UM1981
User manual

SMED configurator v2.0 for STLUX™ and STNRG digital controllers

Introduction

This user manual provides complete information for software developers about the complete STLUX and STNRG SMED configurator toolset.

The STLUX and STNRG SMED configurator is a powerful graphical interface that helps application developers reducing time and effort to efficiently exploiting the SMED technology, getting easily from an idea to proof of the concept and final product over STLUX and STNRG devices.

The STLUX family of controllers is a part of the STMicroelectronics® digital devices tailored for lighting applications. The STLUX controllers have been successfully integrated in a wide range of architectures and applications, starting from simple buck converters for driving multiple LED strings, boost for power factor corrections, half-bridge resonant converters for high power dimmable LED strings and up to full-bridge controllers for HID lamp ballasts. The STLUX natively supports the DALI via the internal DALI communication module (DCM). The DALI is a serial communication standard used in the lighting industry.

STNRG devices are a part of the STNRG family of STMicroelectronics digital devices designed for advanced power conversion applications. The STNRG improves the design of the STLUX family to support industrial power conversion applications such as the PFC + LLC, interleaved LC DC-DC, interleaved PFC for Smart power supplies as well as the full-bridge for pilot line drivers for electric vehicles.

The heart of the STLUX (and consequently STNRG where not differently specified) is the SMED (“State Machine, Event Driven”) technology which allows the device to operate several independently configurable PWM clocks with an up to 1.3 ns resolution. An SMED is a powerful autonomous state machine which is programmed to react to both external and internal events and may evolve without any software intervention. The SMED even reaction time can be as low as 10 ns, giving the STLUX the ability of operating in time critical applications.

The SMEDs are configured and programmed via the STLUX internal low power microcontroller (STM8).

Contents

List of figures

1 Reference documents

- For hardware information on the STLUX controller and product specific SMED configuration, please refer to the STLUX product datasheet and reference manual (RM0380).
- For hardware information on the STNRG controller and product specific SMED configuration, please refer to the STNRG product datasheet and reference manual (RM0380).
- For information about the debug and SWIM (single wire interface module) refer to the “STM8 SWIM communication protocol and debug module” user manual (UM0470).
- For information on the STM8 core and assembler instruction please refer to the “STM8 CPU programming manual” (PM0044).
- For information on the STEVAL-ILL068V1 evaluation board please refer to the databrief.
- For information on the STEVAL-ILL075V1 evaluation board please refer to the to the databrief.
- For information on the STEVAL-ISA164V1 evaluation board, please refer to to the databrief.
- For more information on the “STLUX™ digital controller bootloading procedure”, please refer to the application note AN4656.

2 Acronyms

A list of acronyms used in this document:

Table 1. List of acronyms

Acronym	Description
ACU	Analog comparator unit
ADC	Analog-to-digital converter
AWU	Auto-wakeup unit
CKC	Clock control unit
CPU	Central processing unit
CSS	Clock security system
DAC	Digital-to-analog converter
DALI	Digital addressable lighting interface
ECC	Error Correction Code
FSM	Finite state machine
FW	Firmware loaded and running on the CPU
GPIO	General purpose input/output
HSE	High Speed External crystal - ceramic resonator
HSI	High-speed external crystal - ceramic resonator
I2C	Inter-integrated circuit interface
IAP	In-application programming
ICP	In-circuit programming
ITC	Interrupt controller
IWDG	Independent watchdog
LSI	Low-speed internal RC oscillator
MCU	Microprocessor central unit
MSC	Miscellaneous
PM	Power management
PWM	Pulse width modulation
RFU	Reserved for future use
ROP	Read-out protection
RST	Reset control unit
RTC	Real-time clock|
SMED	State machine event driven
STMR	System timer
SWIM	Single wire interface module

Table 1. List of acronyms (continued)

Acronym	Description
UART	Universal asynchronous receiver transmitter
WWDG	Window watchdog

3 STLUX SMED configurator features

The following features are available in this tool:

- Device selection
- SMED configurations scheme
- Input configuration
- Clock settings
- FSM (finite state machine) configuration
- Register view
- C code generation
- Board connection and setting

4 Home view

Figure 1. STLUX SMED configurator home

The home view gives you following possibility:

1. To open a project by choosing from a list of the last saved project.
2. To choose an action from the menu bar.

Menu bar

The menu bar contains the commands that can be used to manage the application.

The available menus are:

- **New**
  To select a device for a new project
- **Open**
  To open a project from a folder
- **Save**
  To select a save option
- **Option**
  Opens the option window
- **Full screen**
  To run the application in the full screen mode
- **Help**
  Provides information about the desktop application.

New button

Figure 2. Smart device family selection

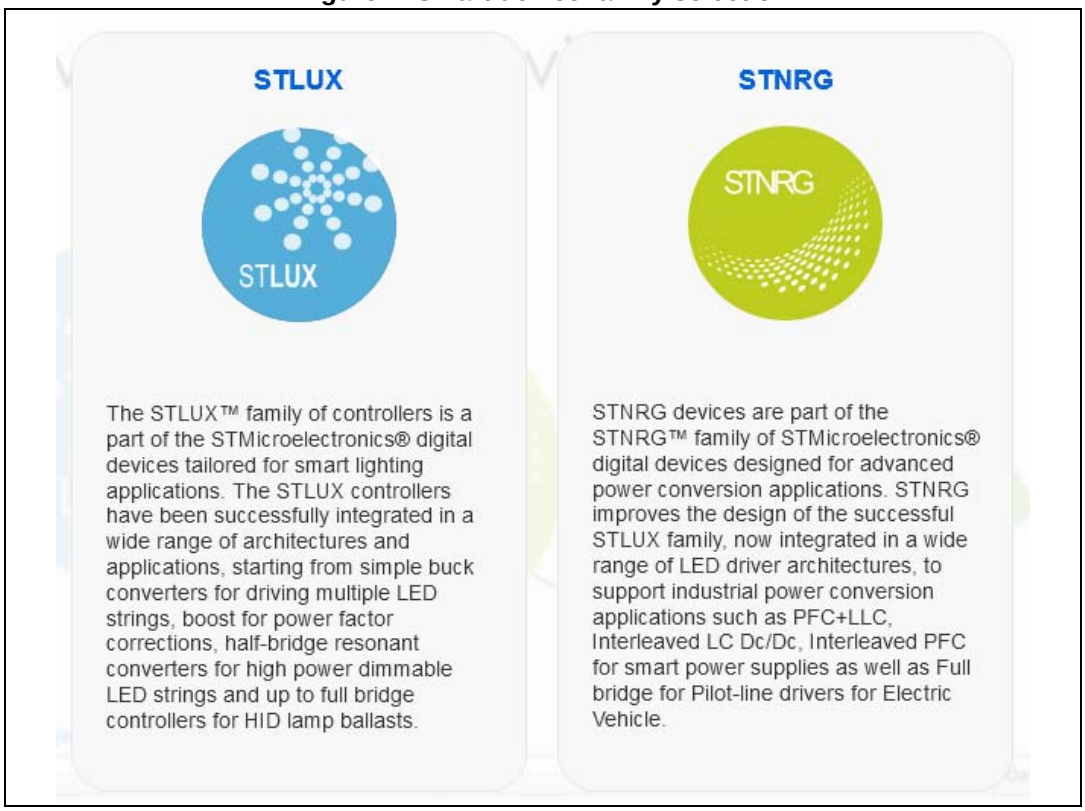


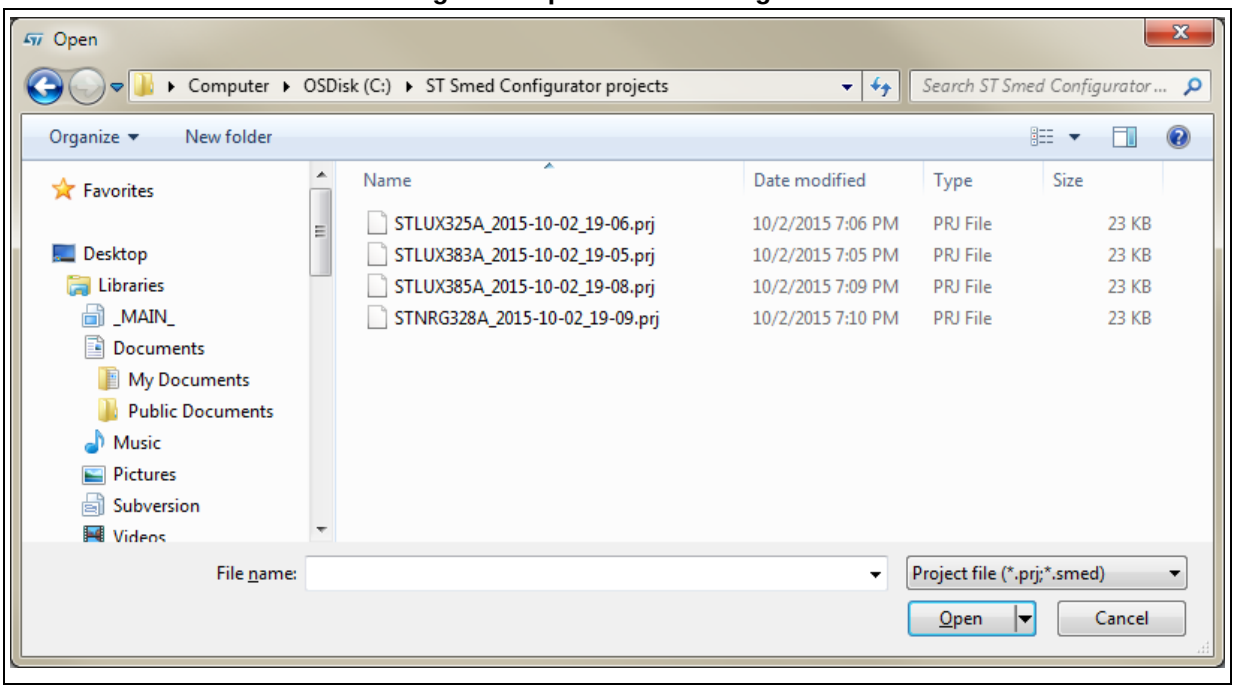
Figure 3. Smart STLUX device family selection

The “**New**” button runs a devices selector that indicates a different field application for a family product and different features among devices of the same family.

Open button

The “**Open**” button opens a browsing windows to select a ***.prj*** or a ***.smed*** project.

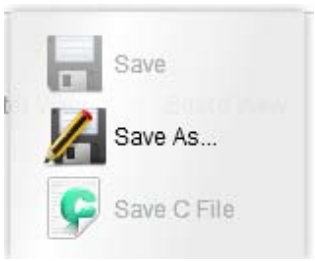
Figure 4. Open button dialog box



Save button

The “**Save**” button opens a drop-down list to select a different option.

Figure 5. Save button menu options



- **Save**

  Saves the active project (if change is detected)
- **Save As…**

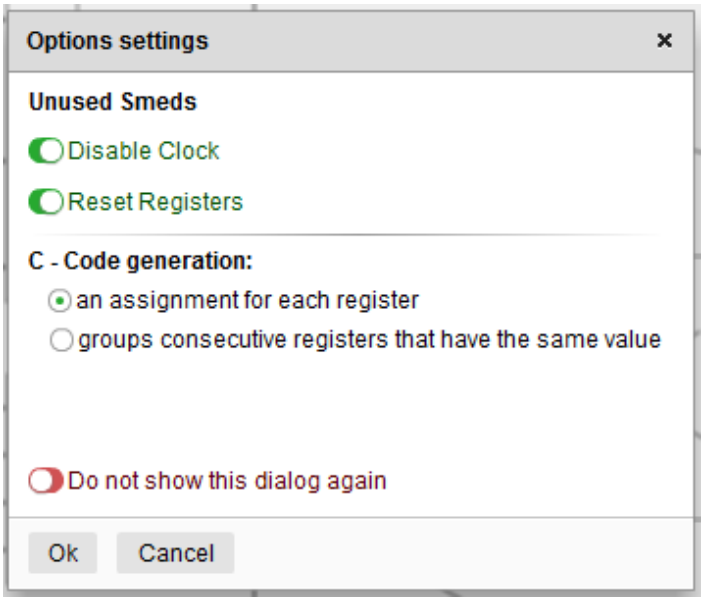
  Saves the active project with a new name
- **Save C File**

  Saves the text file, that contains the “C” source code of a simple function that initializes all the registers conforming to the current configuration.

Option button

The “**Option**” button opens a dialog box for choosing the same option used during the C code generation.

Figure 6. Option button dialog box

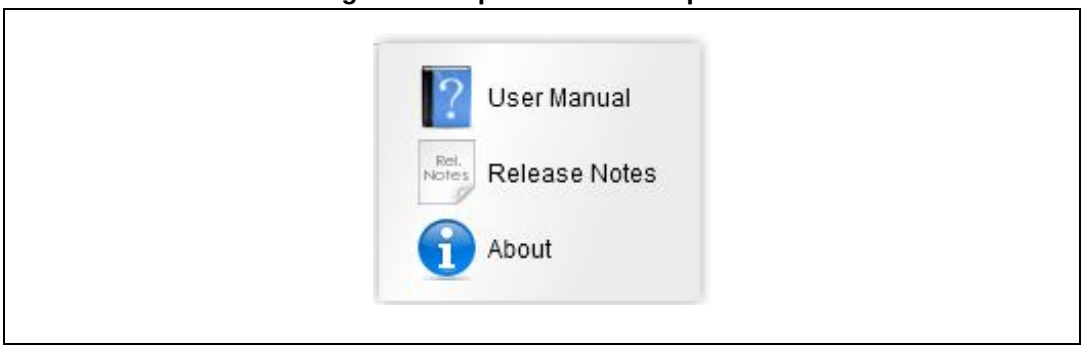


Full screen button

The “**Full screen**” gives possibility to use the entire screen for the application. The feature is useful for a monitor or a projector with a very low resolution.

Help button

Figure 7. Help button menu options



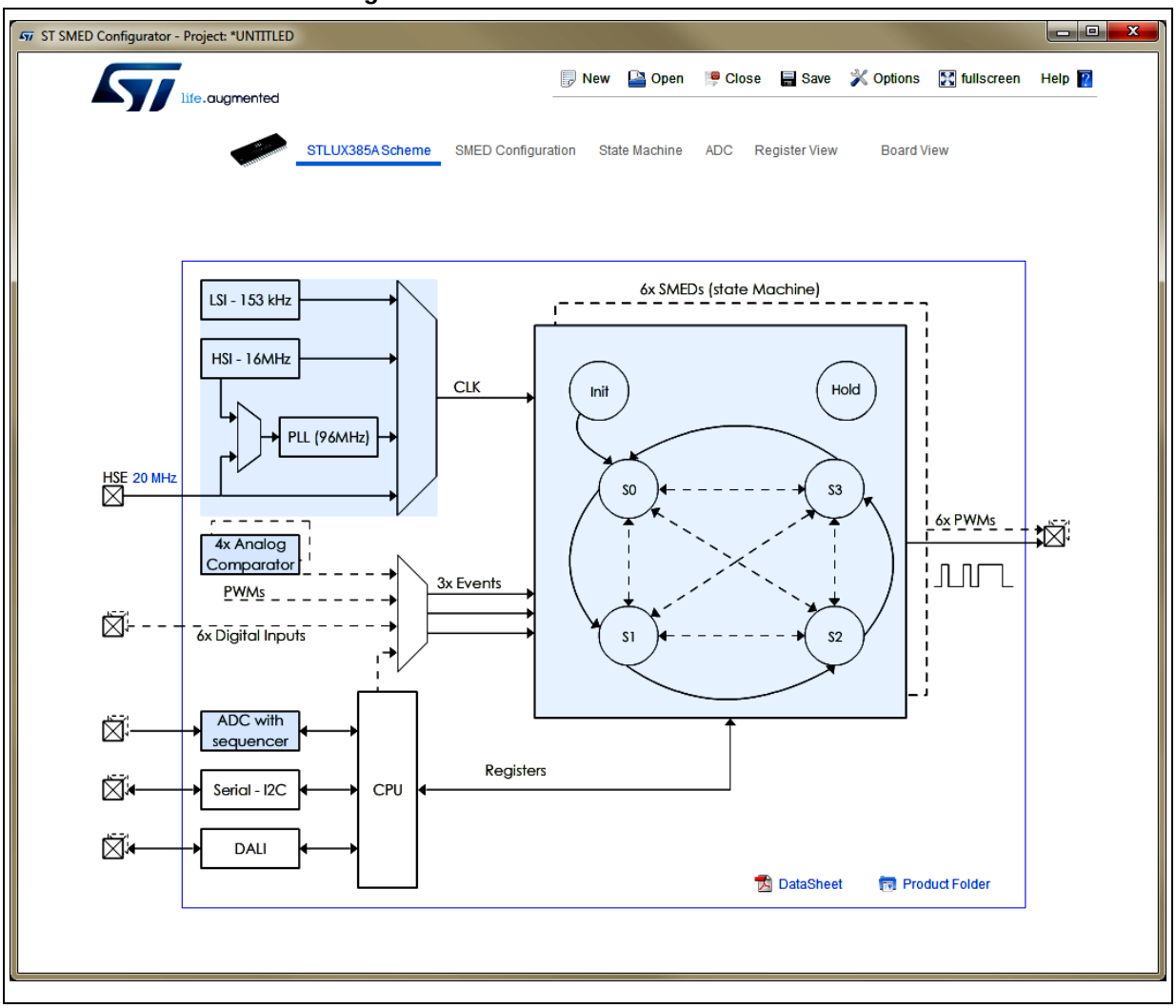
- **Help**
  Opens this file
- **Release Notes**
  Opens the Release Notes document
- **About**
  Opens the About window.

5 Device view

The device view contains a navigation bar and an interactive image in order to:

1. Configure the internal clock (item “3” in “device view picture”)
2. Configure the external clock (item “4” in “device view picture”)
3. Configure the comparator block and SMEDs (item “5” in “device view picture”)
4. Configure the finite state machine (FSM) (item “6” in “device view picture”)
5. Configure the analog-to-digital converter block (item “7” in “device view picture”).

Figure 8. STLUX / STNRG device scheme

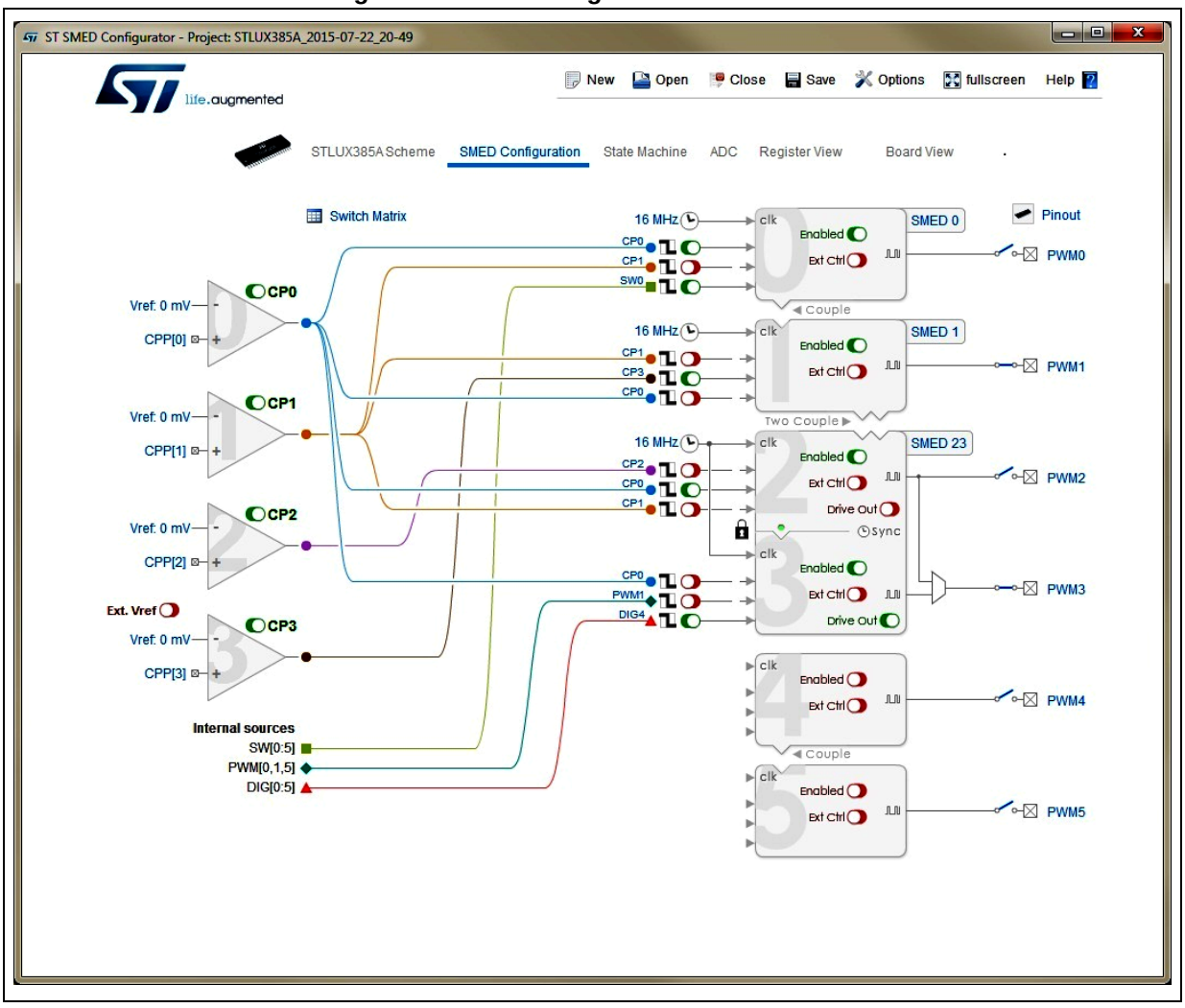


6 SMED configurations scheme

This page allows the user to establish:

- Enabling and setting comparators
- Inputs selection for each SMED
- Working mode for each SMED
- Which PWM is connected to the extern
- Control the switch matrix both in the graphic and in tabular way
- Show up the pinout of the device, highlighting the binding pins.

Figure 9. SMED configuration scheme view



6.1 Comparators configurations option

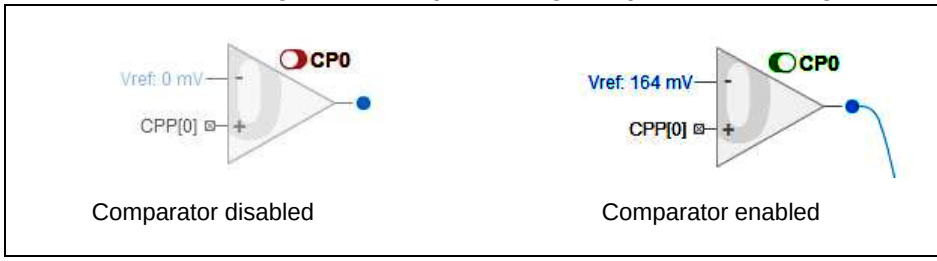
STLUX and STRNG devices show different comparators type:

1. Simple comparator
2. Comparator with external Vref
3. Comparator with hysteresis.

6.1.1 Simple comparators configurations option

The basic configurator allows us to enable the comparator unit and choice voltage reference level.

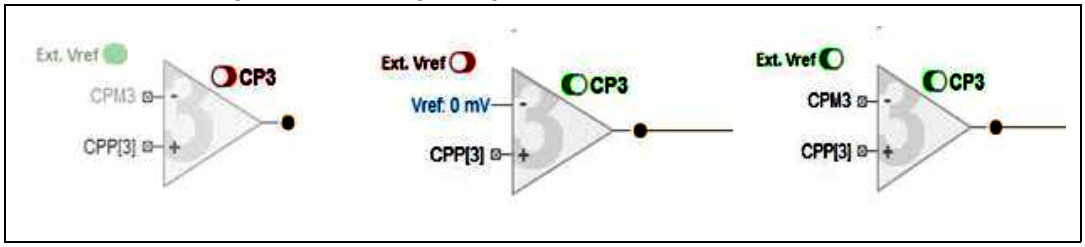
Figure 10. Simple analog comparator enabling



6.1.2 Comparators with external Vref configurations option

Comparators with external reference show an additional control to select if use internal DAC or external reference voltage.

Figure 11. Analog comparator with external reference



6.1.3 Comparators with hysteresis configurations option

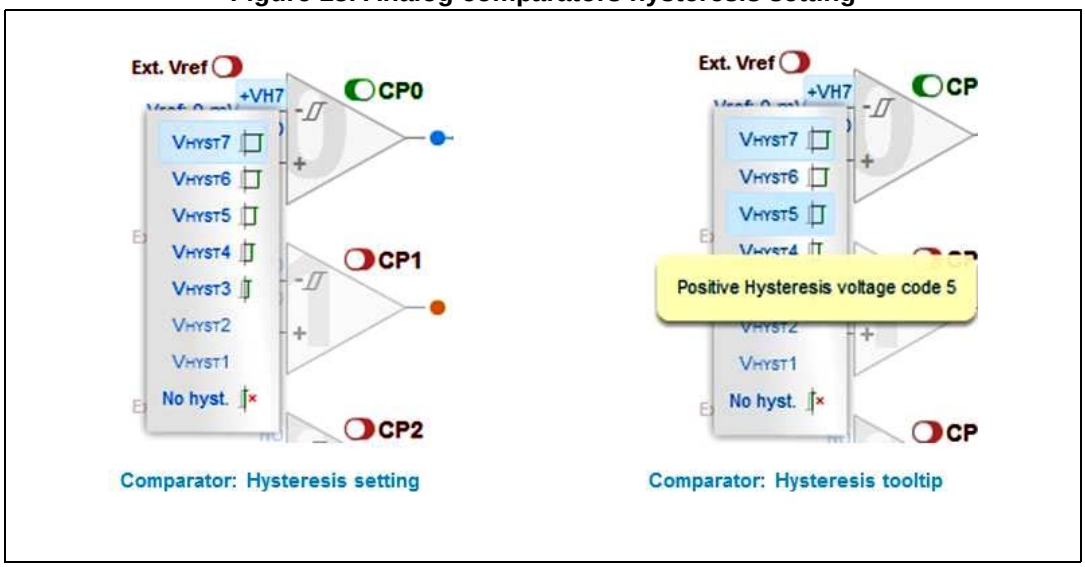
Comparators with hysteresis show additional control to select

- If add or subtract an offset to voltage reference
- Choice the hysteresis level to use (as a percentage of an infernal Vref).

Figure 12. Analog comparators with hysteresis

The graphical user interface helps user to set comparators in a very easy way.

Figure 13. Analog comparators hysteresis setting



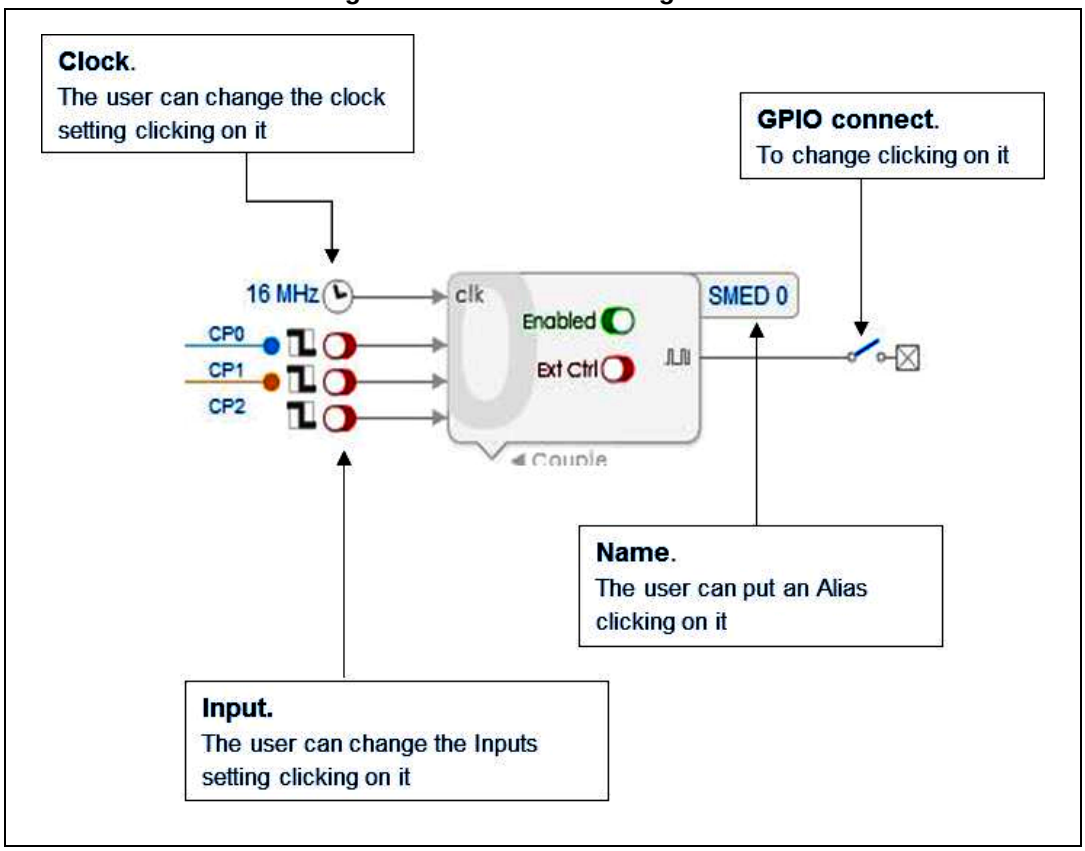
6.2 SMED configurations option

All the possible SMEDs configuration schemes are:

- Single SMED
- Synchronous coupled SMEDs
- Two synchronous coupled SMEDs
- Two asynchronous coupled SMEDs
- Asynchronous coupled SMEDs
- Externally controlled SMED

The page shows the six SMEDs and for each of them there is a button to enable it and a button to choose the control mode (internally/externally). Each SMED, if not coupled to another, will be configured respectively in the SINGLE mode or EXTERNAL depending on whether the control button in either “Int” (internal) or “Ext” (external).

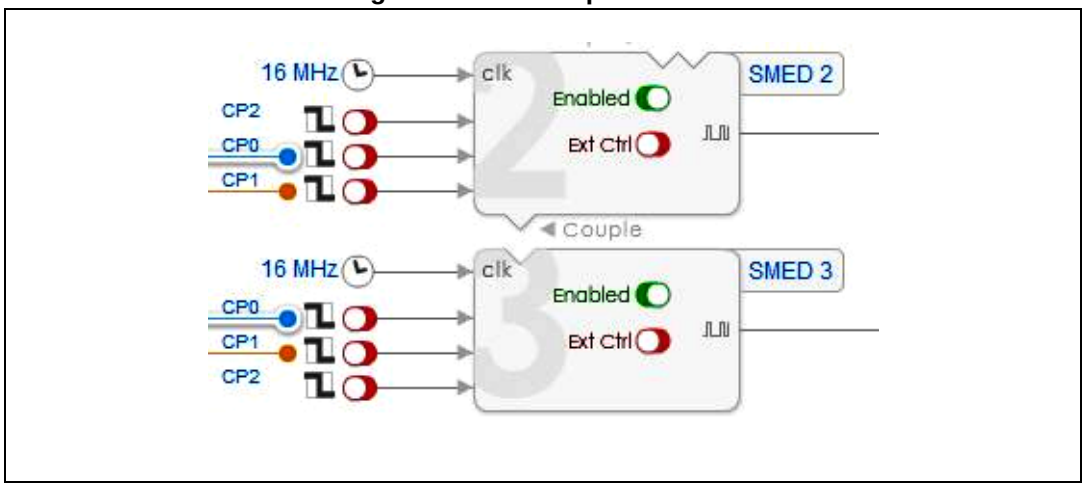
Figure 14. SMED unit configuration



6.2.1 Synchronous/asynchronous coupled SMEDs

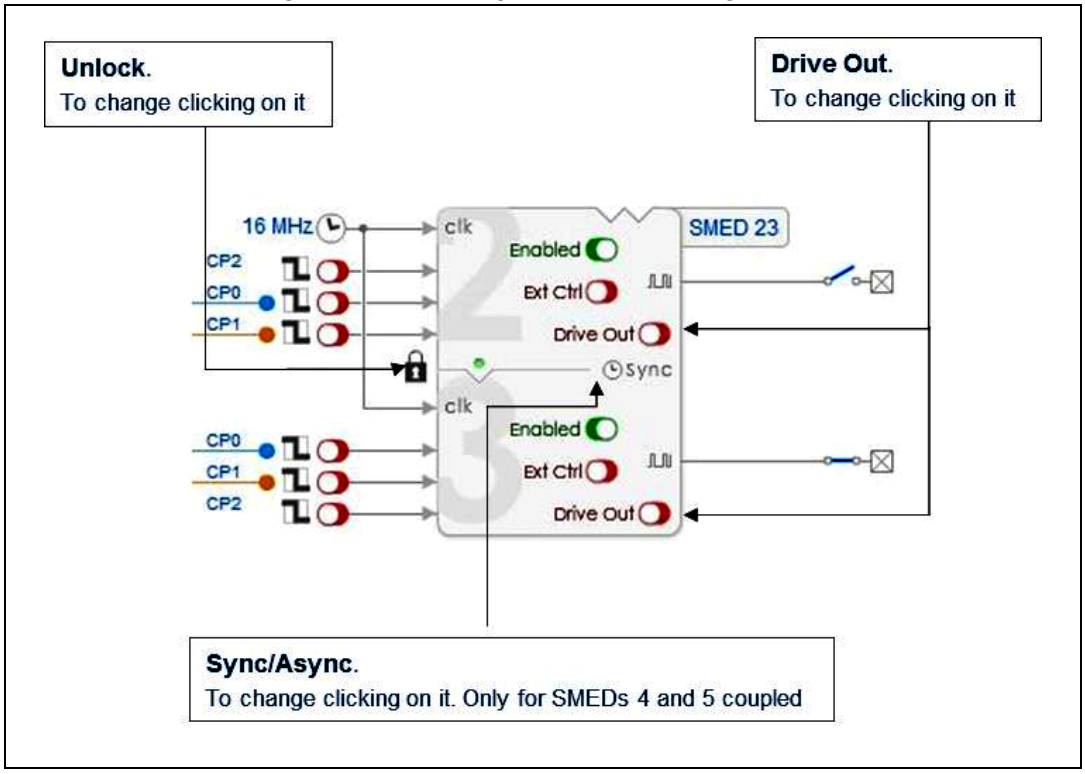
To configure 2 SMEDs in the coupled mode it's needed to click on the figure of the part showing the possibility of coupling the SMED.

Figure 15. Two coupled SMEDs



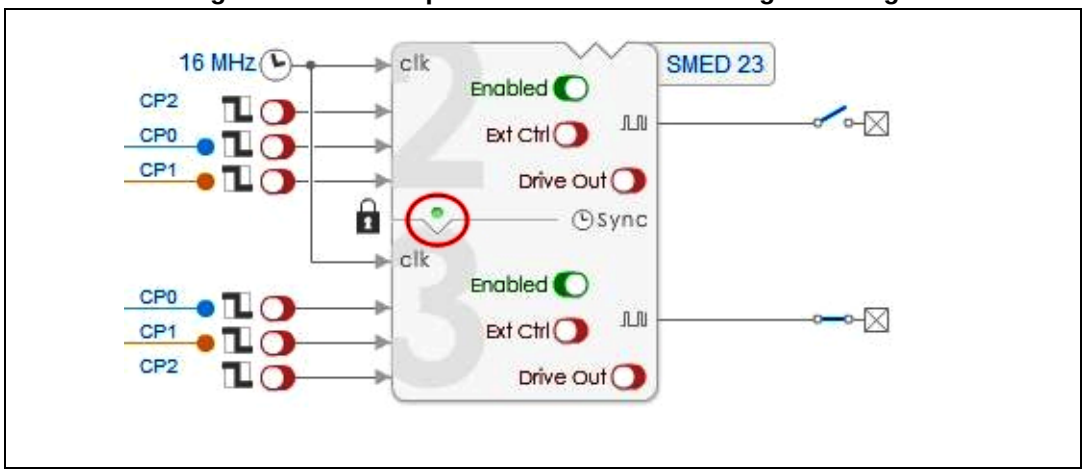
The result is that the tool shows graphically the 2 SMEDs coupled and allows the user to configure their features.

Figure 16. Two coupled SMEDs configuration



To remove the coupled mode click on the part that highlights the coupling of SMEDs.

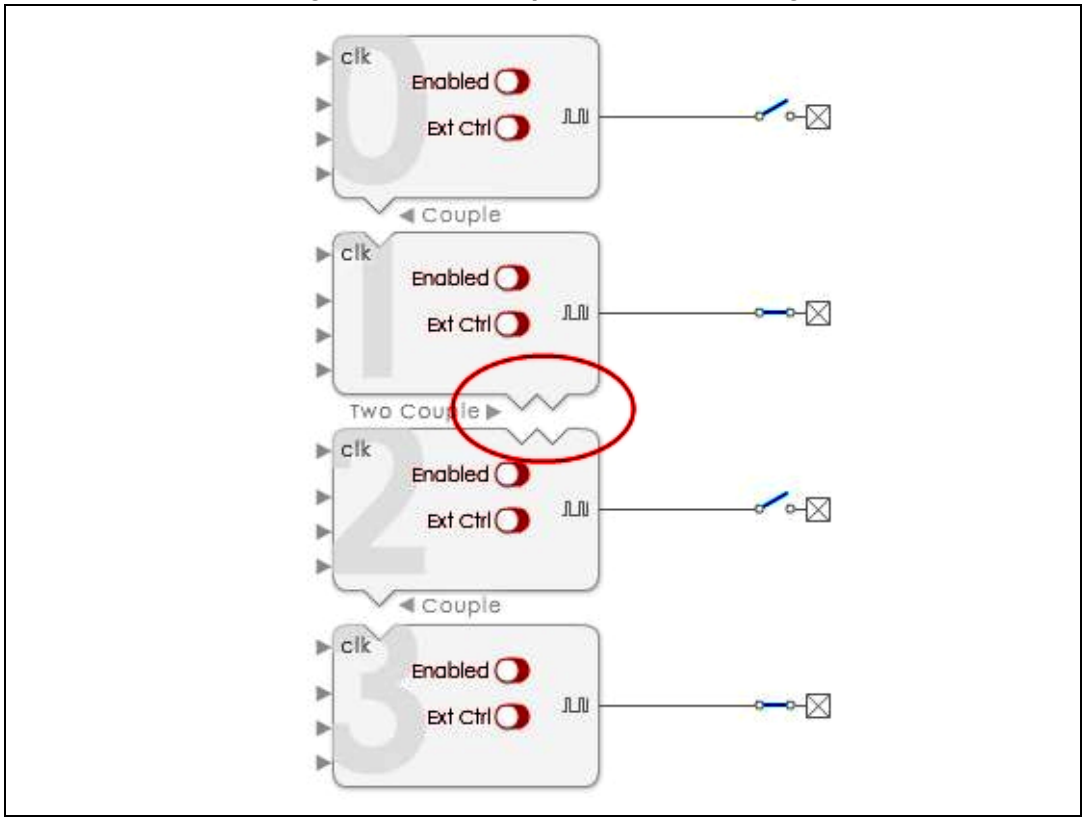
Figure 17. Two coupled SMEDs mode enabling/disabling



6.2.2 Two synchronous/asynchronous coupled SMEDs

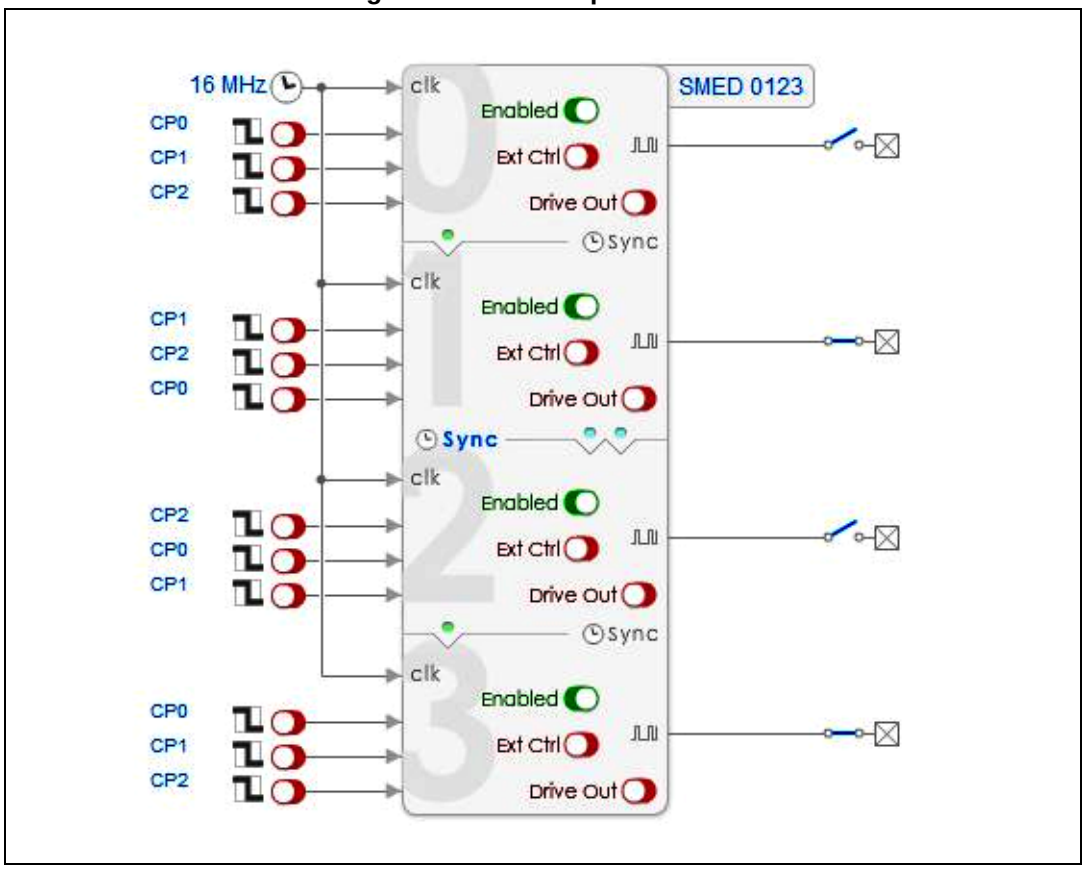
To configure 4 SMEDs (SMED0 - SMED 1 - SMED 2 - SMED 3) in the “two coupled” mode it's needed to click on the area representing this mode:

Figure 18. Four coupled SMEDs enabling



The result is that the tool shows graphically the 2 SMEDs coupled and allows the user to configure their features.

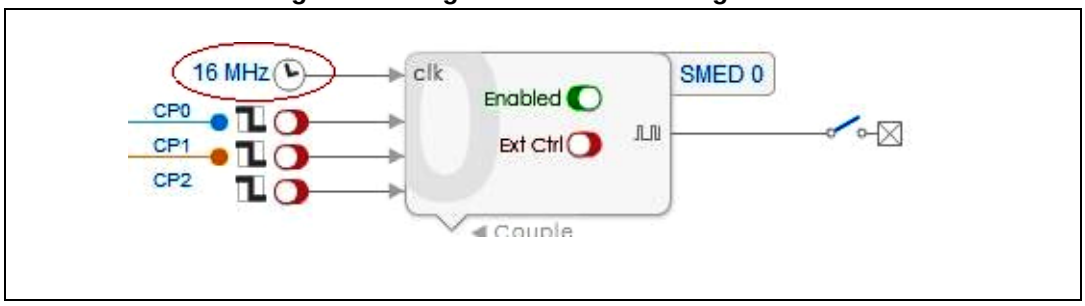
Figure 19. Four coupled SMEDs



6.2.3 Clock setting

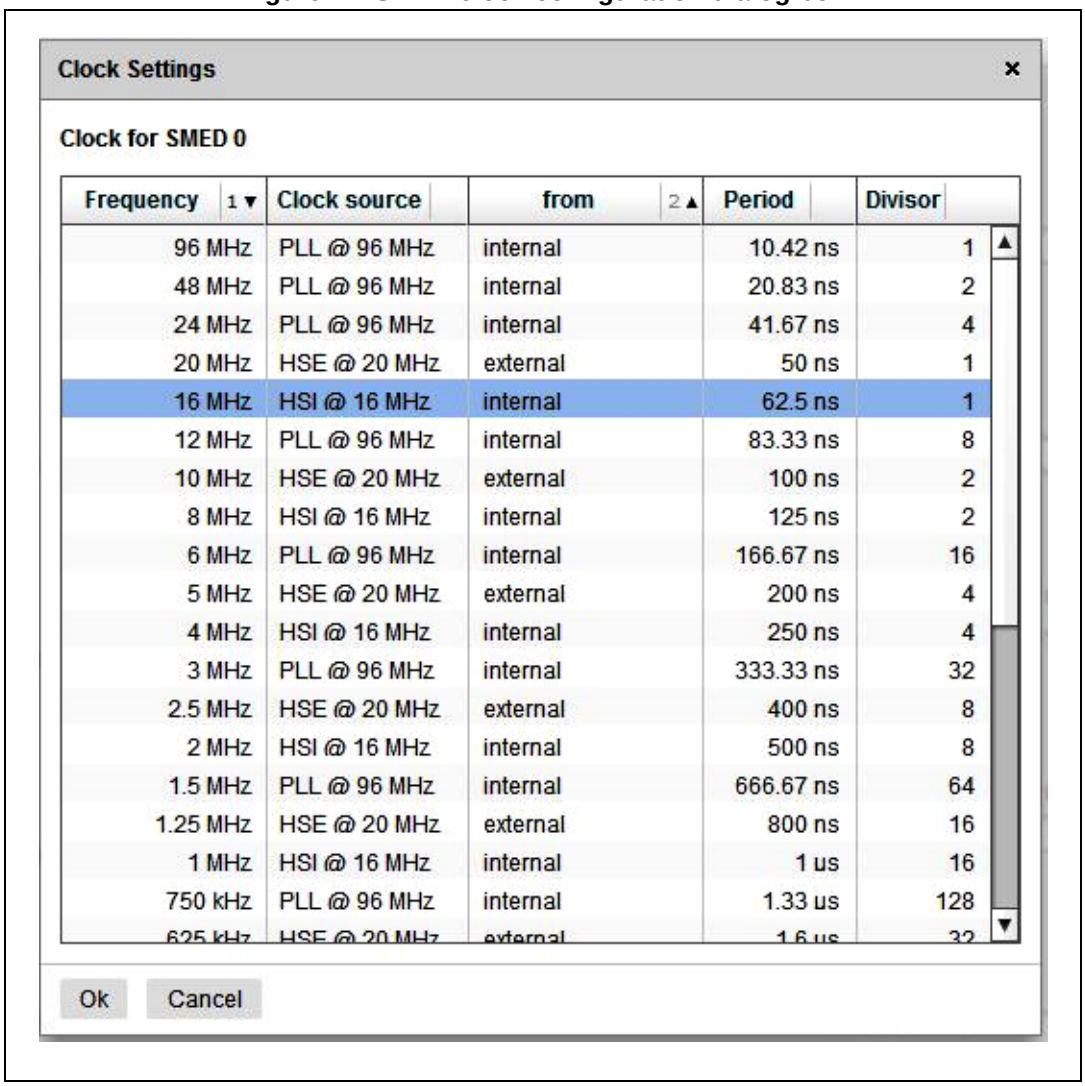
Once a SMED configuration scheme has been selected, it is possible to configure the clock of the used SMEDs clicking on the clock label.

Figure 20. Single SMED clock configuration



A dialog will open in order to select one of the all possible values for the clock.

Figure 21. SMED clock configuration dialog box



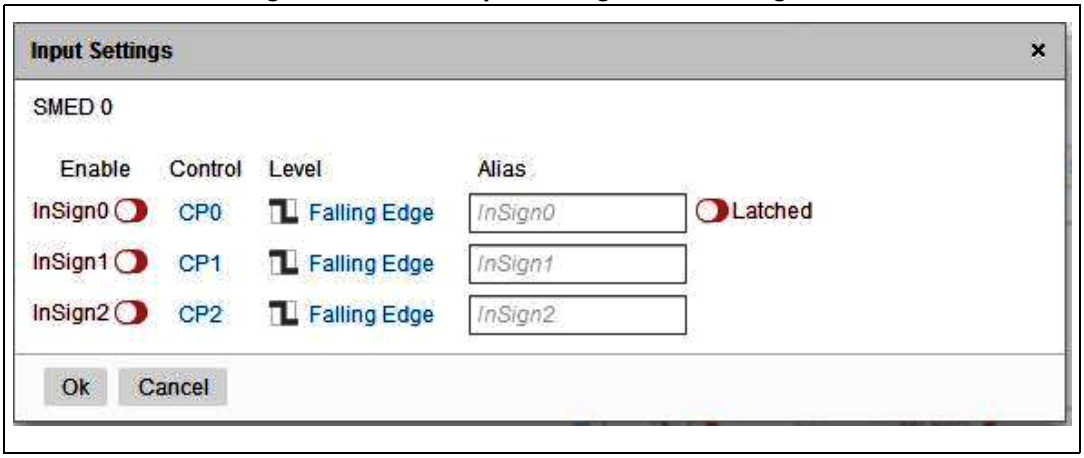
6.2.4 Input setting

Once a SMED configuration scheme has been select, it is possible to configure the inputs of the used SMEDs clicking on the input label.

Figure 22. SMED input configuration

A dialog will be open in order to configure the three inputs of the selected SMED.

Figure 23. SMED input configuration dialog box



It is possible to enable an input directly clicking on the “Enable” button:

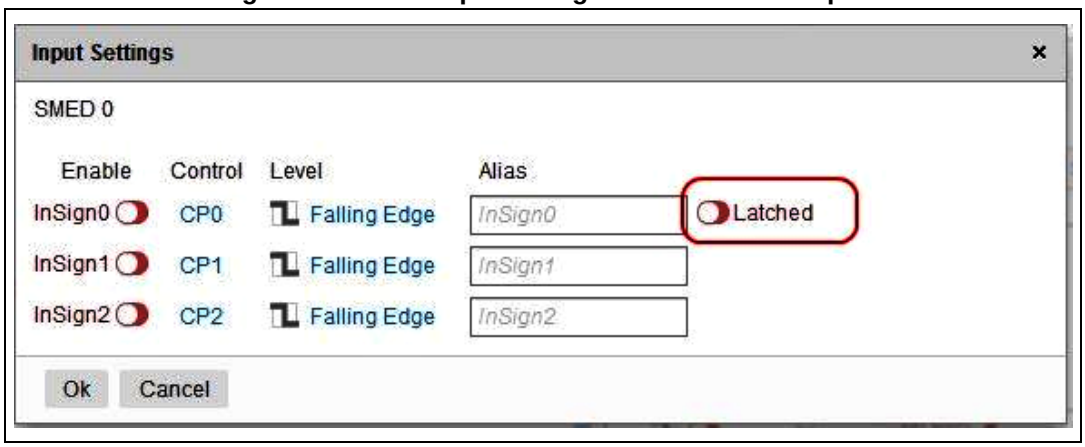
It is also possible to change the input trigger level directly clicking on the trigger icon:

A menu with the 4 possible values will be opened:

Figure 24. Menu with the 4 possible trigger values

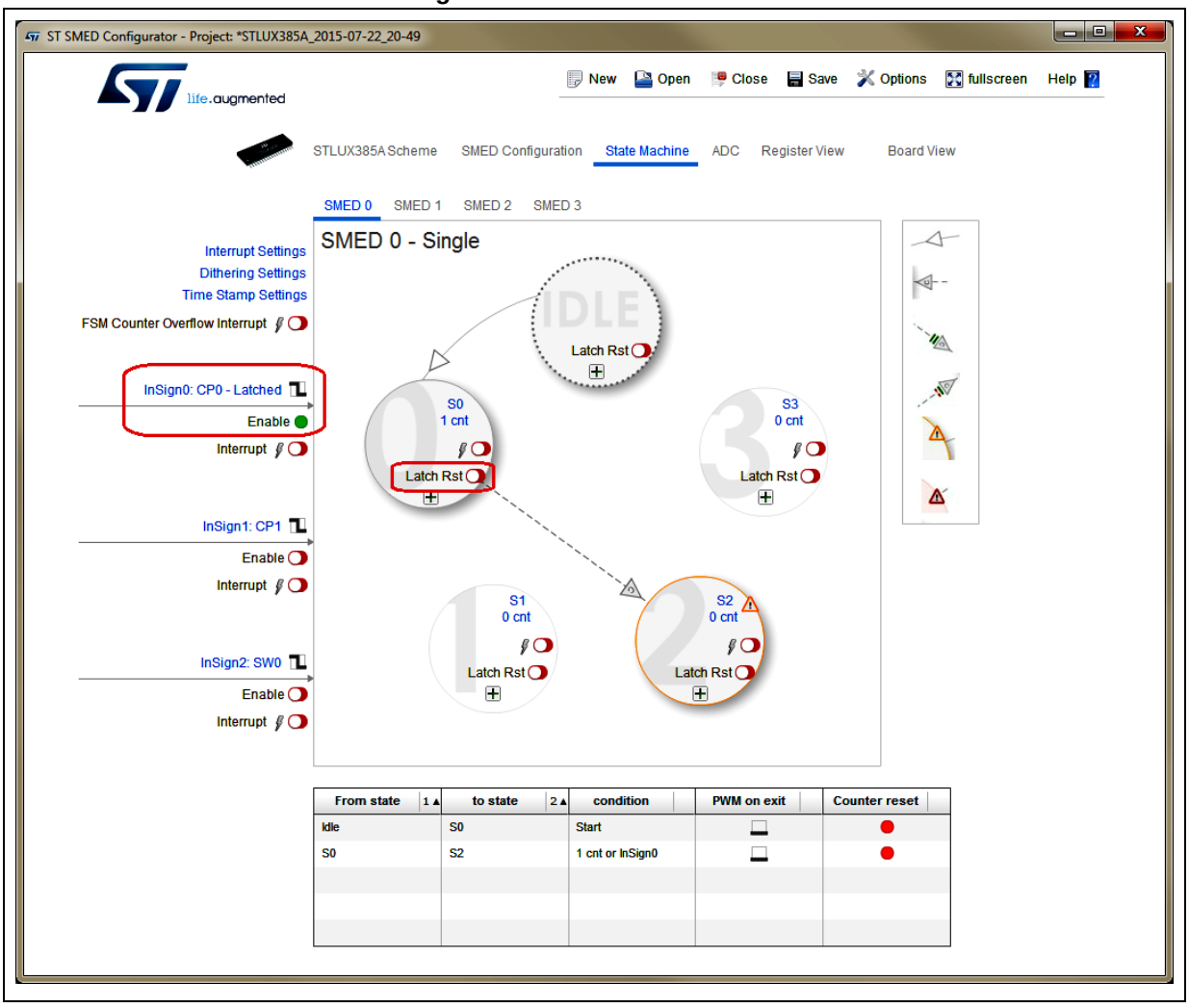
It is also possible to enable on the **InSign0** input line a supplementary latch functionality used to memorize an occurrence of an **InSign0** capture condition.

Figure 25. SMED input configuration - latched input



This allows a deferred event transition occurrence from any of the configured states to react to **InSign0** input capture. The latched information is selectively cleared by entering any of the S0-S3 states if the latch reset for the state is set in the correspondent SMED state machine page.

Figure 26. State machine view



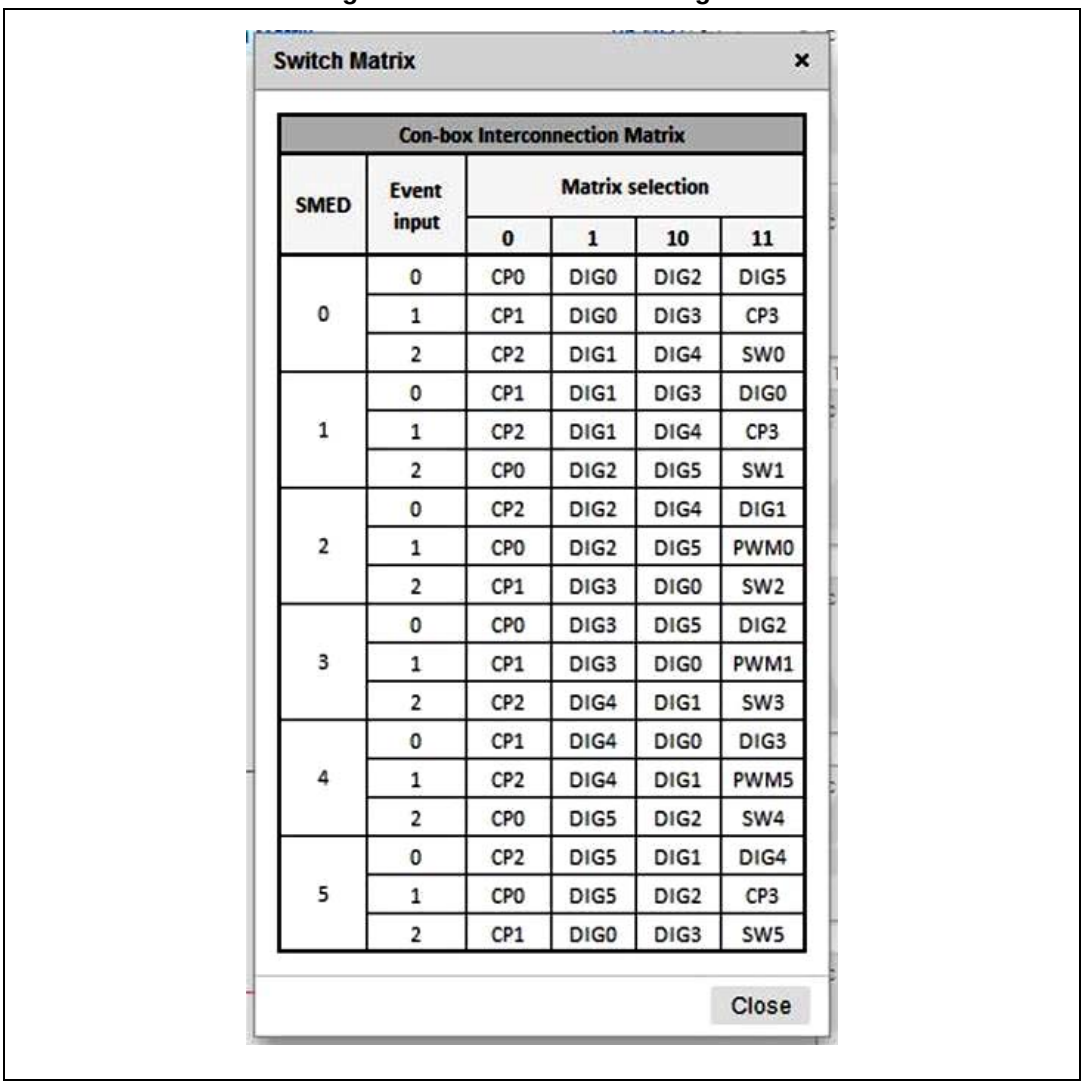
6.2.5 Switch matrix

The “Switch Matrix” button allows to show internal multiplexing.

The signal families multiplexed are the following:

- DIGINs (primary input signals)
- CMPs (output of the internal comparator units)
- SW (internal register signal driven by SW)
- PWMs (available only for some SMED units).

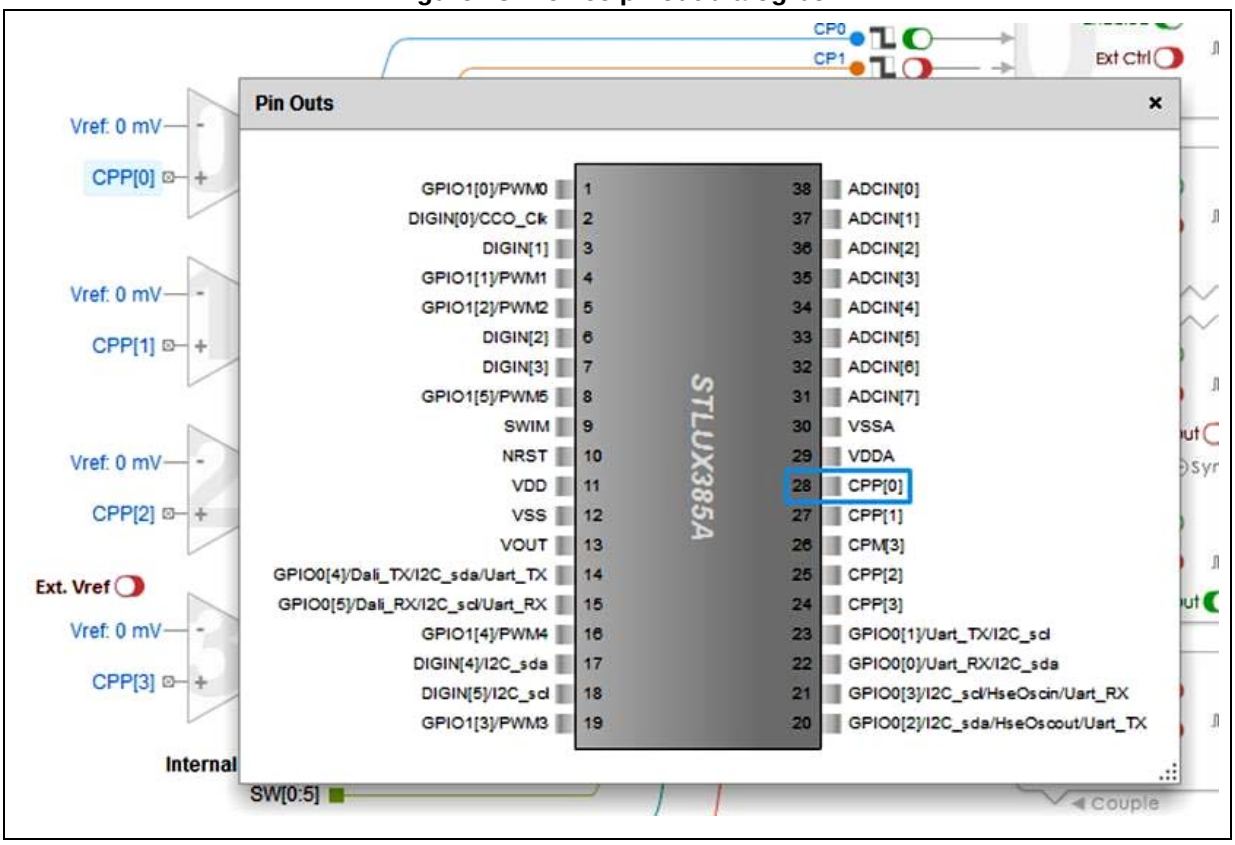
Figure 27. Switch matrix dialog box



6.2.6 Pinout

The pinout button shows the package and pinout.

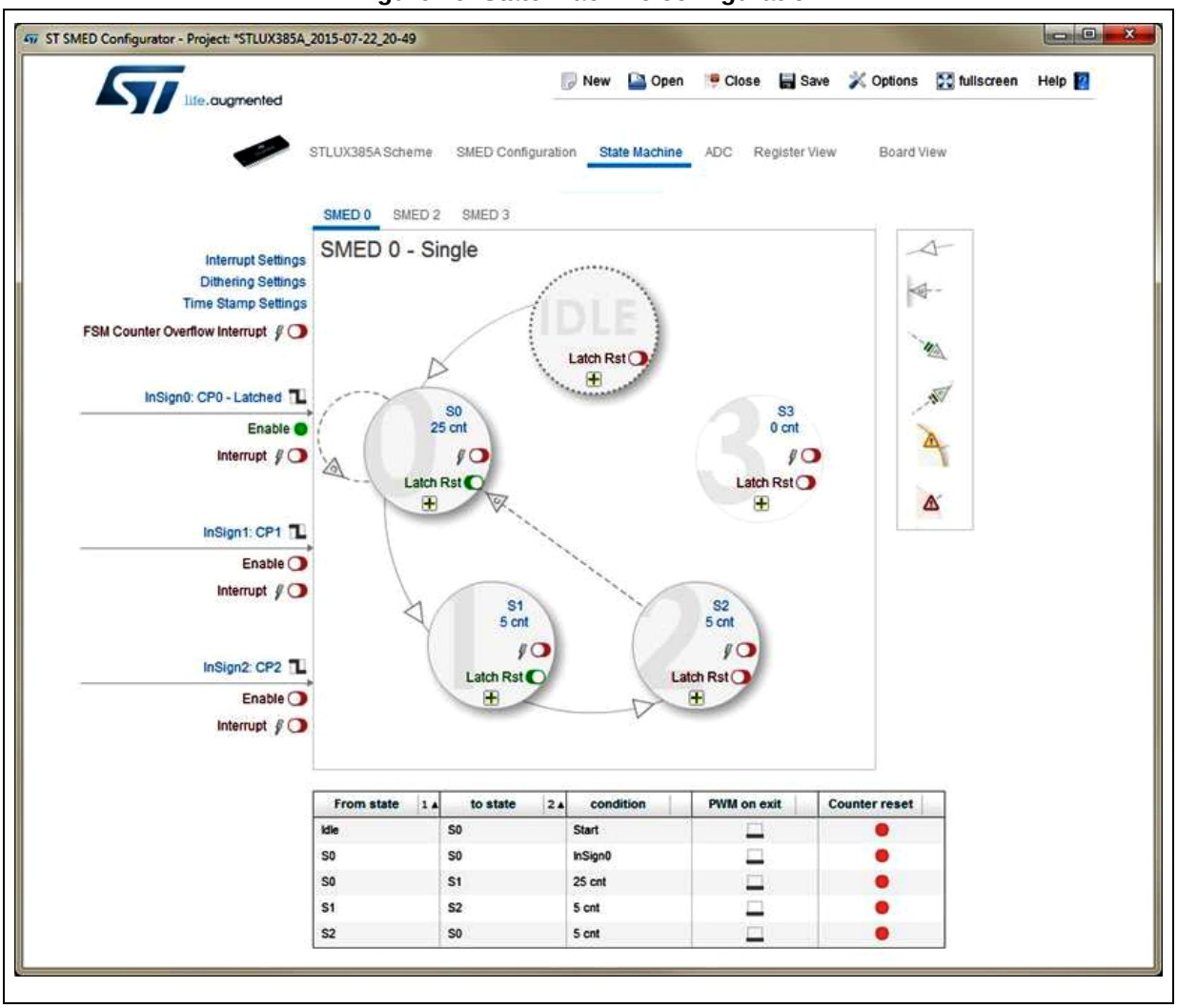
Figure 28. Device pinout dialog box



7 State machine view

The state machine view allows to design the finite state machine configuration and thus set the SMED registers implementing it.

Figure 29. State machine configuration



This page is divided into 2 parts:

1. General settings
   a) Interrupt
   b) Dithering
   c) Time stamp
2. Transitions.

7.1 General settings

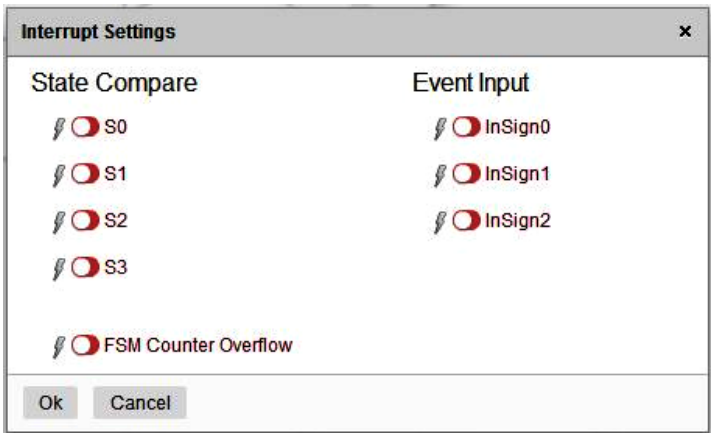
7.1.1 Interrupt settings

The “Interrupt Settings” is used to configure the interrupt handling.

Clicking on the label “Interrupt Settings” a dedicated window will be opened.

The interrupts are grouped in three blocks for the state timers compare events, external input events and counter overflow event.

Figure 30. Interrupt settings dialog box

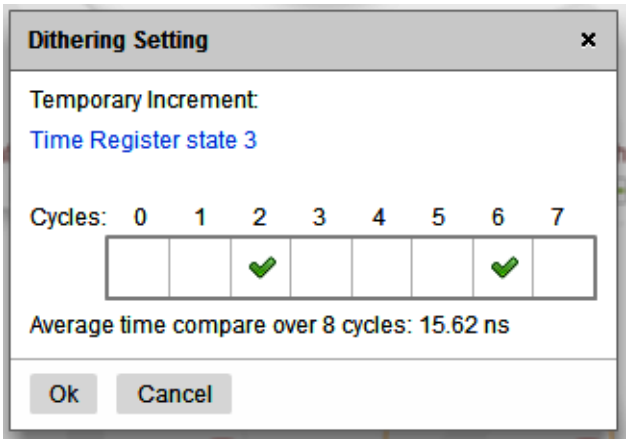


7.1.2 Dithering settings

The “Dithering Settings” is used to determine in which PWM cycle(s) to apply the temporary increment of the selected timer. Any number of cycles may be enabled/disabled.

Clicking on the label “Dithering Settings” a dedicated window will be opened.

Figure 31. Dithering setting dialog box

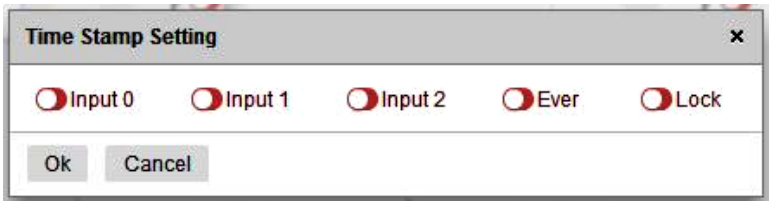


7.1.3 Time stamp setting

The “Time Stamp Setting” is used to control the dumping feature of the SMEDs.

Clicking on the label “Time Stamp Setting” a dedicated window will be opened.

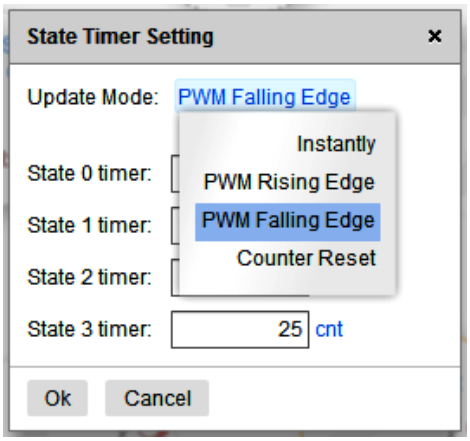
Figure 32. SMEDs time stamp dialog box



7.1.4 State timer setting

The “State Timer Setting” is used to control the initial value of the State 0.3 timer (clock ticks or time interval) and the “Update Mode” to be applied: instantly, on the “PWM Rising Edge”, “PWM Falling Edge”, “Counter Reset”.

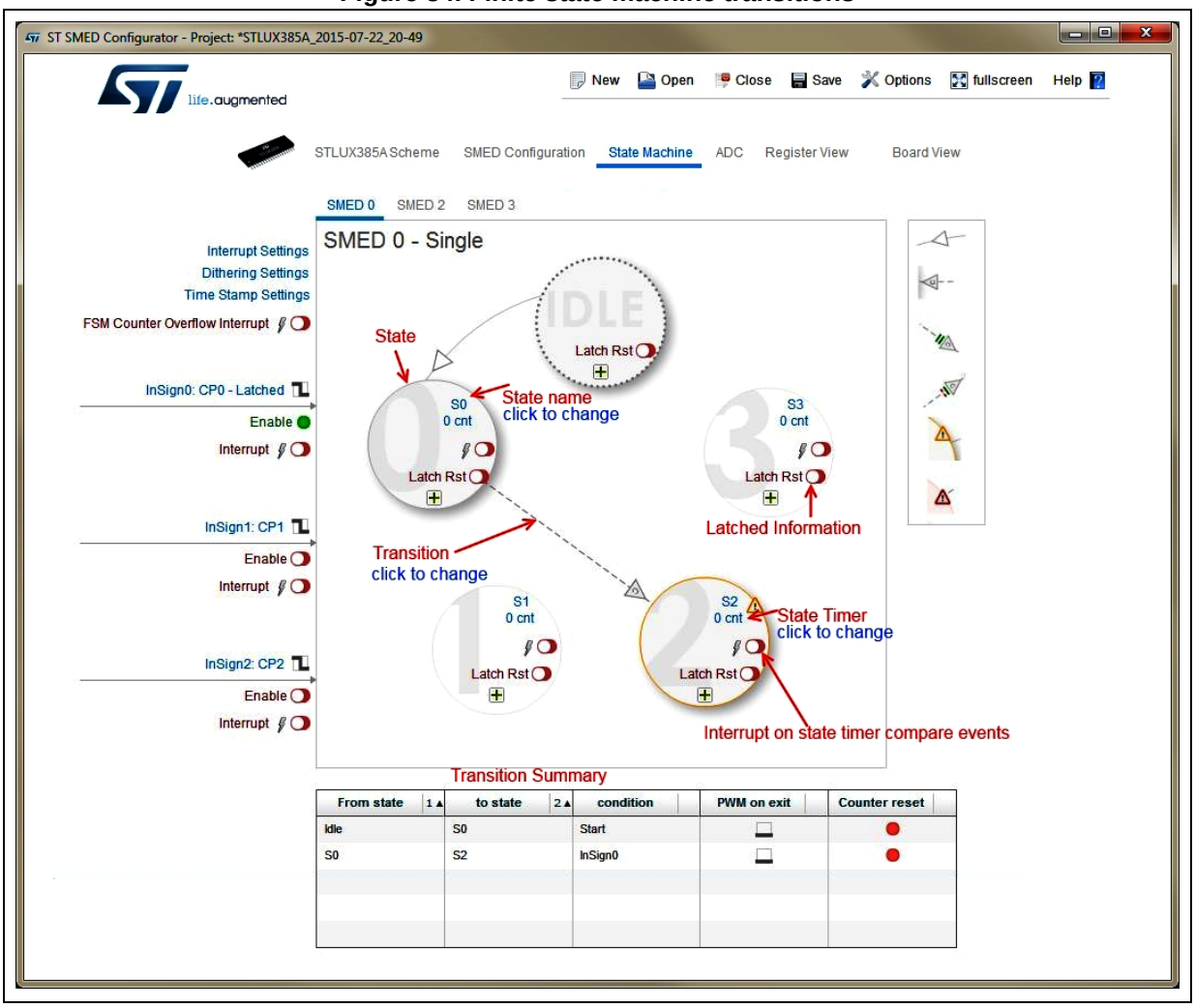
Figure 33. SMED state timer setting dialog box



7.2 Transitions

In the center of the page is representing the FSM.

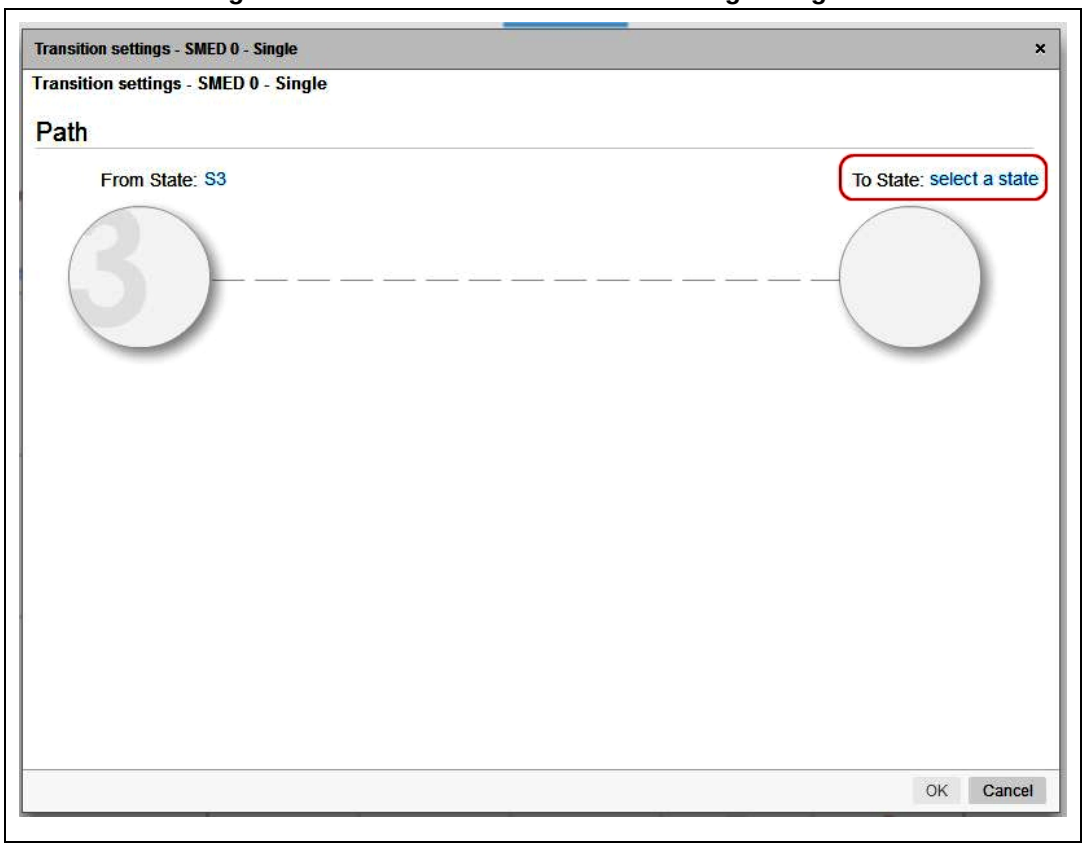
Figure 34. Finite state machine transitions



To add a new transaction, click on the button ⊞ relative to the initial state of the transition.

A dedicated window will be open to select the end state of the transition.

Figure 35. State machine transition setting dialog box



To define a transition **three steps** are needed:

1. **Path:**

   Determines the path of transition from the initial state to the end state. The tool automatically determines the type of transition (sequential or controlled) or, in case of ambiguity, leaving the user the choice.

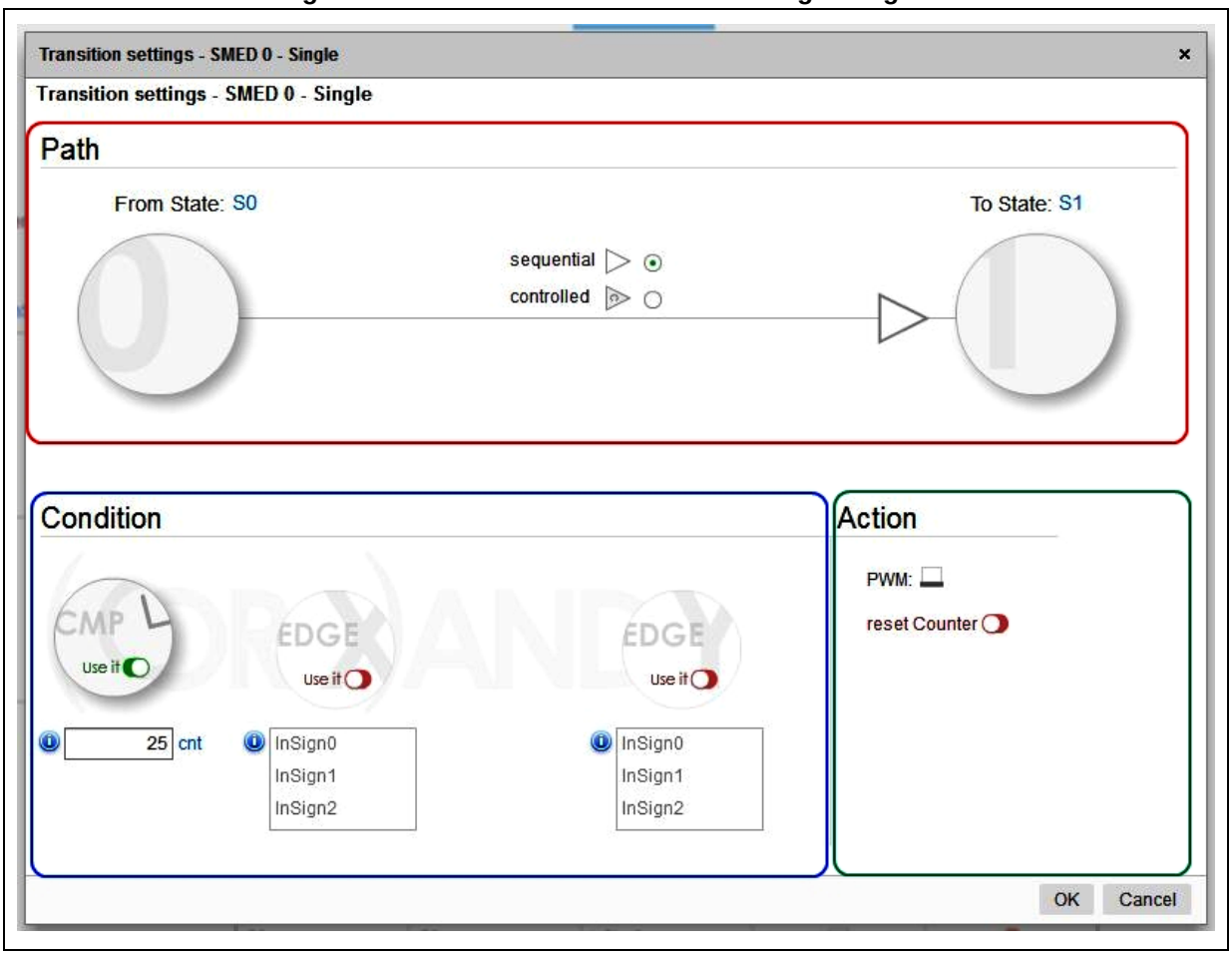
2. **Condition:**

   Determines which is the condition that generates the transition: the state timer compare, edgeX triggering event, edgeY triggering event and their combination.

3. **Action:**

   Determines which is the action of the transition in term of the PWM value and reset counter.

Figure 36. State machine transition setting dialog box



For controlled transition the user can enable the possibility to enter the HOLD state and decides which is the condition that determines the exit from the HOLD state to go on the end state of the transition.

The tool uses four different symbols to identify the transition:


Sequential transition


Controlled transition

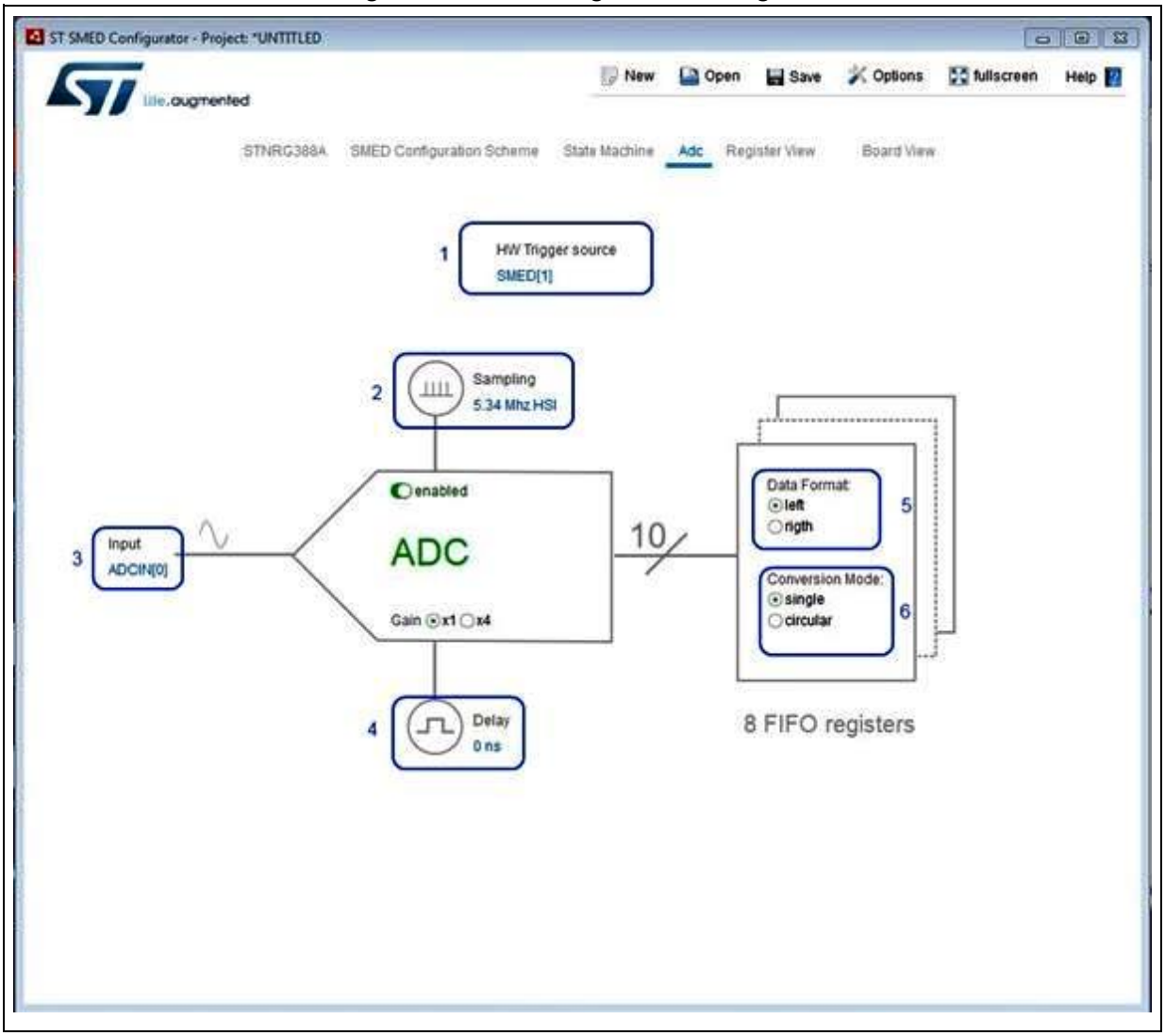

Controlled transition with the HOLD jump and exit from the HOLD when the same condition is retriggered.


Controlled transition with the HOLD jump and exit from the HOLD when the coupled SMED enters in the HOLD.

8 Analog-to-digital converter view

In order to offer a very complete tool for the SMED device setting, you can configure the ADC block. In STNRG devices the user can enable and perform a digital conversion by a trigger generated from the finite state machine.

Figure 37. ADC configuration dialog box



As shown in *Figure 37*, the user can:

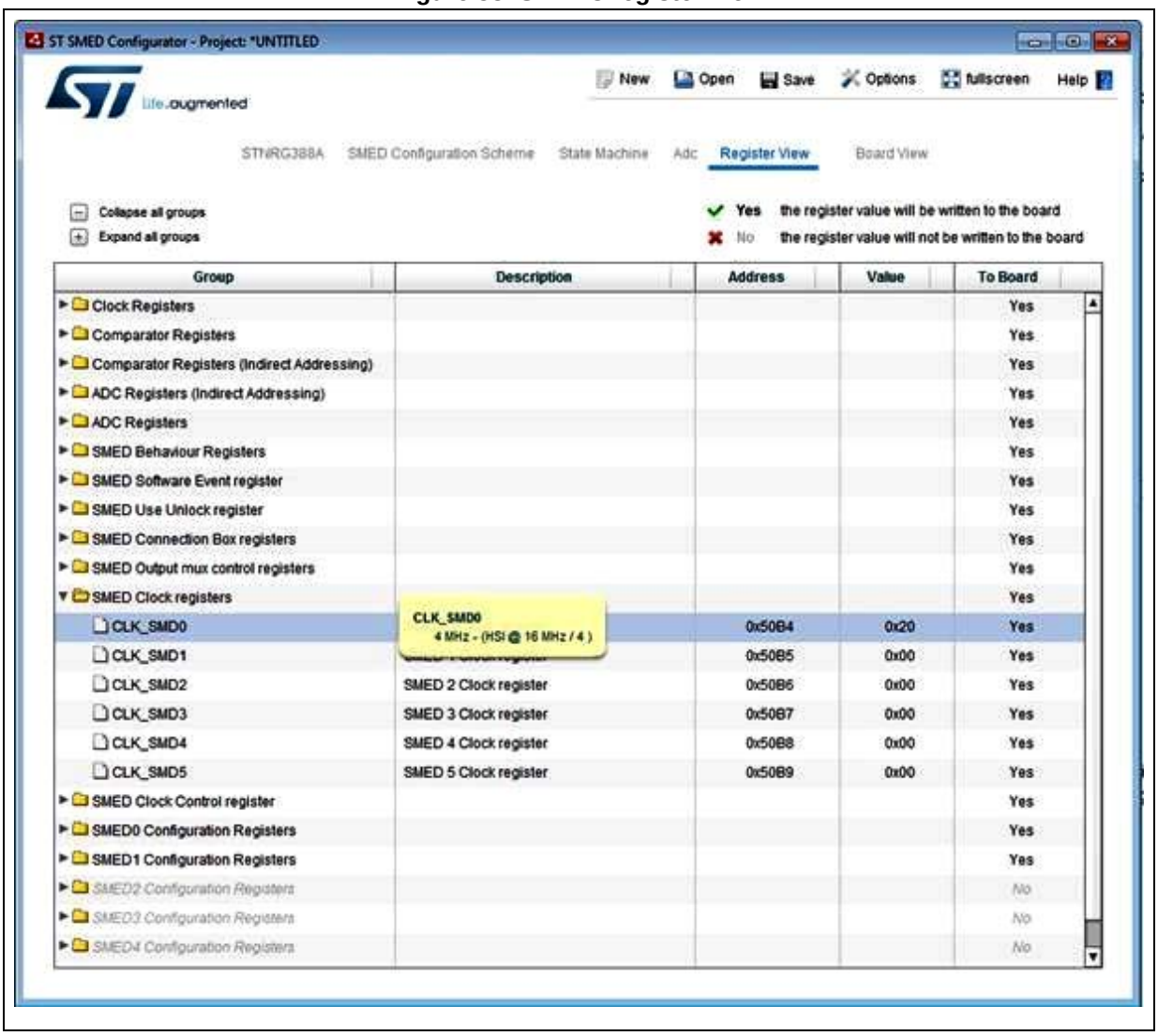
1. Select the source to use as a hardware trigger
2. Select the sampling frequency and source frequency (HSI clock, PLL clock, HSE clock)
3. Select the analog input
4. Select a delay to apply to the first conversion
5. Select which format to use for the digital result
6. Select if perform a single conversion or a circular conversion.

9 Register view

After finishing the project, in the “Register View” the user is able to view how the internal register has been set.

The interactive tooltip shows the setting for each single register row with the light gray color which indicates that the component is not used and no configuration setting will be send to the board.

Figure 38. SMEDs register view



10 Board view

10.1 Preliminary board configuration

In order to be able to connect a STLUX / STNRG device based board, there are a few simple operations to be done to get ready.

10.1.1 General purpose GUI firmware check

The first step to connect your board to the SMED configurator is to be sure the general purpose GUI firmware has been uploaded to your device. This is by default the evaluation boards native configuration for available boards such as the STEVAL-ILL068V1, STEVAL-ILL075V1 and STEVAL-ISA164V1.

In case you need to reset your hardware to this default configuration, you can find the general purpose GUI available on the ST website. You can either download it to your device via the SWIM interface by using development tools (IAR Systems®, Raisonance or Cosmic) or via a serial port by using the bootloading procedure as explained in the “STLUX™ digital controller bootloading procedure” application note (AN4656).

10.1.2 Serial port connection check

Once your board firmware configuration is ready, you can connect the UART serial port to your computer using a USB cable. Then please check the assigned COM port shows in the dialog box as shown in *Figure 40: Board view connection dialog box* and confirm the connection port by pushing the OK button.

10.2 Loading a model on-board

When the model is ready, you can transfer changes on a real board.

Using the “board view”, you will be able to:

- View the current model loaded(a)
- Manage the connection to a real board(a)
- Write SMED configuration's registers to a replicate model on the real board(a)
- Start the execution of a single SMED or all SMEDs(b)
- Run a single operation (read or write) by a dedicated dialog window(c).

a. Refers to*Figure 39: Board view on page 37*: Initial view”.

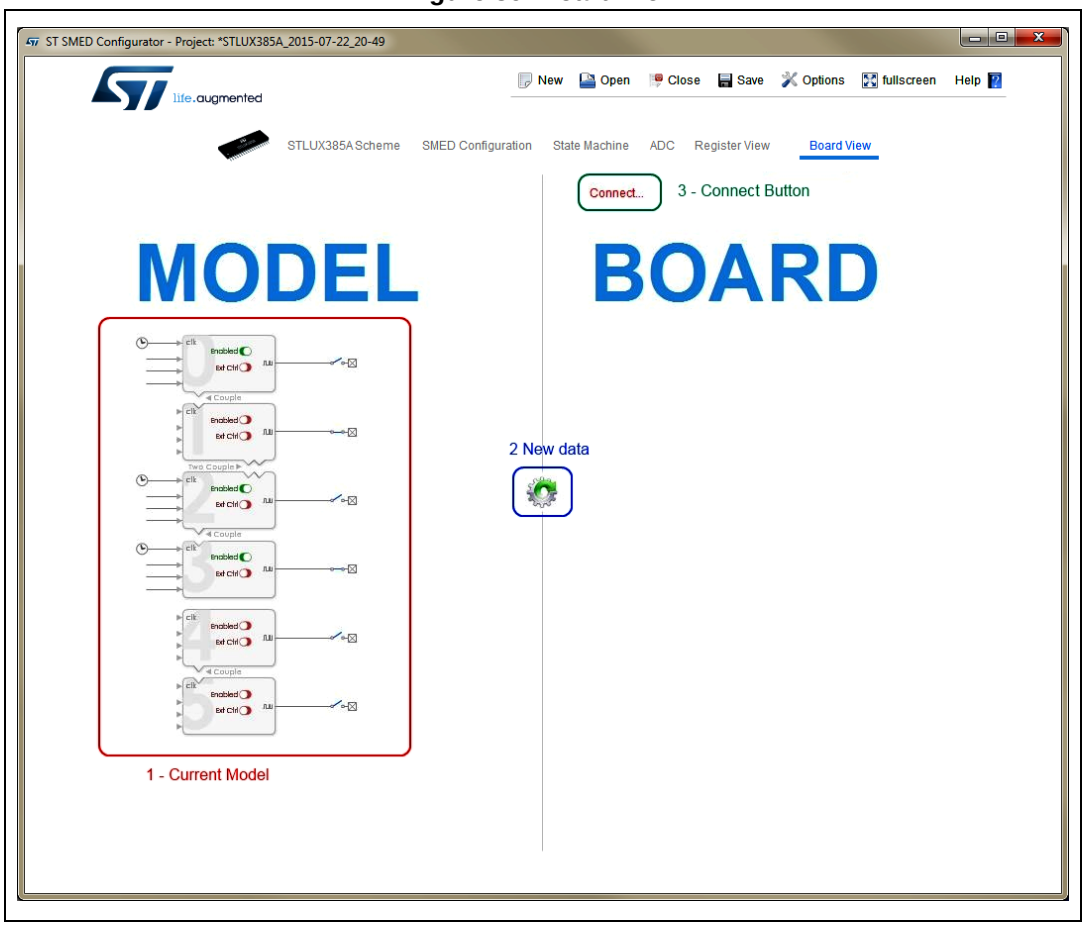
b. Refers to *Figure 39: Board view*: “Final view”.

c. Refers to *Figure 39: Board view*: “Single operation dialog window”.

You can connect the board and write the registers configuration in two ways:

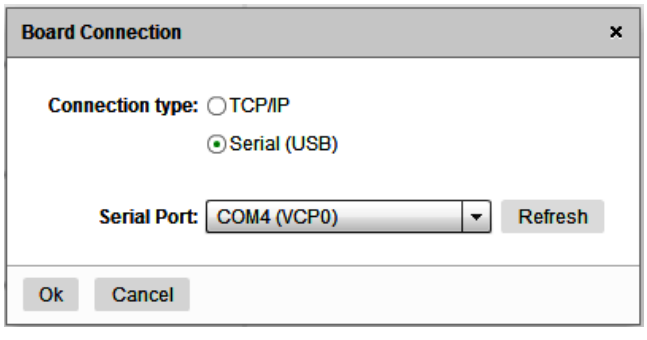
1. One shot
   a) Simply pressing the central button.
2. Two steps
   b) First connect the board by the “Connect…” button
   c) Then write information on the board by the central button.

Figure 39. Board view



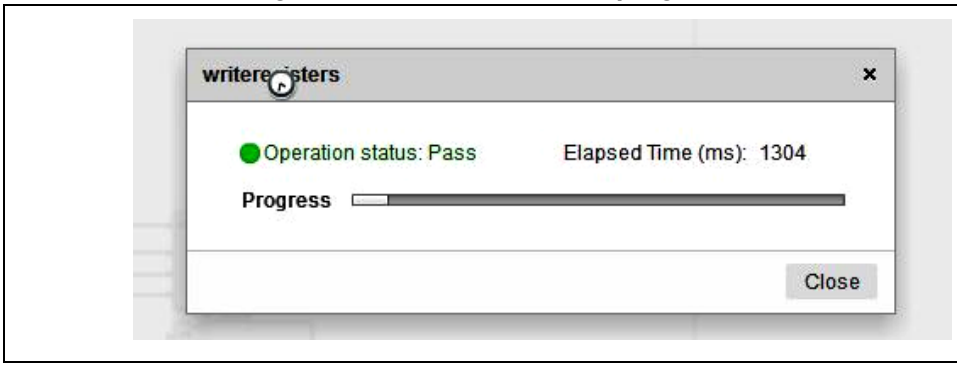
When you start the previous operation, a dialog box asks for the connection type.

Figure 40. Board view connection dialog box



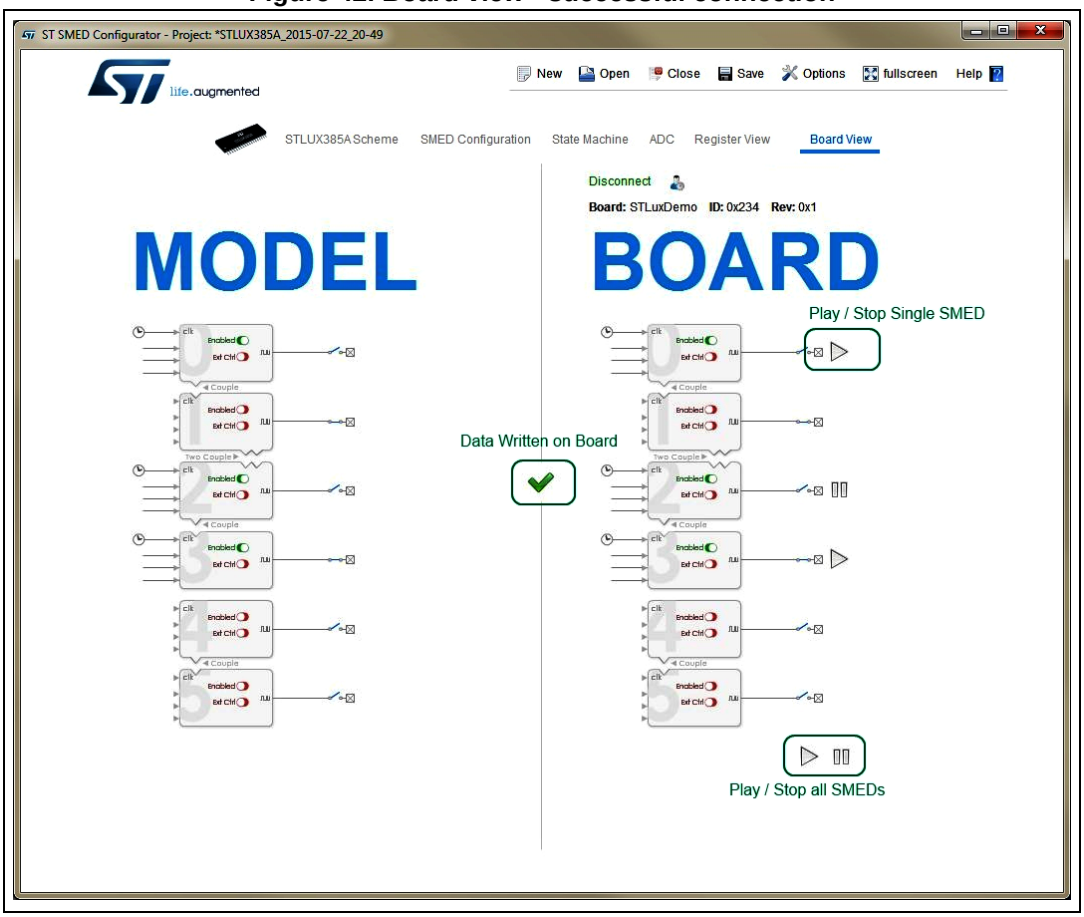
After that, the application starts to write registers on the board. A dialog window shows the progress, time spent, and result of the write operation.

Figure 41. Board connection progress window



If the operation is correctly completed, in the board panel you can see the situation on a real board.

Figure 42. Board view - successful connection



You can run “SMEDs” either individually or together.

Moreover using the “**User**” button ( ) you can open a dialog window in order to execute a single read or write operation on the board.

Figure 43. Board view - single register read operation

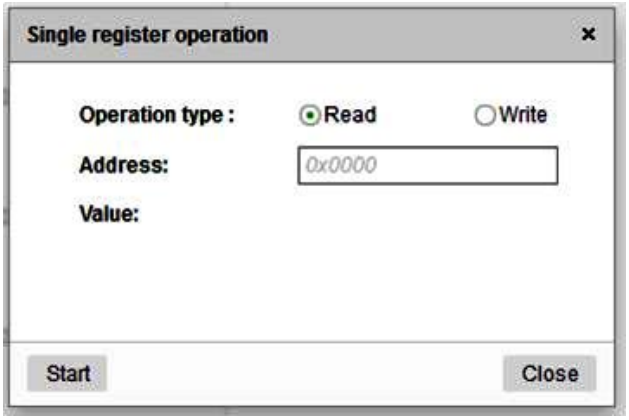
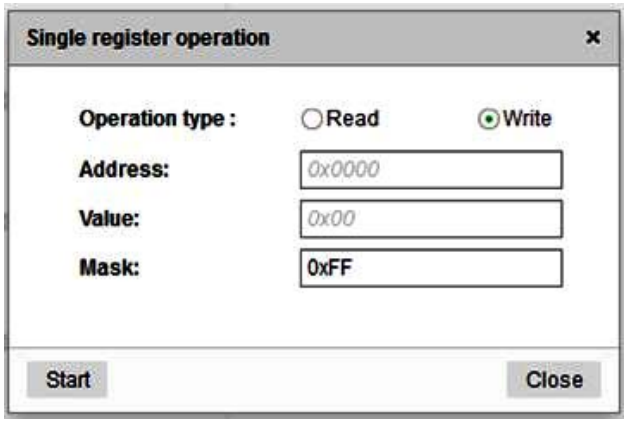


Figure 44. Board view - single register write operation



11 Revision history

Table 2. Document revision history

Date	Revision	Changes
04-Dec-2015	1	Initial release.