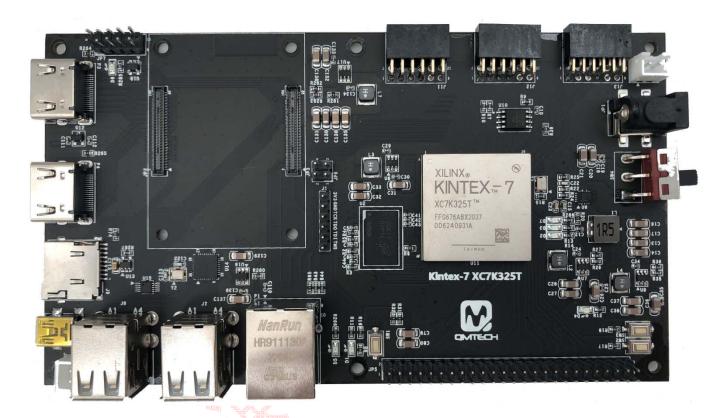
# **QMTECH XC7K325T DEV BOARD**

## **USER MANUAL**



#### **Preface**

The QMTECH® XC7K325T development board uses Xilinx Kintex®-7 devices to demonstrate best price/performance/watt at 28nm while giving you high DSP ratios, cost-effective packaging, and support for mainstream standards like PCIe® Gen3 and 10 Gigabit Ethernet. The Kintex-7 family is ideal for applications including 3G and 4G wireless, flat panel displays, and video over IP solutions.



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#### 1. Vivado 2018.3 Introduction

#### 1.1 Overview

QMTECH XC7K325T Development Board has mounted an 16MB SPI Flash provided by Infineon (Spansion), chip part number is S25FL128L. And the FPGA hardware design allows the FPGA boots from external SPI Flash after power up. The following chapters describe the FPGA download and SPI flash program by using Vivado 2018.3:

- (1) \*.bit file downloaded into FPGA, RAM based content will lost during power up stage;
- (2) \*.mcs file programmed into external SPI Flash, Flash based content is non-volatile and retained during power up stage.

#### 1.2 Vivado 2018.3 Environment

The test examples contained in QMTECH XC7K325T Development Board release package are all developed with Xilinx Vivado 2018.3. Users could download the Vivado 2018.3 from Xilinx official website.

https://www.xilinx.com/support/download.html

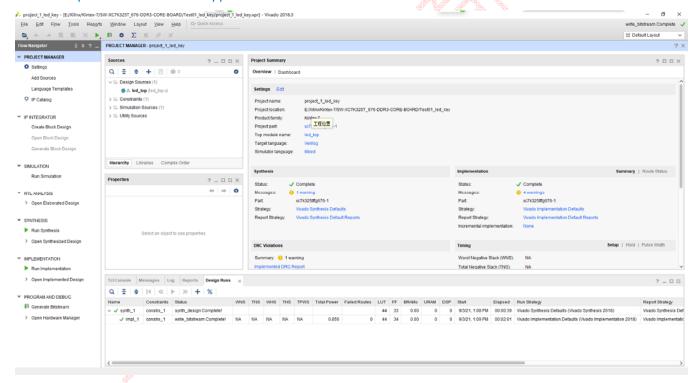


Figure 1-1. Vivado 2018.3 GUI



#### 2. FPGA Download

Users could download \*.bit file directly into FPGA to verify the RTL behavior performs correctly or not. In this section we use the example project Test01\_led\_key to demonstrate the procedure of downloading led top.bit into FPGA.

First step is to make the example project Test01\_led\_key compiled without any error generated. Since this test example is already verified, users could click "Flow Navigator" → "Project MANAGER" → "PROGRAM AND DEBUG" → "Generate Bitstream" to get the led\_top.bit generated directly. If users want to test with some customized project, please follow bellow steps to generate the \*.bit file.

Users could click the 【Run Synthesis】 button shown in below image highlighted with red rectangle to SYNTHESIS the example project. The SYNTHESIS progress is displayed in the tab of "Design Runs" which is also highlighted in below image. Users could get the compile info in the tabs like "Log", "Message":

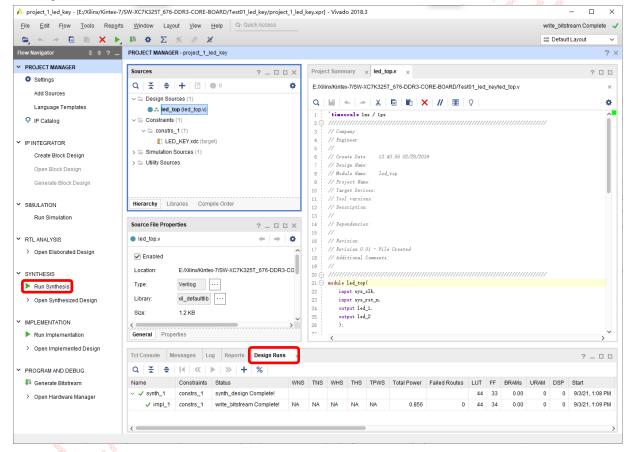


Figure 2-1. Synthesis

There will be a "Synthesis Completed" window popup once the example project successfully synthesized.



Figure 2-2. Synthesis Completed



Users could press the 【ok】 button shown in the previous image to start the project "Implementation". Or press the 【Cancel】 button shown in the previous image and then click "Run Implementation" button highlighted with red rectangle in below image to start a new implementation.

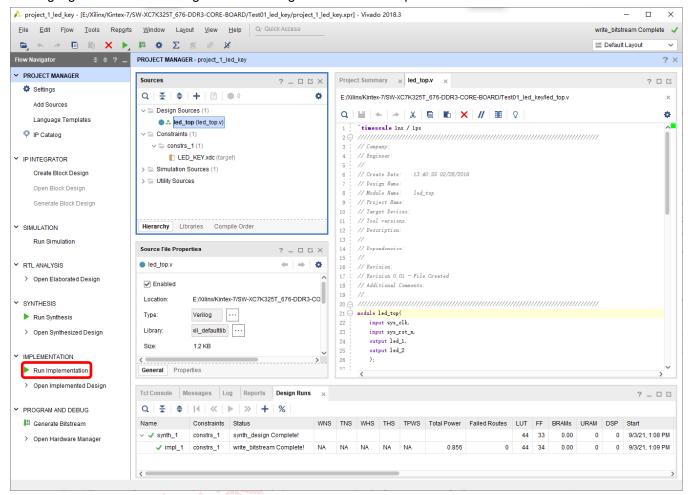


Figure 2-3. Run Implementation

The implementation progress info could be retrieved from the "Design Runs" window. Users could get the implementation info in the tabs like "Log", "Message" and "Reports":

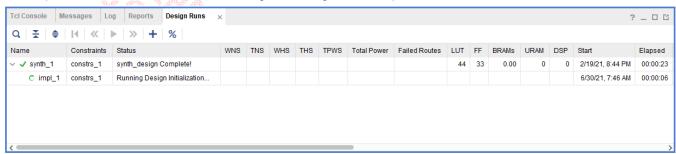


Figure 2-4. Implementation



If there's no error generated during Implementation process, users could start the \*.bit file generation stage. Please make sure the constraint file LED\_KEY.xdc is already contained in the project.

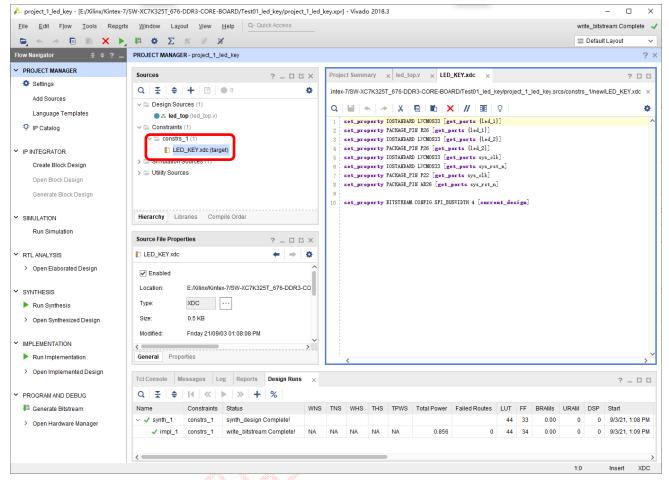


Figure 2-5. LED\_KEY.xdc Constraint File

There'll be a Implemented Completed window popup once the Implementation process finished. Users could click 【OK】 to start the bitstream generation.

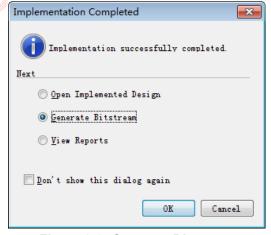


Figure 2-6. Generate Bitstream



Users could also click the 【Cancel】 button shown in the previous image and start to generate the bitstream manually. And then users could click 【Generate Bitstream】 shown in below image to start the bitstream generation.

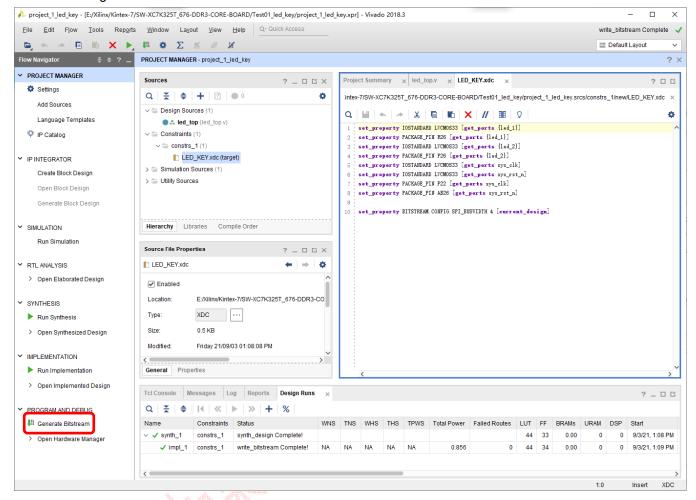


Figure 2-7. Generate Bitstream

Once the \*.bit correctly generated without any error, users could download this \*.bit into FPGA directly. Make sure the Xilinx USB platform cable is correctly connected to the FPGA board's JTAG interface. And then click the 【Open Target】 button shown in below image:

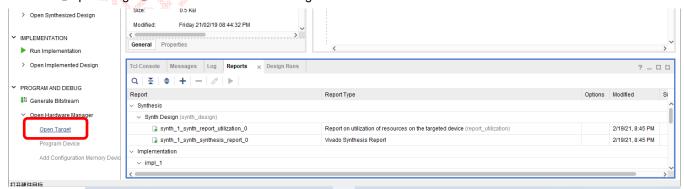


Figure 2-8. Open Target



#### Click [Next] button:



Figure 2-9. "Next"

#### Click [Next] button:

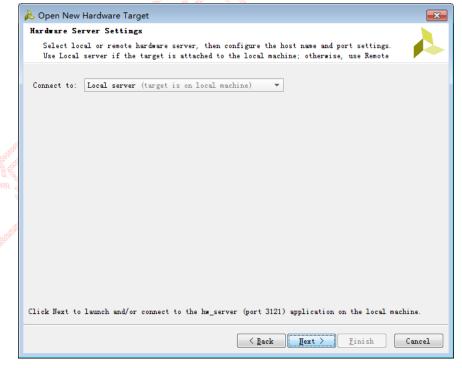


Figure 2-10. "Next"



Below image shows that the Hardware Target "xc7ak325t\_0" is successfully detected, and then click 【Next】:

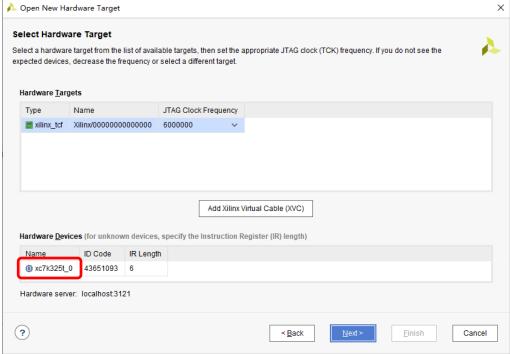


Figure 2-11. Target Detected

#### Click 【Finish】 button:

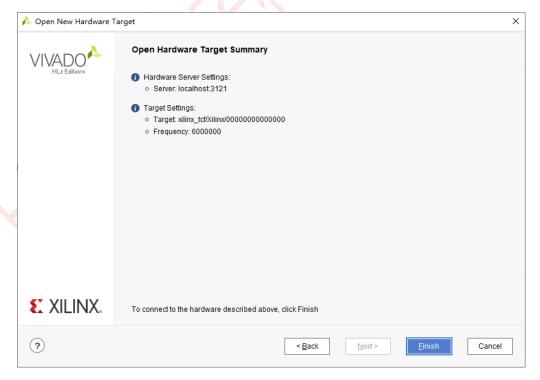


Figure 2-12. "Finish"



project 1 led key - [E:/Xilinx/Kintex-7/SW-XC7K325T 676-DDR3-CORE-BOARD/Test01 led key/project 1 led key.xpr] - Vivado 2018.3 File Edit Flow Tools Reports Window Layout View Help Q- Quick Access write\_bitstream Complete 🗸  $\blacktriangleright$   $\rightarrow$   $\blacksquare$   $\blacksquare$   $\times$   $\blacktriangleright$   $\blacksquare$   $\triangle$   $\Sigma$  %  $\varnothing$  Dashboard  $\lnot$ ■ Default Lavout There are no debug cores. Program device. Refresh device. ? \_ □ [½ × | led\_top.v × LED\_KEY.xdc × Language Templates Q | ₹ | ♦ | Ø | ▶ | ≫ | ■ | ♦ E:/Xillinx/Kintex-7/SW-XC7K325T\_676-DDR3-CORE-BOARD/Test01\_led\_key/led\_top.v Status Name ø ∨ 【 localhost (1) Connected 'timescale ins / ips ▼ IP INTEGRATOR 4 // Engineer I XADC (System Monitor) \$25fl256l-spi-x1\_x2\_x4 Generate Block Design // Create Date: 13:40:55 02/28/2016 // Module Name: led\_top ✓ SIMULATION // Project Name: // Target Devices. Hardware Device Properties ? \_ □ □ × // Tool versions // Description: ← | → | Φ ✓ RTL ANALYSIS > Open Elaborated Design Name: xc7k325t 0 Part // Revision: xc7k325t ✓ SYNTHESIS ID code: 43651093 // Additional Comments Run Synthesis IR length: > Open Synthesized Design Status: Programmed input sys\_clk, ✓ IMPLEMENTATION General Properties Run Implementation Tcl Console × Messages Serial I/O Links Serial I/O Scans > Open Implemented Design set\_property PROGRAM.FILE {E:/%ilinx/Kintex-7/SP-%CTK32ST\_676-DDR3-CORE-BOARD/Test01\_led\_key/project\_1\_led\_key.runz/impl\_1/led\_tep\_bit}. [get\_hw\_devices\_xc7k32St\_0] III Generate Bitstream current\_hw\_device [get\_hw\_devices xc7k325t\_0] refresh\_hw\_device =update\_hw\_probes false [lindex [get hw devices xc7k325t 0] 0] ∨ Open Hardware Manager in INFO: [Labtools 27-1434] Device xc7k325t (JTAG device index = 0) is programmed with a design that has no supported debug core(s) in it create\_hw\_cfgmem =hw\_device [get\_hw\_devices xc7k325t\_0] =mem\_dev [lindex [get\_cfgmem\_parts {s25fl256l=spi=x1\_x2\_x4}] ( Open Target Program Device

Below image shows the main page of the "Hardware Manager":

Type a Tcl command here

Add Configuration Memory De

Figure 2-13. Hardware Manager

Right click the detected chip "xc7k325t\_0 and choose 【Program Device】 to start the \*.bit file download:

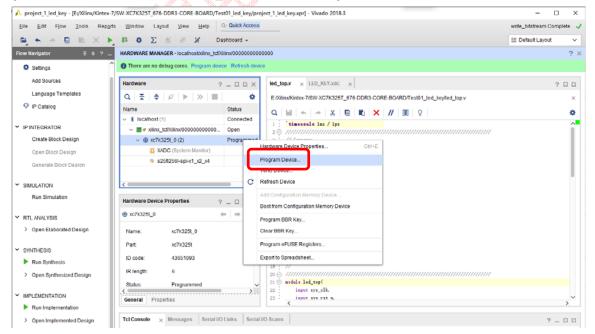


Figure 2-14. Program Device



Choose the previously generated led top.bit file and click the 【Program】:

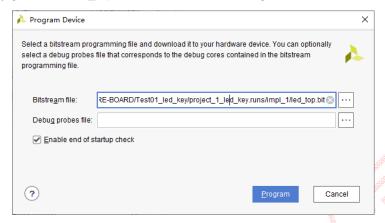


Figure 2-15. Choose \*.bit file

Below image shows the progress of the FPGA downloading:

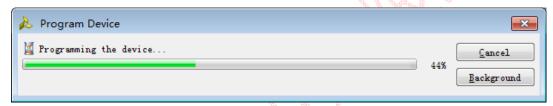


Figure 2-16. Progress Bar

Users could monitor the FPGA internal XADC, Core Voltage supply status, and die temperature by clicking [XADC (System Monitor)] shown in below image:

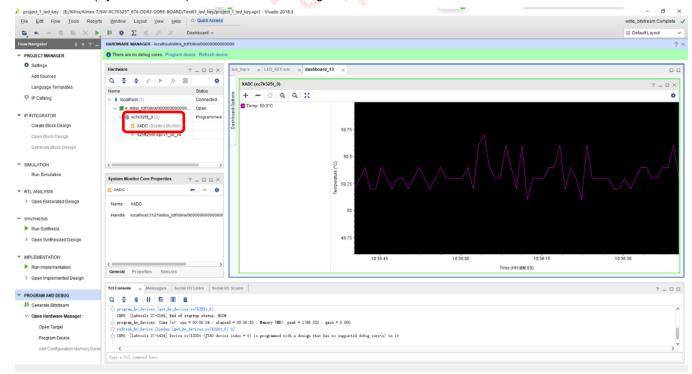


Figure 2-17. XADC



If there's ILA debug core embedded in the example project, users could use this tool to Monitor the waveform and Debug the RTL code. Users could double click the 【hw\_ila\_1 (ILA)】 button and then the waveform monitor window "ILA – hw\_ila\_1" will be displayed. The sampling signals and sampling buffer depth could be configured in the Properties tab. Users could click the 【Run Trigger Immediate】 to start waveform capture.

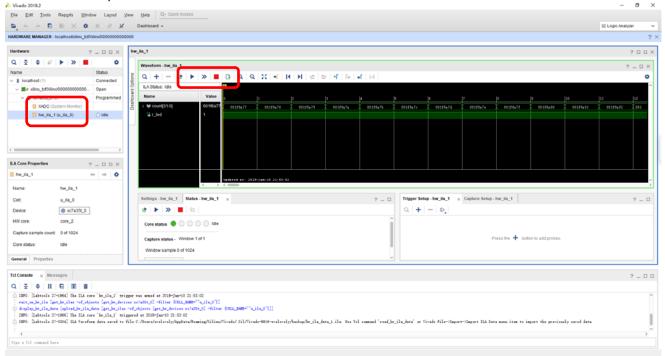


Figure 2-18. ILA Debug

# Waveform in hw ila 1: s x ト → 🗎 lib × 🐧 ± ∅ 💥 Dashboard 🕶 ? \_ 🗆 🗆 X Open thw\_ita\_1 (u\_ita\_0) ILA Core Properties ? \_ 🗆 🖂 🗙 u\_ila\_0 >> = 95 ⊕ xc7a35t\_0 core\_2 us 🌘 🔾 🔾 🔾 Idle unt 0 of 1024 Window sample 0 of 1024 Q X 0 II 0 III i

Figure 2-19. Waveform



### 3. SPI Flash Program

In the previous chapter, we described how to use Vivado Program tool to download \*.bit file into FPGA. But the storage memory embedded in FPGA is SRAM based which means all the content will be flushed during the power on stage. On the QMTECH XC7K325T development board, there's a non-volatile SPI flash mounted. And the XC7K325T FPGA supports to load bitstream from external SPI flash during power on. In this chapter we will introduce the way to program the bitstream into SPI flash.

Since the \*.bit file could not be programmed into SPI flash directly, the file format conversion needs to be done at the very beginning stage.

Users could use Vivado2018.3 【Generate Memory Configuration File 】 to convert the led\_top.bit into led\_test\_S25FL128L.mcs file. Below image shows where this file format convert tool locates:

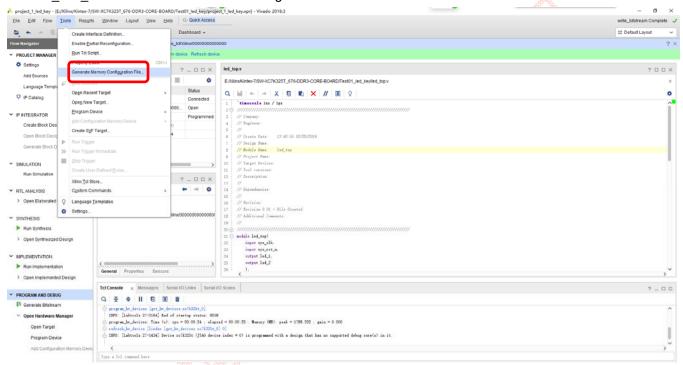
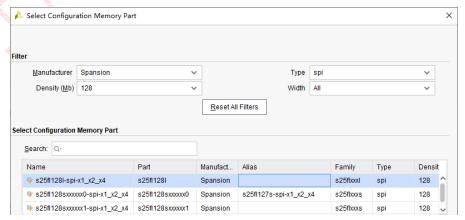


Figure 3-1. Generate Memory Configuration File Tool

Below image shows the example configuration for the file format conversion:

- SPI Flash Part Number: S25FL128L
- > SPI Flash bus width: SPIx4
- > Input File: led top.bit
- Output File: led test S25FL128L.mcs
- Start Address: 0x000000





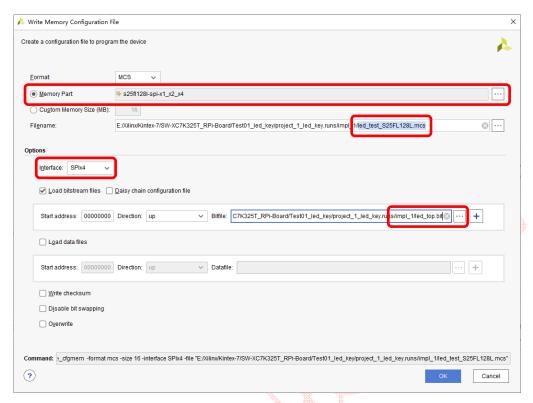


Figure 3-2. Configuration

Once the led\_test\_S25FL128L.mcs file successfully generated, users could program this file into the SPI Flash. Make sure the Xilinx USB Platform Cable is correctly connected to FPGA's JTAG interface. And use Hardware Manager to connect the device "xc7ak325t\_0 (1)". Then right click on the detected FPGA device and choose "Add Configuration Memory Device..". Below image shows the program procedure.

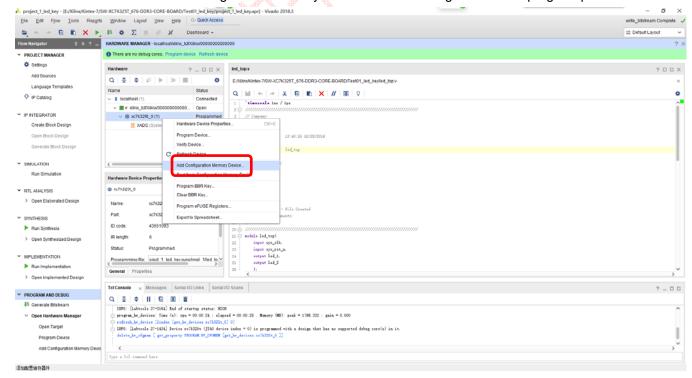


Figure 3-3. Add Memory Device



🝌 Select Configuration Memory Part  $\times$ Filter <u>M</u>anufacturer Spansion spi Density (Mb) 128 Width Reset All Filters Select Configuration Memory Part Search: Q-Name Part Manufact... Alias Family Туре Density (. \$25fl128l-spi-x1\_x2\_x4 s25fl128l s25flxxxl 128 Spansion spi \$\sqrt{s}\$ s25fl128\$xxxxxx0-spi-x1\_x2\_x4 s25fl128\$xxxxxxx0 Spansion s25fl127s-spi-x1\_x2\_x4 s25flxxxs 128 spi \$25fl128sxxxxxx1-spi-x1\_x2\_x4 s25fl128sxxxxxx1 Spansion s25flxxxs spi 128

Choose the SPI Flash chip part: S25FL128L provided by Micron. And then click 【OK】 button:

Figure 3-4. Choose SPI Flash

Click 【OK】 button shown in below image to start the Program:

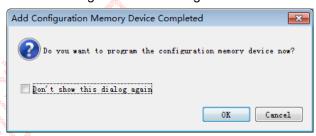


Figure 3-5. Start to Program



?

Cancel

🝌 Program Configuration Memory Device × Select a configuration file and set programming options. Memory Device: s25fl128l-spi-x1\_x2\_x4 Configuration file: ::/Xilinx/Kintex-7/SW-XC7K325T\_RPi-Board/Test01\_led\_key/project\_1\_led\_key.runs/impl\_1/led\_test\_S25FL128L.mcs ٠.. PRM file: State of non-config mem I/O pins: Pull-none **Program Operations** Address Range: Configuration File Only ✓ Erase Blank Check Program ✓ Verify Verify Checksum **SVF Options** Create SVF Only (no program operations) SVF File: (?) Cancel <u>A</u>pply

Choose the led\_test\_S25FL128L.mcs file and click 【OK】button.

Figure 3-6. Start to Program

Below image shows the progress of the SPI flash programming.



Figure 3-7. Progress Bar

Once the program is successfully finished, users could re-power on the board to check whether the FPGA correctly loads the content from SPI flash and implemented functionality is correctly running on FPGA.



### 4. DDR3 Memory Test

Use Vivado2018.3 to open the DDR3 memory test project located in this release folder: /Software/ Test04\_DDR3\_mig\_7series\_0\_3\_ex\_. Below figure shows the example project of example\_top:

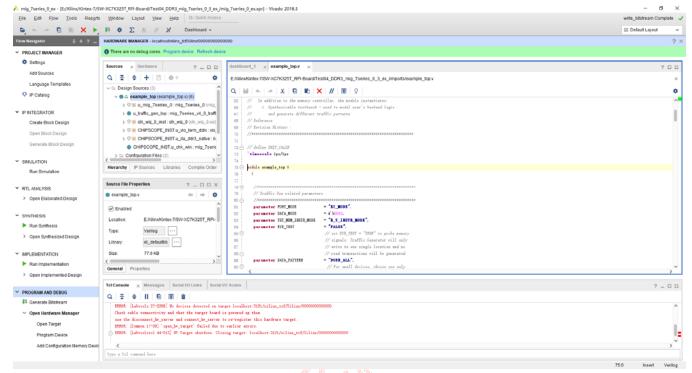
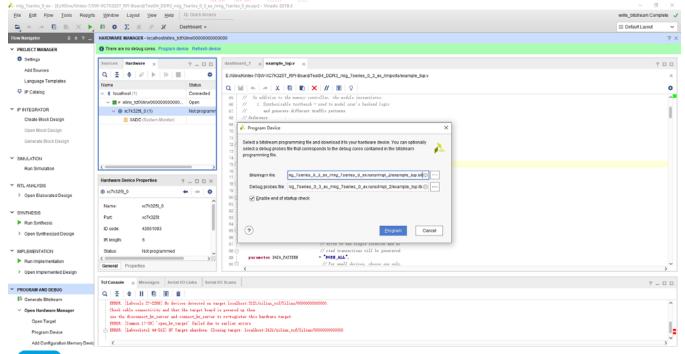


Figure 4-1. DDR3 Test

After the DDR3 memory test project correctly synthesized, implemented and generated \*.bit file, users could use Vivado 2018.3 program tool to program the generated \*.bit file into FPGA. Below image shows the FPGA program status with program tool.





Ming / Series 0, ex - [Et/Klinx/Kintex-7/SW-XC7K325T\_RRI-Board/Test04\_DDR3\_mig\_/Series\_0\_3.ex/mig\_/Series\_0\_ex.xpr] - Vivado 2018.3

File Edit Flow Tools Reports Window Larout New Help | C-Duitt/Access Flow Navigator 5 9 7 HARDWARE MANAGER - localhostrising\_textsinev0000000 □ Default Layout ✓ PROJECT MANAGER Sources | Hardware x ? \_ [ ] example\_top.v x | dashboard\_1 x | hw\_ita\_1 x ? 🗆 🖰 Settings Q | 🛨 | 💠 | 🕫 | 🕨 | 🔳 ٠ ? \_ 🗆 X Add Sources Language Templates Connected ✓ ■ vilinx\_tcfl%ilinx/0000000000... Open P IP Catalog ∨ **⑤** xc7k325t\_0 (3) Programmed ▼ IP INTEGRATOR T XADC (System Mon ☐ hw\_iia\_1 (CHIPSCOPE\_L.. ○ Idle Create Block Design Generate Block Design ✓ SIMULATION dbg pi phaselock err Run Simulation ILA Core Properties ?  $\ \ \, \square \ \ \, \boxtimes \ \ \, \times$ Y RTL ANALYSIS Thw\_ila\_1 ■ dbg\_rdM\_start(1:0) Name: CHIPSCOPE\_INST.u\_ila\_ddr3 ₩ dbg\_rdM\_em[1:0] Run Synthesis Device: @ xc7k325t\_0 HW core: core\_2 Tcl Console X Messages Serial I/O Links Serial I/O Scans ✓ PROGRAM AND DEBUG III Generate Bitstream (in 1890: [Librarola 27-1984] The IIA core 'hejilaj' trigger was armed at 2022-80-20 18:43:27

was,majouja [graducjia vef\_dejerts [graducjavicas refle28,0] filter (CIL\_HUMP'')

diployja jiajata (spleadja-jiajata [graducjia vef\_dejerts [graducjavicas refle281,0]) ✓ Open Hardware Manager LL\_BASS="CHIPSCOPE\_INST w\_ila\_ddr3\_mative")]
s mc7k325t\_0] -filter {CELL\_BASE="CHIPSCOPE\_INST.w\_ila\_ddr3\_mative")]) Open Target 🚣 mig\_7series\_0\_ex - [E;/Xilinx/Kintex-7/SW-XC7K325T\_RPi-Board/Test04\_DDR3\_mig\_7series\_0\_3\_ex\_/mig\_7series\_0\_exxpr] - Vivado 2018.3 o Elle Edit Flow Iools Reports Window Layout View Help Q- Quick Access  $\Rightarrow$   $\blacksquare$   $\Vdash$   $\times$   $\blacktriangleright$   $\clubsuit$   $\diamondsuit$   $\Sigma$  # # Dashboard  $\lnot$ ✓ PROJECT MANAGER Sources Hardware × ? \_ □ □ ple\_top.v × dashboard\_1 × hw\_ifa\_1 × Settings Q | # | # | # | \* | \* | ٠ Waveform - hw\_ita\_1 Add Sources 9 8 4 K N 2 2 Language Templates Connected ∨ ■ vilinx\_tctXilinx/00000000000... Open P IP Catalog Programmed ▼ IP INTEGRATOR T XADC (System Monitor) Create Block Design 5 hw\_vio\_1 (CHIPSCOPE\_I... OK - Outputs F Open Block Design Generate Block Design 🕻 dbg\_rddata\_valid\_r ✓ SIMULATION Run Simulation Debug Probe Properties ? \_  $\square$   $\square$   $\times$ dbg\_rd\_wdt\_err\_w \_ dbg\_cmp\_error + → Φ Source: NETLIST Type: ILA Run Synthesis > Open Synthesized Design ✓ IMPLEMENTATION Run Implementation > Open Implemented Design Tcl Console X Messages Serial I/O Links Serial I/O Scans ✓ PROGRAM AND DEBUG III Generate Bitstream ∨ Open Hardware Manage Onen Tarnet Program Device Add Configuration Me

Users could check the signals like init\_calib\_complete, cmp\_error etc in the ILA waveform window.

Figure 4-2. DDR3 Test Result



#### Reference 5.

- [1] ug470\_7Series\_Config.pdf
  [2] ds182\_Kintex\_7\_Data\_Sheet.pdf
  [3] ug475\_7Series\_Pkg\_Pinout.pdf
  [4] S25FL256L\_S25FL128L\_256-MB\_32-MB\_128-MB\_16-MB\_3.0\_V\_FL-L\_FLASH\_MEMORY.pdf
  [5] MT41K128M16.pdf
  [6] TPS563201.pdf
  [7] MP8712.PDF





# 6. Revision

Doc. Rev.	Date	Comments
0.1	11/12/2023	Initial Version.
1.0	11/21/2023	V1.0 Formal Release.



