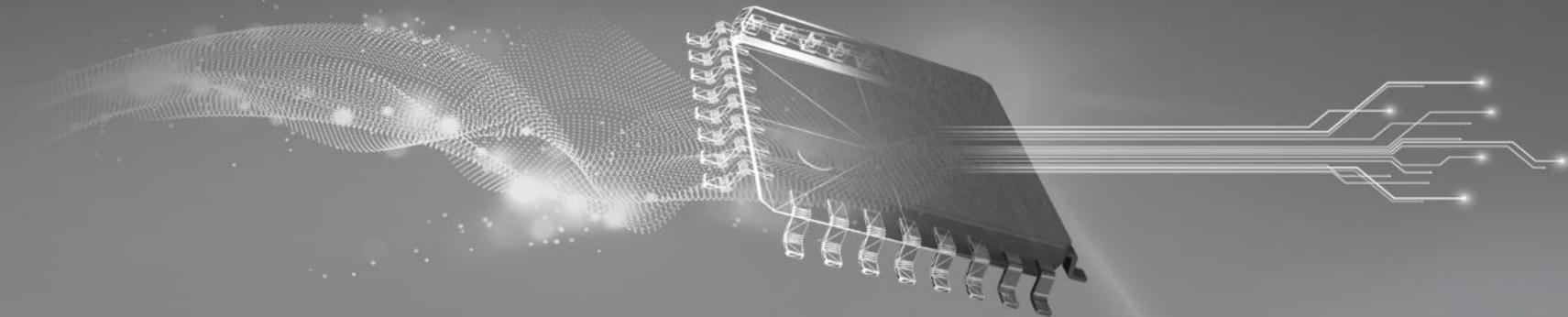


# TI TECH DAYS



## **From start to finish: A product development roadmap for Sitara™ processors**

Schuyler Patton

Sitara Processors

# Overview

- Example Phases for a Product Development
- Evaluation Phase
- Board Development Phase
- Software Development Phase
- Production Phase / SW Lifecycle

# Phases of Product Development

# One Example of a Product Development Timeline



# One Example of a Product Development Timeline

Sitara Processor Evaluation

Board Development

Software Development

Product Lifecycle

HW Platform Options

Custom (Product) Board

TI EVM

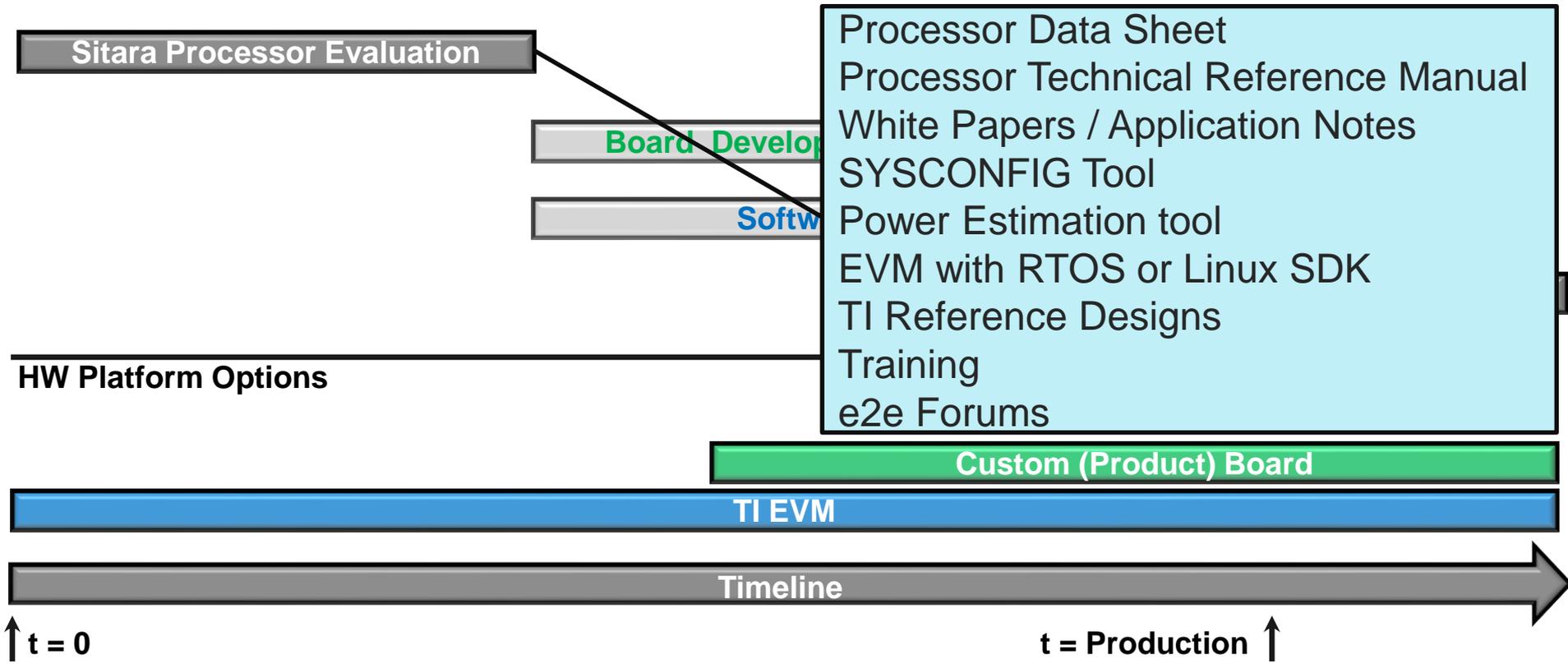
Timeline

$t = 0$

$t = \text{Production}$

# Processor Evaluation

# Product Development Timeline - Evaluation



# Processor Evaluation – Datasheet & TRM

Product Folder Order New Technical Documents Tools & Software Support & Community Reference Design

AM3359, AM3358, AM3357, AM3356, AM3354, AM3351, AM3351

AM335x Sitara™ Processors

## 1 Device Overview

### 1.1 Features

- Up to 1-GHz Sitara™ ARM® Cortex®-A9 32-Bit RISC Processor
- NEON™ SIMD Coprocessor
- 32KB of L1 Instruction and 32KB of Data Cache With Single-Error Detection (Parity)
- 256KB of L2 Cache With Error Correcting Code (ECC)
- 119KB of On-Chip Boot ROM
- 64KB of Dedicated RAM
- Emulation and Debug - JTAG
- Interrupt Controller (up to 128 Interrupt Requests)
- On-Chip Memory (Shared L3 RAM)
- 64KB of General-Purpose On-Chip Memory Controller (OCMC) RAM
- Accessible to All Masters
- Supports Retention for Fast Wakeup
- External Memory Interfaces (EMIF)
- mDDR1, PDDR1, DDR2, DDR3, DDR3L Controller
  - mDDR: 200-MHz Clock (400-MHz Data Rate)
  - DDR2: 266-MHz Clock (532-MHz Data Rate)
  - DDR3: 400-MHz Clock (800-MHz Data Rate)
  - DDR3L: 400-MHz Clock (800-MHz Data Rate)
- 16-Bit Data Bus
- 1GB of Total Addressable Space
- Supports One x16 or Two x8 Memory Device Configurations
- General-Purpose Memory Controller (GPMC)
  - Flexible 8-Bit and 16-Bit Asynchronous Memory Interface With up to Seven Chip Selects (NAND, NOR, Muxed-NOR, SRAM)
  - Uses BCH Code to Support 4-, 8-, or 16-Bit ECC
  - Uses Hamming Code to Support 1-Bit ECC
- Error Locator Module (ELM)
  - Used in Conjunction With the GPMC to Locate Addresses of Data Errors from Synchronous Polynomials Generated Using a BCH Algorithm
  - Supports 4-, 8-, and 16-Bit per 512-Byte Block Error Location Based on BCH Algorithm
- Programmable Real-Time Unit Subsystem and Industrial Communication Subsystem (PRU-ICSS)
  - Supports Protocols such as EtherCAT®
- PROFIBUS, PROFNET, EtherNet/IP™, and More
  - Two Programmable Real-Time Units (PRU)s
    - 32-Bit LoadStore RISC Processor Capable of Running at 200 MHz
    - 8KB of Instruction RAM With Single-Error Detection (Parity)
    - 8KB of Data RAM With Single-Error Detection (Parity)
    - Single-Cycle 32-Bit Multiplier With 64-Bit Accumulator
    - Enhanced GPIO Module Provides Shift-In/Out Support and Parallel Latch on External Signal
  - 32KB of Shared RAM With Single-Error Detection (Parity)
  - Three 120-Byte Register Banks Accessible by Each PRU
  - Interrupt Controller (INTC) for Handling System Input Events
  - Local Interconnect Bus for Connecting Internal and External Masters to the Resources Inside the PRU-ICSS
- Peripherals Inside the PRU-ICSS:
  - One UART Port With Flow Control Pins, Supports up to 12 Mbps
  - One Enhanced Capture (eCAP) Module
  - Two Mill Ethernet Ports that Support Industrial Ethernet, such as EtherCAT
  - One MDIO Port
- Power, Reset, and Clock Management (PRCM) Module
  - Controls the Entry and Exit of Stand-By and Deep-Sleep Modes
  - Responsible for Sleep Sequencing, Power Domain Switch-Off Sequencing, Wake-Up Sequencing, and Power Domain Switch-On Sequencing
  - Clocks
    - Integrated 15- to 35-MHz High-Frequency Oscillator Used to Generate a Reference Clock for Various System and Peripheral Clocks
    - Supports Individual Clock Enable and Disable Control for Subsystems and Peripherals to Facilitate Reduced Power Consumption
    - Five ADPLLs to Generate System Clocks (MPU Subsystem, DDR Interface, USB and

**An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property notices and other important disclosures. (PRODUCT DATA.)**

## AM335x and AMIC110 Sitara™ Processors

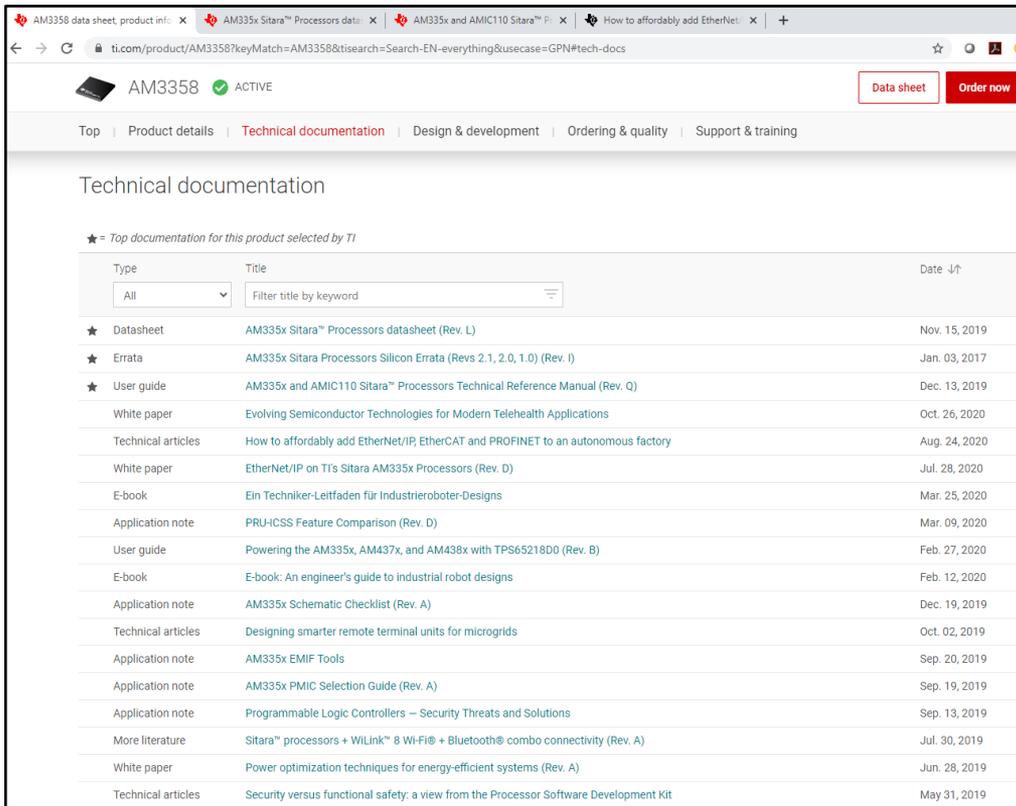
### Technical Reference Manual

TEXAS INSTRUMENTS

Literature Number: SPRUHT10  
October 2011–Revised December 2019

- Datasheet
  - ARM processor frequencies supported
  - Available Peripherals
  - DDR Memory types supported
  - Power, Clocking Capabilities
- Technical Reference Manual (TRM)
  - Companion guide to Datasheet
  - details the integration, environment, functional description, programming models for each peripheral and subsystem in the device

# Processor Evaluation – Technical Documentation



The screenshot shows the TI website's technical documentation page for the AM3358 processor. The page is titled "Technical documentation" and features a navigation bar with links for "Top", "Product details", "Technical documentation", "Design & development", "Ordering & quality", and "Support & training". Below the navigation bar, there is a search bar and a filter dropdown set to "All". The main content is a table listing various documents, including datasheets, errata, user guides, white papers, technical articles, e-books, and application notes, each with a title and a date.

Type	Title	Date ↓↑
★ Datasheet	AM335x Sitara™ Processors datasheet (Rev. L)	Nov. 15, 2019
★ Errata	AM335x Sitara Processors Silicon Errata (Revs 2.1, 2.0, 1.0) (Rev. I)	Jan. 03, 2017
★ User guide	AM335x and AMIC110 Sitara™ Processors Technical Reference Manual (Rev. Q)	Dec. 13, 2019
White paper	Evolving Semiconductor Technologies for Modern Telehealth Applications	Oct. 26, 2020
Technical articles	How to affordably add EtherNet/IP, EtherCAT and PROFINET to an autonomous factory	Aug. 24, 2020
White paper	EtherNet/IP on TI's Sitara AM335x Processors (Rev. D)	Jul. 28, 2020
E-book	Ein Techniker-Leitfaden für Industrieroboter-Designs	Mar. 25, 2020
Application note	PRU-ICSS Feature Comparison (Rev. D)	Mar. 09, 2020
User guide	Powering the AM335x, AM437x, and AM438x with TPS65218D0 (Rev. B)	Feb. 27, 2020
E-book	E-book: An engineer's guide to industrial robot designs	Feb. 12, 2020
Application note	AM335x Schematic Checklist (Rev. A)	Dec. 19, 2019
Technical articles	Designing smarter remote terminal units for microgrids	Oct. 02, 2019
Application note	AM335x EMIF Tools	Sep. 20, 2019
Application note	AM335x PMIC Selection Guide (Rev. A)	Sep. 19, 2019
Application note	Programmable Logic Controllers – Security Threats and Solutions	Sep. 13, 2019
More literature	Sitara™ processors + WiLink™ 8 Wi-Fi® + Bluetooth® combo connectivity (Rev. A)	Jul. 30, 2019
White paper	Power optimization techniques for energy-efficient systems (Rev. A)	Jun. 28, 2019
Technical articles	Security versus functional safety: a view from the Processor Software Development Kit	May 31, 2019

- White papers
  - Power Optimization Techniques
  - Sitara Processor Security
- Application Notes
  - Hardware Design Guide
  - Schematic Checklist
  - EMIF Tool
- E-Books
- Technical Articles

# Processor Evaluation - SYSCONFIG Tool

The screenshot displays the SysConfig web application interface. The browser address bar shows the URL: `dev.ti.com/sysconfig/#/config/?args=--device%20AM335x%20--part%20Default%20--package%20ZCE%20--theme%20...`. The application has a red header with "FILE" and "ABOUT" menus, and a status bar indicating "Changes are unsaved".

The main interface is divided into several sections:

- Left Panel:** A list of peripheral categories with expand/collapse icons. Categories include ADC, DCAN, DEBUGSS, eCAP, eCAP0\_PRUSS1, ECAT\_PRUSS1, eHRPWM, EMIF, eQEP, GLUE, GPIO, GPMC, I2C, LCD, LCDC, MCASP, MDIO, MDIO\_PRUSS1, MII, MII\_PRUSS1, MMC, OSC, PRU\_PRUSS1, RGMII, RMII, RTC, SPI, TEST, TIMER, UART, UART\_PRUSS1, and USB.
- ADC Configuration Panel:** Shows "ADC (0 of 1 Added)". It includes an "ADD" button and a "REMOVE ALL" button. Below, it prompts to "Click the Add button to add a ADC to your design". A table lists configuration options for "MyADC1":

Use Peripheral	Value
Use Peripheral	Any
Preferred Voltage	Any
Use Case	All pins of peripheral

Signals	Pins	Pull Up/Down	Rx
<input checked="" type="checkbox"/>	AIN0	Any	No Pull
<input checked="" type="checkbox"/>	AIN1	Any	No Pull
<input checked="" type="checkbox"/>	AIN2	Any	No Pull
<input checked="" type="checkbox"/>	AIN3	Any	No Pull
<input checked="" type="checkbox"/>	AIN4	Any	No Pull
<input checked="" type="checkbox"/>	AIN5	Any	No Pull
<input checked="" type="checkbox"/>	AIN6	Any	No Pull
<input checked="" type="checkbox"/>	AIN7	Any	No Pull
<input checked="" type="checkbox"/>	VREFN	Any	No Pull
<input checked="" type="checkbox"/>	VREFP	Any	No Pull
- Generated Files Panel:** Lists files generated for the configuration:
  - am335x\_pinmux.h (starterware)
  - am335x\_pinmux\_data.c (starterware)
  - devicetree.dtsi (devicetree)
  - PinmuxConfigSummary.csv (csv)
  - untitled.syscfg (Configuration Script)Total Files: 5
- Device Selection Panel:** Shows "AM335x (Device)" and "ZCE (Package)" with a "SWITCH PART/PACKAGE" button.
- Pinmux Map:** A grid showing pin availability and assignment for the AM335x device. The grid is 19 rows by 19 columns. A legend indicates:
  - Green dot: Pin Available
  - Red dot: Pin Assigned
  - Yellow dot: Warning (Power Domain)
  - Grey dot: Fixed (N/A)

- Software tool that provides a Graphical User Interface for configuring pin multiplexing settings, resolving conflicts
- Perform “what-if” on possible pin mux configurations for a particular application

# Processor Evaluation - TI Reference Designs

Select TI reference designs

Find reference designs leveraging the best in TI technology to solve your system-level challenges

Show quick search

Hide filters Reset 27 matching designs out of 4174 total designs Email

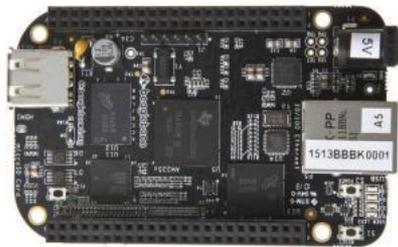
Design title	Market	Product
TIDEP-01013 - Gesture controlled HMI with mmWave sensors and Sitara™ processors reference design	Industrial	Sensors Processors
TIDA-010032 - Universal data concentrator reference design supporting Ethernet, 6LOWPAN RF mesh and more	Industrial	Wireless connectivity Switches & multiplexers Processors Power management Microcontrollers (MCU) Logic Isolation Interface Data converters Amplifiers
TIDEP-01005 - Human Machine Interface (HMI) for Smart Thermostat Reference Design	Industrial	Processors
TIDA-01568 - 12mm x 12mm, 5-Rail Power Sequencing for Application Processors Reference Design	Industrial Communications equipment	Wireless connectivity Processors Power management Logic Interface
TIDA-01555 - Flexible Interface (PRU-ICSS) Reference Design for Simultaneous, Coherent DAQ Using Multiple ADCs	Industrial	Processors Power management

Find power reference designs by parameter

- Vin (V) (Min)
- Vin (V) (Max)
- Isolated/Non-Isolated
- Input Type
- Vout (V) (Nom)
- Iout (A) (Max)
- Output Power (W)

- Leverage TI technology to solve your system-level challenges
- Some designs use TI Evaluation Modules
- Schematics and other documentation provided such as PCB layouts, Bill of Materials (BOM) and User Guide

# Product Timeline - Evaluation



Use TI Processor SDKs to run demos as well as build experimental applications on TI Evaluation Modules

Processor SDK for AM335x Sitara Processors - Linux and TI-RTOS support  
PROCESSOR-SDK-AM335X

[Description & Features](#) [Technical documentation](#) [Support & Training](#) [Order Now](#)

Order Now

Part Number	Buy from Texas Instruments or Third Party	Alert Me	Status	Current Version	Version Date	OS	Linux Kernel
PROCESSOR-SDK-LINUX-AM335X: Linux Processor SDK for AM335x	Free <a href="#">Get software</a>	<a href="#">Alert Me</a>	ACTIVE	v06.03	19-Apr-2020	Linux	v4.19
PROCESSOR-SDK-LINUX-RT-AM335X: Linux-RT Processor SDK for AM335x	Free <a href="#">Get software</a>	<a href="#">Alert Me</a>	ACTIVE	v06.03	20-Apr-2020	Linux-RT	v4.19
PROCESSOR-SDK-RTOS-AM335X: RTOS Processor SDK for AM335x and AMIC110 devices	Free <a href="#">Get software</a>	<a href="#">Alert Me</a>	ACTIVE	v06.03	20-Apr-2020	TI-RTOS	n/a

# Product Evaluation Summary

- Use the Datasheet and The Technical Reference Manual to determine processor compatibility
- Review the available Application Notes, Whitepapers and other technical documentation available on ti.com
- Use the SYSCONFIG tool to evaluate possible pin mux outputs to determine “what if” processor configurations
- Review TI Reference Designs for design elements to be used in a new product
- Experiment with TI Evaluation Modules and the RTOS and Linux Software Development Kits to evaluate processor capabilities

# Board Development

# Product Timeline – Board Development

Sitara Processor Evaluation

Board Development

Software Development

Product Lifecycle

HW Platform Options

Custom (Product) Board

TI EVM

Timeline

$t = 0$

$t = \text{Production}$

# Product Timeline – Board Development

- The purpose of this application report is to walk hardware designers through the various stages of designing a board on this platform.
- Block diagram of suggested of hardware design flow for a board design
- Use Reference material provided by TI in the Technical Documentation tab of the Processor Product folder

The screenshot shows the cover page of the 'AM335x Hardware Design Guide' application report. At the top left is the Texas Instruments logo. To its right, the text reads 'Application Report' and 'SPRABU5–May 2019'. The main title 'AM335x Hardware Design Guide' is centered, with 'Catalog Processors' below it. An 'ABSTRACT' section states the report's purpose. A 'Contents' table lists 12 sections with page numbers. A 'Trademarks' section mentions ARM and TI. At the bottom, there are links for 'Submit Documentation Feedback' and 'Copyright © 2019, Texas Instruments Incorporated'.

**TEXAS INSTRUMENTS** Application Report  
SPRABU5–May 2019

**AM335x Hardware Design Guide**  
Catalog Processors

**ABSTRACT**  
The purpose of this application report 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 .....	3
7	Designing the Clocking Subsystem .....	4
8	PCB Floorplan .....	4
9	Creating the Schematics .....	5
10	Laying Out the PCB .....	5
11	Board Bringup/Diagnostic .....	6
12	References .....	6

**Trademarks**  
Cortex is a registered trademark of ARM Limited.  
Arm is a registered trademark of Arm Limited.  
All other trademarks are the property of their respective owners.

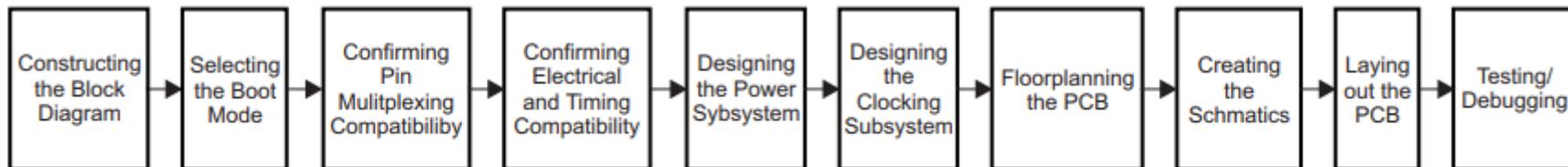
SPRABU5–May 2019  
[Submit Documentation Feedback](#)

AM335x Hardware Design Guide 1  
Copyright © 2019, Texas Instruments Incorporated

SPRABU5

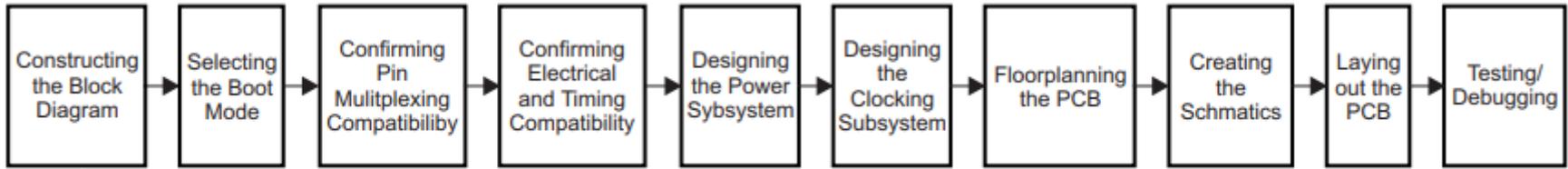
16

# Product Timeline – Board Development



**Figure 1. Hardware Design Timeline**

# Product Timeline – Board Development



**Figure 1. Hardware Design Timeline**

**Processor Datasheet**  
**Technical Reference manual**

# Board Development – Datasheet & TRM

Product Folder Order New Technical Documents Tools & Software Support & Community Reference Design

TEXAS INSTRUMENTS AM3359, AM3358, AM3357, AM3356, AM3354, AM3352, AM3351  
SPR1715 – OCTOBER 2011 – REVISED MARCH 2022

## AM335x Sitara™ Processors

### 1 Device Overview

#### 1.1 Features

- Up to 1-GHz Sitara™ ARM® Cortex®-A9 32-Bit RISC Processor
- NEON™ SIMD Coprocessor
- 32KB of L1 Instruction and 32KB of Data Cache With Single-Error Detection (Parity)
- 256KB of L2 Cache With Error Correcting Code (ECC)
- 179KB of On-Chip Boot ROM
- 64KB of Dedicated RAM
- Emulation and Debug - JTAG
- Interrupt Controller (up to 128 Interrupt Requests)
- On-Chip Memory (Shared L3 RAM)
- 64KB of General-Purpose On-Chip Memory Controller (OCMC) RAM
- Accessible to All Masters
- Supports Retention for Fast Wakeup
- External Memory Interfaces (EMIF)
- mDDR1, PDDR1, DDR2, DDR3, DDR3L Controller
  - mDDR: 200-MHz Clock (400-MHz Data Rate)
  - DDR2: 266-MHz Clock (532-MHz Data Rate)
  - DDR3: 400-MHz Clock (800-MHz Data Rate)
  - DDR3L: 400-MHz Clock (800-MHz Data Rate)
- 16-Bit Data Bus
- 1GB of Total Addressable Space
- Supports One x16 or Two x8 Memory Device Configurations
- General-Purpose Memory Controller (GPMC)
  - Flexible 8-Bit and 16-Bit Asynchronous Memory Interface With up to Seven Chip Selects (NAND, NOR, Muxed-NOR, SRAM)
  - Uses BCH Code to Support 4-, 8-, or 16-Bit ECC
  - Uses Hamming Code to Support 1-Bit ECC
  - Error Locator Module (ELM)
  - Used in Conjunction With the GPMC to Locate Addresses of Data Errors from Synchronous Polynomials Generated Using a BCH Algorithm
  - Supports 4-, 8-, and 16-Bit per 512-Byte Block Error Location Based on BCH Algorithm
- Programmable Real-Time Unit Subsystem and Industrial Communication Subsystem (PRU-ICSS)
  - Supports Protocols such as EtherCAT®
- PROFIBUS, PROFINET, EtherNet/IP™, and More
  - Two Programmable Real-Time Units (PRUs)
  - 32-Bit LoadStore RISC Processor Capable of Running at 200 MHz
  - 8KB of Instruction RAM With Single-Error Detection (Parity)
  - 8KB of Data RAM With Single-Error Detection (Parity)
  - Single-Cycle 32-Bit Multiplier With 64-Bit Accumulator
  - Enhanced GPIO Module Provides Shift-In/Out Support and Parallel Latch on External Signal
  - 32KB of Shared RAM With Single-Error Detection (Parity)
  - Three 120-Byte Register Banks Accessible by Each PRU
  - Interrupt Controller (INTC) for Handling System Input Events
  - Local Interconnect Bus for Connecting Internal and External Masters to the Resources Inside the PRU-ICSS
- Peripherals Inside the PRU-ICSS:
  - One UART Port With Flow Control Pins, Supports up to 12 Mbps
  - One Enhanced Capture (eCAP) Module
  - Two Mill Ethernet Ports that Support Industrial Ethernet, such as EtherCAT
  - One MDIO Port
- Power, Reset, and Clock Management (PRCM) Module
  - Controls the Entry and Exit of Stand-By and Deep-Sleep Modes
  - Responsible for Sleep Sequencing, Power Domain Switch-Off Sequencing, Wake-Up Sequencing, and Power Domain Switch-On Sequencing
  - Clocks
    - Integrated 15- to 35-MHz High-Frequency Oscillator Used to Generate a Reference Clock for Various System and Peripheral Clocks
    - Supports Individual Clock Enable and Disable Control for Subsystems and Peripherals to Facilitate Reduced Power Consumption
    - Five ADPLLs to Generate System Clocks (MPU Subsystem, DDR Interface, USB and

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## AM335x and AMIC110 Sitara™ Processors

### Technical Reference Manual

TEXAS INSTRUMENTS

Literature Number: SPRUHT10  
October 2011 – Revised December 2019

- Datasheet
  - Designing
    - Device interconnections
    - Electrical & Timing requirements
    - Pin Muxing
    - Power
    - DDR Memory Interfacing
- Technical Reference Manual (TRM)
  - Boot Modes
  - Peripheral Clocking and operations
  - Control Module, register descriptions

# Product Timeline – Board Development

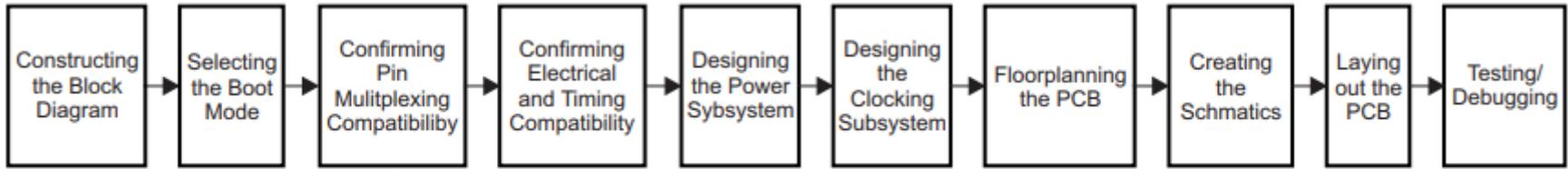


Figure 1. Hardware Design Timeline

↑  
SYSCONFIG



# Board Development - SYSCONFIG Tool

The screenshot shows the Texas Instruments SysConfig website. The navigation bar includes 'Products', 'Applications', 'Design resources', 'Quality & reliability', 'Support & training', 'Order now', and 'About TI'. The main content area is titled 'System configuration tool SYSCONFIG' and includes links for 'Description & Features', 'Technical documentation', 'Support & Training', and 'Order Now'. Below this is an 'Order Now' section with a table of download options.

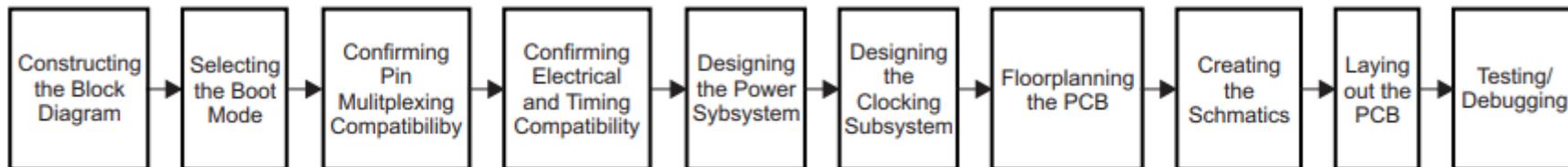
Part Number	Buy from Texas Instruments or Third Party	Alert Me	Status	Current Version	Version Date	Description
SYSCONFIG-DESKTOP: Standalone desktop version of SysConfig	Free <a href="#">Get software</a>	<a href="#">Alert Me</a>	ACTIVE	1.6.0_1543	17-Sept-2020	A standalone installable version of SysConfig is available for third party IDE integration & custom development environments.
SYSCONFIG-CLOUD: System configuration tool cloud development on TI Resource Explorer	Free <a href="#">Start development</a>		ACTIVE			
CCSTUDIO: Code Composer Studio (CCS) Integrated Development Environment (IDE)	<a href="#">Get software</a>		ACTIVE			

- SYSCONFIG tool can be downloaded or has cloud access

The screenshot shows the SysConfig web application interface. The top navigation bar includes 'FILE', 'ABOUT', and 'Changes are unsaved'. The main content area is titled 'Peripherals > ADC' and shows a list of peripherals on the left and a configuration table for the selected ADC (MyADC1) on the right. The configuration table includes columns for Name, Use Peripheral, Preferred Voltage, Use Case, Signals, Pins, Pull Up/Down, and Rx. A legend at the bottom right indicates pin availability and assignment status.

Name	Use Peripheral	Preferred Voltage	Use Case	Signals	Pins	Pull Up/Down	Rx
MyADC1	Any	Any	All pins of peripheral	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN0	<input type="checkbox"/> Pull Up	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN1	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN2	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN3	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN4	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN5	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN6	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> AIN7	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> VREFN	<input type="checkbox"/> No Pull	<input type="checkbox"/>
				<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/> VREFP	<input type="checkbox"/> No Pull	<input type="checkbox"/>

# Product Timeline – Board Development



**Figure 1. Hardware Design Timeline**

IBIS Models for Timing Analysis

# Product Timeline – Board Development

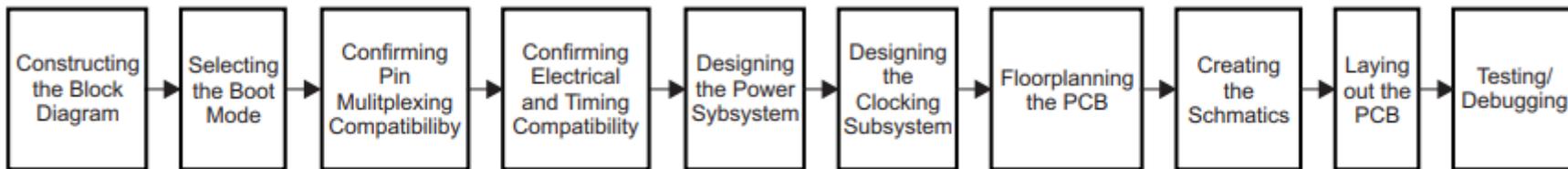
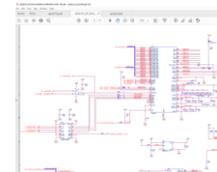


Figure 1. Hardware Design Timeline



EVM Schematics



AM335x Schematic Checklist (SPRABN2A)



# Product Timeline – Board Development

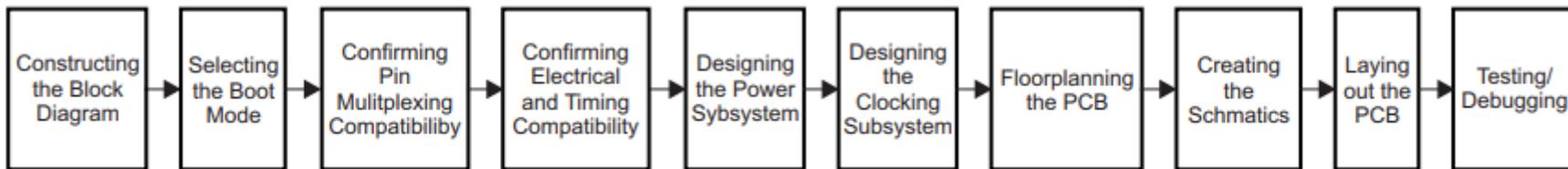


Figure 1. Hardware Design Timeline

TEXAS INSTRUMENTS Application Report  
SPRAAR7H—August 2016—Revised October 2016  
**High-Speed Interface Layout Guidelines**

Embedded Processor Applications

ABSTRACT  
An isolated bus interface requires precise timing and signal, and must be taken in the printed circuit board (PCB) layout phase of a design to ensure a robust solution.

Contents	
1	Introduction
2	General High-Speed Signal Routing
2	High-Speed Differential Signal Routing
4	References
Appendix A	Device Layout Parameters

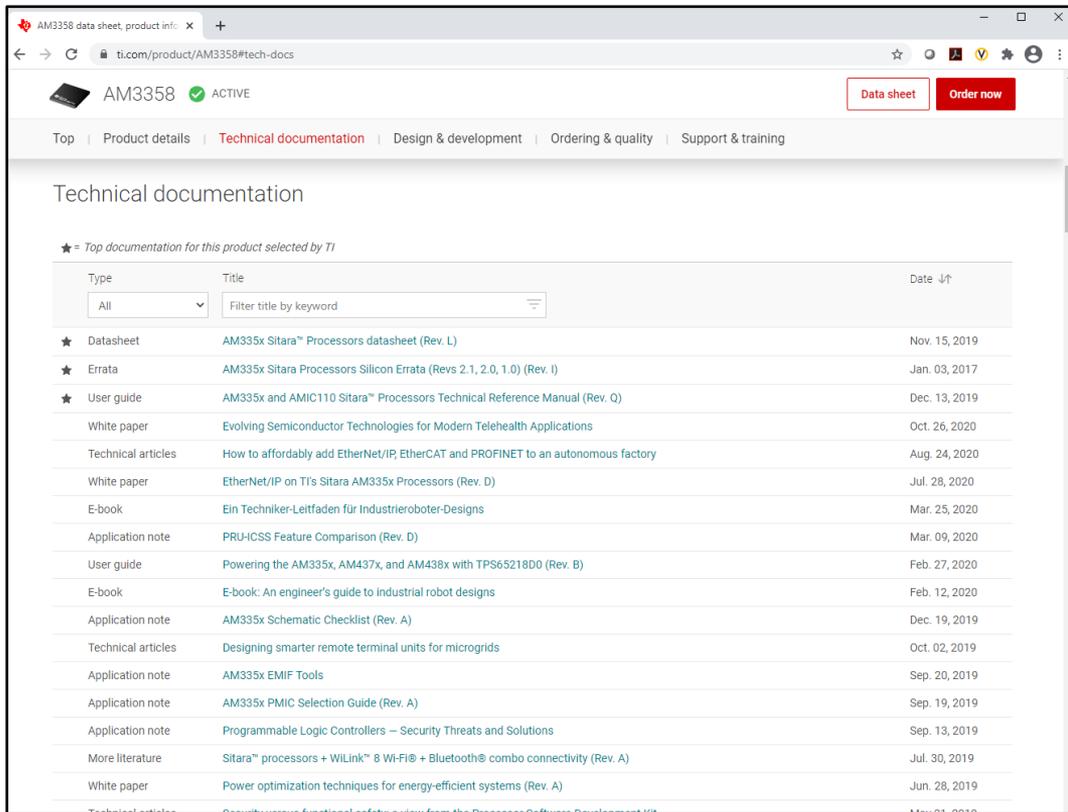
List of Figures	
1	Position of the PCB Image
2	Routing Angle Selection
3	Zip-Up Routing
4	PCB Fiberglass Reinforcement
5	Length Matching
6	Isolated Power Plane Routing
7	Control Plane Signal Routing
8	Isolated Power Plane Signal Routing
9	Aluminum Capacitor Placement
10	Isolated Power Plane Routing
11	Isolation Via
12	USDB (Microvia) vs. USDB (Microvia) Differential Signal Routing (mm)
13	USDB (Microvia) Signal Routing (mm)
14	Offsetting the Geometry
15	USDB Through-Hole Penetrable Connection
16	Via Length (Short Stack)
17	Via Length (Short Stack)
18	Aluminum Capacitor
19	AC-Coupling Placement
20	Reference Plane Visibility of Surface Mount Devices
21	Signal Routing Rules
22	Flow-Through Routing

List of Tables	
1	Critical Signals
2	Example PCB Stackup
3	ANSI/ISO/IEC 60391-1
4	ANSI/ISO/IEC 60391-2

SPRAAR7H—August 2016—Revised October 2016 High-Speed Interface Layout Guidelines  
© Copyright 2016–2018, Texas Instruments Incorporated

High Speed Interface  
Layout Guidelines  
(SPRAAR7H)

# Product Timeline – Board Development



AM3358 data sheet, product info: x +

ti.com/product/AM3358#tech-docs

AM3358 ACTIVE

Data sheet Order now

Top | Product details | **Technical documentation** | Design & development | Ordering & quality | Support & training

### Technical documentation

★ = Top documentation for this product selected by TI

Type	Title	Date ↓↑
★ Datasheet	AM335x Sitara™ Processors datasheet (Rev. L)	Nov. 15, 2019
★ Errata	AM335x Sitara Processors Silicon Errata (Revs 2.1, 2.0, 1.0) (Rev. I)	Jan. 03, 2017
★ User guide	AM335x and AMIC110 Sitara™ Processors Technical Reference Manual (Rev. Q)	Dec. 13, 2019
White paper	Evolving Semiconductor Technologies for Modern Telehealth Applications	Oct. 26, 2020
Technical articles	How to affordably add EtherNet/IP, EtherCAT and PROFINET to an autonomous factory	Aug. 24, 2020
White paper	EtherNet/IP on TI's Sitara AM335x Processors (Rev. D)	Jul. 28, 2020
E-book	Ein Techniker-Leitfaden für Industrieroboter-Designs	Mar. 25, 2020
Application note	PRU-ICSS Feature Comparison (Rev. D)	Mar. 09, 2020
User guide	Powering the AM335x, AM437x, and AM438x with TPS65218D0 (Rev. B)	Feb. 27, 2020
E-book	E-book: An engineer's guide to industrial robot designs	Feb. 12, 2020
Application note	AM335x Schematic Checklist (Rev. A)	Dec. 19, 2019
Technical articles	Designing smarter remote terminal units for microgrids	Oct. 02, 2019
Application note	AM335x EMIF Tools	Sep. 20, 2019
Application note	AM335x PMIC Selection Guide (Rev. A)	Sep. 19, 2019
Application note	Programmable Logic Controllers – Security Threats and Solutions	Sep. 13, 2019
More literature	Sitara™ processors + WiLink™ 8 Wi-Fi® + Bluetooth® combo connectivity (Rev. A)	Jul. 30, 2019
White paper	Power optimization techniques for energy-efficient systems (Rev. A)	Jun. 28, 2019

- The Technical documentation Tab of the product folder contains the list of available documentation for a Processor.

# Board Development Summary

- Follow the steps shown in the Hardware Design guide
- Leverage the documentation provided in the processor product folder
- Use the Datasheet and TRM to create system block diagram
- The tools for SYSCONFIG, EMIF tool assists with determining pin mux configuration

# Software Development

# Product Timeline – Software Development

Sitara Processor Evaluation

Board Development

Software Development

Product Lifecycle

HW Platform Options

Custom (Product) Board

TI EVM

Timeline

$t = 0$

$t = \text{Production}$

# Product Timeline – Software Development

Software Development

SW Development/Testing/Release

Board Port Development – U-Boot/Linux

Board Port Development – RTOS

HW Platform Options

Custom (Product) Board

TI EVM

Timeline

$t = 0$

$t = \text{Production}$

# Product Timeline – Software Development

Software Development

SW Development/Testing/Release

Processors SDK RTOS

Processors SDK Linux

HW Platform Options

Custom (Product) Board

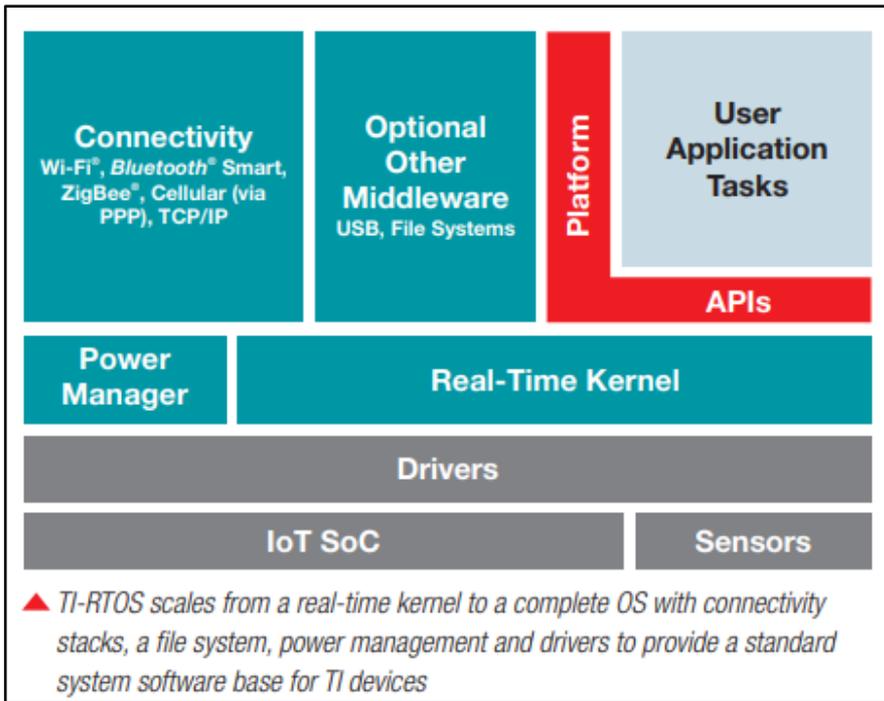
TI EVM

Timeline

$t = 0$

$t = \text{Production}$

# Product Timeline – Software Development RTOS



sprt646a.pdf

- Robust real-time TI-RTOS kernel including TCP/IP networking stack
- Posix thread-compatible API layer available
- Driver libraries that can be used with TI-RTOS or without a kernel
- Free and available as open source

# Product Timeline – Software Development Linux

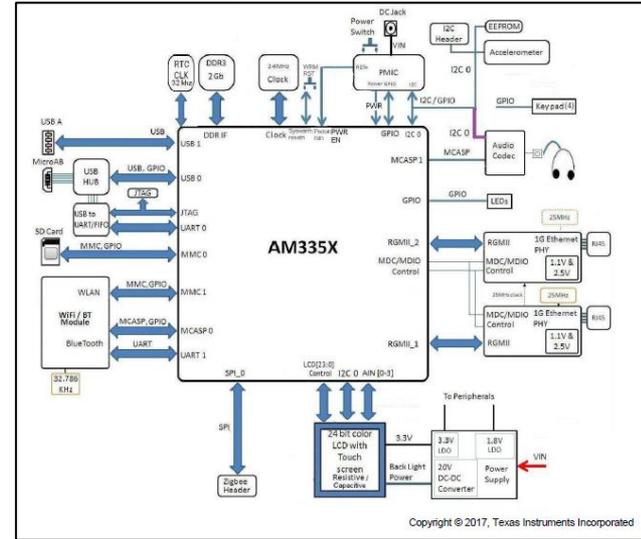
Foundational Components (more information on each piece of the distribution)			
U-Boot	Boot Monitor	Kernel	Filesystem
Tools	OpenCL	OpenCV	Graphics & Display
Multimedia	Examples, Demos	PRU-ICSS / PRU_ICSSG	Virtualization
IPC	OpenVX	CMEM	Machine Learning
ATF	OPTEE		

- Updated to the latest Long Term support (LTS) Linux kernel, boot loader and Yocto file system on an annual basis
- U-Boot community boot loader
- Robust, commercial-grade Linaro® GNU compiler collection (GCC) toolchain
- Yocto Project™ OE Core compatible file systems support enables tailored Linux application support
- RT-Linux releases include a fully pre-emptible kernel for real-time applications

# Product Timeline – Software Development

## Board Port Development – U-Boot/Linux

- Porting - Bring up U-Boot/Linux on Custom Hardware
  - Processor SDK Linux has the processor initialization, driver support for Linux and U-Boot
  - Leveraging TI EVM code makes porting strait forward
  - Use the EMIF and SYSCONFIG tools to assist with the port effort



## HW Platform Options

Custom (Product) Board

TI EVM

Timeline

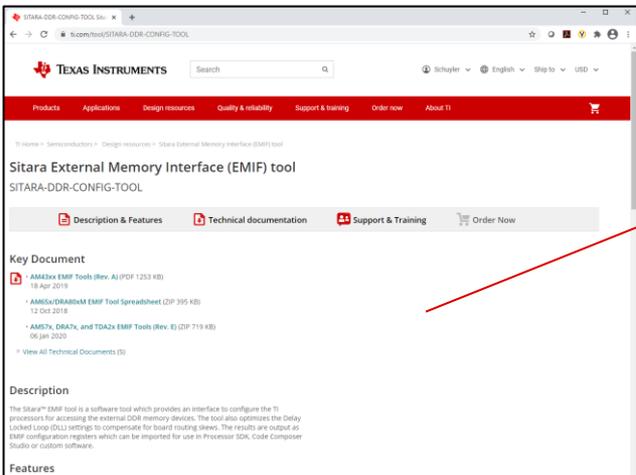
t = 0

t = Production

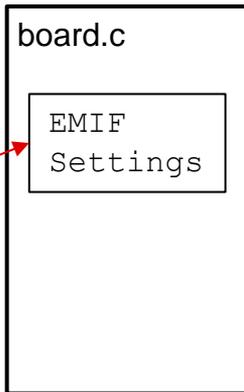




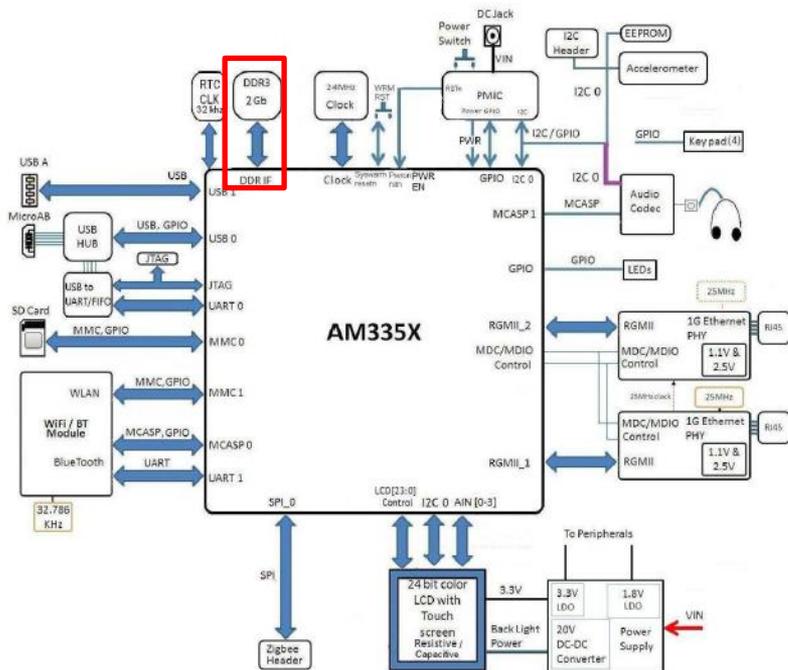
# Product Timeline – U-Boot Board Port



board/ti/am335x/board.c



EMIF Tool



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# Product Timeline – Software Development

Board Port Development – U-Boot/Linux

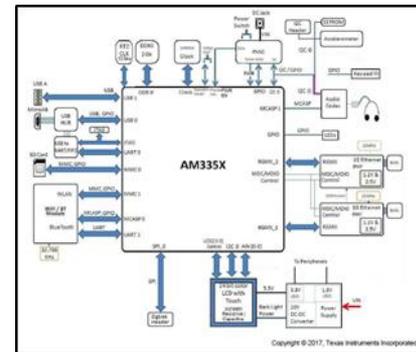
Porting Linux

Leverage TI Code

TI DTS Code

Pin Mux Configuration

SYSCONFIG



# Product Timeline – Linux Board Port

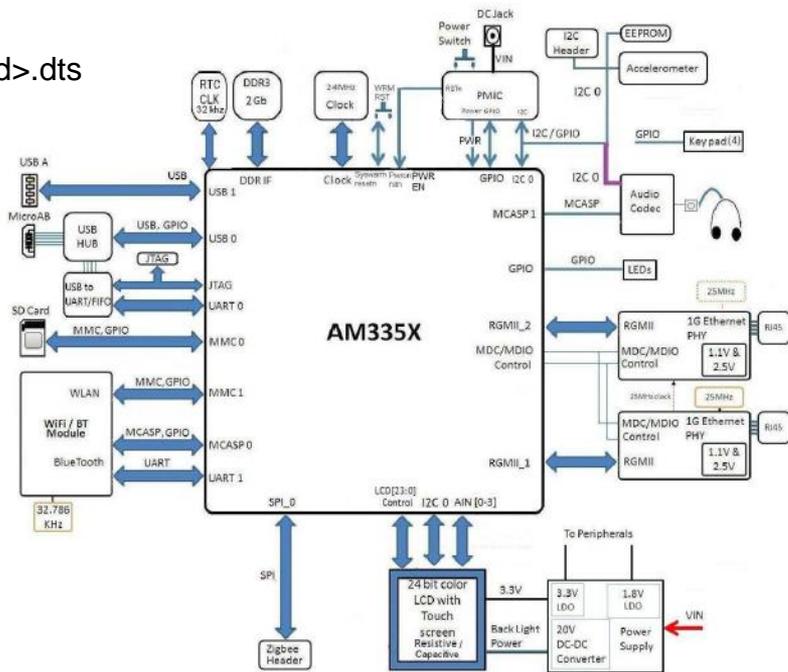
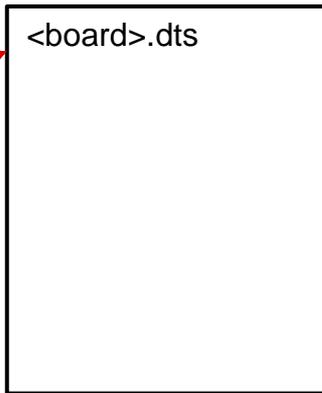
Processor SDK for AM335x Sitara Processors - Linux and TI-RTOS support  
PROCESSOR-SDK-AM335X

Part Number	Buy From Texas Instruments or Third Party	Alert Me	Status	Current Version	Version Date	OS	Linux Kernel
PROCESSOR-SDK-LINUX-AM335X Linux Processor SDK for AM335X	Free	Alert Me	ACTIVE	v06.03	19-Apr-2020	Linux	v4.19
PROCESSOR-SDK-LINUX-RT-AM335X Linux RT Processor SDK for AM335X	Free	Alert Me	ACTIVE	v06.03	20-Apr-2020	Linux-RT	v4.19
PROCESSOR-SDK-RTOS-AM335X RTOS Processor SDK for AM335x and AM3C110 devices	Free	Alert Me	ACTIVE	v06.03	20-Apr-2020	TI-RTOS	nv8

TI Processors SDK Linux

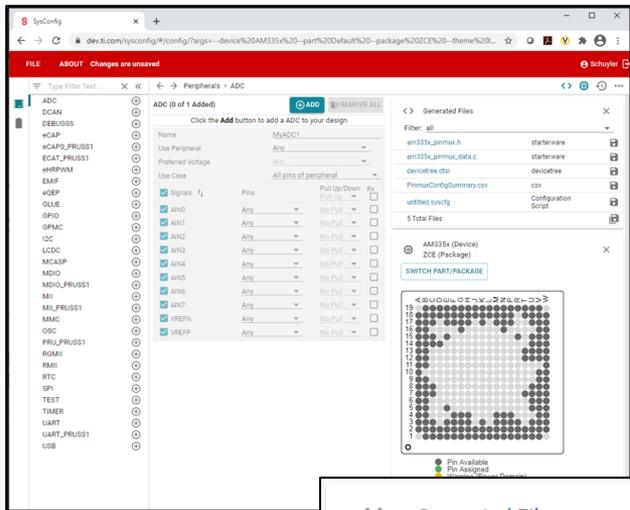
The `<board>.dts` file is the key file for porting Linux to a custom board

arch/arm/boot/dts/<board>.dts



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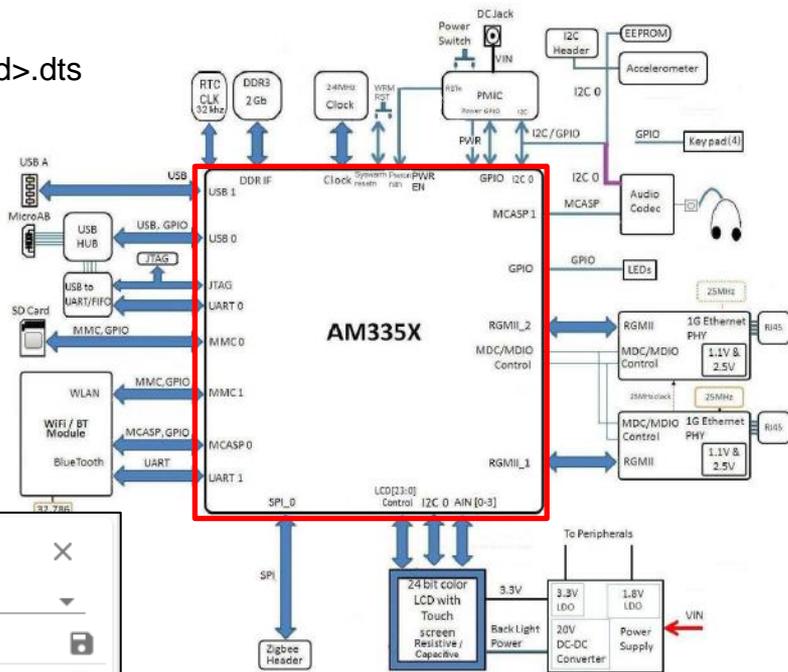
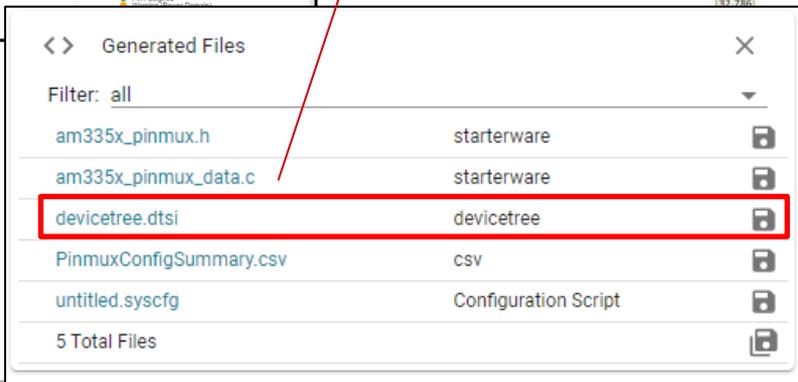
# Product Timeline – Linux Board Port



SYSCONFIG

arch/arm/boot/dts/<board>.dts

<board>.dts  
devicetree.dtsi



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# Software Development Summary

- TI Provides an RTOS and Linux SDK operating system for each processor
- The SDKs provide the starting point for application development
- The SYSCONFIG and EMIF Tools should be used to accelerate porting operating systems to a new board

# Production and Lifecycle

# Product Timeline – Production UniFlash

3.1. Board Support — Processor x +

software-dl.ti.com/processor-sdk-rtos/esd/docs/latest/rtos/index\_board.html#uniflash

Processor SDK RTOS  
06\_03\_00\_106

3.5. Board Utils

3.5.1. Uniflash

3.5.1.1. Introduction

Uniflash is an Unified Flashing tool which provides utilities for flashing the application software images to non-removable flash devices on TI hardware platforms.

Uniflash for TI processors platform includes two components

- Flash Programmer
- Host utility

Flash programmer runs on target platform which takes care of receiving the images from Uniflash host utility and programming them onto flash devices. Flash programmer communicates with Uniflash host utility over the UART interface.

Flash programmer which is part of the Uniflash release can be found at "<Uniflash Root>/processors/FlashWriter/<Board Name>"

Host utility runs on host machine which provides Command-line Interface (CLI) to communicate with flash programmer. Windows and Linux are the supported OS platforms for running Uniflash host utility. Host utility uses UART or JTAG interface to download the flash programmer to the target platform. All data transfers between Uniflash host utility and Flash programmer happens over UART interface.

Refer to [Uniflash Documentation](#) for more details on Uniflash tool.

3.5.1.2. Supported Platforms

Below table shows the platforms supported by Uniflash and flash devices supported on each platform. Download mode indicates the mode of communication for downloading flash programmer to target platform.

SOC	SOC Core	PLATFORM	FLASH DEVICE				DOWNLOAD MODE		
			SPI	QSPI	OSPI	EMMC	JTAG		
							UART	Uniflash CLI	Manual
AM335x	Cortex-A8	AM335x GP EVM	X				X	X	
		AM335x ICEV2	X					X	
		AMIC110 ICE	X				X	X	
AM437x	Cortex-A9	AM437x IDK		X				X	
AM571x	Cortex-A15	AM571x IDK		X				X	
AM572x	Cortex-A15	AM572x IDK		X				X	
AM574x	Cortex-A15	AM574x IDK		X				X	

ti.com/tool/UNIFLASH

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## UniFlash stand-alone flash tool for microcontrollers, Sitara™; processors and SimpleLink™

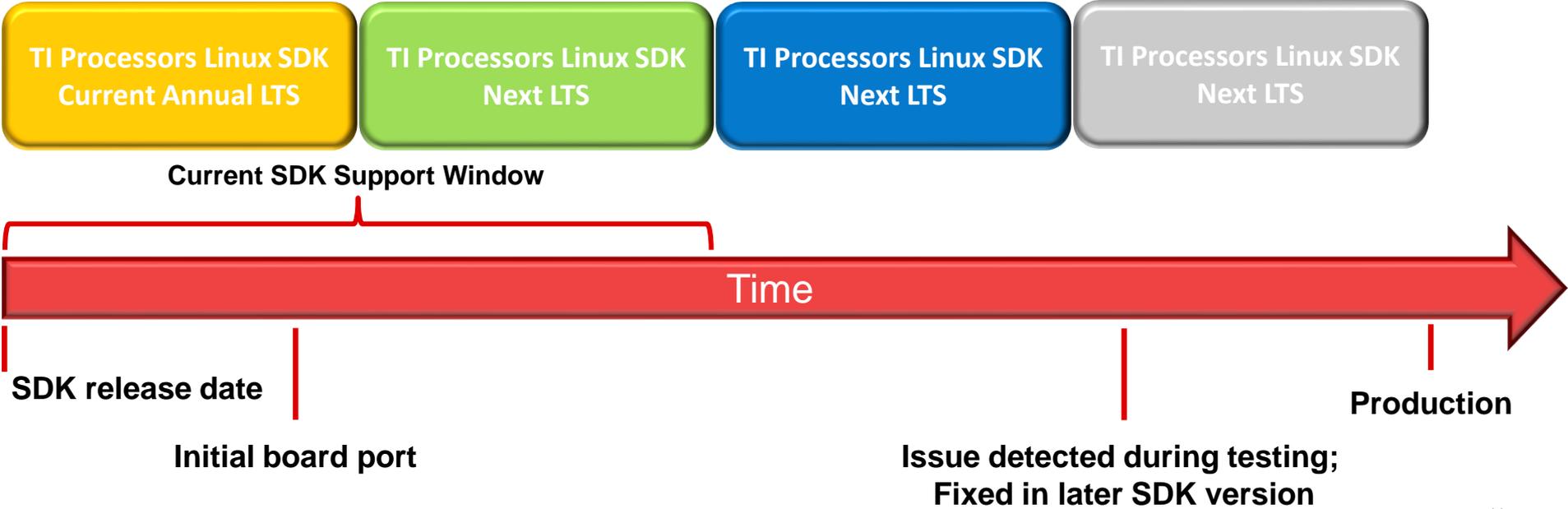
UNIFLASH

Description & Features Technical documentation Support & Training Order Now

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Part Number	Buy from Texas Instruments or Third Party	Alert Me	Status	Current Version	Version Date
UNIFLASH_CLOUD: Uniflash cloud development on TI Resource Explorer	<a href="#">Start development</a>		ACTIVE		
UNIFLASH: Uniflash for most TI microcontrollers (MCLs) and mmWave sensors	<a href="#">Free</a> <a href="#">Get software</a>	<a href="#">Alert Me</a>	ACTIVE	v5.1.0	20-Jul-2020
UNIFLASH_PREVIOUS: Uniflash previous versions with support for CC3200 and CC3100	<a href="#">Free</a> <a href="#">Get software</a>		ACTIVE	v3.4.1	16 Feb 2016

# Product Timeline – Lifecycle





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