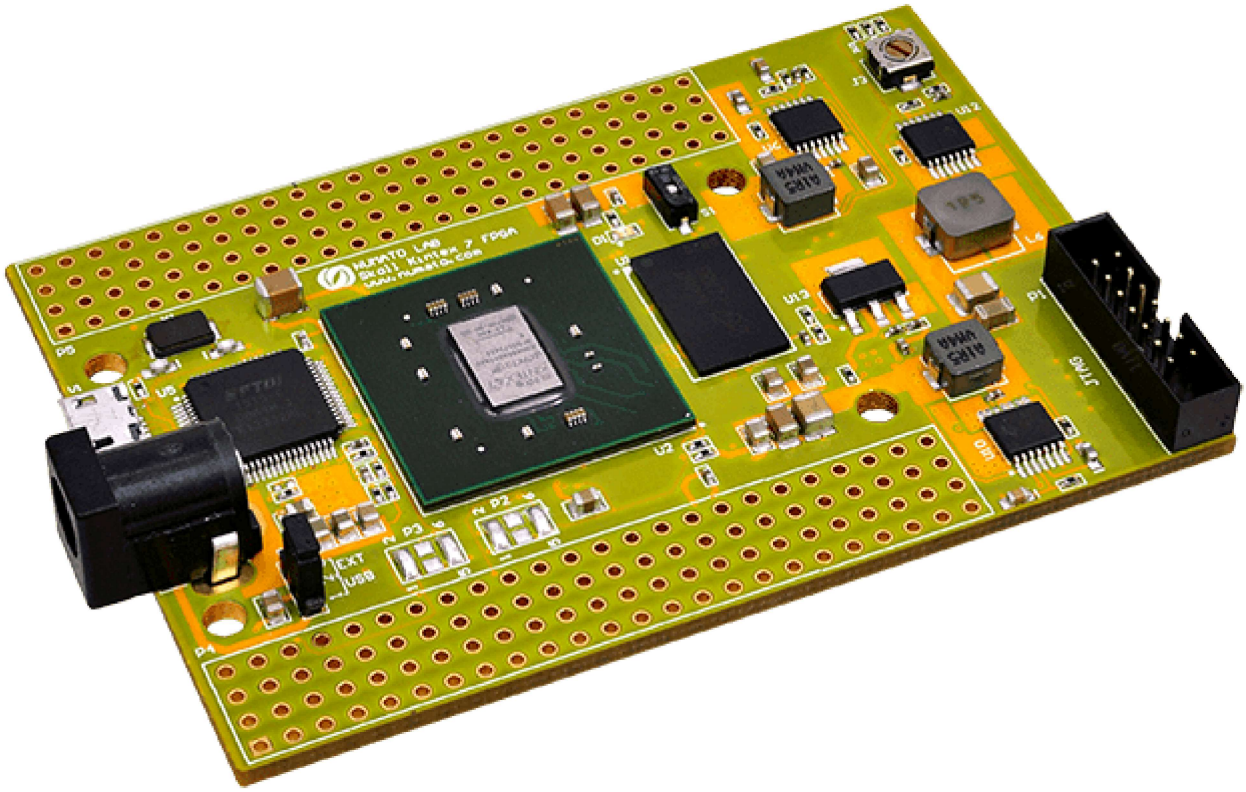
Introduction



(https://docs.numato.com/wp-content/uploads/2016/03/Skoll.png)Skoll is an easy to use FPGA Development board featuring XC7K70T FPGA Kintex 7 FPGA with FTDI's FT2232H Dual-Channel USB device. It is specifically designed for development and integration of FPGA based accelerated features in to other larger designs. The high speed USB 2.0 interface provides fast and easy configuration download to the on-board SPI flash. No programmer or special down loader cable is needed to download the bit stream to the board. The second FTDI channel can be used to develop custom high data-rate USB based applications. Skoll provides user flexibility in adding their own peripherals though IO Expansion Headers

Board features

- Pin compatible with :
  –Saturn Spartan 6 FPGA Module (https://numato.com/product/saturn-spartan-6-fpga-development-board-with-ddr-sdram/)
  –Telesto MAX10 FPGA Module (https://numato.com/product/telesto-max10-fpga-module/)
  –Neso Artix 7 FPGA Module (https://numato.com/product/neso-artix-7-fpga-development-board/)
  –Styx Zynq 7020 FPGA Module (https://numato.com/product/styx-zynq-7020-fpga-module/) and offers a seamless upgrade path

- FPGA: XC7K70T in FBG484 package, Speed Grade: -1
- DDR3: 2Gb DDR3 (MT41J128M16HA-125:K or equivalant)
- Flash memory: 128 Mb Quad bit SPI flash memory (N25Q128A13EF840E)
- 100MHz CMOS oscillator
- **Revision V1**: High Speed USB 2.0 interface for On-board flash programming. FT2232H Channel A is dedicated for SPI Flash /JTAG Programming. Channel B can be used for custom applications.
- **Revision V2**: High Speed USB 2.0 interface for On-board flash programming. FT2232H Channel B is dedicated for SPI Flash /JTAG Programming. Channel A can be used for custom applications.
- On-board voltage regulators for single power rail operation
- FPGA configuration via JTAG and USB
- Maximum IOs for user defined purposes
    - FPGA – 150 IOs
    - FT2232H – 8 IOs

Applications

- Product Prototype Development
- Accelerated computing integration
- Development and testing of custom embedded processors
- Signal Processing
- Communication devices development
- Educational tool for Schools and Universities

How to use the module

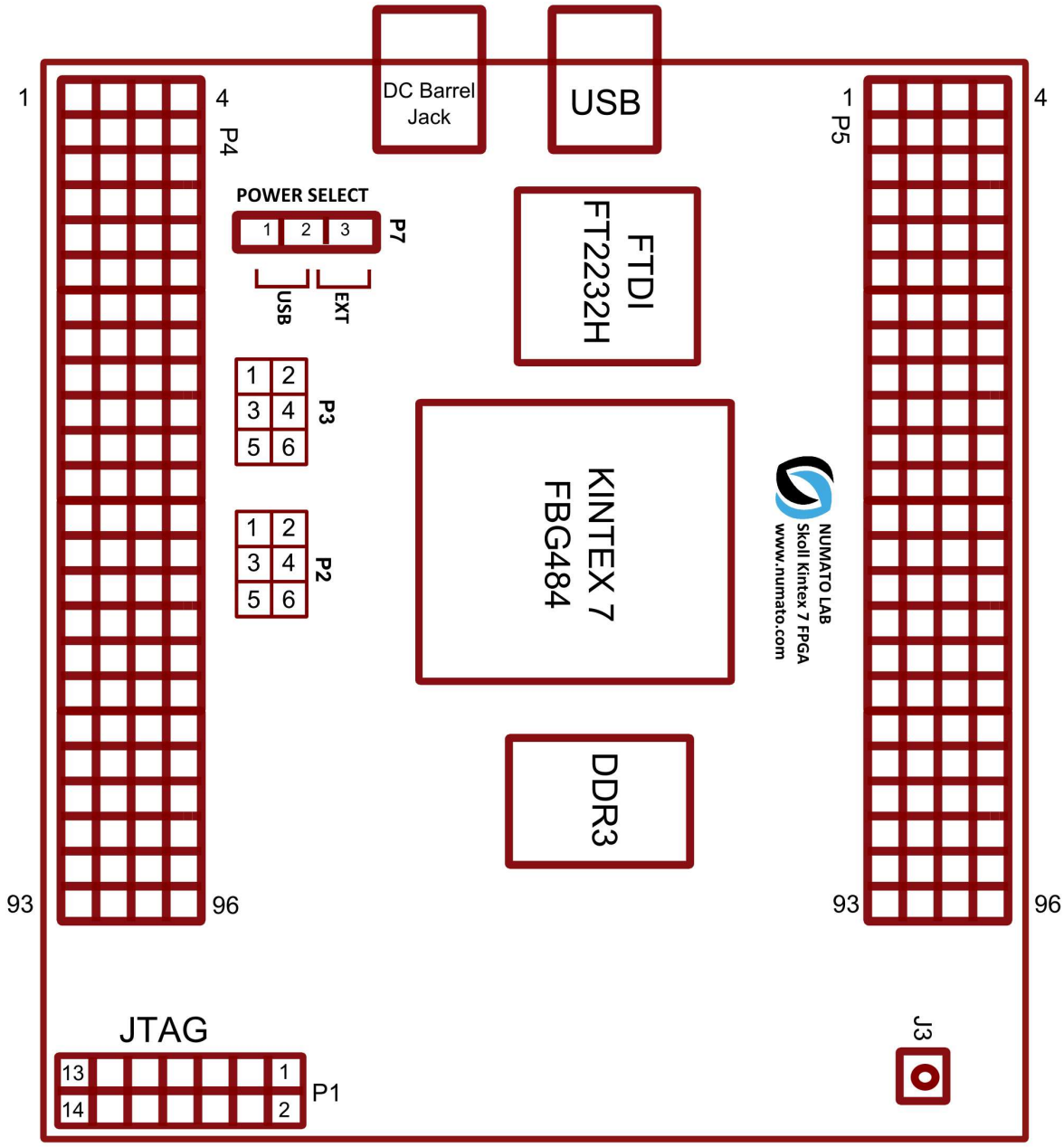
The following sections describe in detail how to use this module.

Hardware Accessories Required

Along with the module, you may need the items in the list below for easy and fast installation.

1. USB A to Micro B cable.
2. DC Power supply.
3. A Xilinx Platform Cable USB II compatible JTAG programmer.

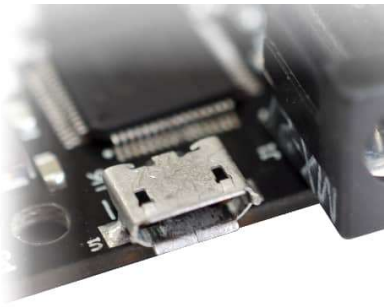
Connection Diagram



(https://numato.com/help/wp-content/uploads/2018/01/skoll_outline.png)

This diagram should be used as a reference only. For detailed information, see Skoll schematics at the end of this document. Details of individual connectors are as below.

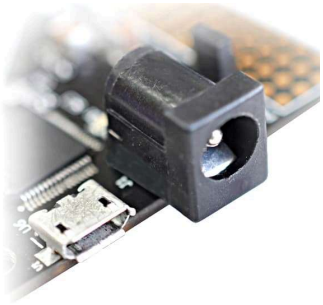
USB Interface



(https://numato.com/help/wp-content/uploads/2016/03/skoll_usb_connector.jpg)The on board full speed USB controller helps a PC/Linux/Mac computer to communicate with this module. Use a USB A to Micro B cable to connect with a PC. By default the module is powered from USB so make sure not to overcrowd unpowered USB hubs (the picture on the right shows USB Micro connector).

FT2232H Channel B is dedicated for SPI Flash /JTAG Programming. Channel A can be used for custom applications.

DC Power Supply



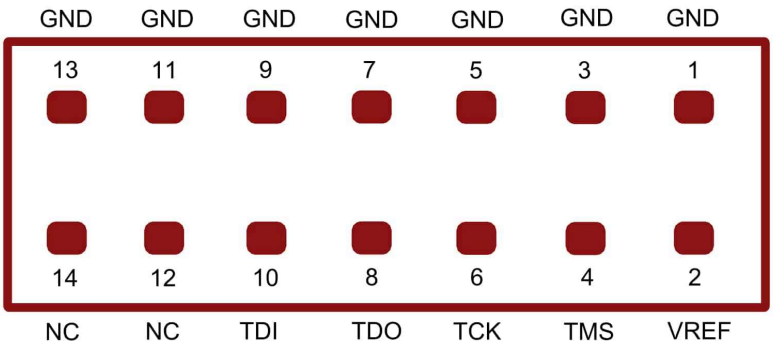
(https://numato.com/help/wp-content/uploads/2016/03/skoll_dc_connector_o.jpg)By default the board is configured to use +5V supply from USB. So an external power is not required unless USB port is unable to supply enough current. USB 2.0 ports are only capable of providing enough current for the module for small designs which require less power. Current requirement for this board largely depends on your application. Please consult FPGA data sheet for more details on power requirements. If for any reason, an external power supply needs to be used for the board, the Power select jumper should be configured properly before connecting the power supply. Please refer to the marking on the board for more details. External power supply should be in the range of +5 to +12V, with sufficient current rating.

Power Select

The Power Select header P7 is used to configure the power source for the board. Connect pins 1 and 2 to use USB power and pin connect pins 2 and 3 to use the external DC power.

JTAG Connector

JTAG connector provides access to FPGA's JTAG pins. A XILINX platform cable can be used to for JTAG programming.



(https://numato.com/help/wp-content/uploads/2016/03/skoll_jtag_outline.jpg)

JTAG/SPI Configuration on FT2232H channel A

Channel A of FT2232H can be connected to the SPI bus that connects the SPI Flash chip to the FPGA or to the JTAG pins of the FPGA. By connecting SPI bus to FT2232H channel A, the SPI flash can be directly programmed to save the configuration permanently. This is the default configuration set when Skoll is shipped. When FT2232H channel A is connected to SPI, Skoll Configuration Downloader utility can be used to program the board.

When FT2232H channel A is connected to FPGA JTAG, the JTAG signals can be accessed directly through FT2232H. Skoll Configuration Downloader utility currently does not support programming FPGA SRAM through JTAG.

Please see the tables below for information about selecting SPI or JTAG for FT2232H channel A. SPI must be selected for Skoll Configuration Downloader utility to work.

Solder Jumpers P2

Jumper Configuration for SPI	Jumper Configuration for JTAG
1 - 2	1 - 3
5 - 6	4 - 6

Solder Jumpers P3

Jumper Configuration for SPI	Jumper Configuration for JTAG
1 - 2	1 - 3
5 - 6	4 - 6

Important: These jumper settings are only meant for accessing the JTAG signals via FT2232H through USB using programs such as `xc3sprog`. If you are using external JTAG such as Xilinx Platform Cable USB II connected to the JTAG header, then please **do not** change these jumpers.

They should be in the factory-shipped SPI configuration. If the jumpers are changed to JTAG mode, and an external JTAG is used, then the external JTAG will **not work**.

GPIOs

This device is equipped with a maximum 150 user IO pins that can be used for various custom applications. All user IOs are length matched and can be used as differential pairs.

Header P4

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
1	GND	2	3V3
3	VCCIN	4	GND
5	K22	6	K21
7	M18	8	M17
9	J22	10	J21
11	L20	12	L19
13	H20	14	J20
15	G22	16	H22
17	E22	18	E21
19	F21	20	G21
21	F20	22	G20
23	D22	24	D21
25	B21	26	B20
27	B22	28	C22
29	A21	30	A20
31	F13	32	G13
33	G16	34	G15
35	K19	36	L18

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
37	D20	38	D19
39	G12	40	H12
41	C20	42	C19
43	E18	44	E17
45	D17	46	E16
47	D16	48	D15
49	GND	50	GND
51	GND	52	GND
53	D14	54	E14
55	E12	56	E13
57	A18	58	B17
59	A19	60	B18
61	A16	62	B16
63	C18	64	C17
65	A15	66	B15
67	C15	68	C14
69	A14	70	A13
71	B13	72	C13
73	B12	74	C12
75	F10	76	F11
77	B10	78	B11
79	C10	80	D10
81	A10	82	A11
83	C9	84	D9
85	A8	86	A9
87	B8	88	C8

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
89	GND	90	GND
91	GND	92	GND
93	3V3	94	3V3
95	3V3	96	3V3

Header P5

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
1	ACBUS0*/BCBUS0**	2	ACBUS1/BCBUS1
3	3V3	4	GND
5	ACBUS2/BCBUS2	6	ACBUS3/BCBUS3
7	N20	8	M21
9	ACBUS4/BCBUS4	10	ACBUS5/BCBUS5
11	N22	12	M22
13	ACBUS6/BCBUS6	14	ACBUS7/BCBUS7
15	M20	16	L21
17	N18	18	N19
19	P19	20	P20
21	R18	22	R19
23	P21	24	P22
25	T18	26	U18
27	R21	28	R22
29	V19	30	W19
31	T20	32	U20
33	AA21	34	AB22
35	U17	36	V18

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
37	AA18	38	AB18
39	AA20	40	AB21
41	P16	42	N17
43	AA19	44	AB20
45	GND	46	GND
47	GND	48	GND
49	GND	50	GND
51	GND	52	GND
53	R17	54	P17
55	V20	56	W20
57	Y18	58	Y19
59	AA16	60	AB17
61	W17	62	Y17
63	R16	64	T16
65	AB15	66	AB16
67	T15	68	U15
69	W14	70	Y14
71	J16	72	J17
73	H14	74	H13
75	AA14	76	AA15
77	G11	78	G10
79	H9	80	H8
81	F9	82	E9
83	U16	84	V17
85	G8	86	F8
87	V15	88	W15

Pin No. On The Header	Kintex-7 (FBG484) Pin No.	Pin No. On The Header	Kintex-7 (FBG484) Pin No.
89	INITB	90	3V3
91	PROGB	92	3V3
93	GND	94	GND
95	GND	96	GND

***Revision V1:** ACBUS0 – ACBUS7 are pins of FTDI FT2232H Dual-Channel USB device.

****Revision V2:** BCBUS0 – BCBUS7 are pins of FTDI FT2232H Dual-Channel USB device.

FT2232H – Kintex-7 (FBG484) FPGA Connection Details

Skoll Revision V1

FTDI Pin No.	Pin Function (245 FIFO)	Kintex-7 Pin No.
38	D0	T21
39	D1	U22
40	D2	U21
41	D3	V22
43	D4	W21
44	D5	W22
45	D6	Y21
46	D7	Y22
48	RXF#	D12
52	TXE#	H15
53	RD#	K17
54	WR#	V14
55	SIWUB	T19

Skoll Revision V2

FTDI Pin No.	Pin Function (245 FIFO)	Kintex-7 Pin No.
16	D0	T21
17	D1	U22
18	D2	U21
19	D3	V22
21	D4	W21
22	D5	W22
23	D6	Y21
24	D7	Y22
26	RXF#	D12
27	TXE#	H15
28	RD#	K17
29	WR#	V14
30	SIWUA	T19
32	CLKOUT	Y16
33	OE#	W16

Driver Installation

Windows

This product requires Numato Lab drivers to be installed for proper functioning when used with Windows. The driver can be downloaded from http://productdata.numato.com/assets/downloads/driver/Driver.zip (https://numato.com/wp-content/uploads/2022/07/NumatoLabFPGADrivers.zip) Windows users should download and run the WHQL Certified executable file that will prompt to install the Numato Lab drivers.

Skoll USB Vendor ID 2A19
Skoll USB Product ID1006

Linux

The Linux ships with the drivers required for Skoll Kintex 7 FPGA Module. It should be enough to run the following two commands in the terminal:

```
>> sudo modprobe ftdi_sio
>> echo 2a19 1006 > /sys/bus/usb-serial/drivers/ftdi_sio/new_id
```

Powering Up Skoll

Skoll is factory configured to be powered directly from USB port so make sure that you are using a USB port that can power the board properly. It is recommended to connect the board directly to the PC instead using a hub. It is practically very difficult to estimate the power consumption of the board, as it depends heavily on your design and the clock used. XILINX provides tools to estimate the power consumption. In any case if power from USB is not enough for your application, external supply can be applied to the board. Jumper PWRSEL should be set up properly (short pin 1-2) to use the board on external power. Skoll requires three different voltages, a 3.3V, a 1.8V supplies and a 1.3V supply. On-board regulators derive these voltages from the USB/Ext power supply.

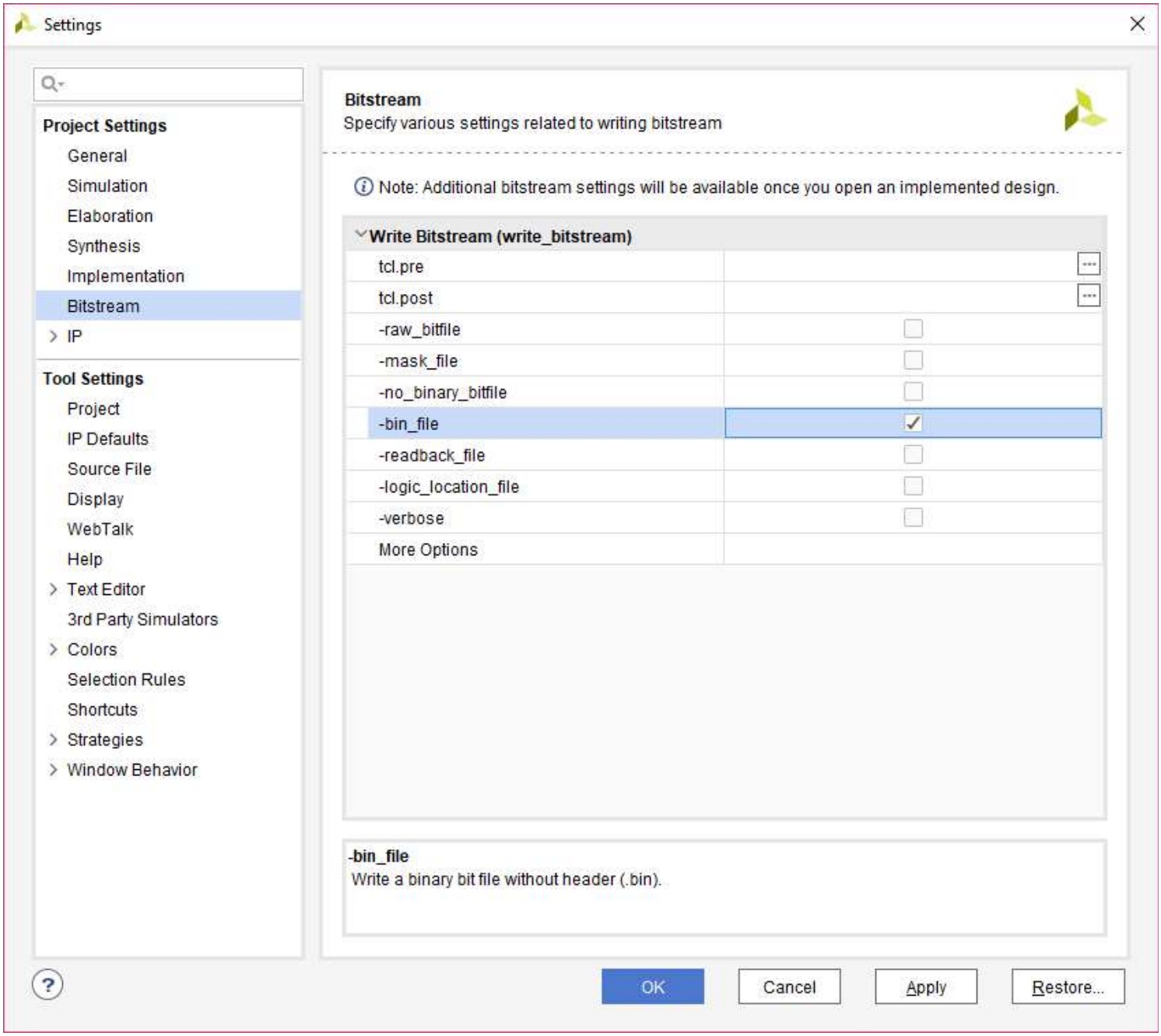
Generating Bit Stream for Skoll

The bitstream can be generated for Skoll in Vivado by following the steps below:

Step 1: It is recommended to generate .bin file along with .bit file. Right-click on “Generate Bitstream” under the “Program and Debug” section of the Flow Navigator window and click “Bitstream Settings”.

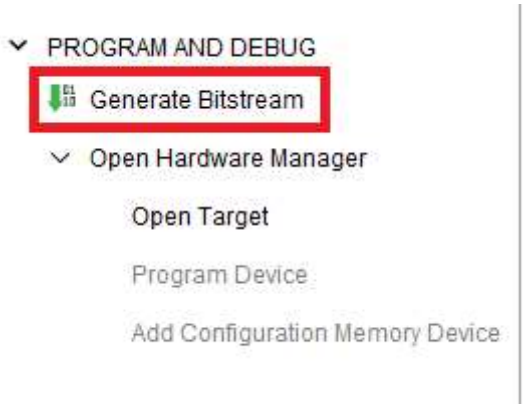
(https://numato.com/help/wp-content/uploads/2018/05/bitstream-settings.png)

Step 2: Select “-bin_file” option in the dialog window and click “Apply” and then “OK”.



(https://numato.com/help/wp-content/uploads/2018/05/bitstream-settings1.png)

Step 3: Finally click “Generate Bitstream”.



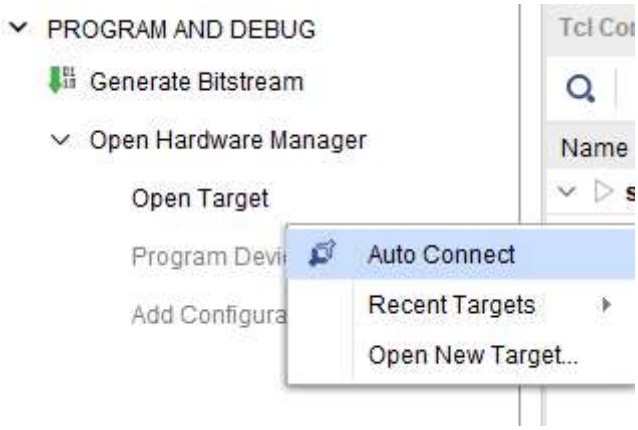
(https://numato.com/help/wp-content/uploads/2018/05/generatebitstream.png)

Programming Skoll Using JTAG

Skoll Kintex 7 FPGA Module features an onboard JTAG connector which facilitates easy reprogramming of SRAM and onboard SPI flash through JTAG programmer like “Xilinx Platform cable USB”. Following steps illustrate how to program FPGA on Skoll using JTAG.

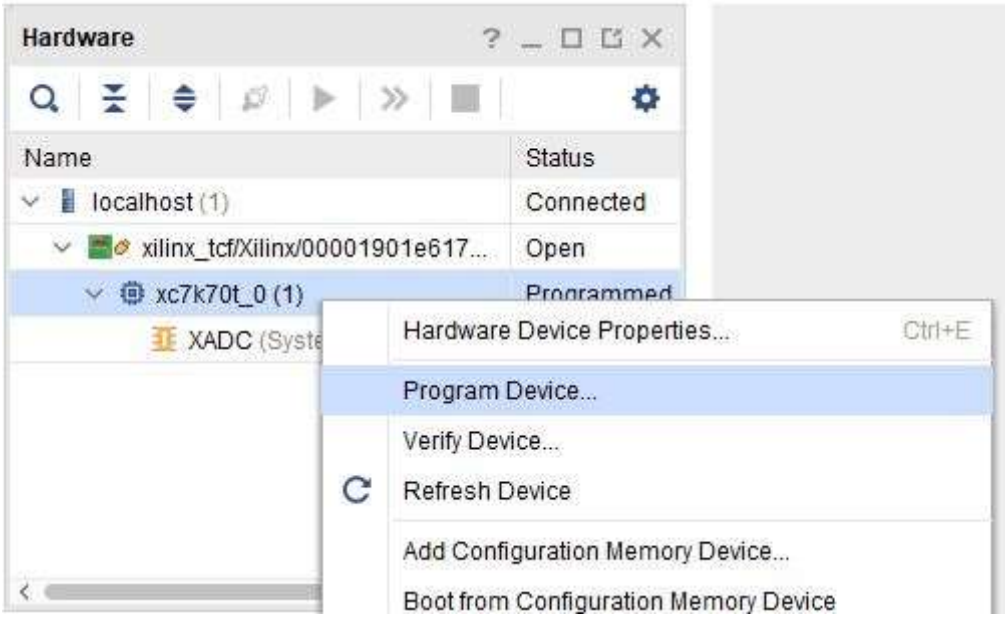
Step 1: By using JTAG cable, connect Xilinx platform cable USB to Skoll and power it up.

Step 2: Open Vivado project and open the target by clicking on the “Open Target” in “Open Hardware Manager” in the “Program and Debug” section of the Flow Navigator window. Select “Auto Connect”.



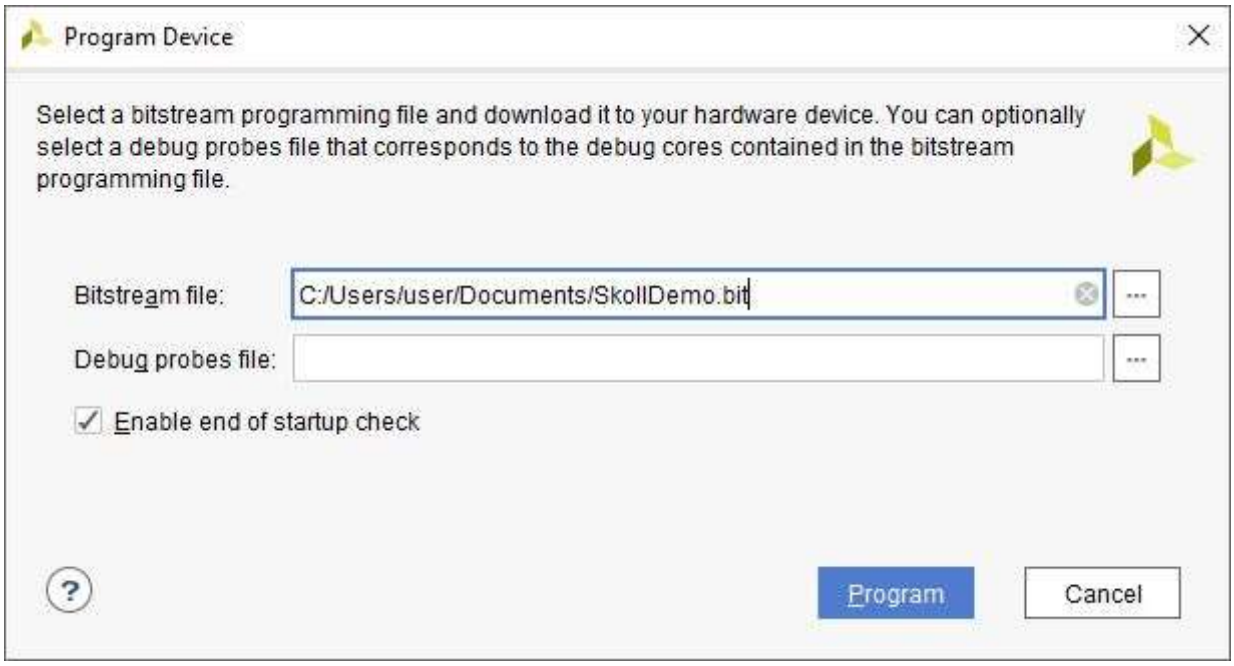
(https://numato.com/help/wp-content/uploads/2018/05/auto-connect.png)

Step 3: If the device is detected successfully, then select “Program Device” after right clicking on the target device “xc7k70t_0 (1)” as shown below.



(https://numato.com/help/wp-content/uploads/2021/08/Skoll_prog_device.jpg)

Step 4: In the dialog window which opens up, Vivado automatically chooses correct bitstream file if the design was synthesized, implemented and bitstream generated successfully. If needed, browse to the bitstream which needs to be programmed to FPGA. Finally, click “Program”.

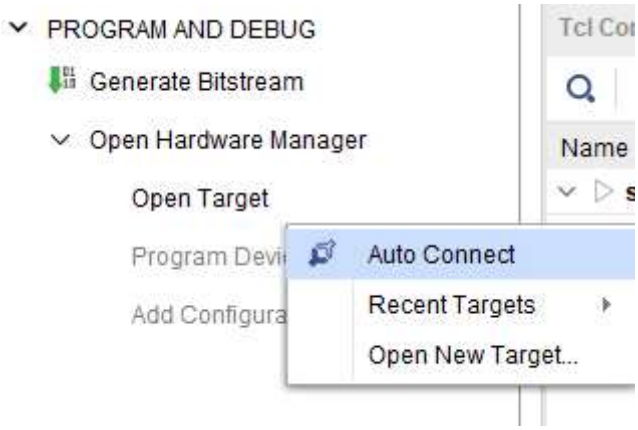


(https://numato.com/help/wp-content/uploads/2021/08/Skoll_prog_device2.jpg)

Programming QSPI Flash using Vivado

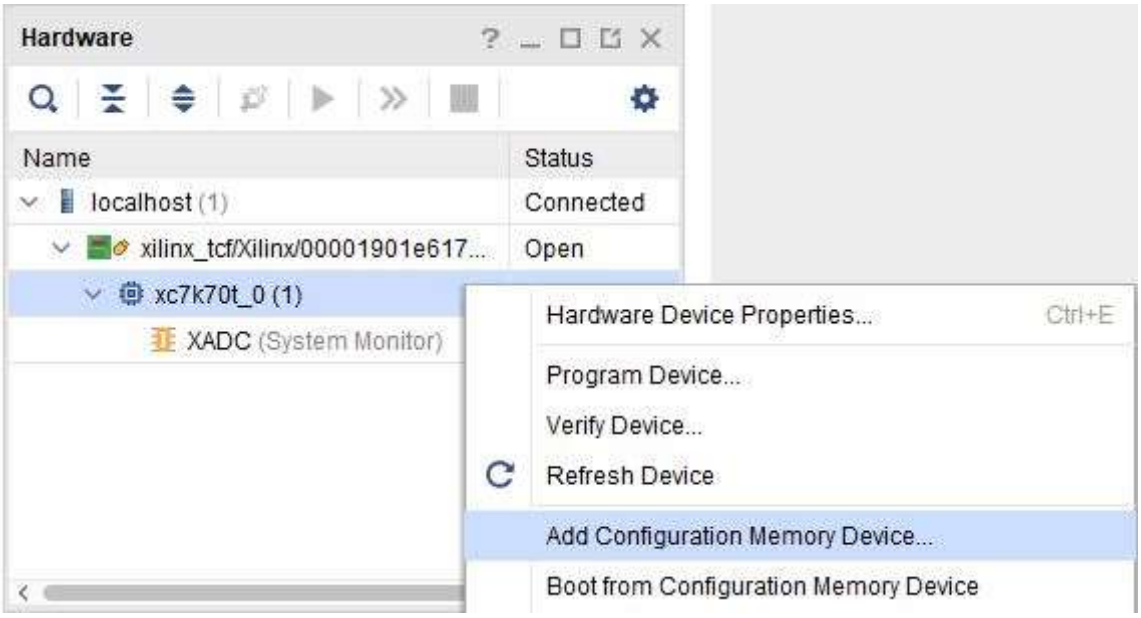
A .bin or .mcs file is required for programming Skoll Kintex 7’s onboard QSPI flash.

Step 1: Open Vivado Project. Click on “Open Target” in “Open Hardware Manager” in the “Program and Debug” section of the Flow Navigator window.



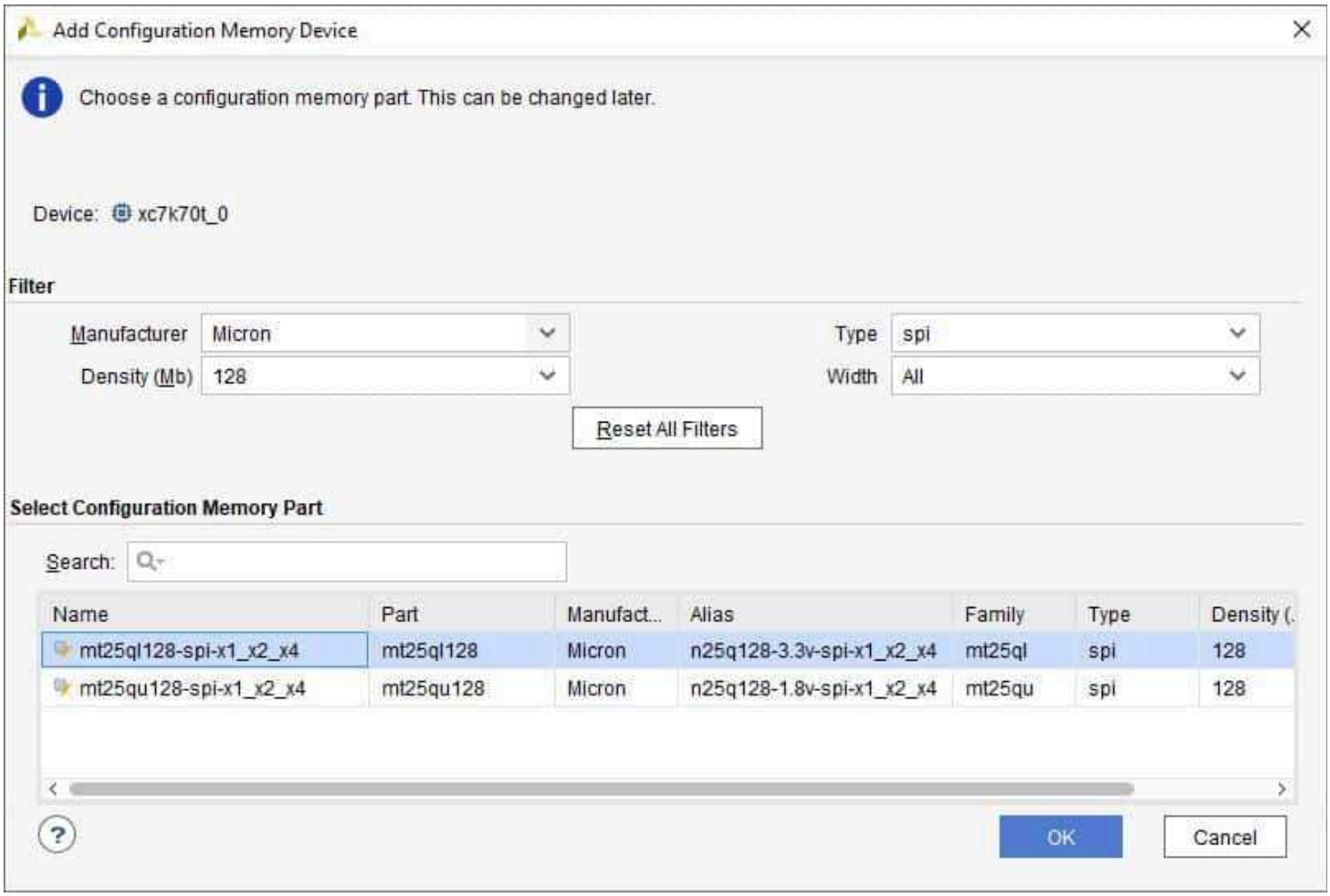
(https://numato.com/help/wp-content/uploads/2018/05/auto-connect.png)

Step 2: If the device is successfully detected, then right-click on the “xc7k70t_0 (1)”. Select “Add Configuration Memory Device” as shown below.



(https://numato.com/help/wp-content/uploads/2021/08/Skoll_add_mem_config.jpg)

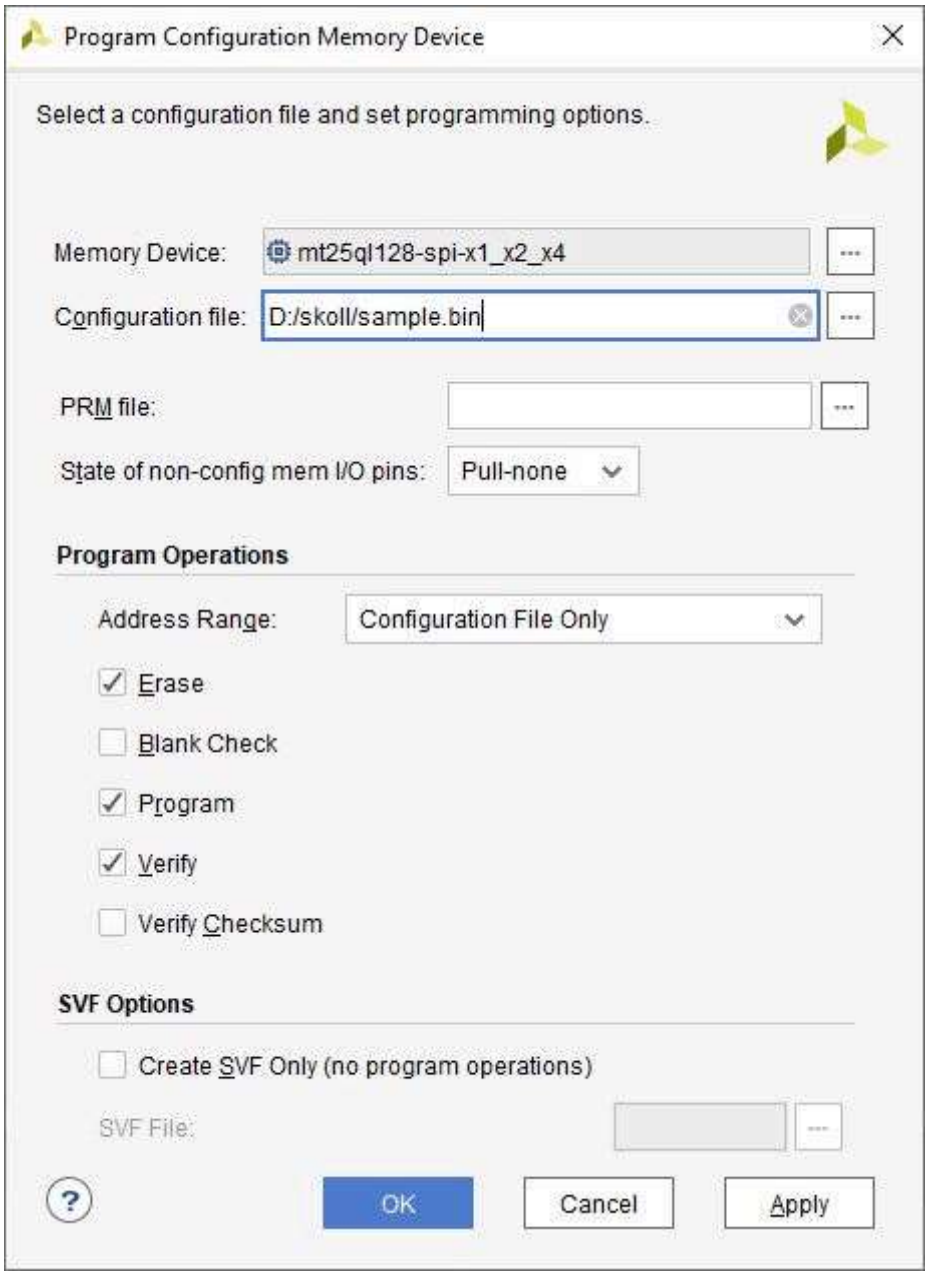
Step 3: Select the memory device “mt25ql128-spi-x1_x2_x4 (which is equivalent to n25q128-3.3v-spi-x1_x2_x4)”, then click OK.



(https://numato.com/help/wp-content/uploads/2021/08/Skoll_select_mem_config.jpg)

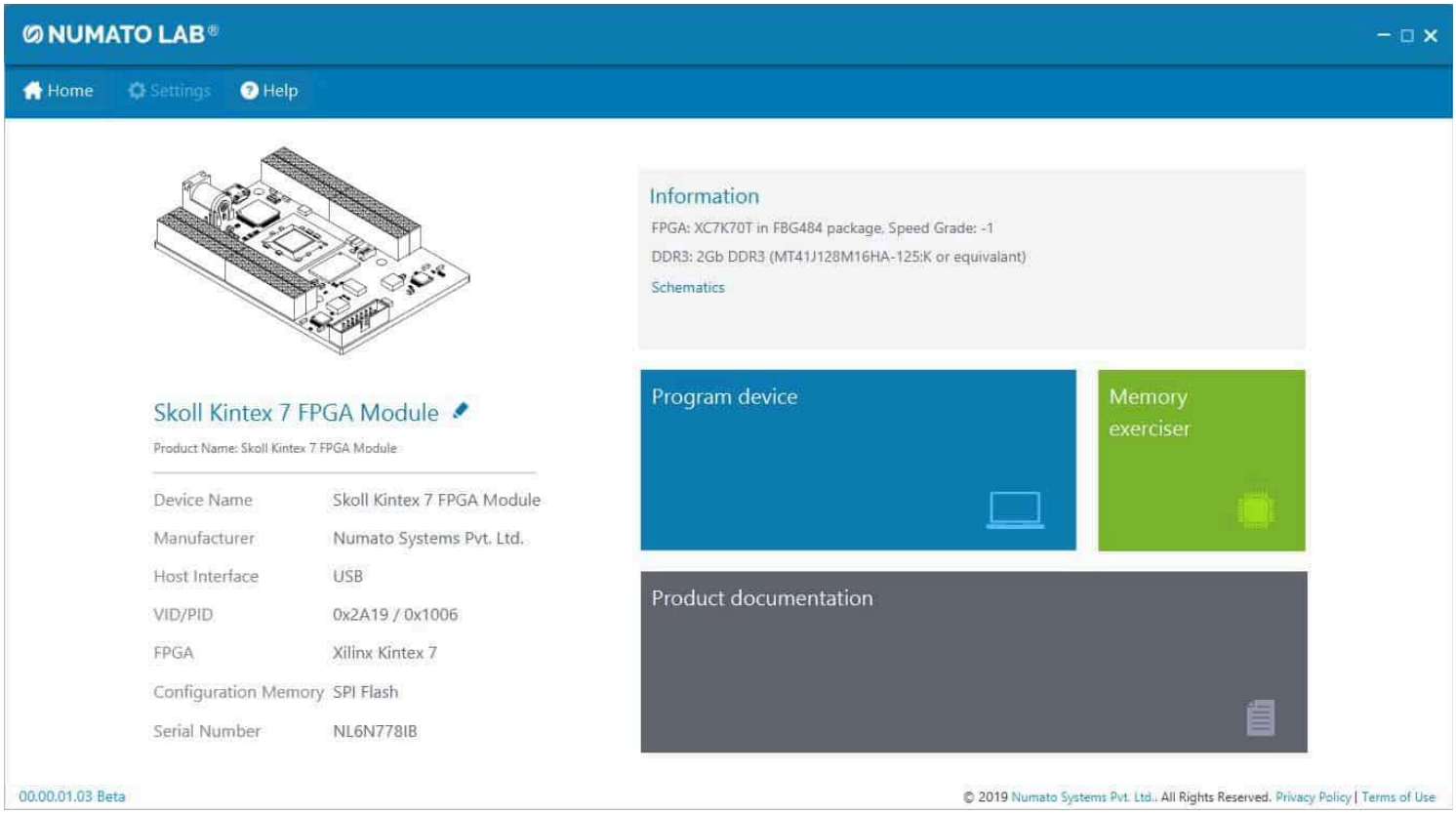
Step 4: After completion of Step 3, a dialog box will open. Click OK.

Step 5: Browse to the working .bin file or the .mcs file (whichever applicable) and click OK to program as shown below. If programming is successful, a confirmation message will be displayed.



(https://numato.com/help/wp-content/uploads/2021/08/Skoll_prog_mem_config.jpg)

Programming Skoll Using Tenagra



(https://numato.com/help/wp-content/uploads/2021/08/Skoll_Tenagra.jpg)

For steps on how to program Skoll using Tenagra, refer the Getting started with Tenagra FPGA System Management Software (https://numato.com/kb/getting-started-with-tenagra-fpga-system-management-software/) article.

Technical Specifications

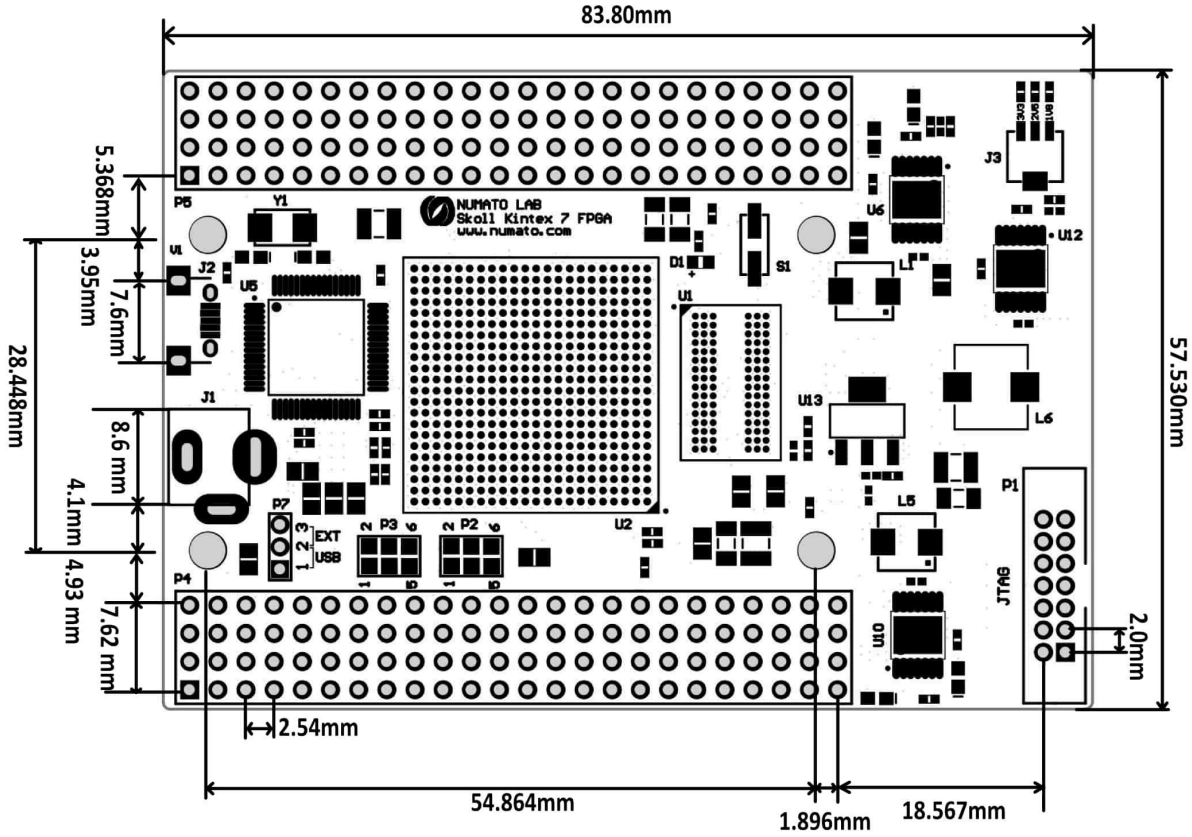
Parameter *	Value	Unit
Basic Specifications		
Number of GPIOs	158(Max)	
On-board oscillator frequency (ASEM1-100.000MHZ-LC-T)	100	MHz
DDR3 Capacity	2	Gb
Quad SPI Flash Memory (N25Q128A13ESE40E)	128	Mb
Power supply voltage (External)	5 - 12	V
FPGA Specifications		
Internal supply voltage relative to GND	0.5 to 1.1	V

Parameter *	Value	Unit
Auxiliary supply voltage relative to GND	0.5 to 2.0	V
Output drivers supply voltage relative to GND	0.5 to 3.6	V
Header Details		
Compatible Female socket header	PPTC242LFBN-RC	
Compatible Male pin header	PRPC024DFAN-RC	

* All parameters considered nominal. Numato Systems Pvt Ltd reserves the right to modify products without notice.

Female socket header : PPTC242LFBN-RC (https://www.digikey.in/en/products/detail/sullins-connector-solutions/PPTC242LFBN-RC/810229)
Male pin header : PRPC024DFAN-RC (https://www.digikey.in/en/products/detail/sullins-connector-solutions/PRPC024DFAN-RC/2775390?s=N4IgTCBcDaIAoCU4GEAMYAsARAYgQQDkBaBZEAXQF8g)

Physical Dimensions



Lx W X H: 83.80mm x 57.53mm x16mm

(https://numato.com/help/wp-content/uploads/2016/03/skoll_phy_dimen.jpg)

Schematics

Skoll Revision V1: Skoll Schematics (https://numato.com/blog/wp-content/uploads/2016/08/Skoll_schematic.pdf)

Skoll Revision V2: Skoll Schematics (https://numato.com/help/wp-content/uploads/2018/01/SkollV2Sch.pdf)

Skoll GPIO Easy Reference

Skoll GPIO Easy Reference (https://numato.com/help/wp-content/uploads/2020/11/SkollGPIOReference.pdf)