

Introduction

The AirNavigationPad is a PC HID (human interface device) peripheral that makes it possible to interact with the PC by sending commands in the same way as a PC mouse. Each command is related to a particular hand movement performed over it.

This is made possible through the use of four touch/proximity sensors on the STM8T143, whose electrodes are placed on the four edges of a 12 cm wide square board.

The system is controlled by the STM32F103C6.

Figure 1. STEVAL-ICB010V1



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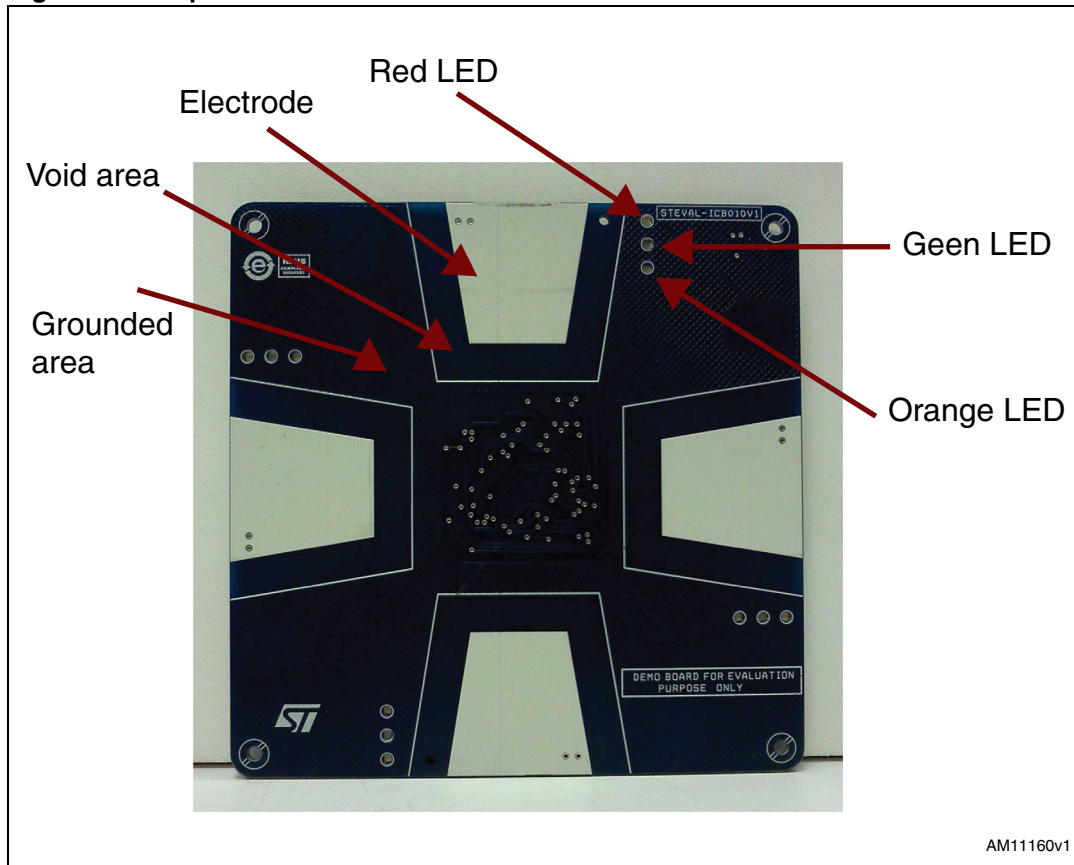
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1 AirNavigationPad

1.1 Top side

Figure 2. Top side



Four electrodes are located on the top side. They are the four trapezoidal areas placed in the center of the four edges. Clockwise, they are “up”, “right”, “down” and “left”.

Each electrode is linked with a proximity sensor located on the bottom side.

A non-metallized area lies between the electrode and a grounded area.

There are three holes on the right of each electrode. Below each hole there is a different colored LED: red, green, and orange.

1.2 Bottom side

Figure 3. Bottom side

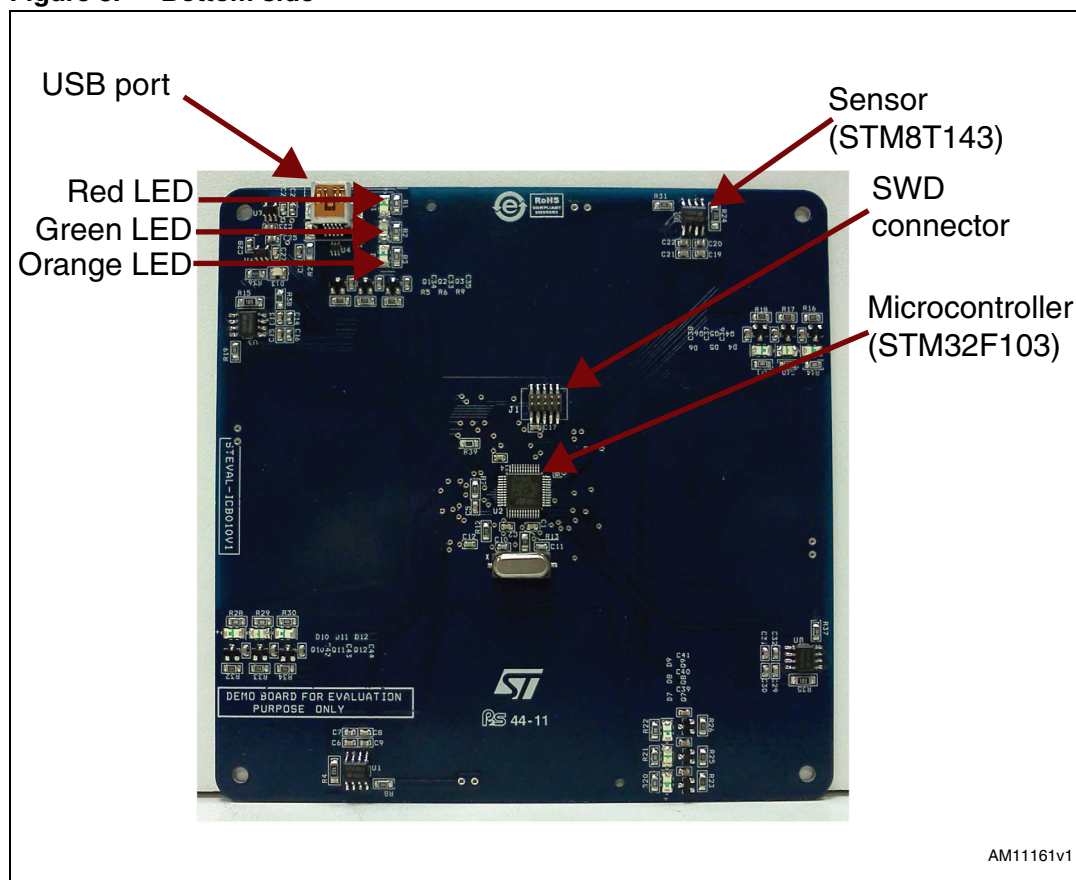
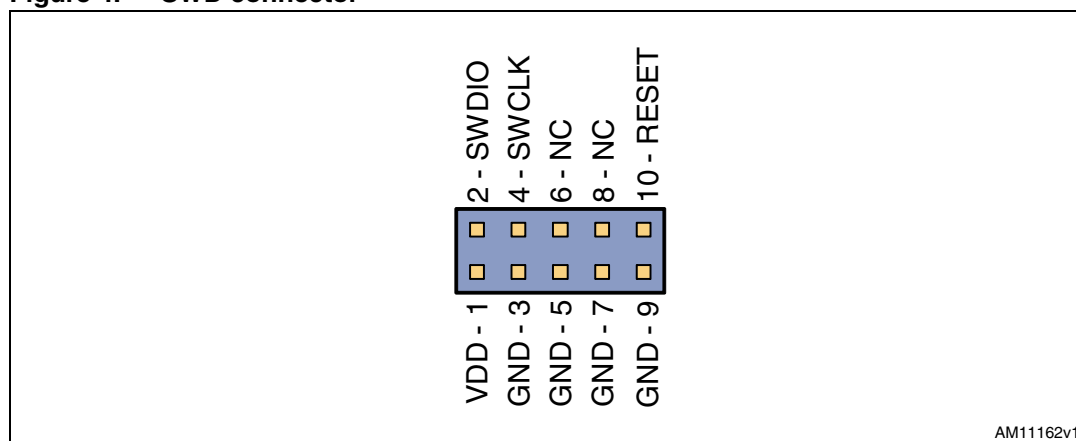


Figure 4. SWD connector



All components are located on this side and are surrounded by a grounded full copper area. The microcontroller is placed at the center of the board.

It is possible to program the microcontroller through the SWD connector located above it.

2 Connection and use

No additional PC driver installation is required in order to use the AirNavigationPad with a PC. The OS recognizes it as a human interface device (HID).

- Connect the USB cable to the AirNavigationPad
- Place the AirNavigationPad in such a way that the direction DOWN / UP is directly in front of, and in line with, the user
- From this point on, make sure that the board is not touched
- Connect the USB cable to an available PC USB port; the board is automatically detected
- Wait until all LEDs are switched off
- If any red LED is switched on, touch the related electrode to switch it off
- As soon as a sensor detects a proximity event over it, the related yellow LED is switched on
- Perform a hand movement over the AirNavigationPad as follows:
 - Up → down
 - Down → up
 - Right → left
 - Left → right
- The detected direction is shown by the related green LED.

Any proximity event on the AirNavigationPad corresponds to a mouse pointer movement on the PC screen in the detected direction.

2.1 HID commands

The AirNavigationPad is able to transmit some HID commands just like a mouse.

[Table 1](#), [2](#), [3](#) and [4](#) show the relationship between either recognized directions or some touches and HID mouse commands while a particular state is on.

The states are:

- State 1: a recognized direction corresponds to a movement of the mouse pointer on the PC screen (no red LED lights up)
- State 2: a recognized direction corresponds to a movement of the mouse pointer on the PC screen performed as if the left mouse key were kept pressed (enable/disable by a touch on the DOWN electrode; when enabled the DOWN red LED lights up)
- State 3: the directions RIGHT, LEFT, and vice versa, are only recognized and their effect is as if the mouse wheel were rotating (enable/disable by a touch on the UP electrode; when enabled the UP red LED lights up).

State 2 and state 3 are mutually exclusive.

The mouse pointer is moved by a fixed number of pixels (CURSOR_STEP) for a fixed number of periods (MOV_STEP_1 or MOV_STEP_2).

The mouse wheel is rotated by a fixed number of pixels (WHEEL_STEP).

The values of the constants:

- CURSOR_STEP
- MOV_STEP_1
- MOV_STEP_2
- WHEEL_STEP

can be changed by means of the file “parameters.h” that is part of the project written for the IAR Embedded Workbench®.

The following tables show which commands the AirNavigationPad is able to send to the PC.

Table 1. Touch vs. effect (all states)

Touch	Command
Up	Enable/disable “state 3”
Down	Enable/disable “state 2”
Right	Mouse wheel rotation of WHEEL_STEP steps forward
Left	Mouse wheel rotation of WHEEL_STEP steps backwards

Table 2. Direction vs. effect (state 1)

Direction	Command
Up → down	Down movement of MOV_STEP_1 per CURSOR_STEP pixel
Down → up	Up movement of MOV_STEP_1 per CURSOR_STEP pixel
Right → left	Left movement of MOV_STEP_1 per CURSOR_STEP pixel
Left → right	Right movement of MOV_STEP_1 per CURSOR_STEP pixel

Table 3. Direction vs. effect (state 2)

Direction	Command (each command is performed within the command “mouse left key pressed”)
Up → down	Down movement of MOV_STEP_2 per CURSOR_STEP pixel
Down → up	Up movement of MOV_STEP_2 per CURSOR_STEP pixel
Right → left	Left movement of MOV_STEP_2 per CURSOR_STEP pixel
left → right	Right movement of MOV_STEP_2 per CURSOR_STEP pixel

Table 4. Direction vs. effect (state 3)

Direction	Command
Up → down	None
Down → up	None

Table 4. Direction vs. effect (state 3)

Direction	Command
Right → left	Wheel 4 steps backwards
Left → right	Wheel 4 steps forward

2.2 Examples of use

By means of the AirNavigationPad, it is possible to interact with the most common PC software.

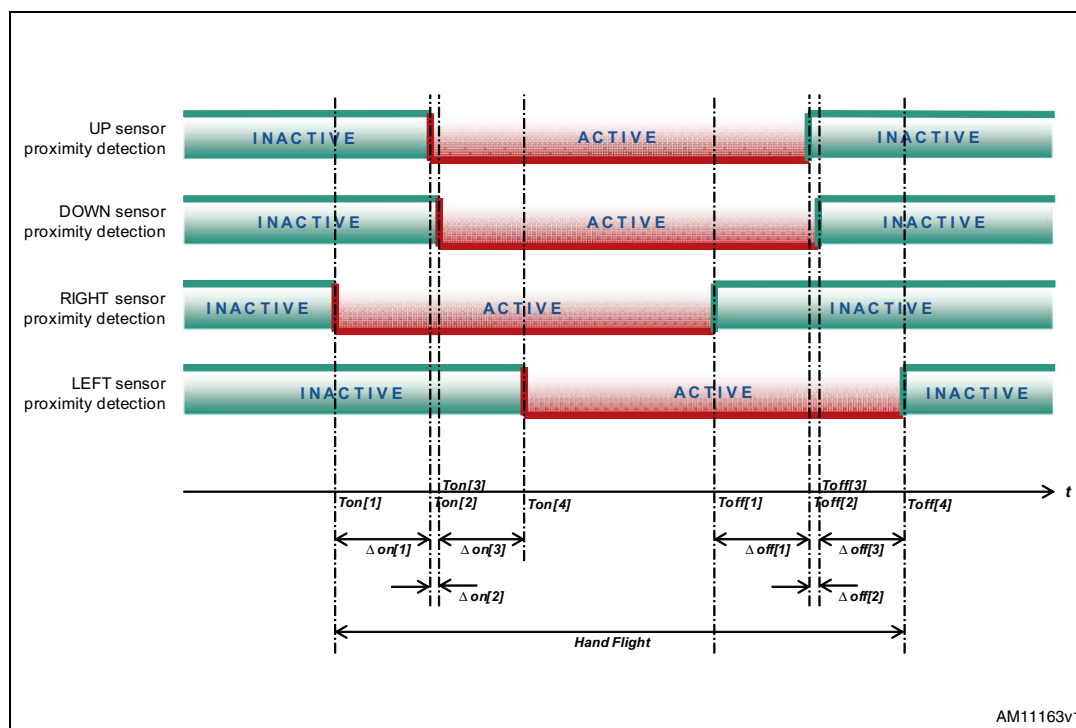
For example, if the user wants to browse through a slide presentation they can set the “State 3” so that a hand movement from right to left, performed over the AirNavigationPad, changes the page to the following one, the opposite movement makes it possible to change the page to the previous one.

3 Direction recognition algorithm

To detect a hand movement direction, the AirNavigationPad is provided with 4 sensors (STM8T143) able to recognize events as proximity and touch.

Each of these sensors is placed in the middle of each of four edges of the AirNavigationPad. As soon as a hand crosses the AirNavigationPad, it covers each sensor but not at the same time.

Figure 5 shows the typical timing of sensor activation while a hand crosses the AirNavigationPad from right to left.

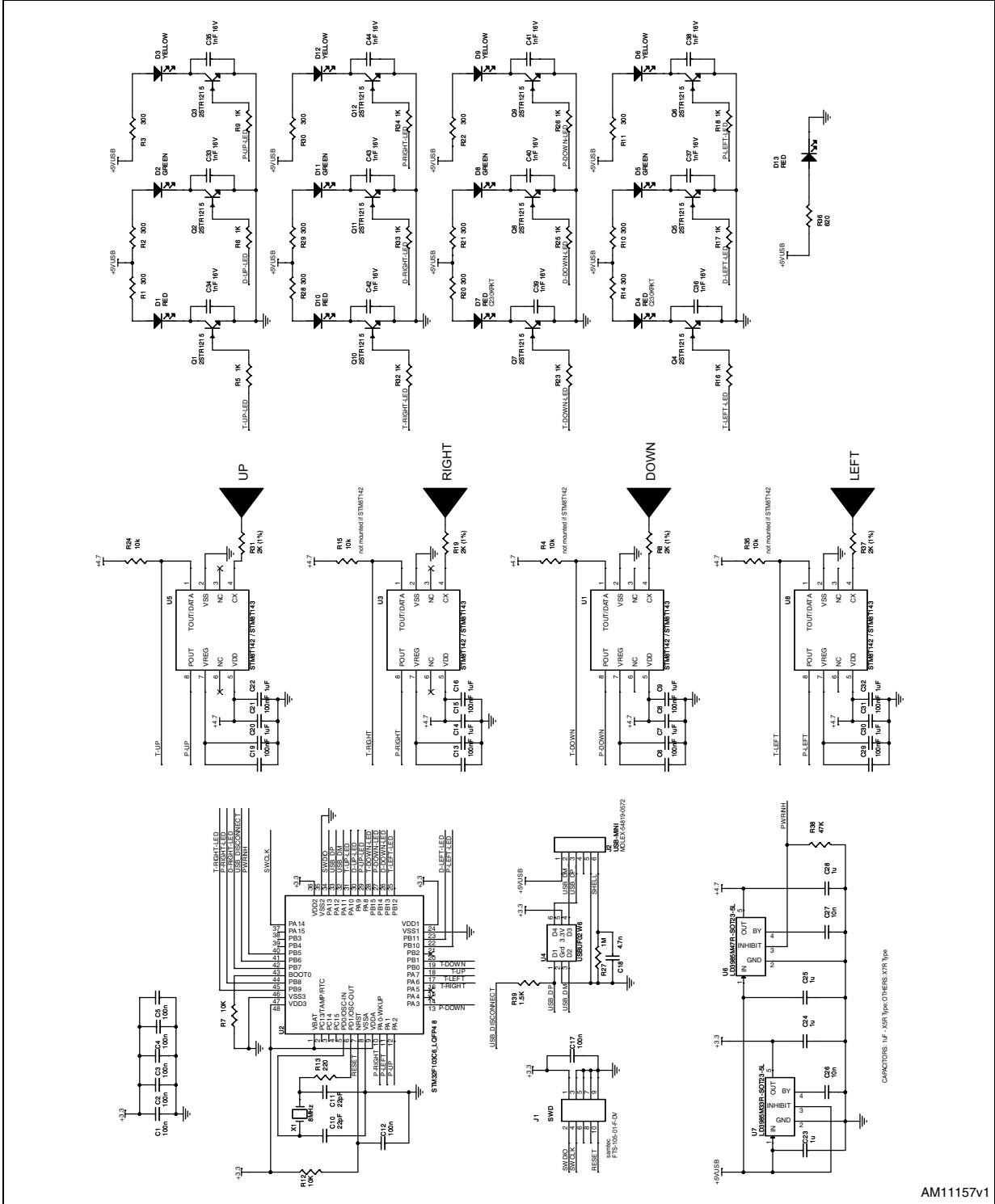


The microcontroller (STM32F103) analyzes the timing of sensor activation to detect the hand movement direction, see Section 2.

Appendix A Schematic, layout and BOM

A.1 Schematic

Figure 6. STEVAL-ICB010V1 - schematic



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A.2 Layout

Figure 7. STEVAL-ICB010V1 - top side layout

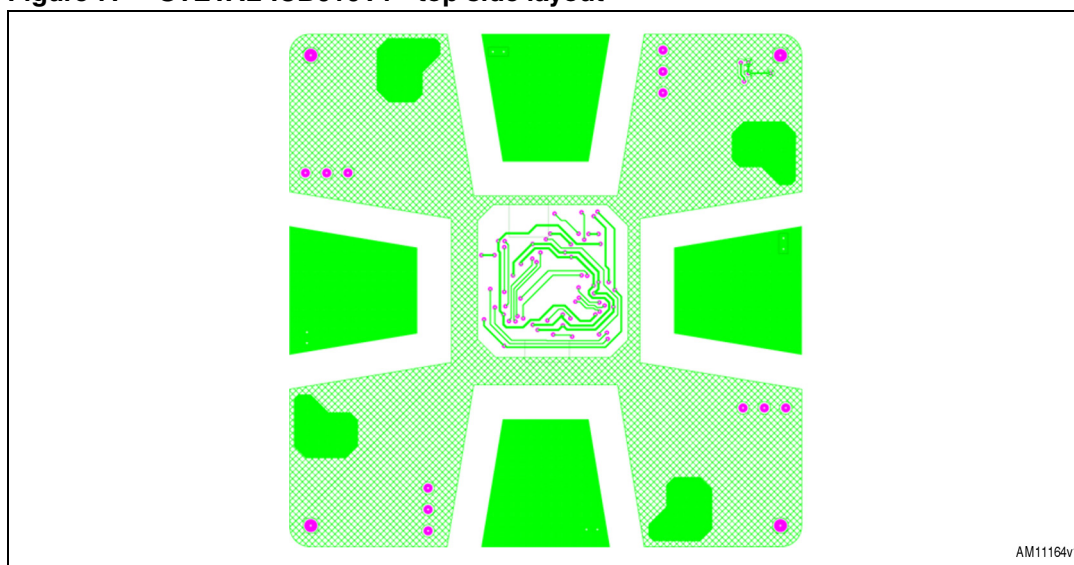
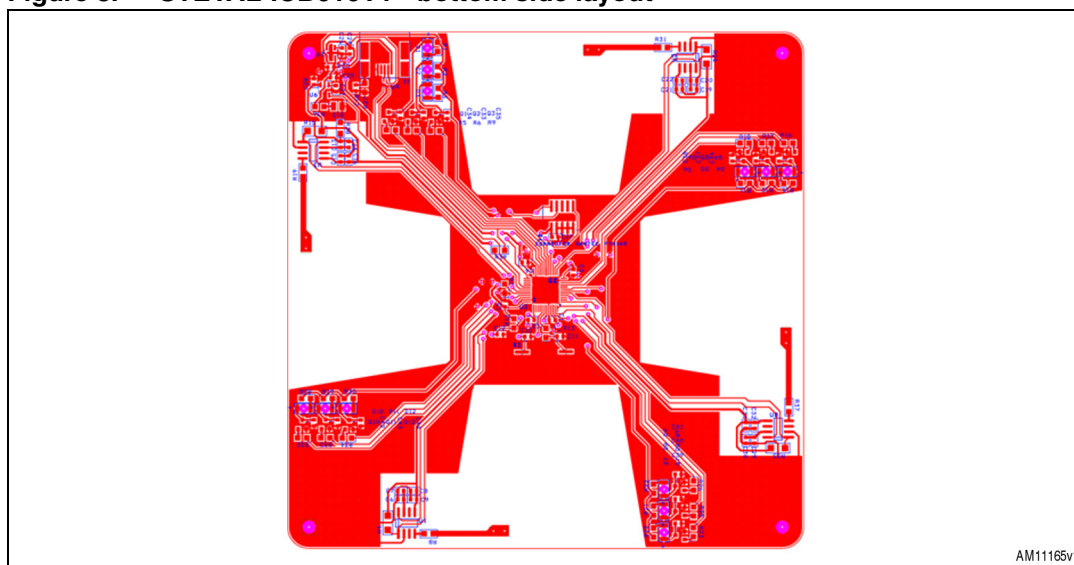


Figure 8. STEVAL-ICB010V1 - bottom side layout





A.3 Bill of materials

Table 5. STEVAL-ISF00V1 BOM

Ref.	Part value	Toll.	Voltage current	Watt	Technology information	Package	Manufacturer	Manufacturer code	RS distrelec other code	More info
C1, C2, C3, C4, C5, C6, C8, C12, C13, C15, C17, C19, C21, C29, C31	100 nF		> 5.5 Vcc		X7R	0603	AVX	0603YC104KAT2A	RS: 698-3320	Capacitor MLCC 0603 100 nF 16 V
C10, C11	22 pF					0603	Any			
C18	4.7 nF					0603	Any			
C26, C27	10 nF		> 5.5 Vcc		X7R	0603	AVX	06035C103KAT2A	RS: 698-3254	Capacitor MLCC 0603 10 nF 50 V
C33, C34, C35, C36, C37, C38, C39, C40, C41, C42, C43, C44	1 nF					0603	Any			
C7, C9, C14, C16, C20, C22, C23, C24, C25, C28, C30, C32	1 μ F		> 5.5 Vcc		X5R	0603	AVX	06036D105KAT2A	RS: 698-3314	Capacitor MLCC 0603 1 μ F 6.3 V
D2, D5, D8, D11	Direction LED					1206	LITE-ON	LTST-C230KGKT	RS: 692-1105	LED, 1206, reverse mount, green, 35 mcd (direction detection)

**Table 5. STEVAL-ISF00V1 BOM (continued)**

Ref.	Part value	Toll.	Voltage current	Watt	Technology information	Package	Manufacturer	Manufacturer code	RS distrelec other code	More info
D13	Power LED					0805	OSRAM	LYR976NR1020R18	RS: 497-4804	LED, 0805, RED, package 2.0 mm x 1.25 mm x 0.8 mm
D1, D4, D7, D10	Touch LED					1206	LITE-ON	LTST-C230KRKT	RS: 692-1108	LED, 1206, reverse mount, red, 60 mcd (touch detection)
D3, D6, D9, D12	Proximity LED					1206	LITE-ON	LTST-C230KSKT	RS: 692-1102	LED, 1206, reverse mount, yellow, 50 mcd (proximity detection)
J1	SWD Connector						Samtec	FTS-105-01-F-DV		10 W dual body, SMT micro terminal strip, pitch 1.27 mm
J2	Surface mount USB mini-B connector		30 Vdc / 1 A				Molex	54819-0572	RS: 515-1995	
Q1, Q2, Q3, Q4, Q5, Q6, Q7, Q8, Q9, Q10, Q11, Q12	2STR1215		15 V - 1.5 A			SOT-23	STMicroelectronics	2STR1215		Low voltage fast-switching NPN power transistor
R1, R2, R3, R10, R11, R14, R20, R21, R22, R28, R29, R30	300 Ω			0.125		0805	Any			
R12, R7	10 kΩ			0.125		0805	Any			
R13	220 Ω			0.125		0805	Any			

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Schematic, layout and BOM



Table 5. STEVAL-ISF00V1 BOM (continued)

Ref.	Part value	Toll.	Voltage current	Watt	Technology information	Package	Manufacturer	Manufacturer code	RS distrelec other code	More info
R27	1 M Ω			0.125		0805	Any			
R36	620 Ω			0.125		0805	Any			
R4, R15, R24, R35	10 k Ω					1206	Any			
R5, R6, R9, R16, R17, R18, R23, R25, R26, R32, R33, R34	1 k Ω			0.125		0805	Any			
R8, R19, R31, R37	2 k Ω	1%		0.125		0805	Any			
R38	47 k Ω					0805	Any			
R39	1.5 k Ω					0805	Any			
U1, U3, U5, U8	STM8T143					SO8	STMicroelectronics	STM8T143AM62T		Single-channel capacitive sensor for touch and proximity detection
U2	STM32F103 C6					LQFP48	STMicroelectronics	STM32F103C6T6 A		Low-density performance line, ARM-based 32-bit MCU with 16 or 32 KB Flash, USB, CAN, 6 timers, 2 ADCs, 6 communication interfaces
U4	USBUF02W6					SOT323-6L	STMicroelectronics	USBUF02W6		EMI filter and line termination for USB upstream ports



Table 5. STEVAL-ISF00V1 BOM (continued)

Ref.	Part value	Toll.	Voltage current	Watt	Technology information	Package	Manufacturer	Manufacturer code	RS distrelec other code	More info
	MHz					HC-49/US	ABRACON	ABLS-8.000MHz-B2	RS: 703-1783	Quartz SMD
	USB standard A - mini-B cable		1 A				Molex	88732-8600	RS: 656-3939	
	SWD connector cable						Samtec	FFSD-05-D-08.00-01-N		10-pin cable, pitch 1.27 mm

Note: If it is not specified, for TRH and SMD resistors their tolerance is at 5%.

4 References

1. STM8T143 datasheet.
2. STM32F103C4, STM32F103C6 datasheets.

Revision history

Table 6. Revision history

Date	Revision	Changes
09-Feb-2012	1	Initial release.

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