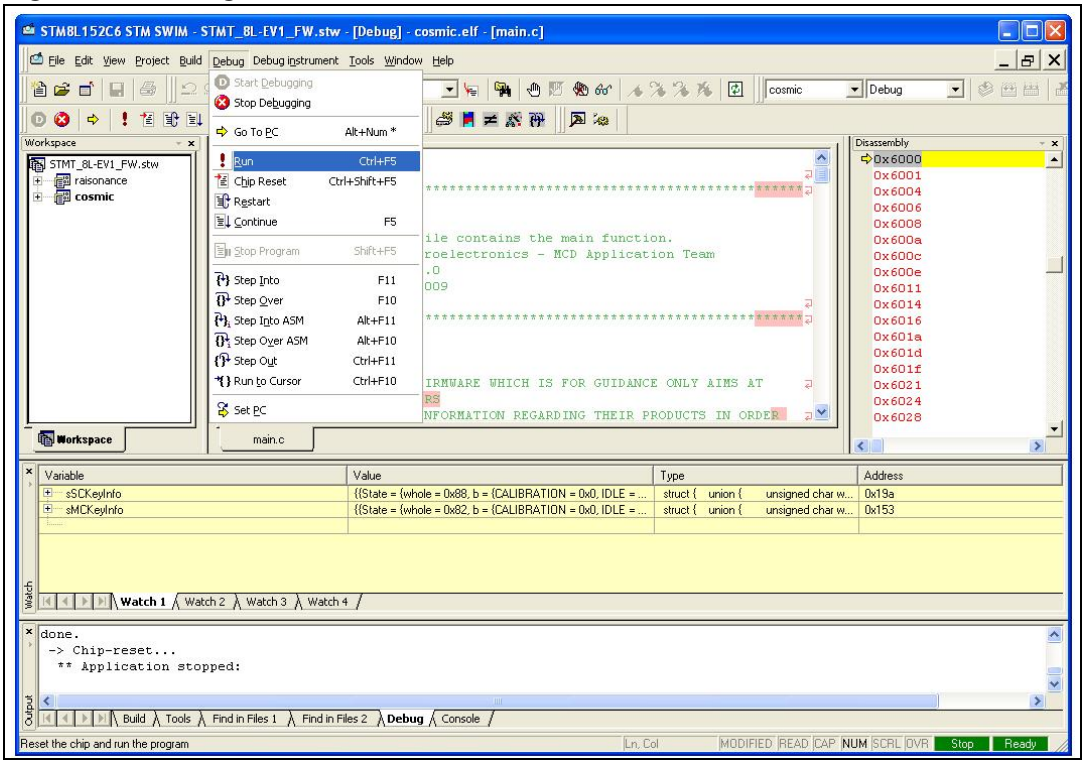
9. Select SWIM ST-Link as the debugging tool as follows:
   a) In the Debug instrument menu, click **Target setting**.
   b) Select **Swim ST-Link** as shown in *Figure 10*.

Figure 10. Debug instrument settings



10. Start the debugging process as follows:
    a) In the Debug menu, select **Start debugging** and wait for the connection with the evaluation board.
    b) In the Debug menu, click **Run** (or press **CTRL-F5**) to start the application in debug mode (see *Figure 11*).

Figure 11. Debug mode

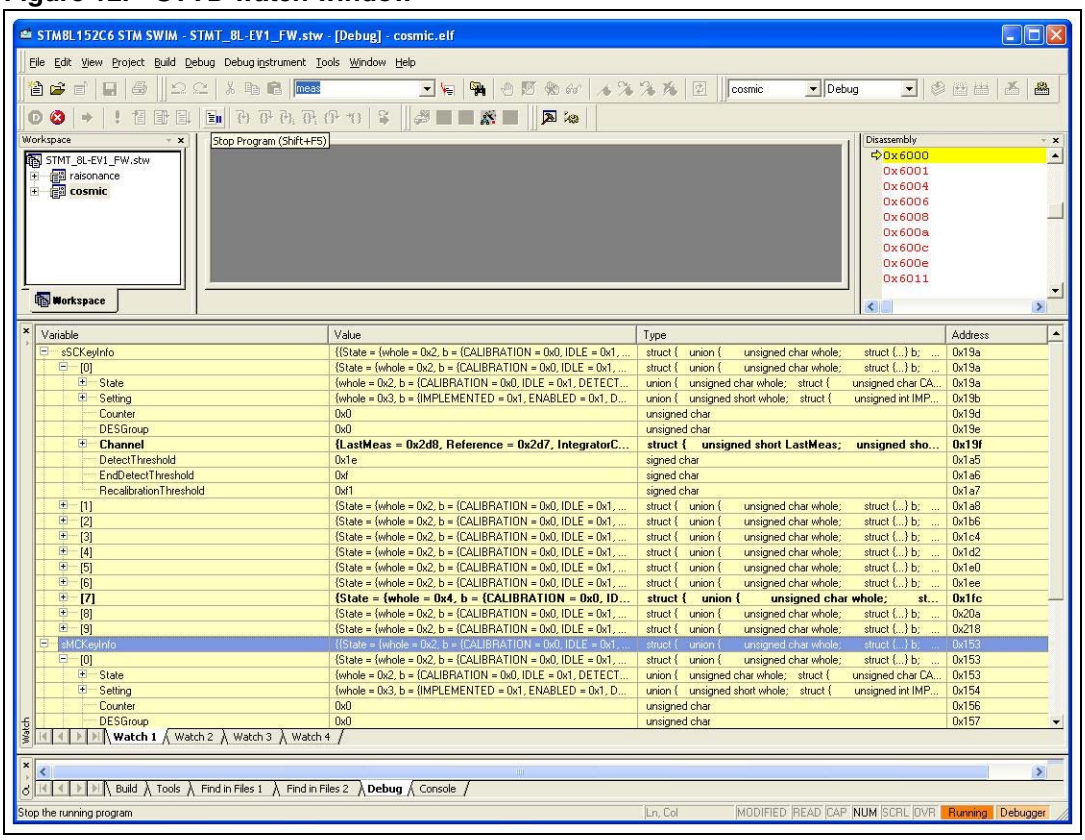


4.3 Exploring key structures

All key and slider data structures can be monitored through the STVD watch window *Figure 12*). The main touch-sensing structures are `sSCKeyInfo` and `sMCKeyInfo`.

To learn more about library variables and function descriptions, refer to the CHM file available at *<installation path>\STM8 Touch-Sensing Library Package\stm8_tsl_um.chm*.

Figure 12. STVD watch window



5 Performance

Touch-sensing performances may vary a lot from one application to an other. Thus, the information provided below is for reference only. It has been determined with the STMT/8L-EV1 evaluation board programmed with the firmware v1.2.0C and with the default settings (all channels enabled, DI = 2).

5.1 Device power consumption

The STM8L15x device power consumption depends on several parameters:

- the number of touch-sensing channels supported
- the duration of the device run mode which is mainly defined by the acquisition duration
- the duration of the device low power mode (typically active halt mode)

The corresponding formula is given in *Equation 1*.

Equation 1

$$I_{DD} = ((T_a + T_{app}) \times I_{DDrun} + T_{lp} \times I_{DDahalt}) / (T_a + T_{app} + T_{lp})$$

where:

I_{DD} = current consumption

T_a = acquisition duration

I_{DDrun} = device power consumption in Run mode

$I_{DDahalt}$ = device power consumption in Active Halt mode

T_{app} = application duration (the part of the application not related to touch sensing)

T_{lp} = low power duration

Table 4 provides a summary of the measurements.

Table 4. Summary of measurements

LP setting	T_{lp} measured	$T_a + T_{app}$ measured	I_{DD}
no LP	—	9.3 ms	4.4 mA
1 ms	860 µs		4.0 mA
2 ms	1.7 ms		3.7 mA
4 ms	3.2 ms		3.3 mA
8 ms	6.3 ms		2.6 mA
16 ms	12.3 ms		1.9 mA
32 ms	25 ms	10 ms	1.3 mA
64 ms	50 ms		0.73 mA
128 ms	99 ms	11 ms	0.44 mA
256 ms	200 ms	12 ms	0.25 mA

Note: The low power duration (T_{lp}) may vary from board to board as the LSI oscillator is, by default, not calibrated.

5.2 Acquisition duration and reaction time

The acquisition duration depends on the sampling capacitor value, charge transfer frequency, layout ground parasitic capacitance, and electrode capacitance. When using STM8L15x devices, the acquisition of the 16 capacitive sensing channels is performed in two steps with up to 8 channels acquired in parallel. The duration of each step corresponds to the longer channel acquisition.

On the STMT/8L-EV1, the acquisition time of a:

- key is about 2.5 ms
- wheel or slider is about 4.5 ms

The formula used to determine the response time is given in *Equation 2*.

Equation 2

$$T_r = (DI + 1) \times (T_a + T_{app} + T_{lp})$$

where:

T_r = reaction time (the time from user touch to touch reported by the system)

T_a = acquisition duration

T_{app} = application duration (the part of the application not related to touch sensing)

T_{lp} = low power duration

DI = detection integrator

Table 5 summarizes the reaction time depending on the low power mode setting.

Table 5. Reaction timer

LP setting	T_r
no LP	28 ms
1 ms	30.5 ms
2 ms	33 ms
4 ms	37.5 ms
8 ms	46.8 ms
16 ms	64.8 ms
32 ms	105 ms
64 ms	180 ms
128 ms	330 ms
256 ms	636 ms

Appendix A Schematics

Figure 13. STM8L evaluation board

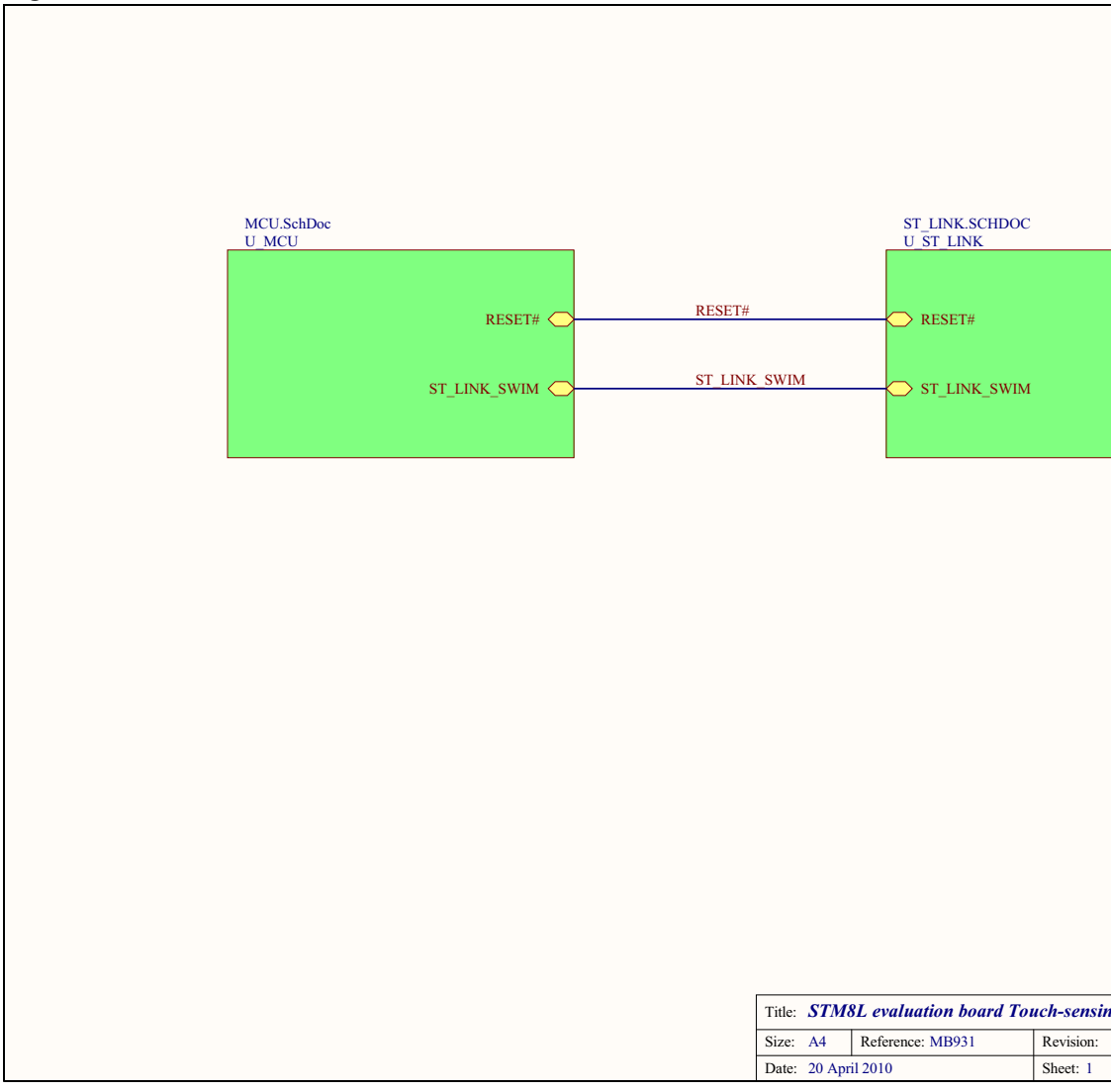


Figure 14. ST-Link

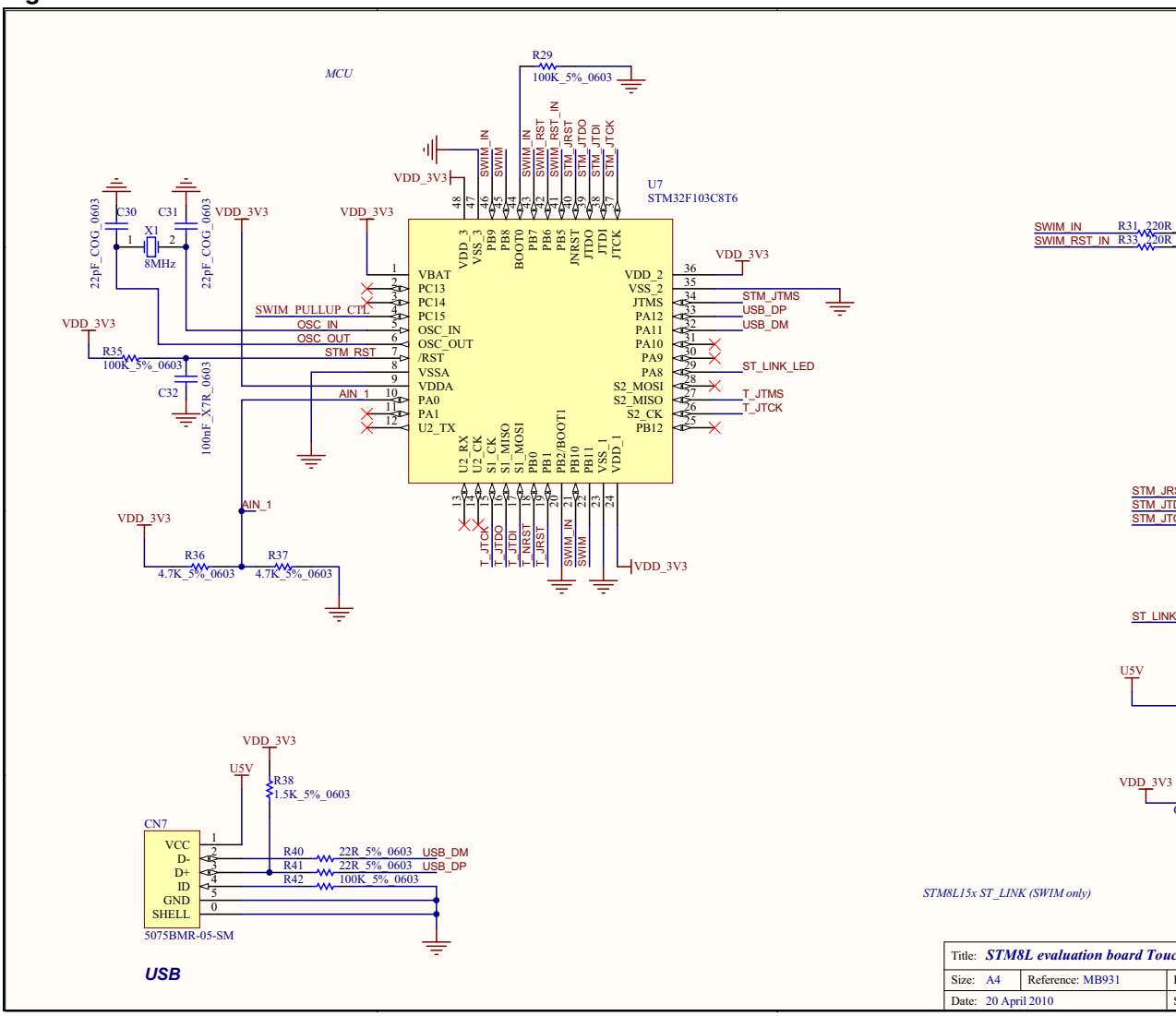
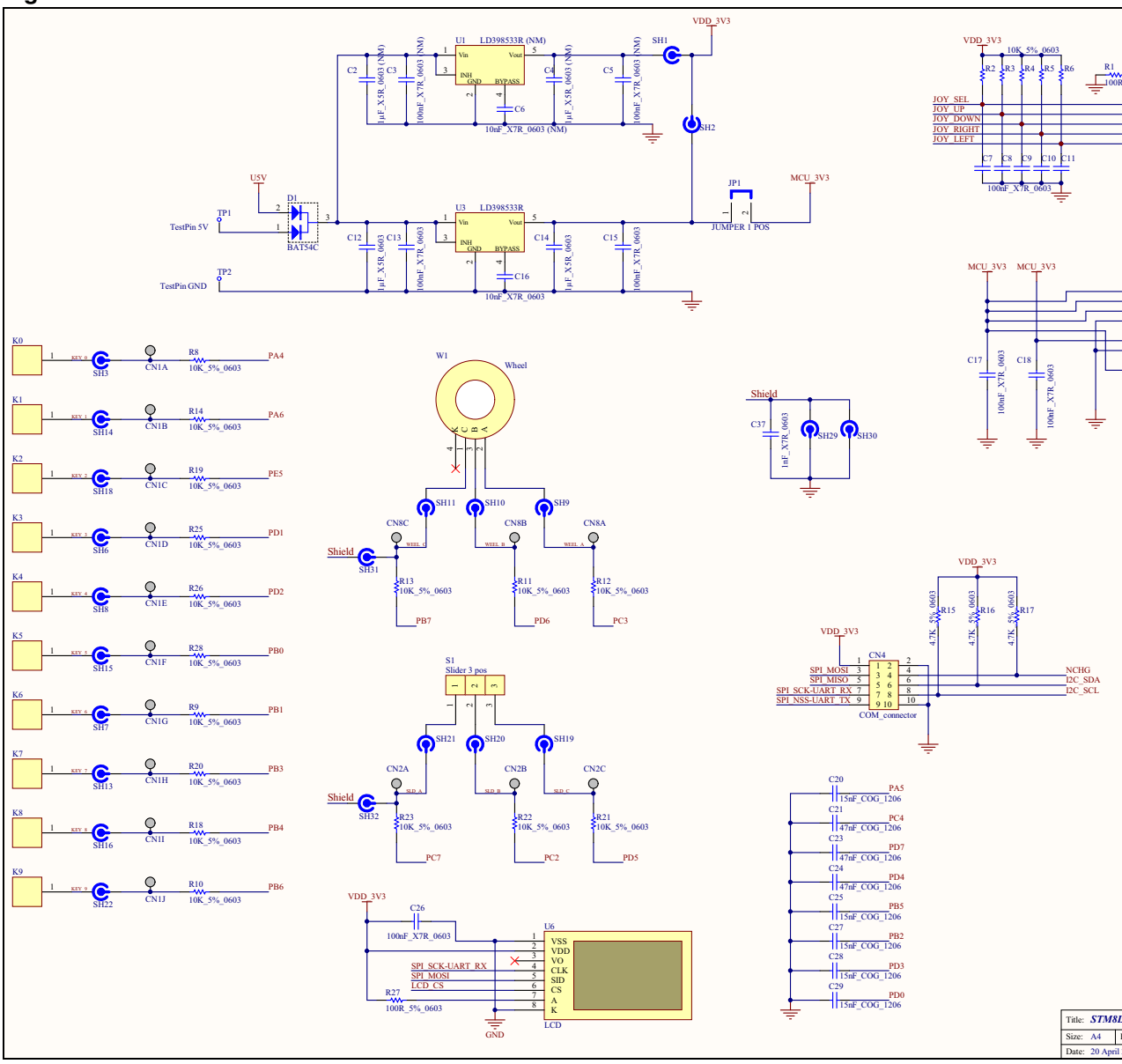


Figure 15. STM8L15xxx controller



Revision history

Table 6. Document revision history

Date	Revision	Changes
13-Sep-2010	1	Initial release.
20-Dec-2010	2	*Section 1.2.1: Touch-sensing library*: added “DxS” to “Detection exclusion system”. *Section 1.2.2: STM8L evaluation board*: updated last bullet point concerning ST-Link. *Figure 2: Main features*: added “U2”. Added *Figure 3: Joystick*. *Section 1.3: User interface*: updated bullet point concerning the joystick. Removed *Figure 3: Navigation scheme of the touchsensing library user interface*. Replaced *Section 2.2: Dielectric* *Section 3.1: Using the STM8L evaluation board: removed title and added text to Section 3: Getting started*; added *some additional text.* *Removed Section 3.2: Parameter setting submenus* and *Section 3.3: Display submenus.* *Added Section 3.1: Main level menus*, *Section 3.2: Channels information menus*, *Section 3.3: Slider and wheel menus*, and *Section 3: Getting started*: aligned all menus with the STMT/8L-EV1 evaluation firmware v1.2.0. *Section 4.1: Running the evaluation firmware in debug mode*: updated introductory text and added note to first bullet point. *Section 4.2: Debugging the application using STVD*: renamed section title and updated the first sentence of this section. Added *Section 5: Performance.*

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