STEVAL-IME014 – USER MANUAL

Introduction

STEVAL-IME014 is a product evaluation board designed around the STHV1600 16-channel high voltage pulser, a device designed for ultrasound imaging applications.

This software can be used to evaluate characteristics and functionalities of STHV1600.

The output waveforms can be displayed directly on an oscilloscope by connecting the scope probe to the relative RF connectors.

4 preset programs are available to test the HV pulser under varying conditions.

GUI or textual interface is available to change as many waveforms/configurations as the user want

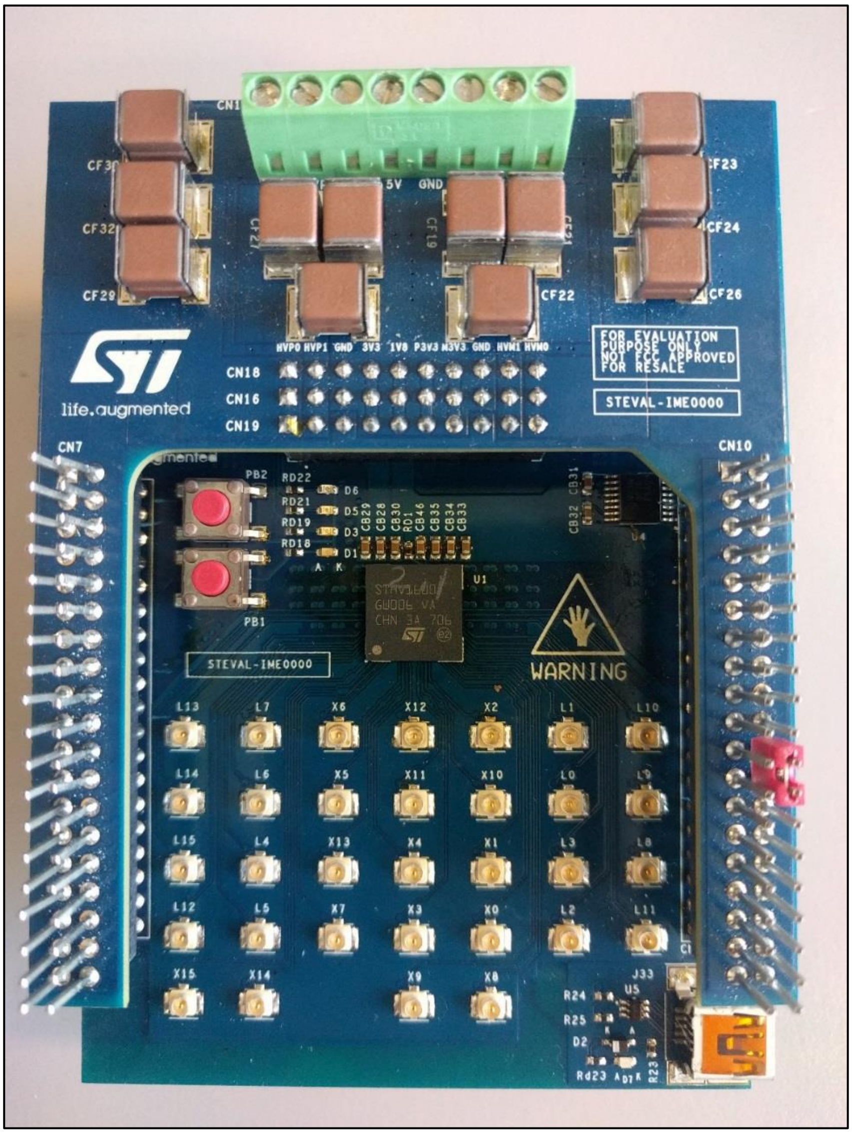


Figure 1: STEVAL-IME014

Contents

1 STEVAL-IME014 features

- 16 channel high voltage outputs (XDCR): RF connectors
- Typical load directly connected on XDCRs (100Ω // 300pF)
- Possibility to disconnect load on XDCR removing solder bridges
- 16 channel low voltage outputs (LVOUT): RF connectors
- No load on LVOUT
- 4 preset programs
- USB connector to change programs and waveforms
- Button interface to build, select, start and stop the generation of waveforms
- LEDs to monitor STHV1600 behavior
- System based on STM32 microcontroller
- 3 layers (modules) stacked:
  - Nucleo
  - STHV1600 Module
  - Power Supply Module
- Possibility to use more than one STEVAL-IME014 connected in master/slave mode and synchronized
- Low voltage supplies generated on board (Power supply module)
- Only 5 supply lines needed: 4 High Voltage, 1 Low Voltage (5V)
- GUI or textual interface available to configure STEVAL-IME014 by yourself

2 Hardware description

2.1 STEVAL-IME014

STEVAL-IME014 is a group of 3 stacked PCBs (modules) (Figure 2)

A jumper on left is needed to select if STEVAL-IME014 run as master or slave.

Figure 2: STEVAL-IME014

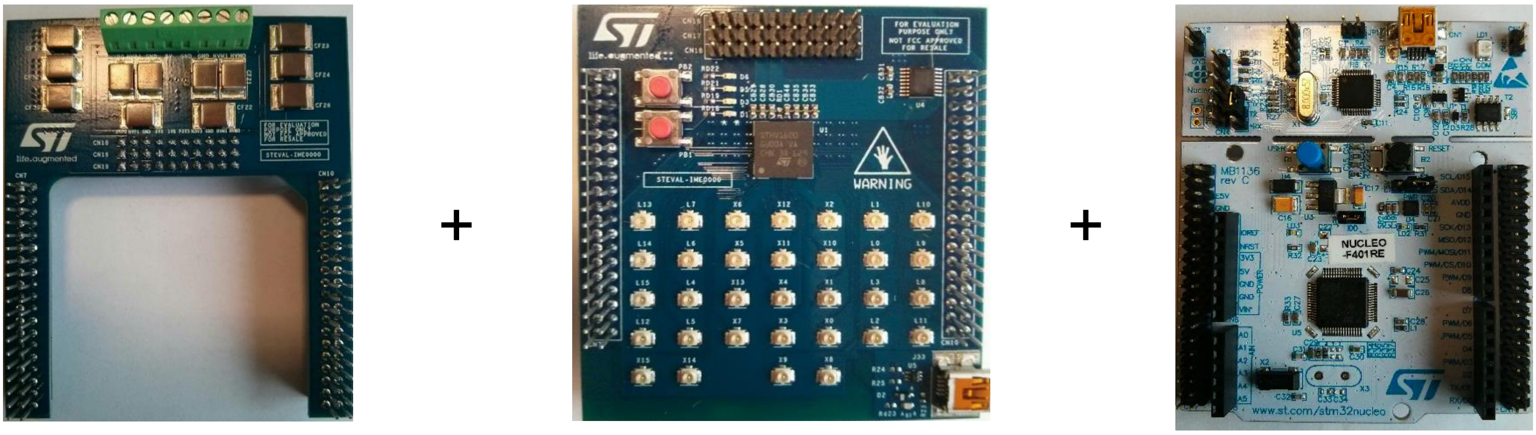
2.2 STEVAL-IME014 composition

Figure 3 shows single PCB layers.

Power supply Module is used to generate low voltage supplies and manage all power supplies.

STHV1600 Module mount the STHV1600 device, CLKSYS generator and all connectors and Buttons.

Nucleo mount the STM32 microcontroller used to generate the correct signals for STHV1600



Power Supply Module

STHV1600 Module

Nucleo STM32F401
or
STM32F411

Figure 3: STEVAL-IME014 composition

2.2.1 Power supply module

Power Supply module (Figure 4) mounts the power supply connector (4 High voltage supplies to directly supply device and 1 Low voltage supply used to generate all others low voltage supplies), the decoupling capacitors and the LDOs able to generate from 5V the VDDM, VDDP, DVDD and IOVDD for STHV1600.

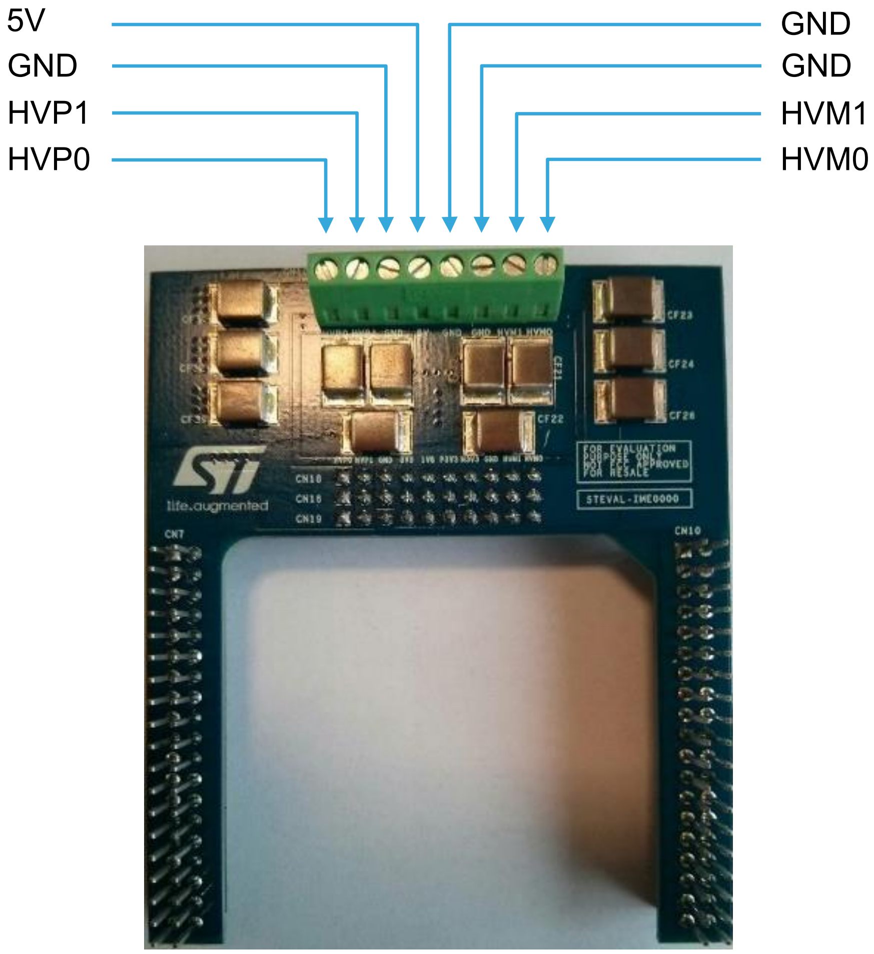


Figure 4: Power Supply module

Pin Number	Signal Name	Function
1	HVP0	Positive high voltage TX0 supply
2	HVP1	Positive high voltage TX1 supply
3	GND	Ground
4	5V	5V supply
6	GND	Ground
7	GND	Ground
8	HVM1	Negative high voltage TX1 supply
9	HVM0	Negative high voltage TX0 supply

Table 1: Power supplies connector description

2.2.2 STHV1600 Module

STHV1600 Module (Figure 5) mount STHV1600 device, clock generator for SYSCLK, a USB port and the button interface.

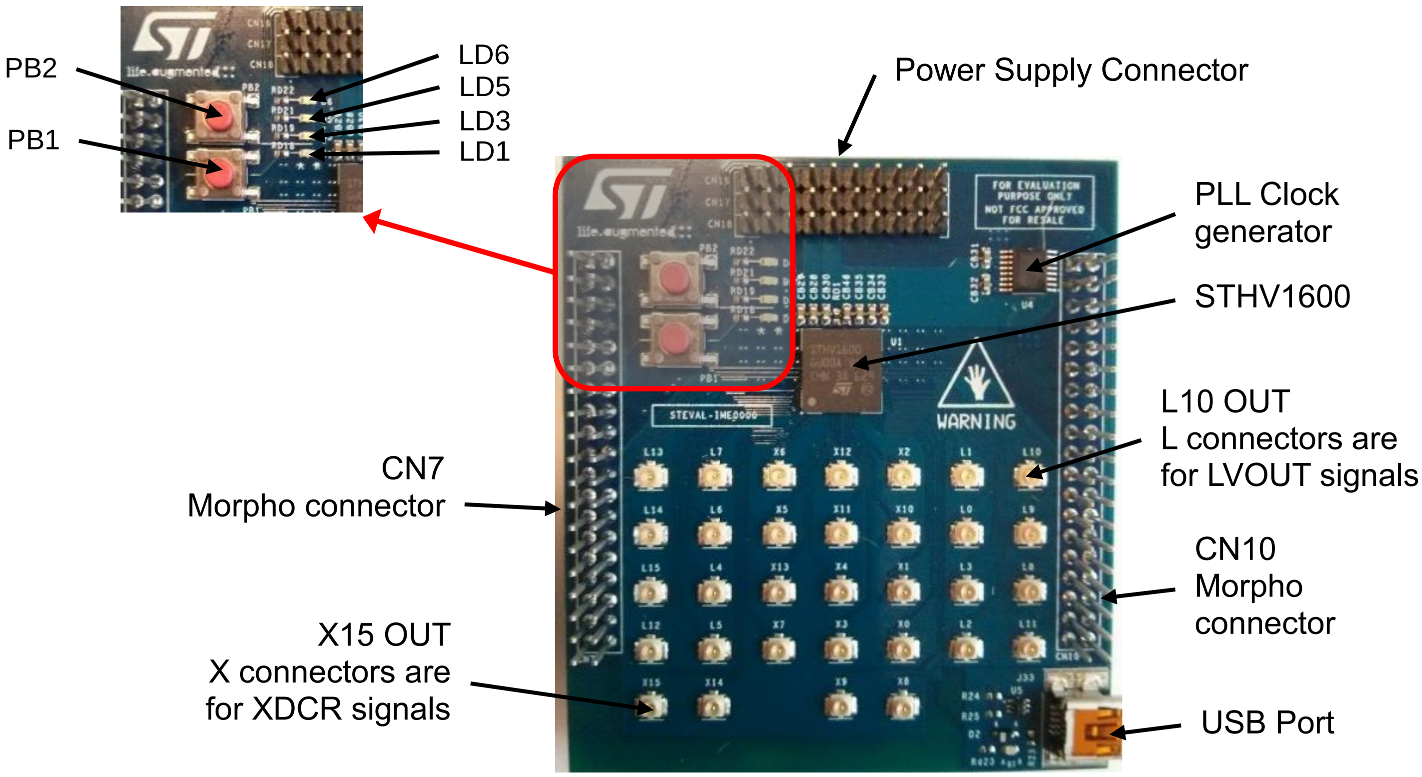


Figure 5: STHV1600 Module

Part Name	Function Description
PB1	Press to Start wave generation (Master mode trigger) Press again to Stop wave generation (Only for continuous mode)
PB2	Press to change wave (if more than one wave is stored, max. 4 waves) Press for 2 seconds to save wave in flash memory
LD1	Blinking: wave execution (or trigger waiting in Slave mode trigger) Single flash: flash write done
LD3, LD5, LD6	Selected wave in binary code (LD3 is the lsb)
USB Port	Connect to a PC USB port for waves update
L15 – L0	STHV1600 LVOUT15 to LVOUT0 output
X15 – X0	STHV1600 XDCR15 to XDCR0 high voltage output

Table 2: SHV1660 Module components

2.3 STEVAL-IME014 – Connector Signals

On Figure 6, Table 3, Table 4 and Table 5, the position and function of signals on STEVAL-IME014 connectors are specified.

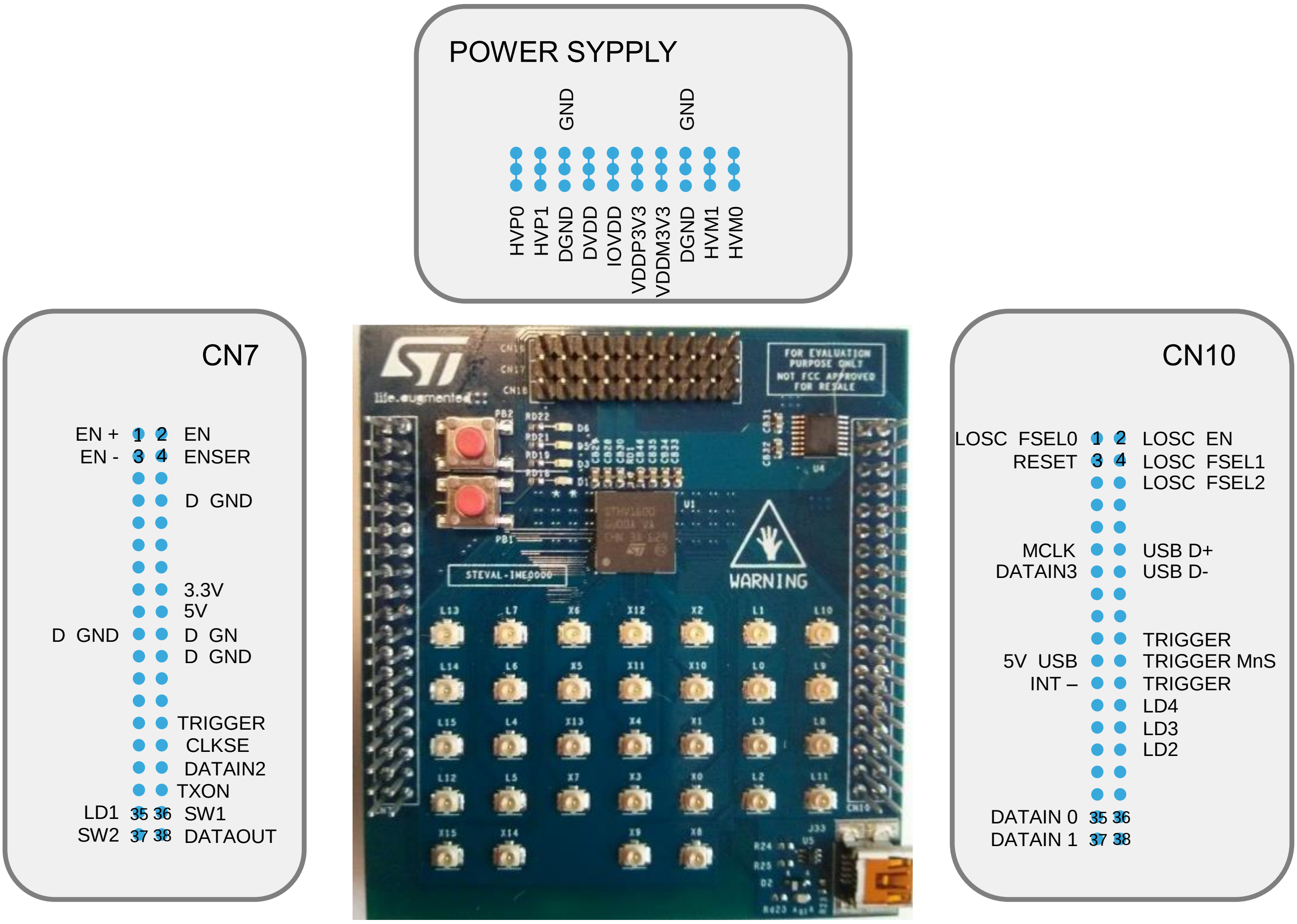


Figure 6: Connectors

POWER SUPPLY CONNECTOR		
Pin Number	**Signal Name**	**Function**
1-2-3	HVP0	Positive high voltage TX0 supply
4-5-6	HVP1	Positive high voltage TX1 supply
7	DGND	Digital Ground (0V)
8-9	GND	Power Ground (0V)
10-11-12	DVDD	Positive logic supply (1.8V) -> generated on Power supply Module

13-14-15	IOVDD	CMOS IO supply (3.3V) -> generated on Power supply Module
16-17-18	VDDP3V3	Positive low voltage supply (3.3V) -> generated on Power supply Module
19-20-21	VDDP3M3	Negative low voltage supply (-3.3V) -> generated on Power supply Module
22	DGND	Digital Ground (0V)
23-24	GND	Power Ground (0V)
25-26-27	HVM1	Negative high voltage TX1 supply
28-29-30	HVM0	Negative high voltage TX0 supply

Table 3: Power supply connector

CN7 CONNECTOR		
Pin Number	**Signal Name**	**Function**
1	EN +	Enable VDDP3V3 voltage regulator
2	EN	Enable DVDD and IOVDD voltage regulator
3	EN -	Enable VDDM3V3 voltage regulator
4	ENSER	STHV1600 ENSERP signal
8, 19, 20, 22	D_GND	Digital ground
16	3.3V	3.3V supply
18	5V	5V supply
28	TRIGGER	STHV1600 TRIGGERP signal
30	CLKSER	STHV1600 CLKSERP signal
32	DATAIN2	STHV1600 DATA_INP[2] signal
34	TXON	STHV1600 TX_ON signal
35	LD1	LED 1 driving signal
36	SW1	Button PB1 logic state (start/stop)
37	SW2	Button PB2 logic state (change wave, save wave)
38	DATAOUT	STHV1600 DATA_OUT signal

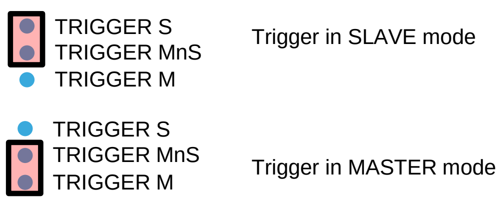
Table 4: CN7 connector

CN10 CONNECTOR

Pin Number	Signal Name	Function
1	LOSC_FSEL0	PLL frequency selection, bit 0
2	LOSC_EN	PLL enable
3	RESET	STHV1600 RESET signal
4	LOSC_FSEL1	PLL frequency selection, bit 1
6	LOSC_FSEL2	PLL frequency selection, bit 2
11	MCLK	PLL master clock input signal
12	USB D+	USB data +
13	DATAIN3	STHV1600 DATA_INP[3] signal
14	USB D-	USB data -
20	TRIGGER S	See note 1
21	5V_USB	5V from USB
22	TRIGGER MnS	Master / Slave selector
23	INT	STHV1600 INT signal
24	TRIGGER M	See note 1
26	LD4	LED 4 driving signal
28	LD3	LED 3 driving signal
30	LD2	LED 2 driving signal
35	DATAIN0	STHV1600 DATA_INP[0] signal
37	DATAIN1	STHV1600 DATA_INP[1] signal

Table 5: CN10 connector

<u>NOTE 1:</u> Put a jumper to short TRIGGER MnS pin, according to your preferred configuration: <u>TRIGGER MnS pin can't be leave floating</u>



2.4 Multi Board Mode

More than one STEVAL-IME014 can be connected together in a Multi Board configuration.

It can be useful to simulate a multi-device system, all devices will be synchronized on same trigger event.

Hardware configuration on Figure 7

A single STEVAL-IME014 must be set as MASTER, all others will be set as SLAVE.
Trigger will be generated only from MASTER, SLAVE boards will wait for external trigger

External trigger must be provided by wire (normally connected to the trigger generated on MASTER)

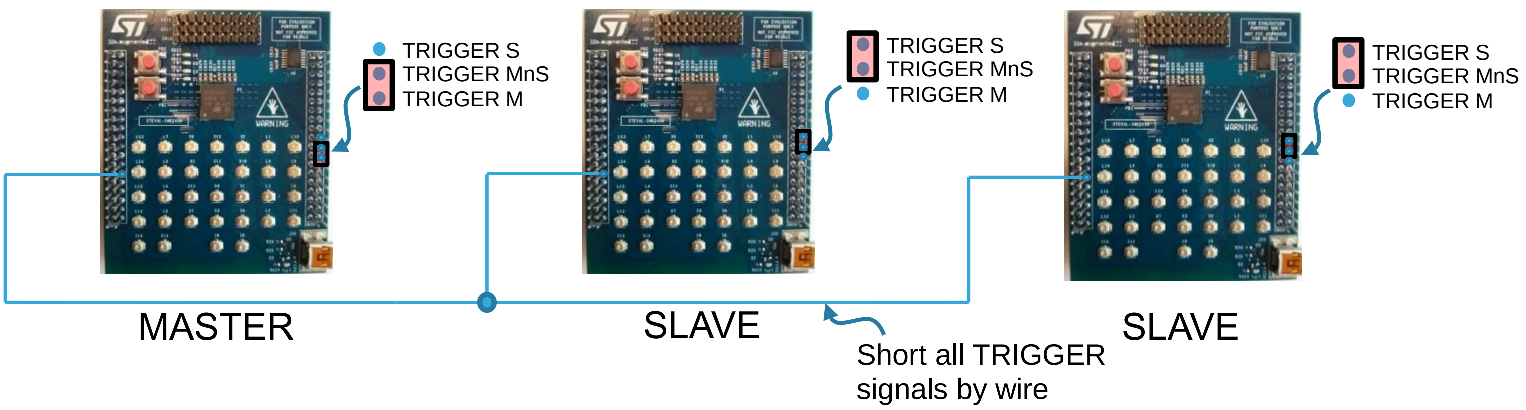


Figure 7: Multi board mode

How to start wave generation:

- First configure each STHV1600 Module (one by one) with bin file
- Select the correct program using PB2 on each Module
- Press the Start button PB1 on all the SLAVE modules, the LD1 will blink.
- Then press Start button on the master module.
- XDCRs will start to generate waveforms
- Stopping wave generation:
  - In continuous mode: press Stop button on MASTER board, then on all SLAVEs
  - In single mode: press Stop button just on the SLAVE modules

3 Getting started

STEVAL-IME014 characteristics:

- It can stores up to 4 programs. Push a button to change program (see chapter 3.1).
- The available SYSCLK frequencies are:
  - 10MHz
  - 50MHz
  - 100MHz
  - 200MHz (**WARNING**: Because the STEVAL-IME014 interface is CMOS, It can work improperly at this frequency.)

  Take into account that the real clock in case of 100MHz selection is: f_{SYSCLK}=101.5MHz -> T_{SYSCLK}=9.85ns

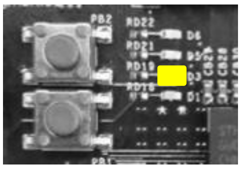
- The available operative modes are (see Figure *8*):
  - **Continuous**: a multiple trigger is generated. On XDCRs a pulse train will be generated.
  - **Single**: a single trigger event is generated. On XDCRs just a single repetition of waveforms
  - **CW**: a continuous switching wave is generated.

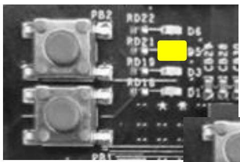
Figure 8: Operative modes

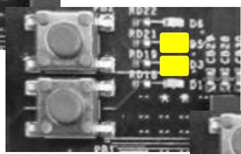
3.1 Wave generation

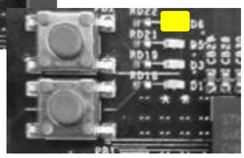
To start the XDCR waveform generation, follow the procedure below (a .bin file must be already present on STEVAL-IME014):

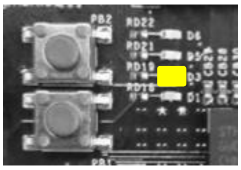
1. Connect the required supply voltages according to the specifications (in case of high supply voltage value, we suggest to disconnect the USB cable)
2. Connect all the probe you need to evaluate high voltage waves and digital signals
3. Select the required wave (PB2). Push PB2 to change program (waveform) in loop. Program number is shown by LD3, LD5, LD6 in binary code, starting from 1 (LD3 is the lsb). Link from Program number and wave frequency is on previous table

Ex: push PB2 -> program (waveform) 1 selected -> led status  ->

push PB2 -> program 2 selected ->  ->

push PB2 -> program 3 selected -> led status  ->

push PB2 -> program (waveform) 4 selected -> led status  ->

push PB2 -> program 1 selected  -> etc.

4. Press once the Start / Stop button (PB1)
5. In single mode the waveform generation will stop automatically at the end of the program.
   In continuous/CW mode the waveform generation can be stopped by the Start / Stop button (PB1)

3.2 Default waveform

The STEVAL-IME014 can memorize up to 4 programs in the on-board Flash memory to show the achievable performance for each pulser output. A default set selectable patterns are already stored in the Flash memory and ready to use, they are stored in a file named 'prog_def.bin'. A detailed description of programs is listed below.

3.2.1 Program 1

The first Program is based on 100MHz SYSCLK and it is described in Table 6, odd outputs are in phase and they are 180° phase respect to the even outputs (waveforms in Figure 9). Its state sequence is indicated in Table 7. All channels are enabled in both TX and RX.

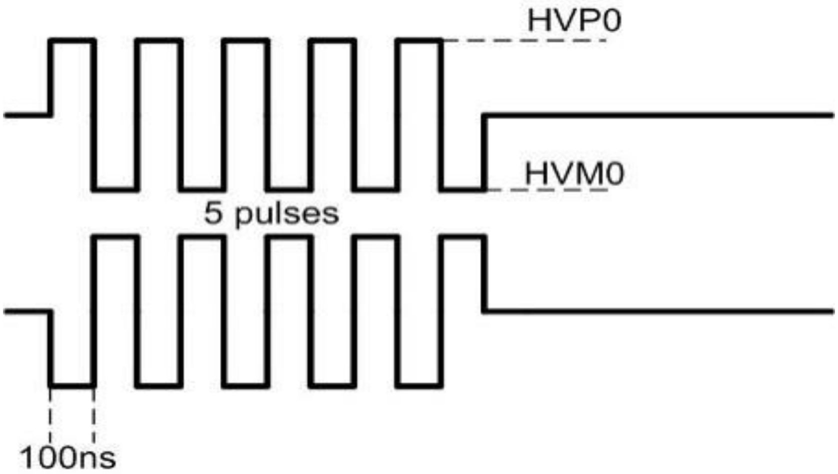


Figure 9: Waveforms out - Program 1

	Mode	Frequency [MHz]	Number of pulses	Initial Pulse	PRF [us]	H-Bridge
XDCR0	PW continuous	5	5	Positive	300	TX0
XDCR1	PW continuous	5	5	Negative	300	TX0
XDCR2	PW continuous	5	5	Positive	300	TX0
XDCR3	PW continuous	5	5	Negative	300	TX0
XDCR4	PW continuous	5	5	Positive	300	TX0
XDCR5	PW continuous	5	5	Negative	300	TX0
XDCR6	PW continuous	5	5	Positive	300	TX0
XDCR7	PW continuous	5	5	Negative	300	TX0
XDCR8	PW continuous	5	5	Positive	300	TX0
XDCR9	PW continuous	5	5	Negative	300	TX0
XDCR10	PW continuous	5	5	Positive	300	TX0
XDCR11	PW continuous	5	5	Negative	300	TX0
XDCR12	PW continuous	5	5	Positive	300	TX0
XDCR13	PW continuous	5	5	Negative	300	TX0
XDCR14	PW continuous	5	5	Positive	300	TX0

XDCR15	PW continuous	5	5	Negative	300	TX0

Table 6: Program 1

XDCR0, XDCR2, XDCR4, XDCR6, XDCR8, XDCR10, XDCR12, XDCR14		XDCR1, XDCR3, XDCR5, XDCR7, XDCR9, XDCR11, XDCR13, XDCR15	
CLAMP	200 t_{CLKSYS}	CLAMP	200 t_{CLKSYS}
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}
CLAMP	200 t_{CLKSYS}	CLAMP	200 t_{CLKSYS}
RX	295 µs	RX	295 µs

Table 7: Program 1 - States description

3.2.2 Program 2

The second Program is based on 100MHz SYSCLK and it is described in Table *8*, odd outputs are in phase and they are 180° phase respect to the even outputs (waveforms in Figure *10*). Its state sequence is indicated in Table *9*. Only 4 channels are running on this Program because the available current from LDOs on ‘Power supply Module’ is not able to drive more channels.

Take attention that in CW a supply higher than 10V is not allowed.

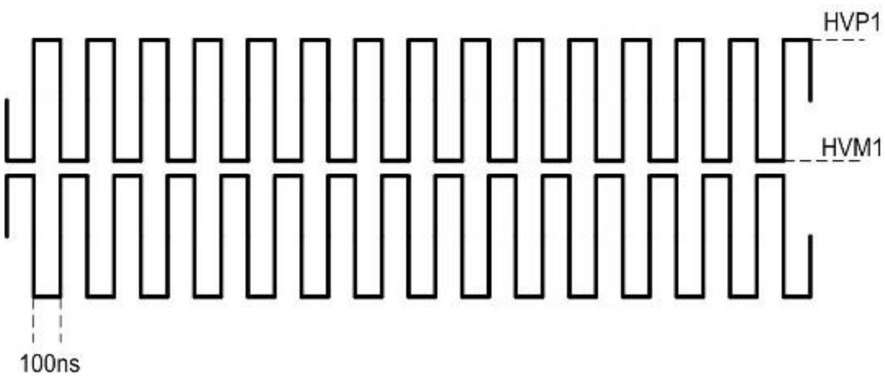


Figure 10: Waveforms out - Program 2

	Mode	Frequency [MHz]	Initial Pulse	H-Bridge
XDCR0	CW	5	Positive	TX1
XDCR1	CW	5	Negative	TX1

XDCR2	CW	5	Positive	TX1
XDCR3	CW	5	Negative	TX1
XDCR4	NO TX – CLAMP	-	-	-
XDCR5	NO TX – CLAMP	-	-	-
XDCR6	NO TX – CLAMP	-	-	-
XDCR7	NO TX – CLAMP	-	-	-
XDCR8	NO TX – CLAMP	-	-	-
XDCR9	NO TX – CLAMP	-	-	-
XDCR10	NO TX – CLAMP	-	-	-
XDCR11	NO TX – CLAMP	-	-	-
XDCR12	NO TX – CLAMP	-	-	-
XDCR13	NO TX – CLAMP	-	-	-
XDCR14	NO TX – CLAMP	-	-	-
XDCR15	NO TX - CLAMP	-	-	-

Table 8: Program 2

XDCR0, XDCR2		**XDCR1, XDCR3**	
HVP0	10 t_{CLKSYS}	HVM0	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}	HVP0	10 t_{CLKSYS}

Table 9: Program 2 - States description

3.2.3 Program 3

The 3rd Program is based on 100MHz SYSCLK and it is described in Table *10*, each output has 10ns of delay respect the next one (waveforms in Figure *11*). Its state sequence is indicated in Table *11*. All channels are enabled in both TX and RX.

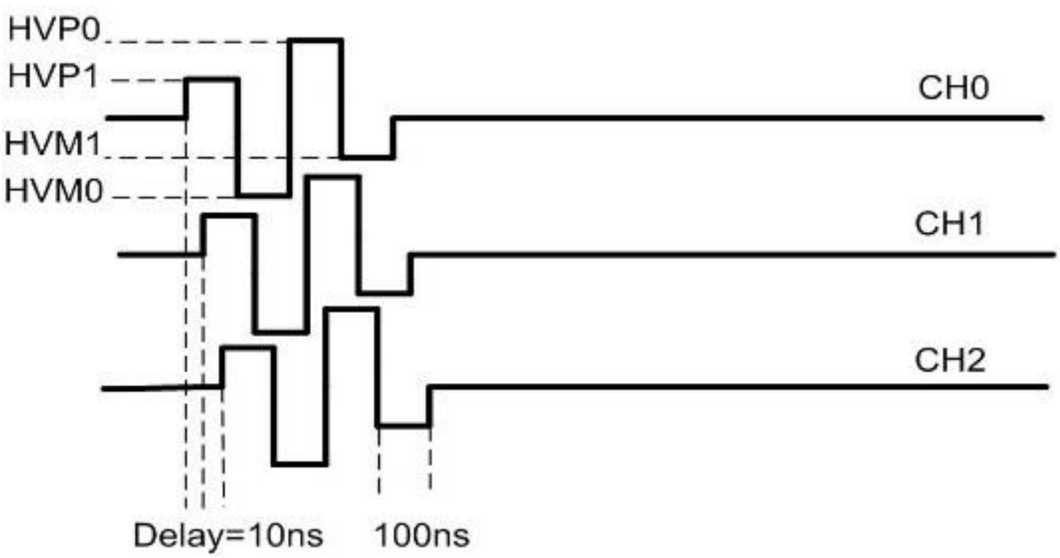


Figure 11: Waveforms out - Program 3

	Mode	Frequency [MHz]	Delay [ns]	Number of pulses	Initial Pulse	PRF [us]	H-Bridge
XDCR0	PW continuous	5	0	2	Positive	300	TX0 and TX1
XDCR1	PW continuous	5	10	2	Positive	300	TX0 and TX1
XDCR2	PW continuous	5	20	2	Positive	300	TX0 and TX1
XDCR3	PW continuous	5	30	2	Positive	300	TX0 and TX1
XDCR4	PW continuous	5	40	2	Positive	300	TX0 and TX1
XDCR5	PW continuous	5	50	2	Positive	300	TX0 and TX1
XDCR6	PW continuous	5	60	2	Positive	300	TX0 and TX1
XDCR7	PW continuous	5	70	2	Positive	300	TX0 and TX1
XDCR8	PW continuous	5	80	2	Positive	300	TX0 and TX1
XDCR9	PW continuous	5	90	2	Positive	300	TX0 and TX1
XDCR10	PW continuous	5	100	2	Positive	300	TX0 and TX1
XDCR11	PW continuous	5	110	2	Positive	300	TX0 and TX1
XDCR12	PW continuous	5	120	2	Positive	300	TX0 and TX1
XDCR13	PW continuous	5	130	2	Positive	300	TX0 and TX1
XDCR14	PW continuous	5	140	2	Positive	300	TX0 and TX1
XDCR15	PW continuous	5	150	2	Positive	300	TX0 and TX1

Table 10: Program 3

All XDCRs	
CLAMP	200 t_{CLKSYS}
HVP1	10 t_{CLKSYS}
HVM0	10 t_{CLKSYS}
HVP0	10 t_{CLKSYS}
HVM1	10 t_{CLKSYS}
CLAMP	200 t_{CLKSYS}
RX	295.5 µs

Table 11: Program 3 - States description

3.2.4 Program 4

The 4th Program is based on 100MHz SYSCLK and it is described in Table 7Table 12, odd outputs are in phase and they are 180° phase respect to the even outputs (waveforms in Figure 12). Its state sequence is indicated in Table 13. All channels are enabled in both TX and RX.

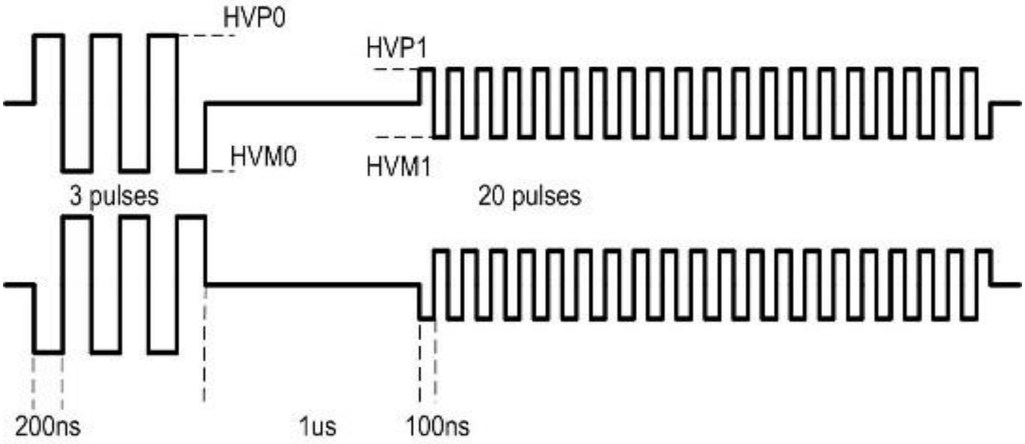


Figure 12: Waveforms out - Program 4

	Mode	Frequency [MHz]	Number of pulses	Initial Pulse	PRF [us]	H-Bridge
XDCR0	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR1	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR2	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR3	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR4	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR5	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR6	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR7	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR8	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR9	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR10	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR11	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR12	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR13	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1
XDCR14	PW continuous	2.5 - 5	3 – 20	Positive	300	TX0 – TX1
XDCR15	PW continuous	2.5 - 5	3 – 20	Negative	300	TX0 – TX1

Table 12: Program 4

XDCR0, XDCR2, XDCR4, XDCR6, XDCR8, XDCR10, XDCR12, XDCR14		**XDCR1, XDCR3, XDCR5, XDCR7, XDCR9, XDCR11, XDCR13, XDCR15**	
CLAMP	200 t_{CLKSYS}	CLAMP	200 t_{CLKSYS}
HVP0	20 t_{CLKSYS}	HVM0	20 t_{CLKSYS}
HVM0	20 t_{CLKSYS}	HVP0	20 t_{CLKSYS}
HVP0	20 t_{CLKSYS}	HVM0	20 t_{CLKSYS}
HVM0	20 t_{CLKSYS}	HVP0	20 t_{CLKSYS}
HVP0	20 t_{CLKSYS}	HVM0	20 t_{CLKSYS}

HVM0	20 t_{CLKSYS}	HVP0	20 t_{CLKSYS}
CLAMP	100 t_{CLKSYS}	CLAMP	100 t_{CLKSYS}
HVP1	10 t_{CLKSYS}	HVM1	10 t_{CLKSYS}
HVM1	10 t_{CLKSYS}	HVP1	10 t_{CLKSYS}
HVP1	10 t_{CLKSYS}	HVM1	10 t_{CLKSYS}
HVM1	10 t_{CLKSYS}	HVP1	10 t_{CLKSYS}
HVP1	10 t_{CLKSYS}	HVM1	10 t_{CLKSYS}
HVM1	10 t_{CLKSYS}	HVP1	10 t_{CLKSYS}
HVP1	10 t_{CLKSYS}	HVM1	10 t_{CLKSYS}
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HVM1	10 t_{CLKSYS}	HVP1	10 t_{CLKSYS}
HVP1	10 t_{CLKSYS}	HVM1	10 t_{CLKSYS}
HVM1	10 t_{CLKSYS}	HVP1	10 t_{CLKSYS}
CLAMP	200 t_{CLKSYS}	CLAMP	200 t_{CLKSYS}
RX	295 µs	RX	295 µs

Table 13: Program 4 - States description

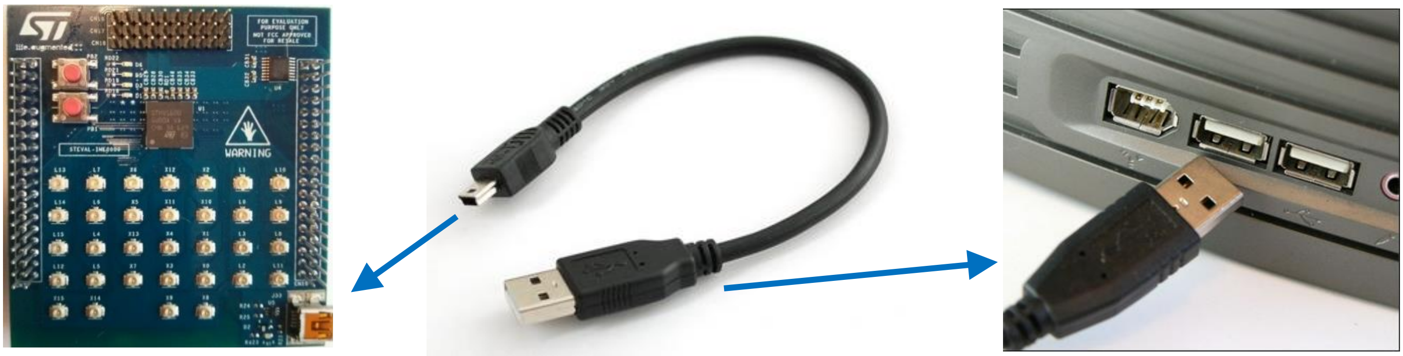
3.3 How to connect STEVAL-IME014 to the PC

STEVAL-IME014 can be connected through a USB cable (type A to mini B) to the PC.

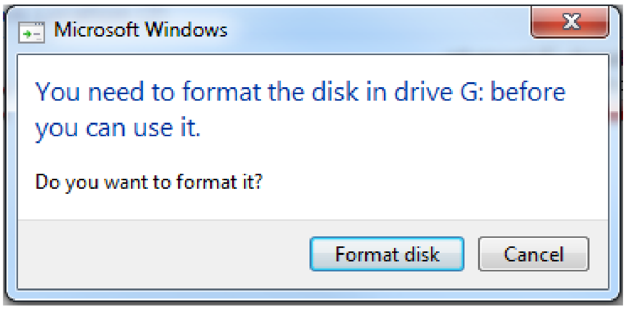
PC will install it like a Mass Storage Device.

To do it please follow next steps:

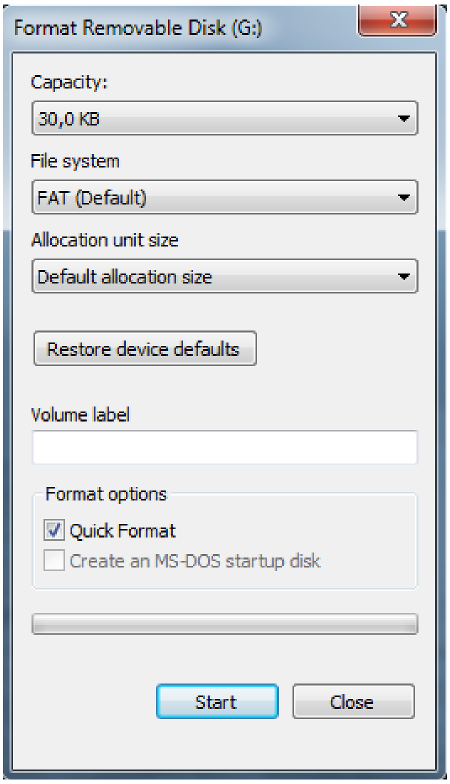
1) Connect the STHV1600 Module to the PC via a USB cable (don’t use the USB connector on Nucleo, use the connector on STHV1600 Module)



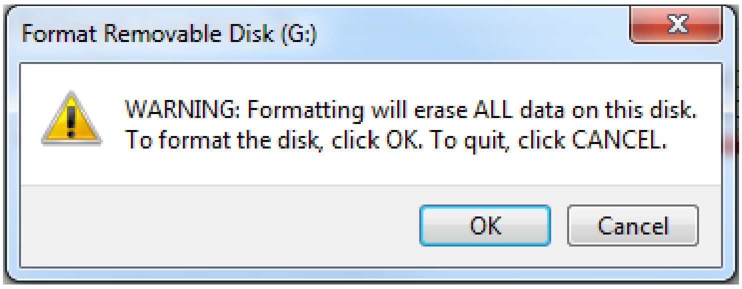
2) Only for first connection, a formatting request will be asked.



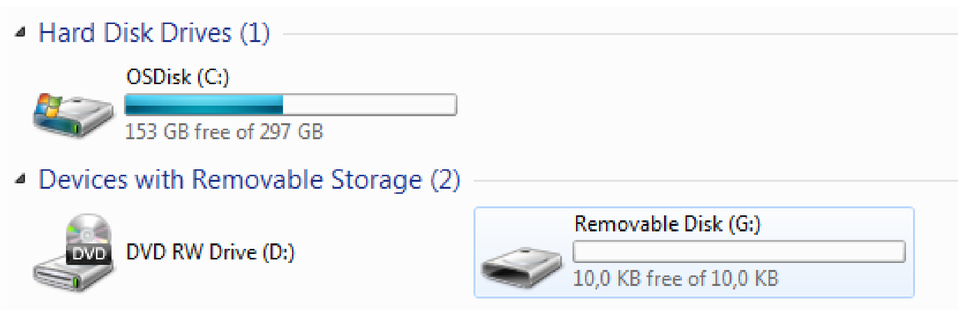
3) Say Format Disk



4) Click on Start

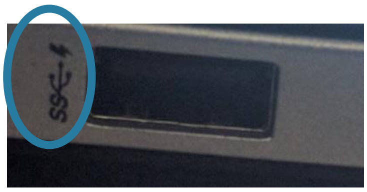


5) Then say OK
6) After the format procedure is end a new removable disk (10 KB capacity) is available in the Computer Resources (G: in my case)



   a. Sometime USB device is not recognized

b. In this case we suggest to try using a USB + charging port, with the following symbol



c. If this trial doesn't work, we suggest to provide the 5V power supply and GND on Power Supply Module before to connect the USB cable

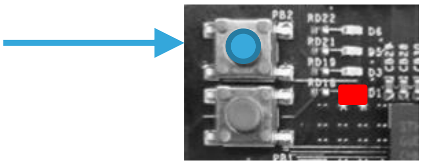
3.4 Store new waveforms

The default waveforms already stored on STEVAL-IME014 can be changed.

The waveforms/configuration setups are in a .bin file.

The changing procedure is listed below:

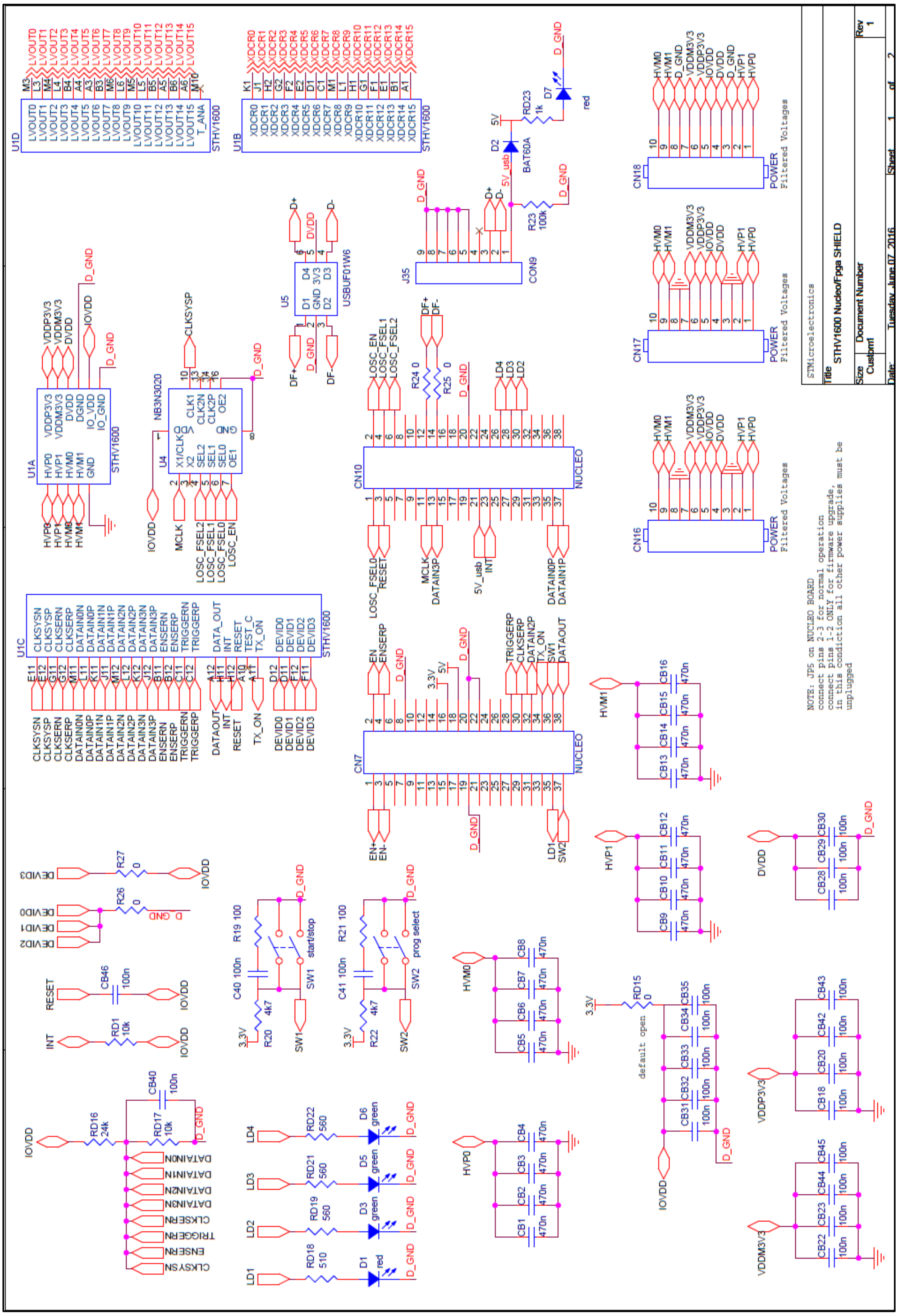
1. Connect the STHV1600 Module to the PC via a USB cable (see chapter 3.3)
2. Double click on Mass Storage drive and open it.
   If you have just now formatted the disk, it is empty, otherwise a file named *.bin will be present.
3. <u>If a file is present delete it</u>
4. Copy and paste the new **.bin* file. This file can be provided From ST Lab or can be generated by the user itself using Graphical Interface (see ‘STSW-IME014 - Application note’ document) or writing a txt register file and compiling it (see ‘Textual interface – Application note’ document)
5. The file is now in RAM. Switching off the supplies, it will be lost. If you want to store it, press PB2 for 3 seconds <u>with USB still connected</u>, the LD1 will light on (red light).



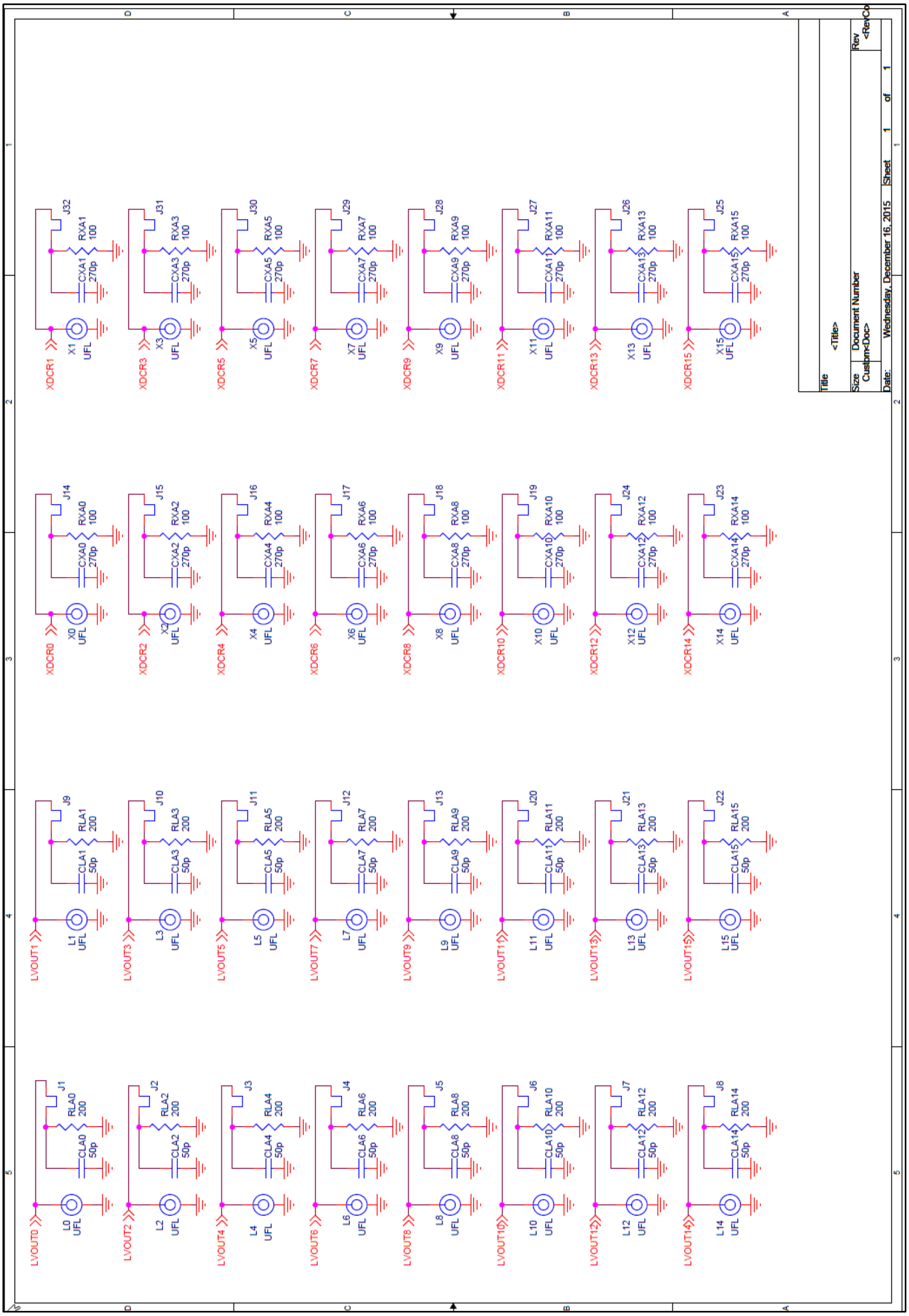
   The new file is now stored in the flash memory.
6. Next time you need to change the file, repeat from step 3

4 Schematic diagrams

4.1 STHV1600 module



life.augmented



4.2 Power supply module