UM0604
User manual

STEVAL-ICB001V1 - touch sensor demonstration board based on the STMPE1208S

Figure 1. STEVAL-ICB001V1 touch sensor demonstration board

Contents

List of figures

1 Introduction

This document explains the functionality and use of the STEVAL-ICB001V1 capacitive touch sensor demonstration board. The STEVAL-ICB001V1 consists of the STMPE1208S capacitive touch sensor device, the ST72F63B 8-bit microcontroller as I^2C master, and a PC GUI (graphical user interface).

The purpose of the board is to demonstrate the features and capabilities of the STMPE1208S capacitive touch sensor, using a Windows®-based host software application and one of several USB low-speed microcontrollers from ST acting as the control device (in this demonstration board, the ST72F63B microcontroller is used). The PC host software and the microcontroller source code provide a user-friendly environment for operating the demonstration board in both Standalone mode and PC GUI mode.

Power to the board is supplied either through a Mini B-type USB connector, or by AAA-size Ni batteries.

In the STEVAL-ICB001V1 demonstration board the ST72F63B microcontroller acts as the I^2C master and controls STMPE1208S device, which functions as an I^2C slave. The STMPE1208S device interfaces with the touch keys, slider and rotator. The device senses touch events and provides the information to the ST72F63B via I^2C communication.

The slider and rotator functions are implemented in the microcontroller firmware, and are based on the change in capacitance value during a touch event. This information is communicated to the microcontroller by the STMPE1208S via I^2C. In standalone mode, touch events are displayed on a 64 X 128 monochrome LCD.

To interface with the PC GUI, the application layer is built above the USB core library that makes all hardware control of the USB interface transparent for the developers.

In addition to displaying all touch events, the PC GUI also provides access to the S-Touch™ device's internal registers. This option can be used to fine-tune daughterboards which are based on S-Touch™ device.

The board also features an in-circuit connector (ICC) to re-program the ST72F63B 8-bit microcontroller Flash memory.

2 Getting started

2.1 System requirements

To use the capacitive touch sensor demonstration board with the Microsoft Windows® operating system, a recent version of Windows (such as Windows 2000® or Windows XP®) must be installed on the PC. The version of the Windows operating system installed on your PC can be determined by clicking on the "System" icon in the control panel (please refer to user manual for your PC and/or Microsoft Windows).

2.2 Package contents

The capacitive touch sensor demonstration board kit includes the following items:

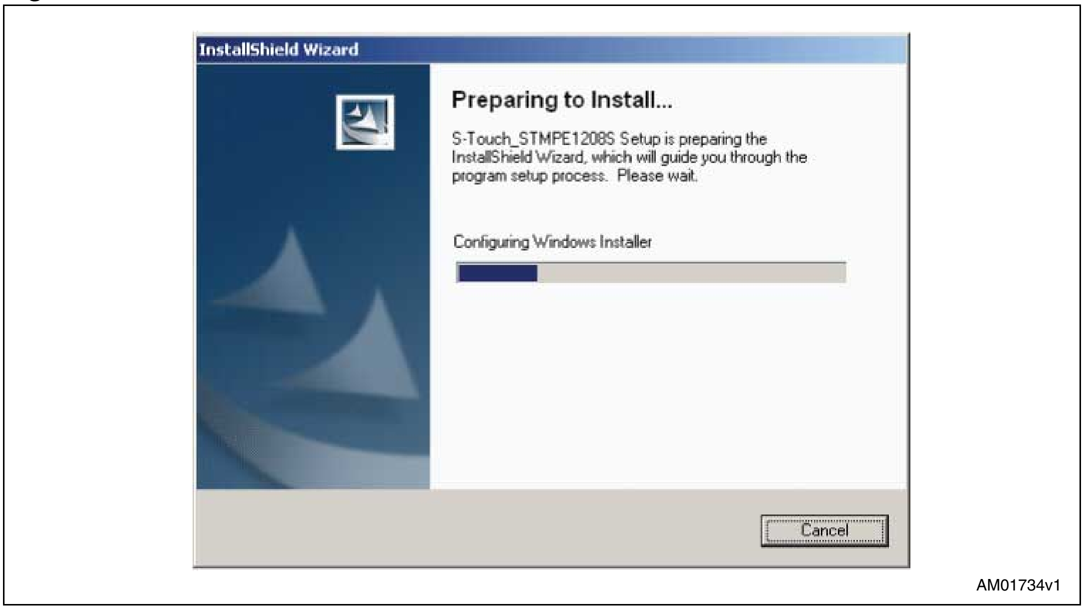
- Hardware:
  - One STEVAL-ICB001V1 demonstration board
- Software:
  - PC software to be used with demonstration board
- Documentation:
  - User manual

2.3 Software installation

To install the PC GUI software, perform the following steps:

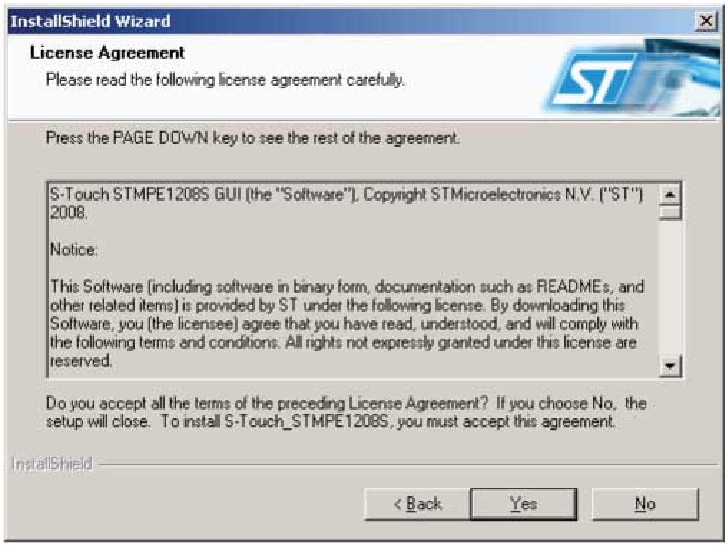
- Step 1: Click on the setup.exe icon. The installation window appears (*Figure 2*).

Figure 2. Installation window



- Step 2: Read the software license agreement and click "Yes" if you accept the terms (*Figure 3*).

Figure 3. License window



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- Step 3: Select the destination folder for the installation of the software. By default, the software is installed in C:\Program Files\STMicroelectronics\S-Touch\STMPE1208S (see *Figure 4*). Click the Next button. The software installation starts (*Figure 5*).

Figure 4. Destination folder

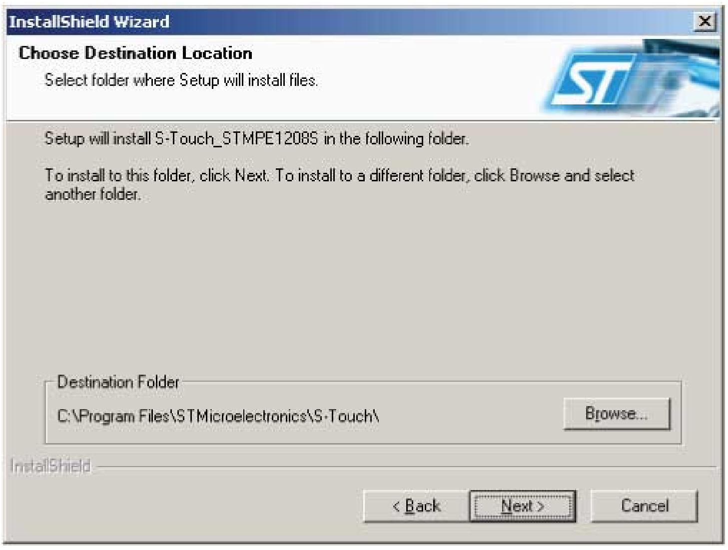

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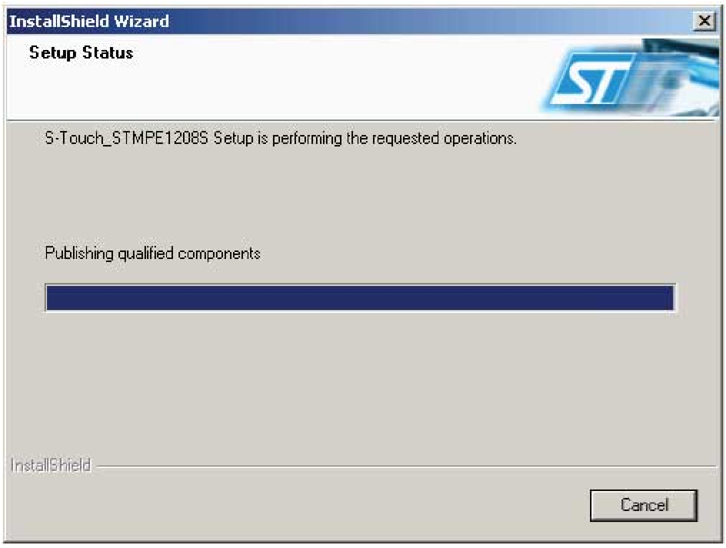
Figure 5. Installation in progress



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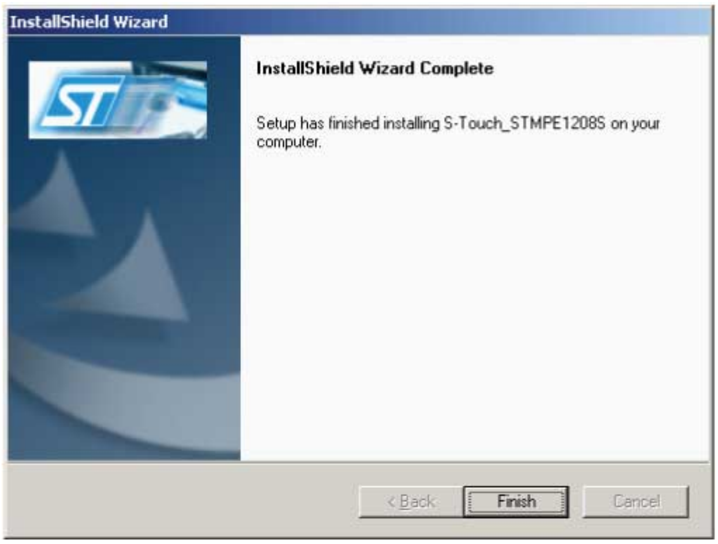
Step 4: Click the Finish button to complete the installation (see *Figure 6*). The software is installed in the directory selected or in the default directory, and a shortcut appears in the Windows START menu. This user manual is also accessible from the same directory.

Figure 6. Installation complete



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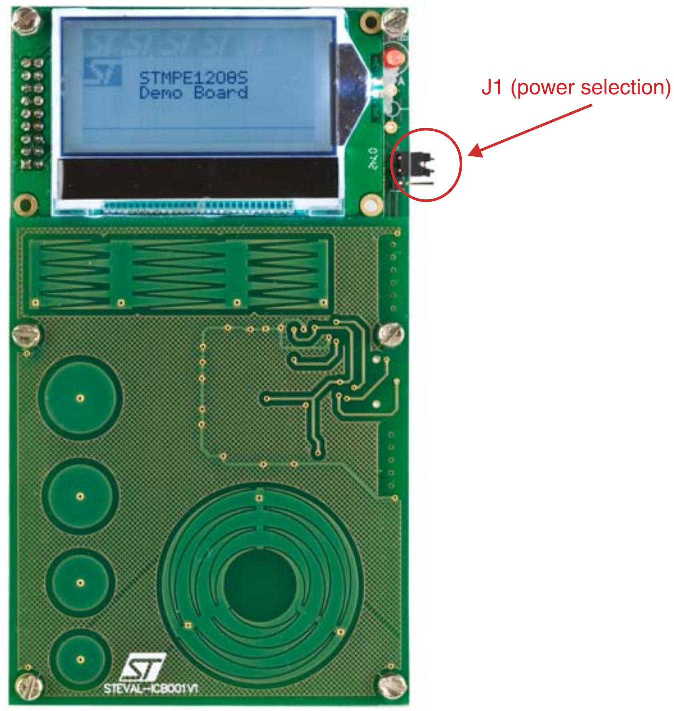
2.4 Hardware installation

Figure 7 shows a snapshot of the STEVAL-ICB001V1 demonstration board.

Figure 7. STMPE1208S capacitive touch sensor demonstration board



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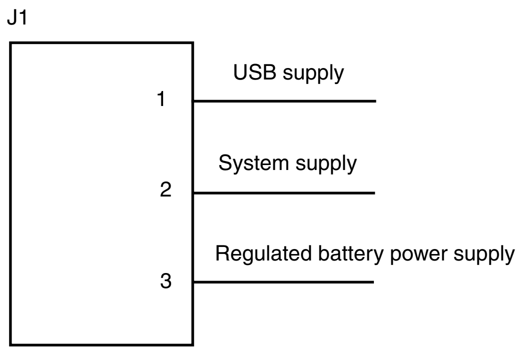
2.4.1 Power supply

The board can be powered by the Mini B-type USB connector (bus powered) or 3 AAA-size batteries which can be inserted in the battery holder on the bottom side of the board.

Jumper J1 is used to select the power supply type. J1 is located between the 1.8 V supply voltage and the supply pins of the STMPE1208S, as shown in *Figure 8*. It can be used for measuring the current consumed by the 1.8 V power supply or the STMPE1208S device.

Figure 8. Jumper J1 for system supply selection



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3 Running the STEVAL-ICB001V1 demonstration board

The capacitive touch sensor demonstration board consists of two main parts:

- PC GUI
- demonstration board

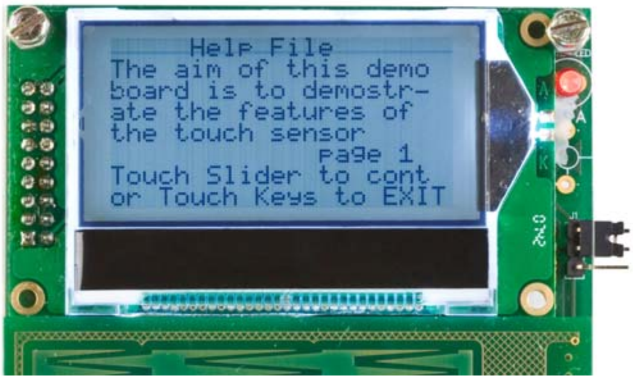
In standalone mode, the demonstration board can be used without the PC GUI, and the power can be supplied by either the Mini B-type USB connector or by battery using jumper J1. If the PC GUI is used, however, the supply to the demonstration board must be furnished by Mini B-type USB connector.

3.1 Running in standalone mode

Within a few seconds after connecting the power supply to the board, a welcome message is displayed on the LCD. This verifies that the demonstration has started correctly.

The welcome message is followed by a series of messages on the LCD screen. At the end, a help manual will appear, which explains the features available in standalone mode (*Figure 9*).

Figure 9. LCD with help manual



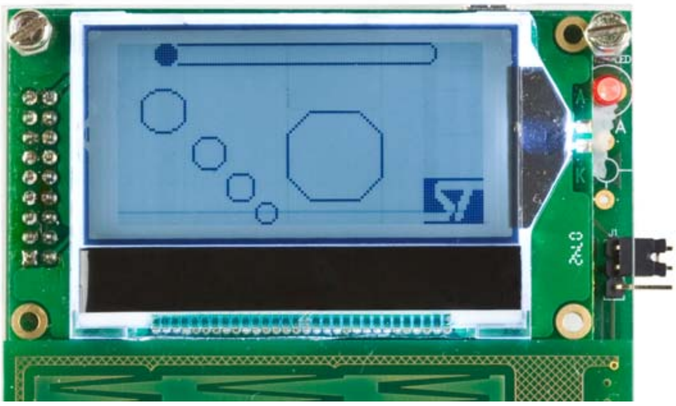
For first-time users, reading the help manual is recommended. Users can navigate through the help menu by running a finger along the slider. To exit from help mode, touch any other keys on the demonstration board.

If no message appears on the LCD after the power supply is connected, remove and reconnect the board from the power supply several times. If no message appears, please contact technical support.

3.1.1 Event detection

Touch events can be observed using the 64 X 128 monochrome LCD on the demonstration board. As shown in *Figure 10*, when the slider, rotator or any of the keys are touched the LCD screen displays a visual representation corresponding to the touch event(s).

Figure 10. LCD showing touch events



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3.1.2 Screensaver mode in standalone mode

The demonstration also includes a screensaver mode, as shown in *Figure 11*. Screensaver mode starts if no touch events are detected for a long period. The demonstration exits screensaver mode when a touch event occurs.

Figure 11. Screensaver mode

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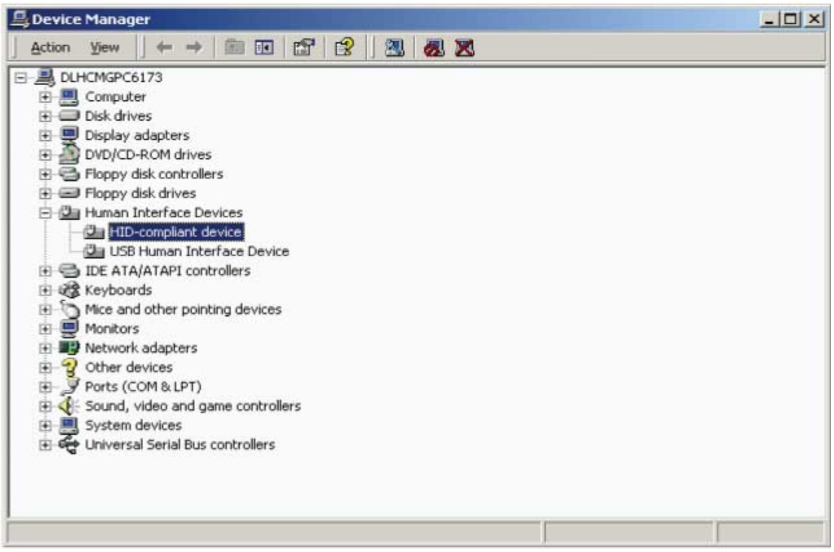
3.2 Running in PC GUI mode

In addition to the features mentioned above, a PC GUI is also available. To run the GUI, the demonstration board must first be connected to the PC with the Mini B-type USB cable after properly setting the jumper J1 as described in *Section 2.4.1*.

The demonstration board is ready to use when the board is listed as an HID (human interface device) in the Windows Device Manager, as shown *Figure 12*. If the board is not listed as an HID, please contact technical support.

Figure 12. HID listing in Windows Device Manager



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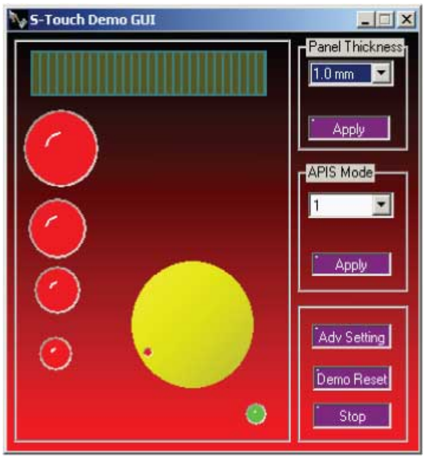
Upon starting the GUI on the PC, an interface window appears (*Figure 13*) which is used for controlling the demonstration board. This software is used to issue various commands and to control data transfer between the PC and the ST7 peripheral.

Figure 13. S-Touch™ PC GUI



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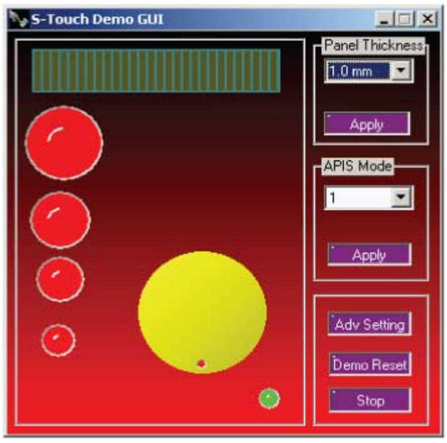
As *Figure 14* illustrates, the user can see whether the board is connected to the PC by observing the indicator on the GUI. A green dot indicates that the board is connected to the PC, while red means that it is not.

Figure 14. LED for demonstration connection status



Once this is done, the PC GUI is properly connected to the demonstration board and ready to use.

The GUI has two operating modes:

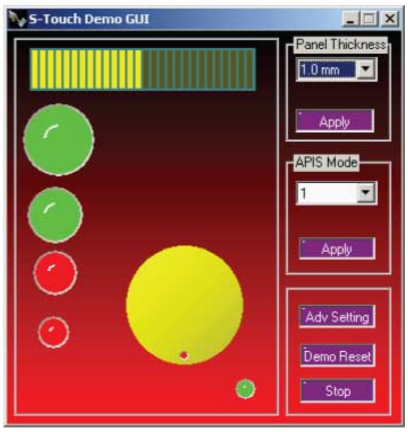
- Read/scan mode; by default the GUI opens in this mode
- Advanced setting mode

In addition to the two modes, there is a RESET option and CAL option available in the GUI. The RESET command is used to return the demonstration to the default settings, and CAL is used to calibrate all of the touch keys on the demonstration board.

3.2.1 Read/scan mode

By default, the GUI opens in read/scan mode. Similar to standalone mode, read/scan mode allows the user to observe touch events in the GUI window, as shown in the *Figure 15*.

Figure 15. Read/scan mode



Other features of the GUI main window are:

- Panel thickness menu:
  – 1.0 mm
  – 1.5 mm
  – 2.0 mm

Note: In the current version, only 1.5 mm panel thickness is supported.

- APIS mode menu:
  – APIS mode 1: only the strongest key is detected
  – APIS mode 2: all valid touch keys are detected
  – APIS mode 3: the two strongest keys are detected

Note: The "strongest" key is the key with the maximum change in capacitance during a touch condition.

- Demonstration reset button:
  Clicking this button resets the demonstration board. Once clicked, please wait until the confirmation message is received (*Figure 16*).

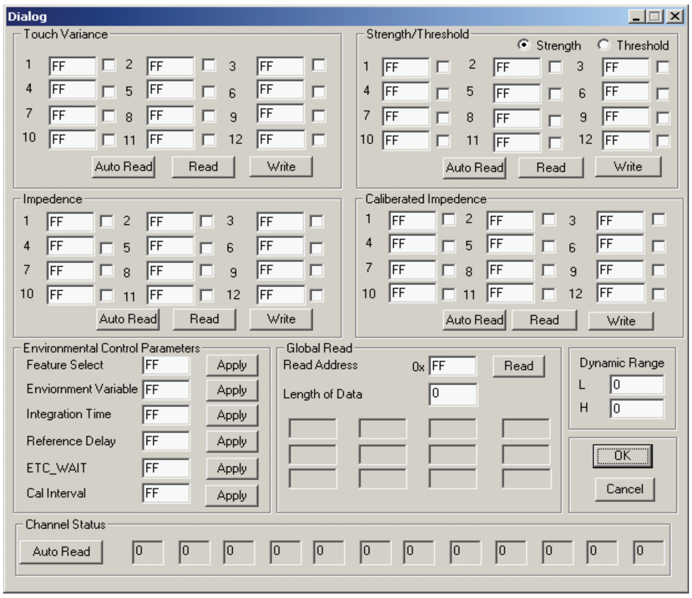
Figure 16. Message

- Scan Board / STOP button:
  This button is used to enable the capture of touch events on the demonstration board in the scan window. By pressing the Scan Board button, the scan window is enabled and the status of the button changes to STOP. The scanning is stopped when the STOP button is clicked or, if other operations are performed such as changing the panel thickness, by changing the APIS mode. Once the scan window is disabled, the status of the button again becomes Scan Board.

3.2.2 Advanced setting mode

This mode is entered by clicking the Adv Setting button. When this button is clicked, the Advanced setting window appears (*Figure 17*).

Figure 17. Advanced setting window



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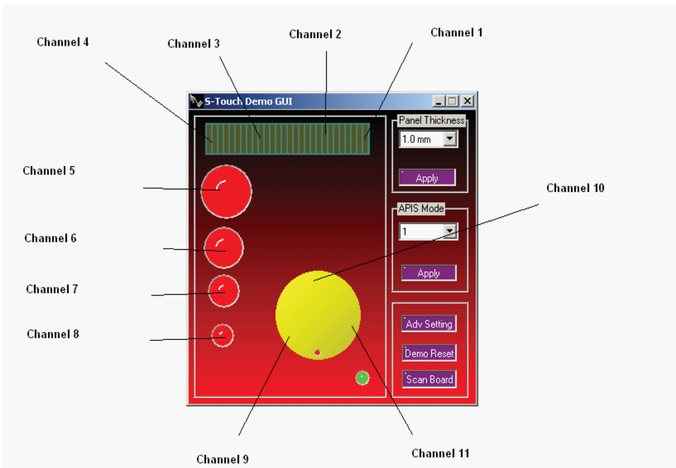
In this window there are several internal parameters of the S-Touch™ device which can be observed and varied, allowing for better control over device operations.

Specifically, the S-Touch™ demonstration board uses 11 touch channels out of 12, which are arranged in the demonstration board as shown in *Figure 18*.

Figure 18. S-Touch™ GUI



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Channels 1 through 4 form the slider and channels 9 through 11 form the rotator. Therefore, overlap impedance readings are possible while reading the values within channels 1-4 and similarly among channels 9-11.

The next few paragraphs explain in greater detail the operations that can be performed.

- Touch Variance section:

There are three buttons 1) Read, 2) Auto Read and 3) Write. If the user clicks the Read button, it will read back the touch variance of the touch channels.

Clicking the Auto Read button causes the touch variance to be continuously read, so the user can see if any changes are made.

To write in the touch variance of the individual touch channel, the user writes in the individual check box and also selects the corresponding check box. Once the Write button is clicked, the values are written in all the touch channels that have check boxes checked.

- Strength/Threshold section:

  This functions similar to the touch variance section, but there is an additional check button to select between strength and strength threshold. The other settings remain the same.
- Impedance section:

  Functions similar to the touch variance section.
- Calibrated Impedance section:

  Functions similar to the touch variance section.
- Environmental Control Parameters section:

  Here changing certain important parameters is permitted, such as feature select (or APIS mode selection), environmental variable (or Beta), integration time, etc.

Warning: Changes in this variable can affect the normal operation of the demonstration board. If this occurs, the user can return to the main window and click the "Demonstration Reset" button.

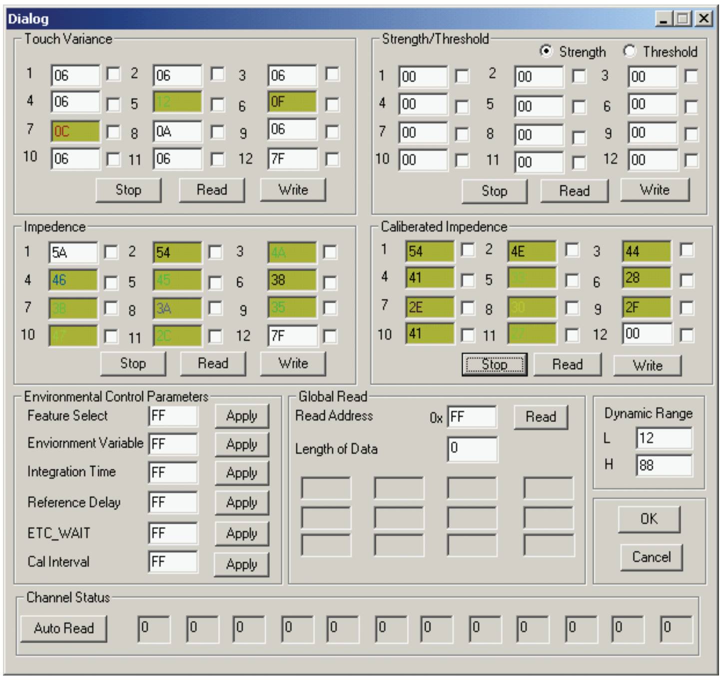
- Global Read:

This option allows the user to read 12 bytes at one time. Once the Read button is clicked, the corresponding data appears in the text box available in this section.

- Dynamic Range:

This option defines a range for values displayed using the Auto Read button. Color coding is used and colors are displayed depending on whether any value is inside or outside the range described in this section (see *Figure 19*).

Figure 19. Dynamic range operation



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This option allows the user to read 12 bytes at one time. Once the Read button is clicked, the corresponding data appears in the textbooks available in this section.

Note: The values in the dynamic range registers are in integers, and in other sections in hex.

- Channel Status section:

  This option allows the touch channels' status to be observed, displaying whether or not they are in a touch condition.

4 Using advanced setting mode to fine-tune the S-Touch™ daughterboard

To fine-tune any S-Touch™ device-based daughterboard, it is necessary to first disassemble the demonstration board and connect the daughterboard using the 10-pin SMD connector (J3) available on the main board. The pin count of this connector is as specified in *Table 1*.

Table 1. 10-pin connector pin definition

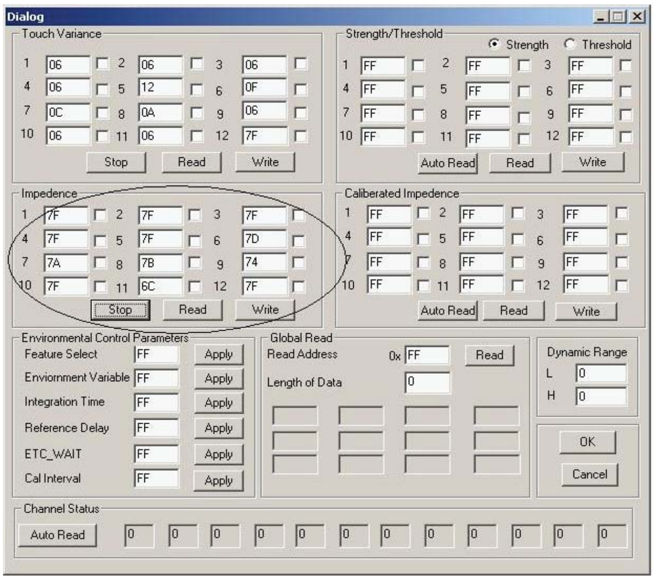
Pin number	Pin definition
1	I^2C clock line
2	I^2C data line
3	Ground
4	VDD
5	TINT
6	GINT
7	Not currently used
8	RESET
9	Not currently used
10	Not currently used

Once the daughterboard is connected to this connector (J3) as per the pin diagram above, it is ready to be fine-tuned. The I^2C slave address is fixed at 0xB0, so in the S-Touch™ daughterboard the user must set the I^2C address lines ID0 and ID1 to 0.

To fine-tune the daughterboard after performing the actions above, start the GUI, open the advanced setting window and perform the following steps:

- Step 1: Read back the impedance values for each touch channel and observe the dynamic range of the default values of the impedances. Impedance values can be read from the section shown in the circled area of *Figure 20*.

Figure 20. Reading the impedance value



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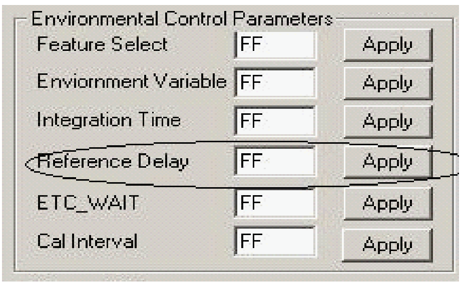
The following interpretations can be made of these impedance readings:

– If all the values are 0 (maximum impedance), it indicates that the default capacitance on the touch channel, due to environmental conditions like track length, etc., is high and therefore a touch event cannot be detected unless the capacitance on the reference line is increased. To do this, a capacitor can be added on the REF pin of the S-Touch™ device and the impedance values can be read back again. This step must be repeated by incrementing the values of the capacitance on REF lines in units of 1 pF up to the dynamic range given in the datasheet starting from 1 pF values.

– The demonstration board default value for the REF DELAY is 100 (the maximum value allowed). REF DELAY is the software method of adding the capacitance on the REF pin. Refer to the STMPE1208S datasheet for further details.
The REF DELAY parameter can be updated by filling in the Reference Delay field in the Environmental Control Parameters section, and then clicking the corresponding APPLY field as shown in *Figure 21*.

Figure 21. REF DELAY parameter



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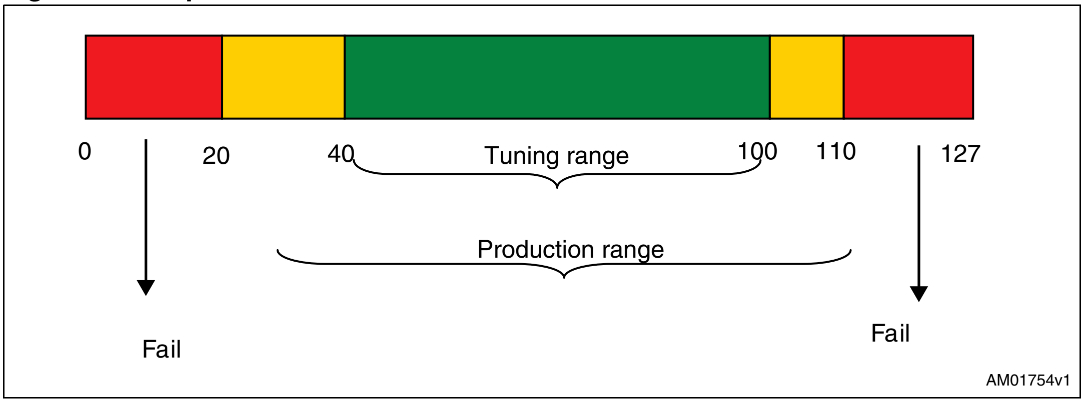
– If the default impedance values are still 0 even after adding the maximum capacitance value on the REF pin, this indicates a problem in the design of the board and a re-design of the daughterboard is necessary.

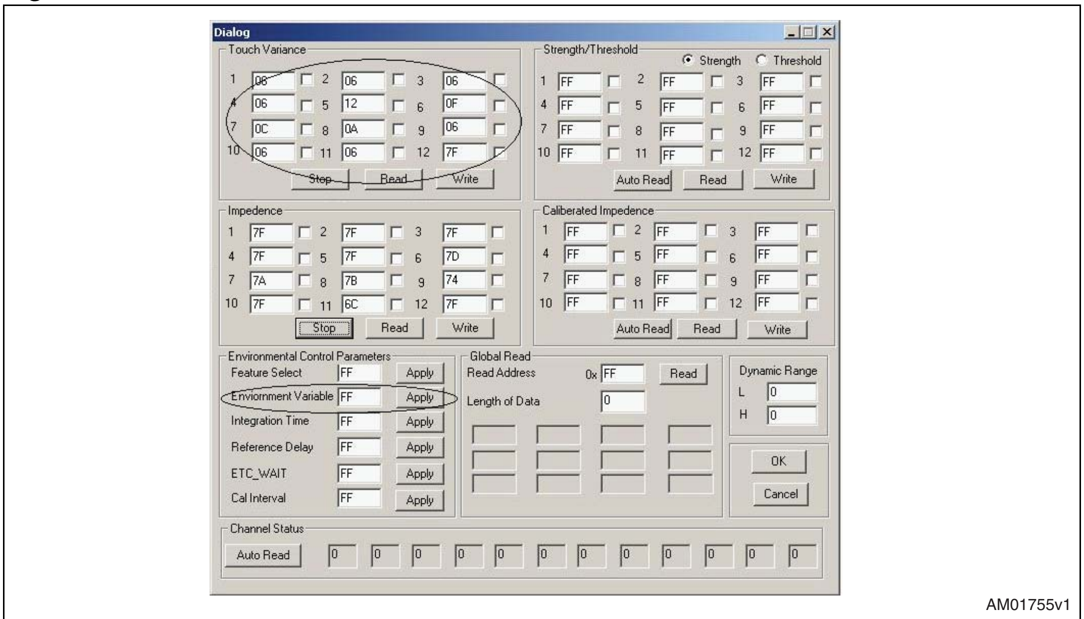
– If the impedance values for each channel are within the green range of the colored scale in *Figure 22*, then the first step was successful.

Figure 22. Impedance values



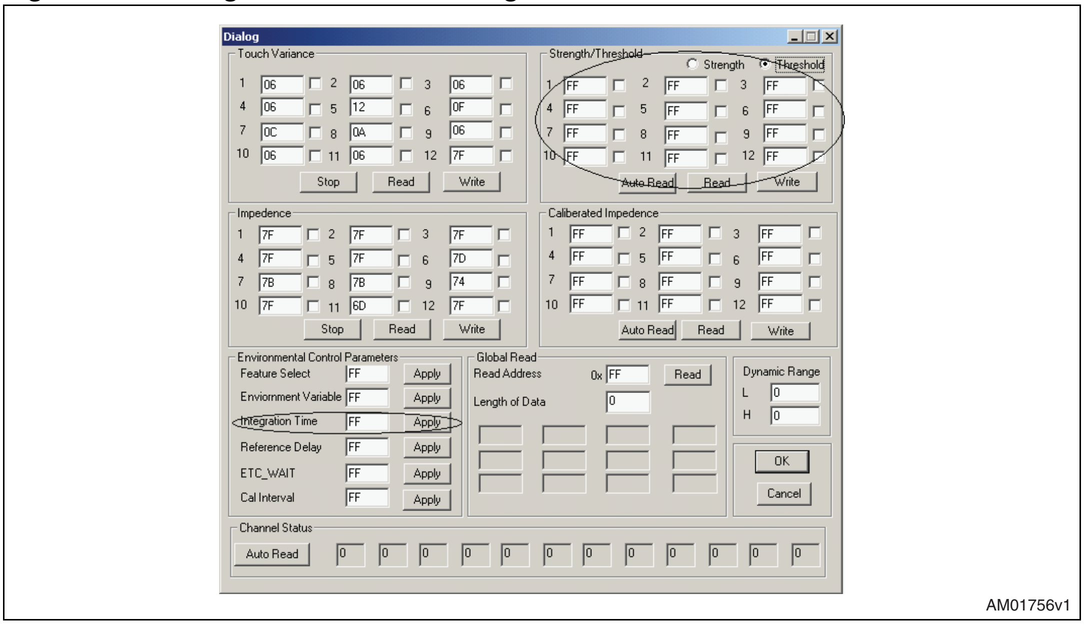
- Step 2: Fine-tune the dynamic range of the touch channel impedance values. Ideally, the variance among the default impedance values should not be more than 15-20. The lower the dynamic range difference, the better the system design. You can also add the capacitance on each touch channel to further fine-tune this dynamic range.
- Step 3: The calibrated impedance values are taken as the impedance values obtained from the fine-tuning of the impedances in steps1 and 2.
- Step 4: Tune the environmental variable and touch variance on each channel. Generally, the environmental variable values are in the 4-8 range and the touch variance values are in the 10-20 range. These values can be set depending on the requirements of the application. *Figure 23* shows the fields where the touch variance and environmental variables are set.

Figure 23. Touch variance and environmental variable



- Step 5: Determine the strength threshold for each touch channel. The values in these fields cannot be greater than the integration time. The circled areas in *Figure 24* specify the sections where these values can be changed.

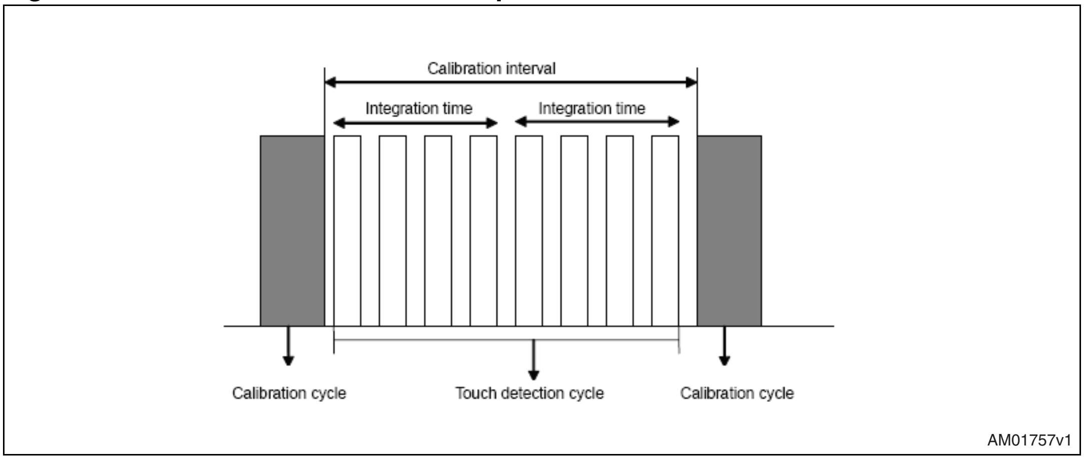
Figure 24. Strength threshold and integration time



The strength threshold parameter works along with the impedance value, touch variance and integration time to determine the valid touch condition.

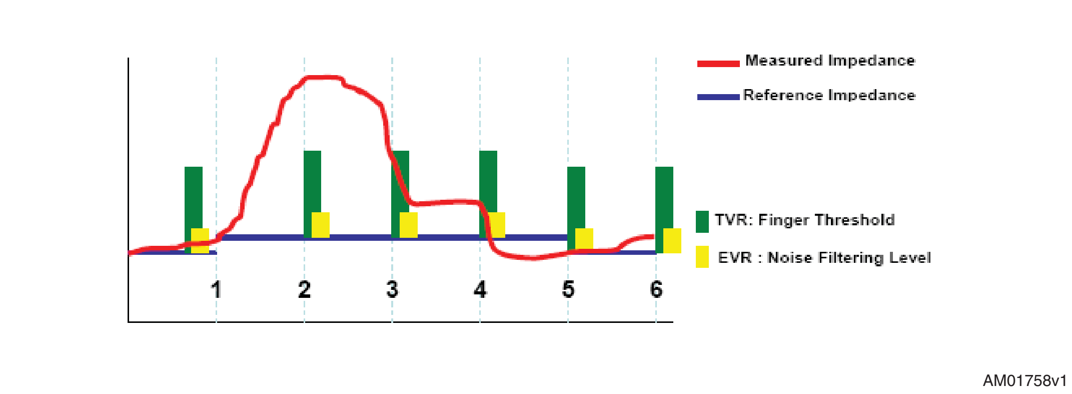
In run mode, the S-Touch™ device runs either a calibration cycle or a touch detection cycle as shown in *Figure 25*. These two modes run at different clock frequencies.

Figure 25. S-Touch™ device normal operation



In touch detection mode, the S-Touch device compares the impedance values with the calibrated impedance and touch variance values to determine the touch conditions across various touch channels.

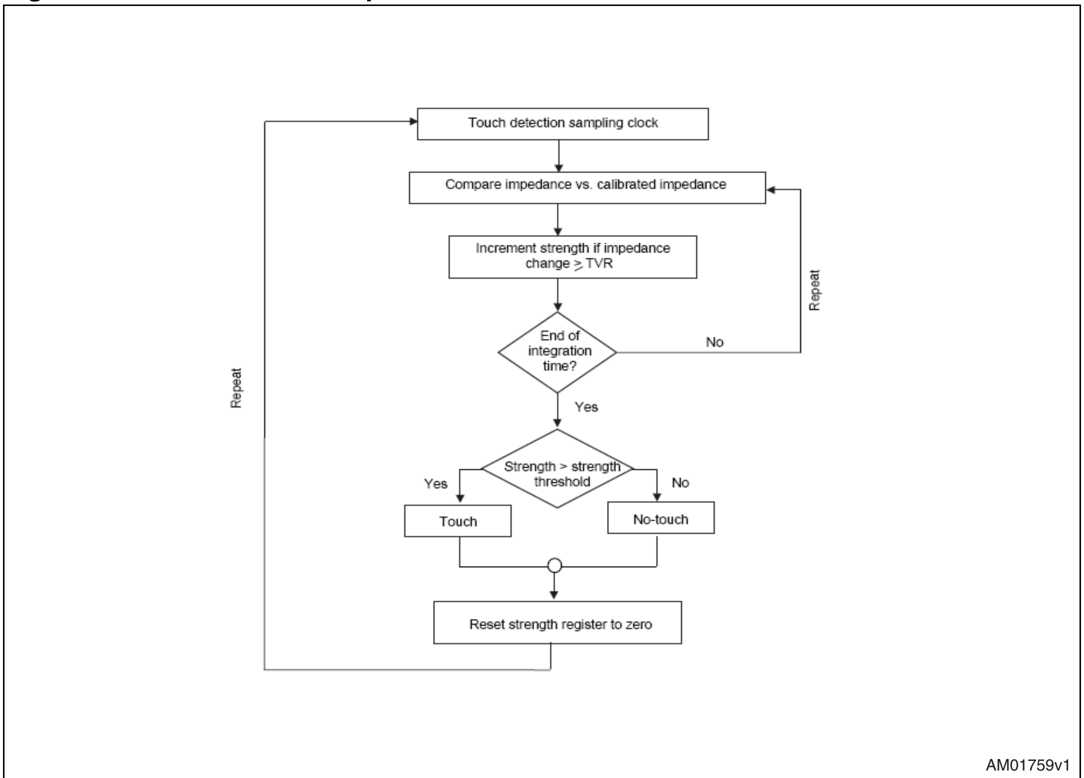
Figure 26. Touch detection scenario



An example is shown in *Figure 26*. For the touch channel, the impedance change value of channel 2 is greater than its touch variance (TVR) value, so its strength is increased by 1. This comparison is done at each sensor clock until the number of clocks is equal to the integration time, and at each sensor clock pulse the strength count for a touch channel is incremented for the number of times it crosses its TVR value with respect to its calibrated impedance, or IMPEDANCE > CALIBRATED IMPEDEDANCE +TVR (reference impedance).

For a valid touch detection, after the completion of the touch detection cycle, the strength and strength threshold register of each touch channel is compared. The touch channel with a strength greater than that of its corresponding strength threshold is given as a touch channel with a valid touch condition. The touch detection flowchart is shown in *Figure 27.*

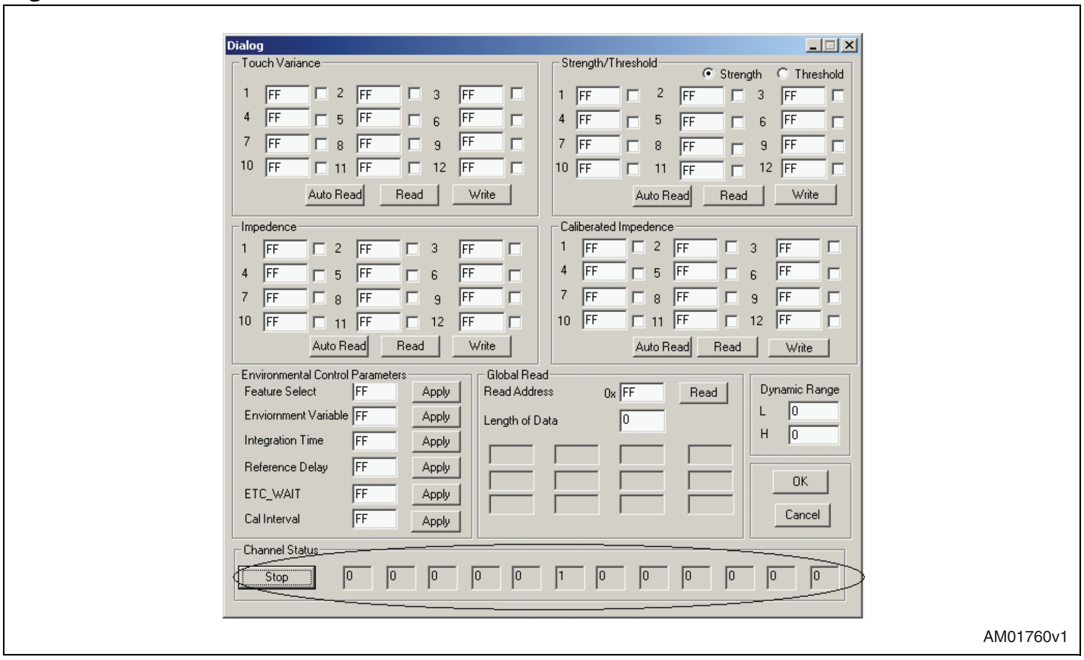
Figure 27. Touch detection process



Note: Remember that for the S-Touch, the impedance is read in reverse order. 0 is the maximum value of the impedance, while TVR and EVR are to be taken as numeric values.

The user can see the status of each channel touch condition in the GUI, as shown in the circled area in *Figure 28*, if its Auto Read option is enabled. Here in the present case, touch channel '6' value is 1 indicating it to be in touched condition.

Figure 28. Channel status



The S-Touch device filters the noise output using two-levels of filtering. The first level is a comparison of the impedance with TVR and the calibrated impedance, and the second filtering level uses the strength values. This ensures a very robust output.

Therefore, depending on the application, the user can fine-tune the strength threshold register values to toughen the touch conditions for noisy environments, or to render the system more sensitive to touch conditions, such as in applications where thick glass panels are used. Using this GUI, the user can check the daughterboard with respect to its application environment to determine the proper values for the relevant fields.

Once these steps are complete, the daughterboard is ready to be used. Any I^2C address can be chosen for the daughterboard to integrate it with the desired system.

Appendix A Schematics

4.1 Demonstration board schematic

Figure 29. Schematic of the S-Touch™ motherboard

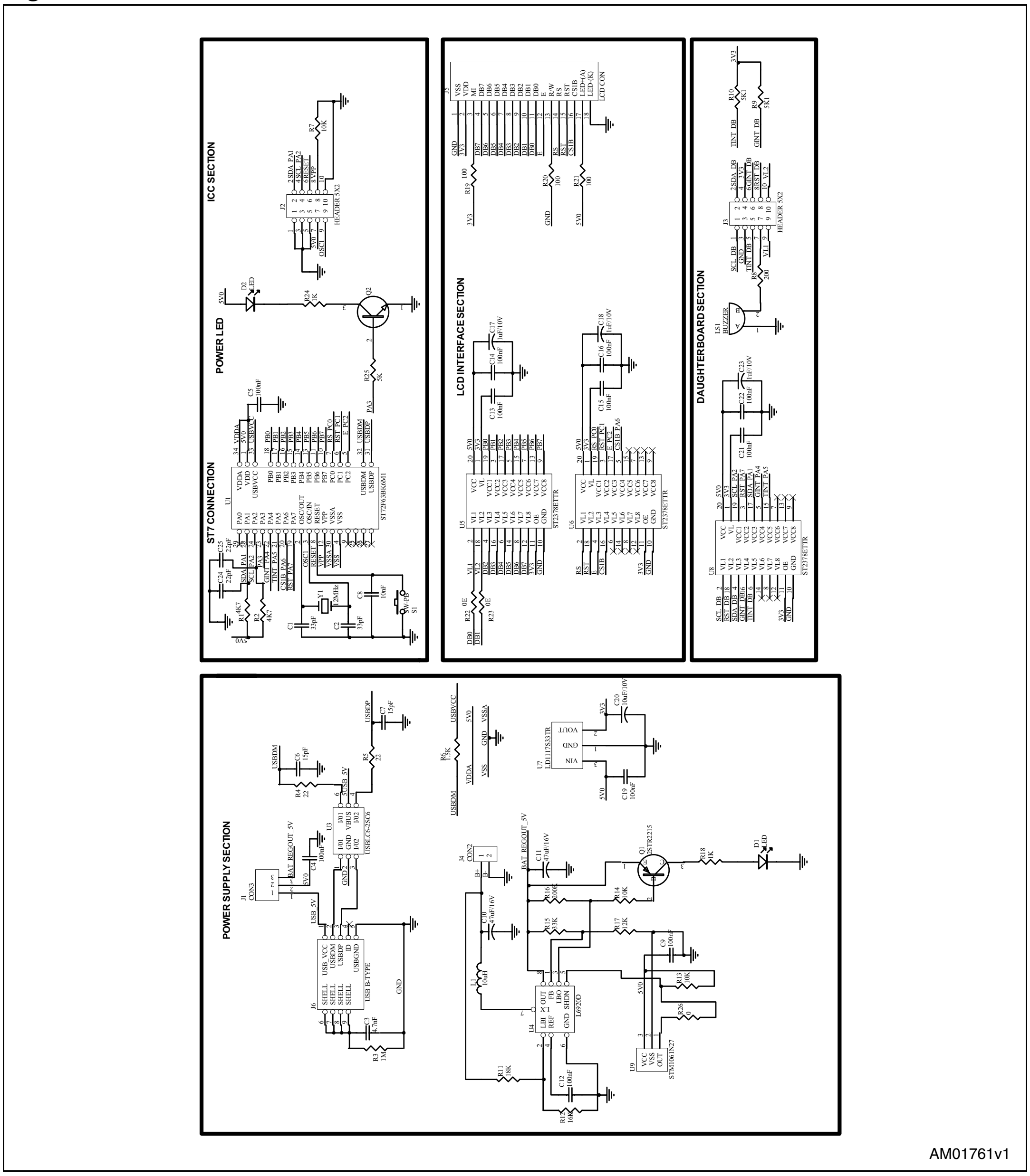
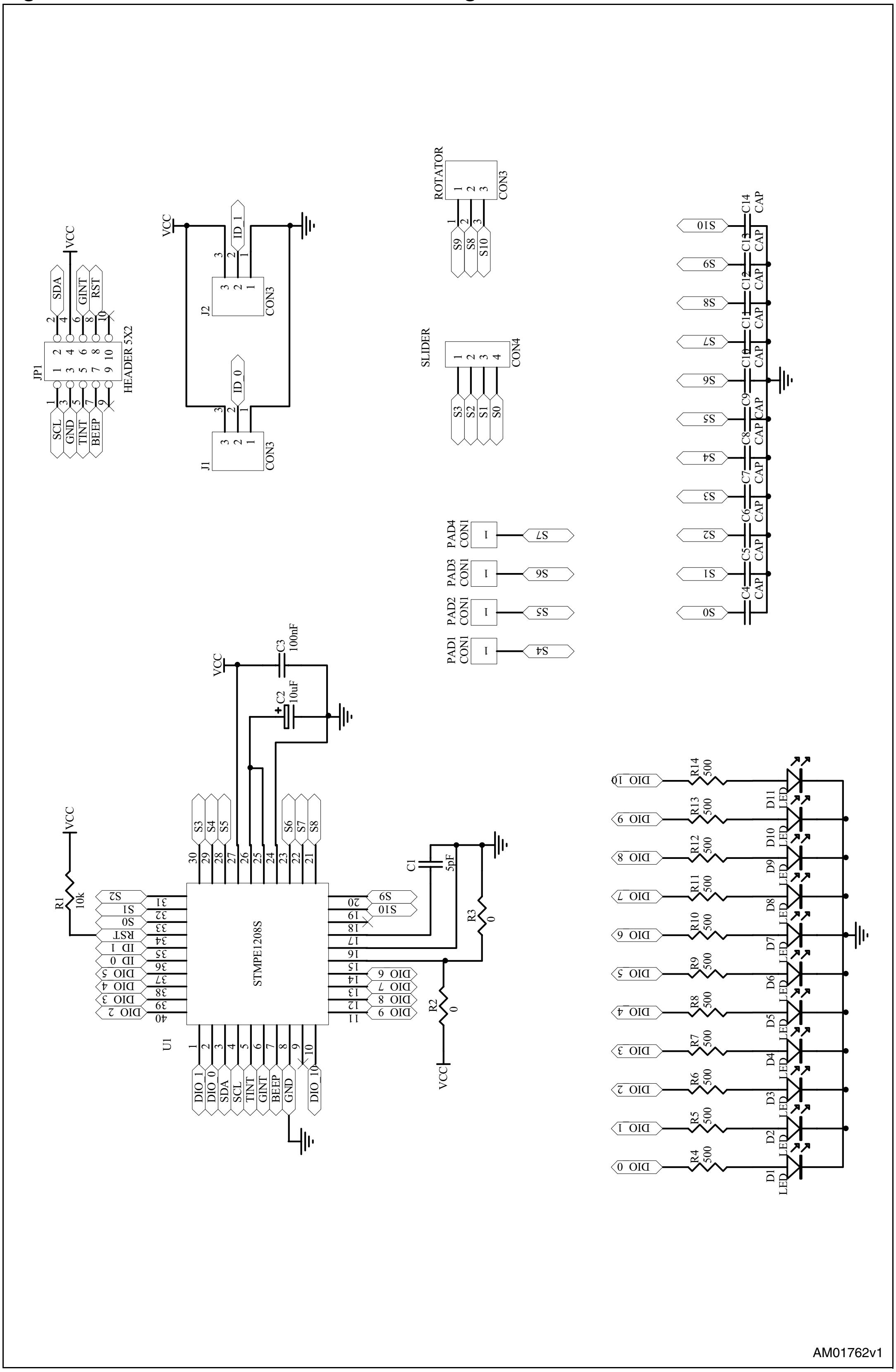


Figure 30. Schematic of the S-Touch™ daughterboard



5 Bill of material

Table 2. BOM

S. number	Reference designator	Quantity	Component description	Package	Manufacturer
S-Touch mother board BOM					
1	U1	1	ST72F63BK6M1	SO34	STMicroelectronics
2	U3	1	USBLC6-2SC6	SOT23-6L	STMicroelectronics
3	U4	1	L6920D	TSSOP8	STMicroelectronics
4	U5, U6, U8	3	ST2378ETTR	TSSOP20	STMicroelectronics
5	U7	1	LD1117S33TR	SOT-223	STMicroelectronics
6	U9 (not used)	1	STM1061N27WX6F	SOT-23	STMicroelectronics
7	Q1	1	2STR2215	SOT-23	STMicroelectronics
8	Q2	1	2STR1215	SOT-23	STMicroelectronics
9	Y1	1	12 MHz	CRYSTAL	Any
10	J1	1	CON3	IDC3	Any
11	J2	1	HEADER 5X2	IDC10B	Any
12	J3	1	HEADER 5X2	SMD HEADER (MALE)	SM Electronic Technologies P. Ltd.
13	J4	1	CON2	IDC2	Any
14	J5	1	LCD CON	LCD	Any
15	S1	1	RESET push button	SWITCH	Any
16	J6	1	USB B-TYPE	USB mini B-type	Any
17	D2	1	LED	3MMLED	Any
18	D1 (not used)	1	LED	SMD LED	Any
19	C17, C18, C23	3	1 µF/10 V	C1206	Any
20	C3	1	4.7 nF	805	Any
21	C8	1	10 nF	805	Any
22	C20	1	10 µF/10 V	C1206	Any
23	C6, C7	2	15 pF	805	Any
24	C1, C2	2	33 pF	805	Any
25	C10, C10	2	47 µF/16 V	C1205	Any
26	C4, C5, C9, C12, C13, C14, C15, C16, C19, C21, C22	11	100 nF	805	Any
27	R22, R26, R23	3	0 Ω	805	Any

Table 2. BOM (continued)

S. number	Reference designator	Quantity	Component description	Package	Manufacturer
28	R6	1	1.5 kΩ	805	Any
29	R18, R24	2	1 kΩ	805	Any
30	R3	1	1 MΩ	805	Any
31	R1, R2	2	4.7 kΩ	805	Any
32	R9, R10	2	5.1 kΩ	805	Any
33	R25	1	5 kΩ	805	Any
34	R7, R13, R14	3	10 kΩ	805	Any
35	R17	1	12 kΩ	805	Any
36	R12	1	16 kΩ	805	Any
37	R11	1	18 kΩ	805	Any
38	R4, R5	2	22 Ω	805	Any
39	R15	1	33 kΩ	805	Any
40	R15	1	33 kΩ	805	Any
41	R19, R20, R21	3	100 Ω	805	Any
42	R8	1	200 Ω	805	Any
43	R16	1	200 kΩ	805	Any
44	L1	1	10 µH	Inductor	Any
45	LS1 (not mounted)	1	Buzzer	Buzzer	Any
46	Mounted on LCD con1	1	64X128MONO BERG 2 WAY	Monochrome LCD	Displaytech Ltd.
S-Touch™ daughterboard BOM					
1	U1	1	STMPE1208SQTR	QFN40	STMicroelectronics
2	J2	1	CON3	HEADER3	Any
3	J1	1	CON3	HEADER3	Any
4	JP1	1	HEADER 5X2	SMD HEADER (FEMALE)	SM Electronic Technologies P. Ltd.
5	D1, D2, D3, D4, D5, D6, D7, D8, D9, D10, D11	11	LED	0805_H	
6	C1	1	5 pF	804	Any
7	C2	1	10 µF	C1206	Any
8	C3	1	100 nF	805	Any
9	C4, C5, C6, C7, C8, C9, 10, C11, C12, C13, C14	11	CAP (between 1-3 pf)	805	Any

Table 2. BOM (continued)

S. number	Reference designator	Quantity	Component description	Package	Manufacturer
10	R2, R3	2	0 Ω	805	Any
11	R1	1	10 kΩ	805	Any
12	R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14	11	500 Ω	805	Any

6 Reference

1. AN2693: S-Touch™ devices: system considerations
2. AN2733: S-Touch™ PCB and layout guidelines
3. STMPE1208S datasheet

7 Revision history

Table 3. Document revision history

Date	Revision	Changes
13-Jan-2009	1	Initial release