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

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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 Lifecyle

HW Platform Options



Processor Evaluation



Product Development Timeline - Evaluation



Processor Evaluation – Datasheet & TRM

INSTRUMENTS	SPRS717L -OCTOBER 2011-REVISED MARCH 2020
AM335x Sitara	M Processors
Device Overview	
1 Features	
Up to 1-GHz Sitara [™] ARM [®] Cortex [®] -A8 32-Bit RISC Processor	PROFIBUS, PROFINET, EtherNet/IP™, and More
IntCoN [®] SIMD Coprocessor OxtRd & L1 Mixedon and XPen/U and Cache SXRd & L1 Mixedon and XPen/U SXRd & L1 Mixedon and XPen/U SXRd & L1 Cache With Error Correcting Code (C) OxtRd & L2 Cache With Error Correcting Code (C) OxtRd & Cachetar RNM Endland & Cachetar RNM Cachetar RNM Cachetar RNM Endland & Cachetar RNM Endland & Cachetar RNM Endland & Cachetar RNM Endland & Cachetar RNM Control RNM Cachetar RNM RNM Cache	Two Programmate Real-Time Units (PRUs) Two Programmate Real-Time Units (PRUs) of Received 200 Metric ends of the State St
EVC 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 Syndrome Polynomiais Generated Using a	uomain switch-Vit Sequencing, Wake-Up Sequencing, and Power Domain Switch-On Sequencing – Clocks – Integrated 15- to 35-MHz High-Frequency Oscillator Used to Generate a Reference
syndrome Poynomias Generated Using a BCH Algorithm – Supports 4-, 8-, and 16-Bit per 512-Byte Block Error Location Based on BCH Algorithms Programmable Real-Time Unit Subsystem and Industrial Computing Mice Subsystem (DB1 UCSS)	Oracimizor user to Semeratata & Netlefence Clocks for Various System and Peripheral Occession of the Semeration of the Semeration Scopera for Subaylations and Peripherata to Facilitate Reduced Power Consumption File ad DP1 is to Generate System Clocks
Industrial Communication Subsystem (PRU-ICSS) – Supports Protocols such as FtherCAT [®]	 Five ADPLLs to Generate System Clocks (MPU Subsystem, DDR Interface, USB and



- 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

🌵 AM3358 da	ata she	et, product info 🗙 👆 AM	1335x Sitara™ Processors data: 🗙 👆 🚸 AM335x and AMIC110 Sitara™ Pr 🗙 😽 How to affordably add EtherNet/ 🗙 🕇 🕂	
← → C		ti.com/product/AM3358?	keyMatch=AM33588ttisearch=Search-EN-everything&usecase=GPN#tech-docs	☆ 🛛 🔼 🔇
4		🕨 AM3358 🥑	ACTIVE	ta sheet Order now
	Тор	Product details	Technical documentation Design & development Ordering & quality Support & training	
	Teo	chnical docum	nentation	
	*=	Top documentation for thi	s product selected by TI	
		Туре	Title	Date ↓↑
		All	Filter title by keyword	
	*	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

\$	SysConfig	×	+							-		×
÷	→ C 🔒 dev.ti.co	om/syscon	fig/#/config/?args=de	evice%20AN	//335x%20pa	art%20Default%2	20pad	kage%20ZCE%20theme%20I 😭	0 📕 🔇) *	Θ	:
F	ILE ABOUT Change	es are unsa	ved							e	Schuy	/ler 🕒
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	DEBUGSS	Ð	Click the A	dd button to	add a ADC to	your design						`
- L	eCAP	Ð	Name		MyADC1			Filter: all				<u> </u>
	eCAP0_PRUSS1	Ð	Use Peripheral		Any		~	am335x_pinmux.h	starterware			8
	ECAT_PRUSS1	\oplus	Preferred Voltage				~	am335x_pinmux_data.c	starterware			8
	eHRPWM	\oplus	Lise Case		All pins of p	eripheral	-	devicetree.dtsi	devicetree			8
	EMIF	\oplus	-			Pull Un/Down	Rv	PinmuxConfigSummary.csv	CSV			8
	eQEP GLUE	(±)	Signals T	Pins		Pull Up 🔻		untitled.syscfg	Configuration Script	on		8
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	LCDC	Ð	MIN3	Any	Ψ	No Pull 🔻		ZCE (Package)			×	(
	MCASP	Ð	AIN4	Any	Ψ	No Pull 🔻		SWITCH PART/PACKAGE				
	MDIO DBUSS1	(±)	MIN5	Any	Ψ	No Pull 🔻						
	MUIO_PR0351	Ð	AIN6	Any	T	No Pull 🔻						
	MIL PRUSS1	÷.	AIN7	Any	Ŧ	No Pull 🔻			->>>			
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	RTC	\oplus										
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	UART DRUGGT	(±)										
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								 Pin Available Pin Assigned Warning (Power Domain Fixed (N/A) 	1)			

- 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

😓 AM3358 data sheet, p 🗙 👍 TI Refe	erence Desig	ns 🛙 🗙 🚸 AM335x Sitara [™] Proce 🗙 🛛 🚸 AM335x and AMIC110 🗙 📔 G texas instruments tech	🗙 🏘 TMS320x2833x, TM	s: × +
→ C 🔒 ti.com/reference-de	esigns/inde	ex.html#search?keyword=AM3358		☆ ♀ ⊿ ♥ ★ 8
Select TI refer	rence	e designs In TI technology to solve your system-level challenges		
		Show quick search		
Hide filters Reset		27 matching designs out of 4174 total designs		Email
Market	^	Design title Filter by keyword(s) Q	Market	Product
Communications equipment Enterprise existence		TIDEP-01013 - Gesture controlled HMI with mmWave sensors and Sitara [™] processors reference design	Industrial	Sensors Processors
Industrial Personal electronics		TIDA-010032 - Universal data concentrator reference design supporting Ethernet, 6LoWPAN RF mesh and more	Industrial	Wireless connectivity Switches & multiplexers Processors Power management
Product Find power reference designs by para	∼ ameter			Microcontrollers (MCU) Logic Isolation Interface Data converters Amplifiers
Vin (V) (Min)	~	TIDEP-01005 - Human Machine Interface (HMI) for Smart Thermostat Reference Design	Industrial	Processors
vini (V) (Max) lisolated/Non-Isolated input Type Vout (V) (Nom)	* * *	TIDA-01568 - 12mm x 12mm, 5-Rail Power Sequencing for Application Processors Reference Design	Industrial Communications equipment	Wireless connectivity Processors Power management Logic Interface
lout (A) (Max) Output Power (W)	× ×	TIDA-01555 - Flexible Interface (PRU-ICSS) Reference Design for Simultaneous, Coherent DAQ Using Multiple ADCs	Industrial	Processors Bower management

- 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

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Product Timeline - Evaluation





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



Sitara Processor Evaluation

Board Development

Software Development

Product Lifecyle

HW Platform Options



- 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

-	EXAS NSTRUMENTS	SPRABU5-May 20
	AM335.	x Hardware <mark>D</mark> esign Guid
		Catalog Processor
	ABSTRAC	т
The	purpose of this application report is to walk hard igning a board on this platform.	ware designers through the various stages
	Contents	i
1	Introduction	
3	Selecting the Boot Mode	
4	Confirming Pin Multiplexing Compatibility	
5	Confirming Electrical and Timing Compatibility	
5	Designing the Power Subsystem	
8	PCB Floorplan	
9	Creating the Schematics	
10	Laying Out the PCB	
11	Board Bringup/Diagnostic	
12	Refereces	
Arm All d	is a registered trademark of Arm Limited.	vners.
	May 2019	AM335x Hardware Design Guide





Figure 1. Hardware Design Timeline





Processor Datasheet Technical Reference manual



Board Development – Datasheet & TRM

INSTRUMENTS	SPRS717L -OCTOBER 2011-REVISED MARCH 2020
AM335x Sitara™	Processors
Device Overview	
1 Features	
	PROCISIES, PROFIRET, Elsenheal Pi ⁿ , and More Teo Programmable Real-True Units (PRUs) - Teo Programmable Real-True Units (PRUs) - Real Pilling and Pilling Pilling - Real Pilling Pilling Pilling Pilling - Real Pilling Pilling Pilling - Real Pilling Pilling Pilling - Real Pilling Pilling Pilling - Real Pilling Pilling - Real Pilling Pilling - Real Pilling Pilling - Real



- 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







Board Development - SYSCONFIG Tool

💠 SYSCONFIG System configuration 🗙 🕂						-	1 × I	SvsConfig	×	+					-	
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🐺 Texas Instrumen	NTS Search			Q		Login / Register 🔀 English 🗸 Ship to 🗸 USD 🗸		FILE ABOUT Chan	jes are unsav	ed						😫 Schuyler
Products Applications De	esign resources Quality	ty & reliability	Suppo	ort & training	Orde	r now About TI 🎽 🎽			× «	\leftrightarrow \rightarrow Peripherals \rightarrow	ADC				\diamond	@ 49
								ADC	÷	ADC (0 of 1 Added)		() A	DD	() Generated Files		~
Ti Home > Semiconductors > Design resources	5 > System configuration tool						- H.e.	DEBUGSS	Ð	Click the A	dd button to	add a ADC to	your design			~
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SYSCONFIG							- H.	eCAP0_PRUSS1	\oplus	Use Peripheral		Any	Ŧ	am335x_pinmux.h	starterware	6
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📄 Description & Featu	res 📑 Technie	cal docume	ntation	8	Support	& Training 🛛 📜 Order Now	- II	EMIE	⊕ ⊕	Use Case		All pins of p	eripheral 👻	devicetree.dtsi	devicetree	6
							- 11 -	eQEP	÷	☑ Signals † ₁	Pins		Pull Up/Down Rx	PinmuxConfigSummary.csv	CSV	d
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Part Number	Buy from Texas Instruments or Third	Alert Me	Status	Current Version	Version Date	Description	- II	I2C	⊕ ⊕	AIN2	Any	~	No Pull 👻 🔲			
	Party						- H.	LCDC	÷	AIN3	Any	Ŧ	No Pull 👻 🔲	AM335x (Device)		×
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														Warning (Power Don Fixed (N/A)	nain)	





IBIS Models for Timing Analysis











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← →	c	i.com/product/AM	3358#tech-docs	☆	0	자	⊗ :	* 6	9
		AM3358 🥑	ACTIVE	Data sheet		Ord	er now		
	Тор	Product details	Technical documentation Design & development Ordering & quality Support & training						
	Te	chnical docun	nentation						
	*=	Top documentation for the	is product selected by TI						
		Туре	Title	D	ate -	¢↑			
		All 🗸	Filter title by keyword						
	*	Datasheet	AM335x Sitara [®] Processors datasheet (Rev. L)	N	lov. 1	5, 201	9		
	*	Errata	AM335x Sitara Processors Silicon Errata (Revs 2.1, 2.0, 1.0) (Rev. I)	J	an. O	3, 201	7		
	*	User guide	AM335x and AMIC110 Sitara [™] Processors Technical Reference Manual (Rev. Q)	D	ec. 1	3, 201	9		
		White paper	Evolving Semiconductor Technologies for Modern Telehealth Applications	C	ct. 2	6, 202	0		
		Technical articles	How to affordably add EtherNet/IP, EtherCAT and PROFINET to an autonomous factory	A	ug. 2	24, 202	20		
		White paper	EtherNet/IP on TI's Sitara AM335x Processors (Rev. D)	J	ul. 28	B, 202)		
		E-book	Ein Techniker-Leitfaden für Industrieroboter-Designs	N	1ar. 2	5, 202	0		
		Application note	PRU-ICSS Feature Comparison (Rev. D)	N	1ar. 0	19, 202	0		
		User guide	Powering the AM335x, AM437x, and AM438x with TPS65218D0 (Rev. B)	F	eb. 2	7, 202	0		
		E-book	E-book: An engineer's guide to industrial robot designs	F	eb. 1	2, 202	0		
		Application note	AM335x Schematic Checklist (Rev. A)	D	ec. 1	9, 201	9		
		Technical articles	Designing smarter remote terminal units for microgrids	C	ict. O	2, 201	9		
		Application note	AM335x EMIF Tools	s	ep. 2	0, 201	9		
		Application note	AM335x PMIC Selection Guide (Rev. A)	s	ep. 1	9, 201	9		
		Application note	Programmable Logic Controllers – Security Threats and Solutions	s	ep. 1	3, 201	9		
		More literature	Sitara™ processors + WiLink™ 8 Wi-Fi® + Bluetooth® combo connectivity (Rev. A)	J	ul. 30	D, 201	9		
		White paper	Power optimization techniques for energy-efficient systems (Rev. A)	J	un. 2	8, 201	9		
		Technical orticles	Coourity versus functional safety: a visu from the Drasseer Politivers Development Vit		low 0	1 001	0		

 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



Sitara Processor Evaluation

Board Development

Software Development

Product Lifecyle

HW Platform Options



Software Development

SW Development/Testing/Release

Board Port Development – U-Boot/Linux

Board Port Development – RTOS



Software Development

SW Development/Testing/Release

Processors SDK RTOS

Processors SDK Linux





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



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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



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









TI Processors SDK Linux

Product Timeline – U-Boot Board Port



porting U-Boot to a custom board

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Supply

DC-DC

Converter

Power

DCJack

screen

Resistive /

Capacitive

Zigbee Header



Product Timeline – U-Boot Board Port



Copyright © 2017. Texas Instruments Incorporated

Converter



Product Timeline – U-Boot Board Port



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Board Port Development – U-Boot/Linux

Porting Linux

Leverage TI Code

Pin Mux Configuration

TI DTS Code

SYSCONFIG



Product Timeline – Linux Board Port





Product Timeline – Linux Board Port





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

C		×	← → C it.com/tool/UNIFLASH					🖈 😡 🛃 🕅
🌵 3.1. Board Support — Processor S	× +						-	
\leftrightarrow \rightarrow C $$ software-dl.ti	i.com/processor-sdk-rtos/esd/docs/latest/rtos/index_board.html#uniflash Q 🛧 Q 🖪 😢 🏚	:	Products Applications Design resources Qui	ality & reliability Support	& training Order now	About TI		
	Other failures blink blink blink blink blink	*	TI Home > Semiconductors > Design resources > UniFlash stand-alone fla	sh tool for microcontrollers, Sitar	a** processors and SimpleLink**			
06_03_00_106	3.5. Board Utils		UniFlash stand-alone flash tool fo SimpleLink™	r microcontrol	lers, Sitara™; pr	ocess	ors and	
1. Overview	3.5.1. Uniflash		UNIFLASH					
2. Release Specific	3.5.1.1. Introduction		Description & Features	nical documentation	🚨 Support & Trainir	ng	ेःः Order Nov	,
3.1. Board Support	Unifiesh is an Unified Flashing tool which provides utilities for flashing the application software images to non-removable flash devices on Ti hardware platforms.							
3.2. Diagnostics			Order Now					
# 3.3. Diagnostics Execution	Uniflash for TI processors platform includes two components							
3.4. Power-On Self Test	Each Programmer		Part Number	Buy from Texas Instrume	its or Third Party Alert Me	Status	Current Version	Version Date
😑 3.5. Board Utils	Host utility		UNIFLASH-CLOUD: UniFlash cloud development on TJ Recourse Explorer	Start development		ACTIVE		
🗎 3.5.1. Uniflash			onniest close development of it resource explorer	Free	Alexa Mar	ACTIVE	v6.1.0	20-101-2020
3.5.2. UART Apploader	Flash porgrammer runs on target platform which takes care of receiving the images from Uniflash host utility and programming them onto flash devices. Flash programmer		UNIFLASH: UniFlash for most Ti microcontrollers (MCUs) and mmWave sensors	mmWave sensors Get software				,
4. Foundational Components	communicates with onlines in host during over the order internate.							
5. DSP Software	Flash programmer which is part of the Uniflash release can be found at - " <uniflash root="">/processors/FlashWriter/<board name="">"</board></uniflash>			Free		ACTIVE	v3.4.1	16 Feb 2016
6. Device Drivers			UniFlash previous versions with support for CC3200 and CC3100	Get software				
7. PRU-ICSS Firmware	Host utility runs on host machine which provides Command-line Interface (LLI) to communicate with hash programmer. Windows and Linux are the supported to Splatforms tor running [Unlifsch host utility. Uses Lintar or TAG interface to download the flack programmer to the target olafforms. All data targets heaven Llintars host utility and							
8. Compilers	Finally programmer happens over UART interface.							
9. Examples and Demonstrations								
10. How to Guides	Refer to Uniflash Documentation for more details on Uniflash tool.							
11. Frequently Asked Questions	2.5.1.2. Supported Distorme							
12. Documentation Tarball	5.5.1.2. Supported Platforms							
	Below table shows the platforms supported by Unifiash and flash devices supported on each platform. Download mode indicates the mode of communication for downloading flash programmer to target platform.							

			FLASH DEV	ICE		DOWNLOAD MODE				
								JTAG		
SOC	SOC Core	PLATFORM	SPI	QSPI	OSPI	EMMC	UART	Uniflash CLI	Manual	
AM335x		AM335x GP EVM	х				х	х		
	Cortex-A8	AM335x ICEv2	х					х		
		AMIC110 ICE	х				х	x		
AM437x	Cortex-A9	AM437x IDK		×				х		
AM571x	Cortex-A15	AM571x IDK		х				х		
AM572x	Cortex-A15	AM572x IDK		x				х		
AM574x	Cortex-A15	AM574x IDK		х				х		



Product Timeline – Lifecycle





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