

AM57xx hardware

ABSTRACT

The purpose of this guide is to walk hardware designers through the various stages of designing a board on this platform.

Contents

1	Introduction	2
2	Constructing the Block Diagram	2
3	Selecting the Boot Mode.....	2
4	Confirming Pin Multiplexing Compatibility	3
5	Confirming Electrical and Timing Compatibility	3
6	Designing the Power Subsystem	4
7	Designing the Clocking Subsystem	4
8	Analyzing Thermal Management Requirements.....	5
9	Floorplanning the PCB	5
10	Creating the Schematics.....	5
11	Laying Out the PCB	6
12	Board Bringup/Diagnostic.....	6
13	References	7

Trademarks

All trademarks are the property of their respective owners.

1 Introduction

This document follows the structure shown in [Figure 1](#). Each design stage in the Timeline links to a collection of useful documentation, application reports, and design recommendations pertaining to that stage. Using this guide, hardware designers can efficiently locate the resources they need at every step in the board design flow.

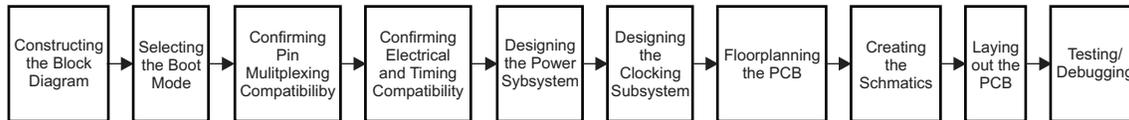


Figure 1. Hardware Design Timeline

2 Constructing the Block Diagram

The first step in designing the hardware platform is to create a detailed block diagram. The block diagram should contain all major system ICs and illustrate which I/O ports are used for device interconnection. Below is a collection of resources to aid in the Block Diagram creation process.

- The links at the TI website below provide block diagrams, application reports, tools, software, design considerations, and other related information for various products under category "Related End Equipments".
 - [AM574x Product Folder](#)
 - [AM572x Product Folder](#)
 - [AM571x Product Folder](#)
 - [AM570x Product Folder](#)
- An EVM (Evaluation Module) is always a good source from which to start building a reference design for these devices. The technical documentation for the EVM is available for download from the following locations:
 - [TMDSEVM572X](#)
 - [TMDXIDK5728](#)
 - [TMDXIDK5718](#)
 - [TMDSIDK574](#)
- The AM57xx family of devices offer a range of performance options while being all designed using the same processing elements and interfaces. This allows that family to be software compatible. Additionally, AM574x, AM572x and AM571x have very similar footprints that allow migration on the same board design. The [AM574x/AM572x/AM571x Compatibility Guide](#) covers the differences in ball assignment, pin multiplexing and basic features between AM574x, AM572x, and AM571x.
- Select from a list of complementary devices to attach to AM57xx device in your system:
 - AM574x Power Management Device (required): [TPS659037](#)
 - AM572x Power Management Device (required): [TPS659037](#)
 - AM571x Power Management Device (required): [TPS659037](#) or [TPS65916](#)
 - AM570x Power Management Device (required): [LP87332D](#) + [LP873220](#) or [TPS65916](#)

3 Selecting the Boot Mode

The block diagram that you are creating should also indicate which interface will be used for booting this device. These devices contain an on-chip ROM bootloader with the following features:

- The boot config pins are sampled at power-on-reset
- Sets up system for boot depending on boot configuration selected
- Depending on boot mode, copies image to internal RAM and then executes it
- Maximum size of the boot image is 128 KBytes

The following boot modes are supported:

- NOR Flash boot
- NAND Flash boot
- SD boot
- eMMC boot
- QSPI_1 boot (1-bit SPI flash memories)
- QSPI_4 boot (4-bit (Quad) SPI flash memories)
- SATA boot
- Universal Asynchronous Receiver/Transmitter (UART) boot
- Universal Serial Bus (USB) boot (like an ethernet card, not as mass storage)
- HS USB 2.0 boot (like an ethernet card, not as mass storage)

If the first boot source fails to boot, the ROM will move on to the next one in the sequence. Keep in mind that some boot sources take some time to timeout if that boot source isn't available.

To understand details on different boot modes, see the device-specific technical reference manual (TRM).

Key Boot Considerations are:

- It is recommended to include population options for other boot modes to aid in development
- Boot pins have other functions after reset. Make sure your board design takes this into account when choosing pull-up/down resistors for the boot pins.

4 Confirming Pin Multiplexing Compatibility

The AM57xx device contains many peripheral interfaces. In order to reduce package costs while maintaining maximum functionality, many of the AM57xx terminals can multiplex up to 16 signal functions. Some background about the AM57xx pin-multiplexing:

- Although there are many combinations of pin-multiplexing that are possible, only a certain number of sets, called IO sets, are valid due to timing limitations. These valid IO sets were carefully chosen to provide many possible application scenarios for the user.
- In order to guarantee the IO timings published in the AM57xx data manual over the lifetime of the device, AM57xx software must implement the proper pin configuration requirements. These requirements impact software configuration of the following registers and are fully documented in the *Pad Configuration* section of the device-specific AM57xx TRM
 - Pad Configuration Registers (muxmode, slew control, Virtual IO Timing Modes, and so forth)
 - IODELAYCONFIG Registers (Manual IO Timing Modes)

Texas Instruments has developed a Windows/Linux application called the TI PinMux Tool that helps a system designer select the appropriate pin-multiplexing configuration for their AM57xx-based product design. This tool provides a way to select valid IO Sets of specific peripheral interfaces to insure the pin-multiplexing configuration selected for a design only uses valid IO Sets supported by AM57x. Additionally, it also provides generated output files to help software correctly implement the pad configuration requirements necessary for guaranteeing the device's IO timings. These generated files are named with the prefix "boardPadDelay." The TI PinMux Tool must be used to validate the device pin definitions chosen in your design. It can be accessed at the link below:

- [TI PinMux Tool](#)

5 Confirming Electrical and Timing Compatibility

A key step in the hardware design before beginning schematic capture is to confirm both DC and AC electrical compatibility between this device and the other ICs connecting to it.

- The device data sheet has important information with regards to timing and electrical characteristics.
- For high-speed interfaces, you can run IBIS simulations using IBIS models provided for AM57x ZCE and ZCZ package to confirm signal Integrity. The IBIS model for your chosen AM57xx device can be downloaded from the Models section under the Tools & Software tab of the device's product page on [ti.com](#).

- [Using IBIS Models for Timing Analysis](#)

NOTE: TI provides PCB layout specifications for the following interfaces, eliminating the need to perform electrical analysis:

- DDR3/DDR3L - see the device-specific data manual (precludes timing analysis)
 - USB, HDMI, SATA, PCIe - see the [High-Speed Interface Layout Guidelines](#)
-

6 Designing the Power Subsystem

Once the block diagram has been validated for pin multiplexing, electrical, and timing compatibility, the power sub-system can be designed. Texas Instruments requires that the following PMIC (or Power Management IC) be used with AM57x designs:

- AM574x Power Management Device (required): [TPS659037](#)
- AM572x Power Management Device (required): [TPS659037](#)
- AM571x Power Management Device (required): [TPS659037](#) or [TPS65916](#)
- AM570x Power Management Device (required): [LP87332D](#) + [LP873220](#) or [TPS65916](#)

Note that both the TPS659037 and TPS65916 PMICs require an external 16.384MHz crystal.

See the resources below on estimating power consumption and designing a AM57x + PMIC solution.

- The Power Estimation Tool (PET) provides insight into the power consumption of select AM57xx processors. The tool includes the ability for you to choose multiple application scenarios and understand the power consumption as well as how advanced power saving techniques can be applied to further reduce overall power consumption.
- [AM574x Power Estimation Tool](#)
- [AM572x Power Estimation Tool](#)
- [AM571x Power Estimation Tool](#)
- [AM570x Power Estimation Tool](#)
- [AM572x Power Consumption Summary](#)
- [AM571x Power Consumption Summary](#)
- [AM570x Power Consumption Summary](#)
- [TPS659037 Power Management Unit \(PMU\) for Processor Data Sheet](#)
- [TPS659037 User's Guide to Power AM574x, AM572x, and AM571x User's Guide](#)

7 Designing the Clocking Subsystem

In addition to the power subsystem, the clocking subsystem needs to be designed to provide appropriate clocks to all ICs in the system. These clocks can be created by pairing crystals with internal oscillators within the system ICs, or they can be created by a separate clock generator. For your design, see the information below on designing the clocking subsystem.

Key Considerations:

- The device operation requires one or more of the following clocks:
 - A 32k optional crystal as an optional clock source for the RTC.
 - Two HF crystals, SYS_CLKIN1 (mandatory) with either 19.2, 20, or 27 MHz and SYS_CLKIN2 (optional) with 19.2-32 MHz quartz or 12-38.4 MHz CMOS square clock source as reference clocks for system operation.
- For more details, see the *Clocking* sections of the device-specific data sheet and TRM.

8 Analyzing Thermal Management Requirements

The product design cycle should include thermal analysis and thermal management techniques to ensure the operating junction temperature of the device is within functional limits.

- [Thermal Design Guide for DSP and ARM Application Processors](#)
- [Power and Thermal Design Considerations Using TI's AM57x Processor Reference Design](#)
- [AM572x Thermal Considerations](#)
- Thermal ratings listed in the device-specific data manual
- Thermal models on the device-specific product page on ti.com

9 Floorplanning the PCB

Before beginning schematic capture, it is recommended to floorplan the system PCB to determine the interconnect distances between the various system ICs.

10 Creating the Schematics

At this point in the design, it is time to start capturing the schematics. The following collection of information will aid you in creating the schematics:

- Key Considerations
 - Output clocks that are internally looped back
 - Do not forget to install a JTAG connection
 - JTAG: Make sure to use the RTCK pin on the JTAG connector. For more information, see the [Emulation and Trace Headers Technical Reference Manual](#).
- It is helpful to refer to the EVM schematics (that can be downloaded from the EVM links listed above in [Section 2](#)) as examples throughout the schematic capture process:
- Make sure to use the canned schematics in the device-specific data sheet for the following interfaces:
 - DDR3/DDR3L
- For detailed information on USB, HDMI, SATA, and PCIe board design, see the [High-Speed Interface Layout Guidelines](#)
- During and after schematic capture, check your design against the schematic checklist:
 - [AM57x Schematic Checklist](#)
- Plan to have an internal review to go through the schematic checklist and inspect other key areas of the schematic to look for inaccuracies, missing net connections, and so forth.

Below is a list of additional aids available on the AM57xx device's product page that can be used during your schematic and board design:

- Altium symbols
- Pin names and numbers in the device-specific data manual:
- BSDL Simulation Models
- IBIS Simulation Models

11 Laying Out the PCB

After completing schematic capture, see the following information on laying out the PCB:

- It is often helpful to refer to an example layout when designing a custom PCB:
 - The EVM designs listed in [Section 2](#) all contain full PCB layouts that can be used as successful sample designs.
- Make sure to follow the Layout Specifications for the following Critical Interfaces:
 - DDR3/DDR3L - see device-specific data sheet
 - USB, HDMI, SATA, PCIe - see the [High-Speed Interface Layout Guidelines](#)
- Plan to have an internal PCB layout review with your design team to verify that net connection traces and the power distribution network were created correctly.
- General Information Articles:
 - [Understanding TI's PCB Routing Rule-Based DDR Timing Specification](#)
 - [AM57xx BGA PCB Design](#)

12 Board Bringup/Diagnostic

Once your custom PCB has been produced and assembled, see the following information on bringing-up and debugging the system.

- Overview of [Debug and Trace Tools](#) wiki
- Category: [Code Composer Studio v6](#)
- Code Composer Studio Using BSDL to validate AM57xx based board
 - You can use AM57xx BSDL files to validate the connectivity on board build.
- [Processor SDK RTOS Diagnostics](#)

13 References

1. <http://www.ti.com/tool/tmdxevm5728>
2. [AM5748](#)
3. [AM5728](#)
4. [AM5718](#)
5. [AM5708](#)
6. [TPS659037](#)
7. [AM574x Sitara™ Processors Silicon Revision 1.0 Technical Reference Manual](#)
8. [AM572x Sitara Processor Technical Reference Manual](#)
9. [AM571x and AM570x Sitara Processor Technical Reference Manual](#)
10. [Pin Mux Tool](#)
11. [OMAP5910 ARM Data Throughput Analysis](#)
12. [High-Speed Interface Layout Guidelines](#)
13. [AM574x Power Estimation Tool](#)
14. [AM572x Power Estimation Tool](#)
15. [AM571x Power Estimation Tool](#)
16. [AM570x Power Estimation Tool](#)
17. [AM572x Power Consumption Summary](#)
18. [AM571x Power Consumption Summary](#)
19. [AM570x Power Consumption Summary](#)
20. [TPS659037 Power Management Unit \(PMU\) for Processor](#)
21. [TPS659037 User's Guide to Power AM574x, AM572x, and AM571x User's Guide](#)
22. [Power and Thermal Design Considerations Using TI's AM57x Processor Reference Design](#)
23. [AM572x Thermal Considerations](#)
24. [AM574x Sitara™ Processors Silicon Revision 1.0 Data Manual](#)
25. [AM570x Sitara Processors Data Manual](#)
26. [AM57xx BGA PCB Design wiki](#)
27. [General hardware design/BGA PCB design/BGA decoupling wiki](#)
28. [AM572x GP EVM Power Simulations](#)
29. [DM814x, DM814x Debug and Trace Tools wiki](#)
30. [Category:Code Composer Studio v6 wiki](#)
31. [AM570x Power Consumption Summary](#)
32. [Thermal Design Guide for DSP and ARM Application Processors](#)
33. [Emulation and Trace Headers Technical Reference Manual](#)
34. [AM57x Schematic Checklist](#)
35. [AM57xx BGA PCB Design](#)

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (www.ti.com/legal/termsofsale.html) or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2019, Texas Instruments Incorporated