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Chapter 5: Connectivity

Stellaris® Cortex™-M3 - Microcontroller Family

Texas Instruments

Texas Instruments - University Program

Heilbronn University, Campus Künzelsau

Prof. Dr.-Ing. Ralf Gessler

Rev. 1.0

Contents

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- **Topics:** comparison LM3S1968 with LM3S9B92; porting of software projects, connectivity features of LM3S9B92; comparison EKS-LM3S1968 with EKS-LM3S9B92; basics connectivity & Stellaris® features

Learning Objectives

- The chapter describes the basics (theory) of Stellaris® Connectivity
  - Comparison LM3S1968 with LM3S9B92
  - Porting of software projects
  - Connectivity features of the LM3S9B92
  - Comparison EKS-LM3S1968 with EKS-LM3S9B92 (Evaluation Kits)
- Top-Down-Approach
  - From Chapter 5.1 Theory/Overview
  - To Chapter 5.2 Stellaris® Ethernet and 5.3 USB
- Theory: communications serial interfaces and applications fields
- Basics Connectivity and Stellaris® Features
  - Ethernet
  - USB
  - CAN, I^2S etc.
- Structure and questions:
  - How can I port software projects from the LM3S1968 to the LM3S9B92?

Stellaris® value proposition

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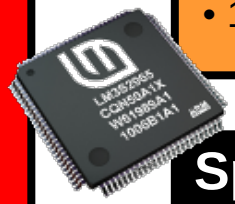
High performance Features

20-80 MHz ARM-M3 CPU

- Optimized for single-cycle flash usage
- Integrated 32-ch DMA for ease of use & high data rate without CPU overhead
- Thumb-2 ISA with high code density
- Flexible clock system sources up to 8 timers
- Single-cycle multiply and hardware divide
- Three power modes and battery-backed hibernation with non-volatile memory

Connectivity

- Ethernet MAC & PHY with 1588 PTP support
- USB Host, Device, or On-The-Go
- CAN 2.0 A/B with 32 mailboxes
- External Peripheral Interface supporting SRAM, SDRAM, M2M, FPGA, CPLD
- Integrated UART, I^2C, SSI module
- Integrated I^2S master or slave



Broad Portfolio

- ***Largest ARM MCU portfolio in the world with 167devices***
- 8KB to 256KB Flash and up to 96KB RAM
- Up to 8 advanced PWM modules
- RTC, and integrated LDO
- Analog comparators and temp sensor
- 28 to 108 pin from SOIC to BGA
- 10-bit, 8ch ADCs from 250 kSPS-1MSPS

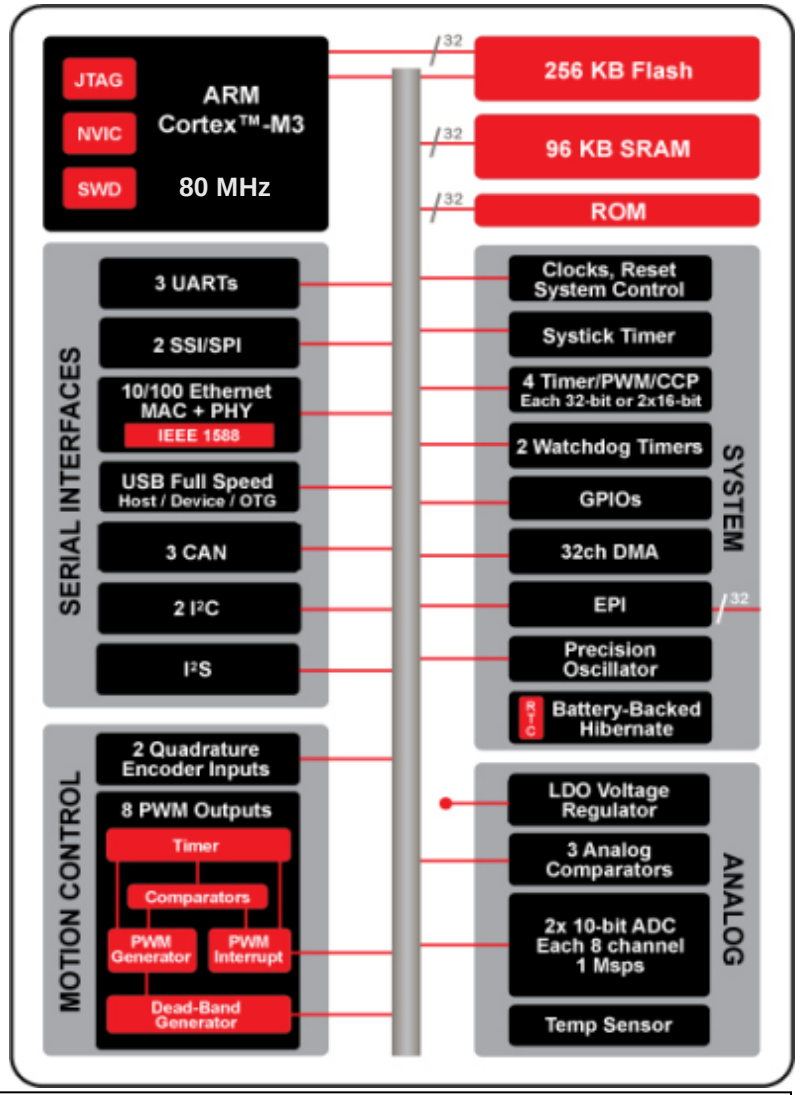
Speed to Market

- StellarisWare on ROM includes driver and peripheral libraries to ease development
- C friendly IDE and compilers from industry leaders
- Low cost development tools
- Application specific and advanced development kits
- Production-ready application modules

Stellaris® Family Overview

Over 160 family members
20, 25, 50, and 80 MHz
8K to 256K Flash
2K to 96K SRAM

48-LQFP
64-LQFP
100-LQFP
and 108-BGA
Industrial & Extended Temperature



Stellaris® product lines

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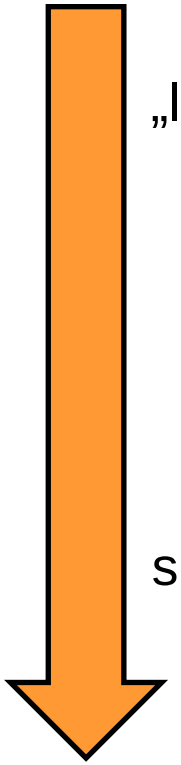
- LM3S1nnn non-CAN, non-Ethernet

- LM3S2nnn CAN
- LM3S3nnn USB
- LM3S5nnn CAN + USB

- LM3S6nnn Ethernet
- LM3S8nnn Ethernet + CAN
- LM3S9nnn Ethernet + CAN + USB



„low cost“

„high“ specification

Stellaris® product lines

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Part number	Flash size	SRAM size
– LM3Sx1xx	64k Flash	16K SRAM
– LM3Sx2xx		32K SRAM
– LM3Sx3xx	96k Flash	16K SRAM
– LM3Sx4xx		32K SRAM
– LM3Sx5xx		64K SRAM
– LM3Sx6xx	128k Flash	32K SRAM
– LM3Sx7xx		64K SRAM
– LM3Sx8xx	256k Flash	32K SRAM
– LM3Sx9xx		64K SRAM
– LM3SxBxx		96K SRAM
– LM3SxDxx	512k Flash	96K SRAM

Stellaris® Product Selector Guide

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- Stellaris® Product Selector Guide

- Important tool for choosing Stellaris®-M3

	Memory						Core				Timers													Serial Interfaces										Analog												
																Motion Control								Ethernet					UART					ADC												
Part Number	Flash (KB)	SRAM (KB)	EEPROM (bytes)	ROM Software Libraries	DMA	SAFERTOS™	ARM® Cortex™ CPU	Max Speed (MHz)	Internal Precision Oscillator	MPU	SysTick (24-Bit)	General-Purpose (Total)	64-Bit Wide	Real-Time Clock (RTC)	Watchdog	PWM Units	PWM Outputs[d]	PWM Fault	Dead-Band Generator	CCP (Total)	64-Bit Wide CCP	QEI Channels	External Peripheral Interface	10/100 MAC+PHY	10/100 MAC with MII Interface	IEEE 1588	CAN MAC	USB D, H, or O[c]	UART	UART Modem Status[e]	I^2C	SSI/SPI	I^2S	Units	Resolution (10- or 12-bit)	Channels	Speed (samples/sec)	External Voltage Reference[f]	Internal Temp Sensor	Analog/Digital Comparators	5-V Tolerant GPIOs[a]	Battery-Backed Hibernation	LDO Voltage Regulator	Operating Temperature[b]	Package	Production (P) or Sampling (S)
LM3S5U91	384	96	–	✓	✓	–	M3	80	✓	✓	✓	4	–	✓	2	1	8	4	✓	8	–	2	✓	–	–	–	2	O	3	✓	2	2	1	2	12	16	1M	✓	✓	3/16	72	–	✓	I	100LQFP 108BGA	P
LM3S5Y36	16	8	–	✓	✓	–	M3	80	✓	✓	✓	3	–	✓	2	1	6	4	✓	6	–	1	–	–	–	–	1	D	3	–	2	2	–	2	10	8	1M	✓	✓	2/16	33	✓	✓	I	64LQFP	P
LM3S6100	64	16	–	–	–	–	M3	25	–	✓	✓	3	–	✓	1	–	–	–	–	4	–	–	–	✓	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	1/0	30	–	✓	I/E	100LQFP 108BGA	P
LM3S6110	64	16	–	–	–	–	M3	25	–	✓	✓	3	–	✓	1	1	2	1	✓	4	–	–	–	✓	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	3/0	35	–	✓	I/E	100LQFP 108BGA	P

- Link: see document “spmc001j.pdf”

Interactive Product Search

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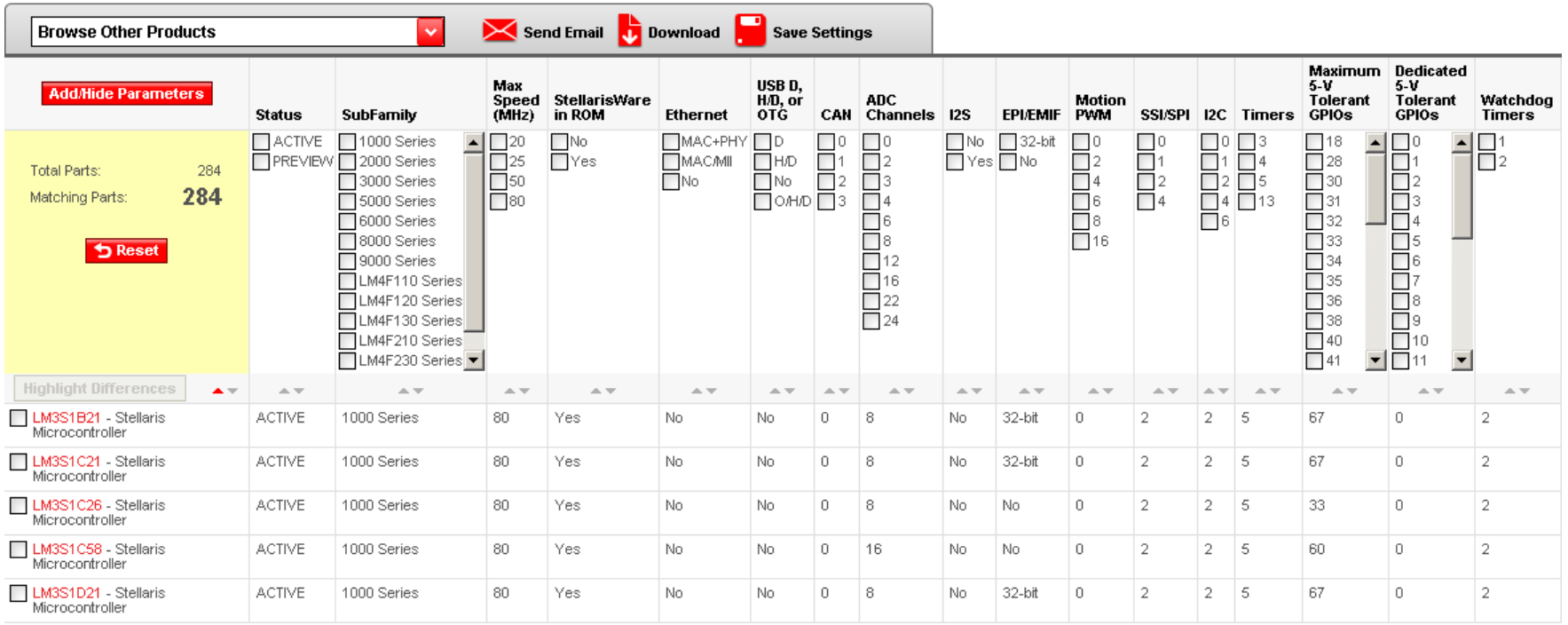

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Add/Hide Parameters

Total Parts: 284
Matching Parts: 284
Reset

Status	SubFamily	Max Speed (MHz)	StellarisWare in ROM	Ethernet	USB D, H/D, or OTG	CAN	ADC Channels	I2S	EPI/EMIF	Motion PWM	SSI/SPI	I2C	Timers	Maximum 5-V Tolerant GPIOs	Dedicated 5-V Tolerant GPIOs	Watchdog Timers
ACTIVE, PREVIEW	1000 Series, 2000 Series, 3000 Series, 5000 Series, 6000 Series, 8000 Series, 9000 Series, LM4F110 Series, LM4F120 Series, LM4F130 Series, LM4F210 Series, LM4F230 Series	20, 25, 50, 80	No, Yes	MAC+PHY, MAC/MII, No	D, H/D, No, O/H/D	0, 1, 2, 3	0, 2, 3, 4, 6, 8, 12, 16, 22, 24	No, Yes	32-bit, No	0, 2, 4, 6, 8, 16	0, 1, 2, 4	0, 1, 2, 4, 6	3, 4, 5, 13	18, 28, 30, 31, 32, 33, 34, 35, 36, 38, 40, 41	0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11	1, 2

Highlight Differences

	Status	SubFamily	Max Speed (MHz)	StellarisWare in ROM	Ethernet	USB D, H/D, or OTG	CAN	ADC Channels	I2S	EPI/EMIF	Motion PWM	SSI/SPI	I2C	Timers	Maximum 5-V Tolerant GPIOs	Dedicated 5-V Tolerant GPIOs	Watchdog Timers
LM3S1B21 - Stellaris Microcontroller	ACTIVE	1000 Series	80	Yes	No	No	0	8	No	32-bit	0	2	2	5	67	0	2
LM3S1C21 - Stellaris Microcontroller	ACTIVE	1000 Series	80	Yes	No	No	0	8	No	32-bit	0	2	2	5	67	0	2
LM3S1C26 - Stellaris Microcontroller	ACTIVE	1000 Series	80	Yes	No	No	0	8	No	No	0	2	2	5	33	0	2
LM3S1C58 - Stellaris Microcontroller	ACTIVE	1000 Series	80	Yes	No	No	0	16	No	No	0	2	2	5	60	0	2
LM3S1D21 - Stellaris Microcontroller	ACTIVE	1000 Series	80	Yes	No	No	0	8	No	32-bit	0	2	2	5	67	0	2

...

- Link: see URL http://www.ti.com/mcu/docs/mculuminaryprodsearch.tsp?sectionId=95&tabId=2485&familyId=1755

Comparison: Microcontroller

Microcontroller (MC)	LM3S1968	LM3S9B92
Core	ARM Cortex™-3	
	50 MHz	80 MHz (100 DMIPS)
Storage	256 kB single-cycle Flash; ROM	
	64 kB SRAM	96 kB SRAM
System peripheral	SysTick Timer	
	4 Timer (32 bit)	
	2 Watchdog Timer	
	GPIOs	
	32 channel DMA	
	Battery-backed Hibernate	

Comparison: MC (cont.)

Microcontroller	LM3S1968	LM3S9B92
Motion control peripheral	8 PWM	
	2 QEI	
Analog peripheral	LDO Voltage regulator	
	3 Analog Comparators	
	10 Bit ADC (8 ch.); 10 MSPS	2x 10 Bit ADC (8 ch.); 10 MSPS
	Temperature sensor	
Serial Interface peripheral	3 UARTs	
	2 SSI/SPI	
	2 I^2C	
		10/100 Ethernet
		USB 2.0 OTG/host/device
		2 CAN
		I^2S

Porting from family to family

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	MCUs in Series	Flash (KB)	SRAM (KB)	ROM SW Library	Ext. Peripheral Interface	Max Speed (MHz)	Precision Oscillator	Ethernet	IEEE 1588	CAN	USB (Host, OTG, Device)	I2S	ADC Channels	GPIOs (5-V)	Package Options
LM3S100	2	8	2	-	-	20	-	-	-	-	-	-	-	18	48-LQFP
LM3S300	8	16	4	-	-	25	-	-	-	-	-	-	8	36	48-LQFP, QFN
LM3S600	11	32	8	-	-	50	-	-	-	-	-	-	8	36	48-LQFP, QFN
LM3S800	9	64	8	-	-	50	-	-	-	-	-	-	8	36	48-LQFP, QFN
LM3S1000	37	256	64	✓	✓	50	✓	-	-	-	-	-	8	60	64 & 100 LQFP, 108 PBGA
LM3S2000	26	256	96	✓	✓	80	✓	-	-	2	-	✓	16	60	64 & 100 LQFP, 108 PBGA
LM3S3000	9	128	64	✓	✓	50	✓	-	-	-	✓	-	8	61	64 & 100 LQFP
LM3S5000	26	256	96	✓	✓	80	✓	-	-	2	✓	✓	16	71	64 & 100 LQFP
LM3S6000	19	256	64	-	-	50	-	✓	✓	-	-	-	8	46	64 & 100 LQFP
LM3S8000	12	256	64	-	-	50	-	✓	✓	3	-	-	8	46	100 LQFP, 108 PBGA
LM3S9000	8	256	96	✓	✓	80	✓	✓	✓	2	✓	✓	16	65	100-LQFP

over 160 options and growing

Porting from family to family

- Comparing StellarisWare® examples for EK-LM3S1968 with EK-LM3S9B92 there are four things which should be focused on:
  - Naming of header files should be changed. Depending on peripherals, some should be added and those not used should be deleted (e.g. for OLED display)
  - Naming of pinouts is different between the two devices
  - Differences in peripherals. If they are common, then the convention of naming is also the same. However, if there are some difference in the names, the best solution is to look inside header files (in CCS Ctrl+Left_Mouse_Button_Click on name of header file)
  - Memory sizes and mapping are different. It is recommended that the datasheet appropriate be studied [4].

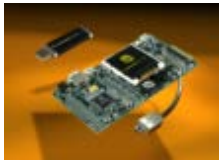
Stellaris® Evaluation Kits

- Start in 10 minutes or less
- Evaluation Kits (EK) packages includes:
  - Cables
  - A choice of evaluation tools suites for popular development tools
  - Documentation (QuickStart guide, User's guide, …)
  - StellarisWare ® software
  - Applications notes


EK-LM3S811
Low pin count
49 USD


EK-LM3S1968
High pin count
59 USD


EK-LM3S2965
CAN Functionality
79 USD


EK-LM3S3748
USB Host/Device
109 USD


EK-LM3S6965
Ethernet MAC+PHY
69 USD


EK-LM3S8962
Ethernet+CAN
89 USD


EK-LM3S9B90
Ethernet+USB OTG
99 USD


EK-LM3S9B92
Ethernet+OTG+MC
99 USD

- Function both as an evaluation platform and as a serial in-circuit debug interface for any Stellaris® microcontroller-based target board
- Note: Evaluation Kit with Code Composer Studio Tools (EKS)

EKS-LM3S9B92 Evaluation Kit

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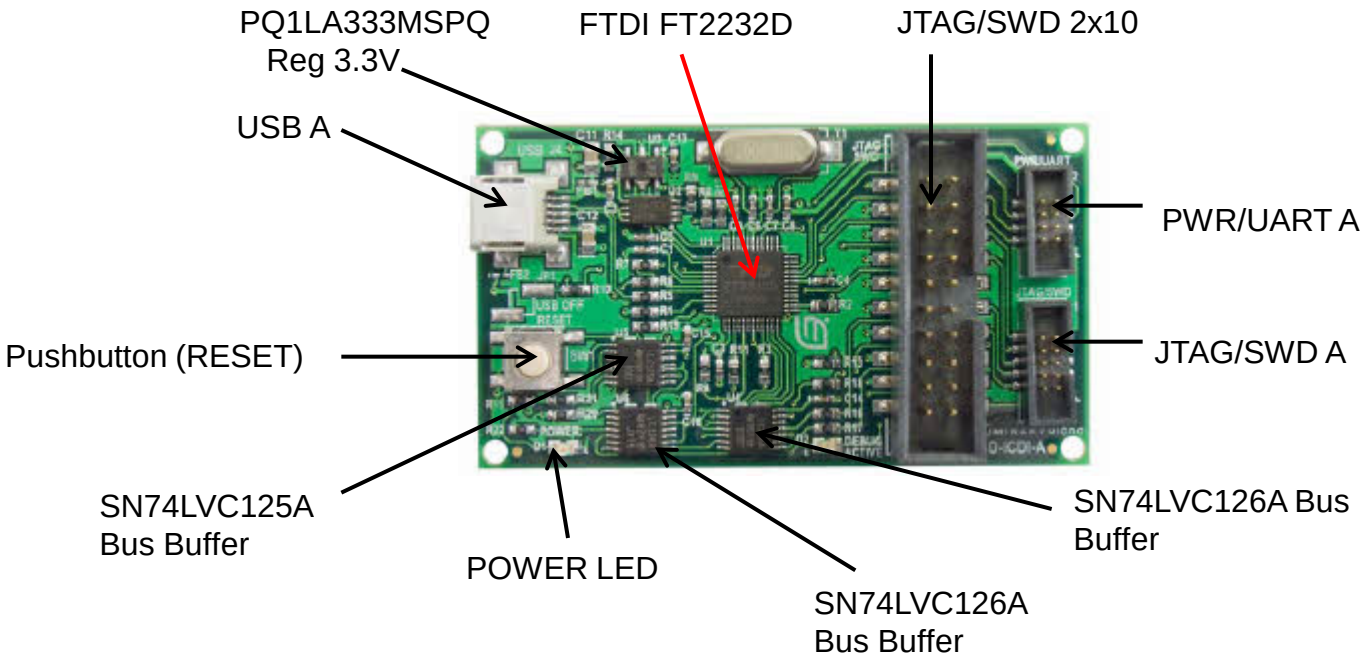
- In-Circuit Debug Interface BoarD (BD-ICDI Board)



EKS-LM3S9B92 Evaluation Kit

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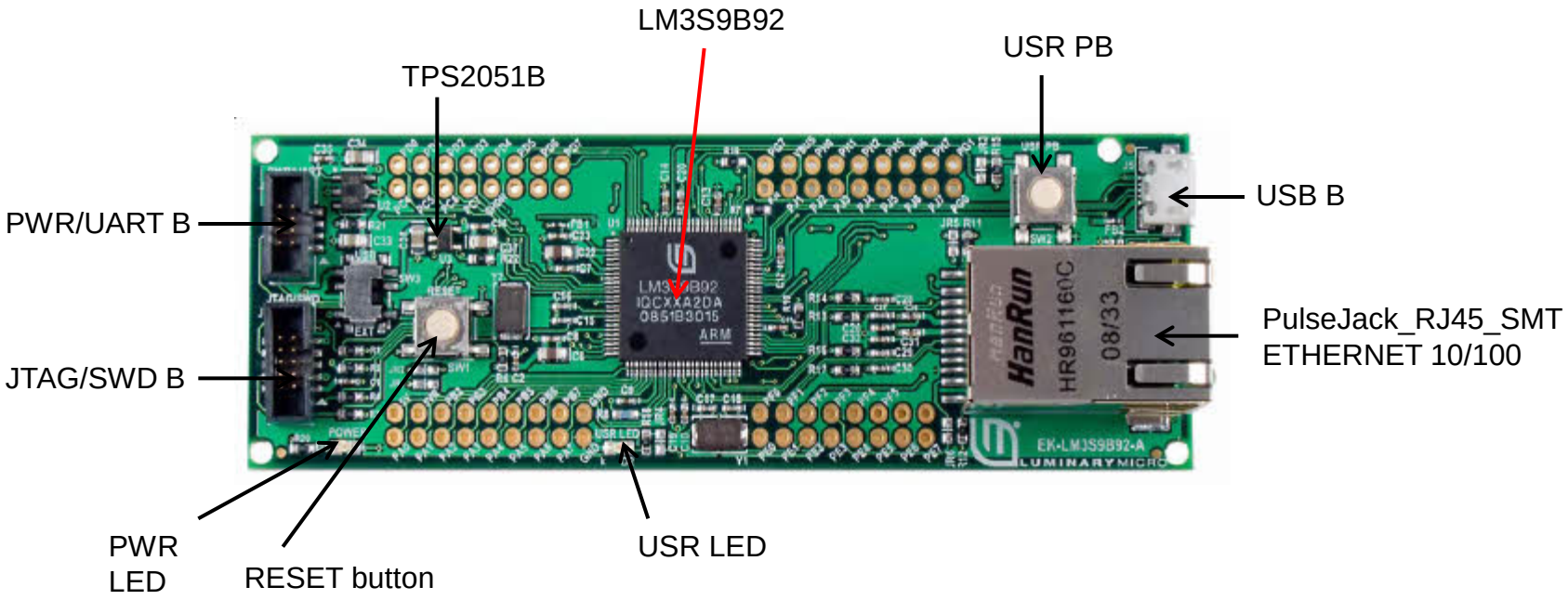
- EK-LM3S9B92 Board



Main Features EKS-LM3S9B92

- LM3S9B92 high-performance Stellaris® microcontroller and large memory
  - 32-bit ARM Cortex™-M3 core
  - 256 KB single-cycle Flash memory, 96 KB single-cycle SRAM, 23.7 KB single-cycle ROM
- Ethernet 10/100 port with two LED indicators
- USB 2.0 Full-Speed OTG port
- Virtual serial communications port capability
- Oversized board pads for GPIO access
- User push button (USR PB) and User LED (USR LED)
- Detachable ICDI board can be used for debugging other Luminary Micro boards

Main Features EKS-LM3S9B92

- Easy to customize
  - Includes full source code, example applications and design files
  - Develop using tools supporting FastMATH from Keil, IAR, Code Sourcery and Code Red (using a Stellaris® evaluation kit or preferred ARM Cortex™-M3 debugger)
  - Supported by Luminary Micro StellarisWare® peripheral driver library

Comparison: Evaluation Kits

Evaluation Kits	EKS-LM3S1968	EKS-LM3S9B92
Debug interface	In-Circuit-Debug-Interface	
Peripherals	User LED	
	Navigation switches	Push buttons
	User Pins/Pads	
	OLED	
	3V-battery for hibernate	
	loudspeaker & amplifier	
Serial Interface		10/100 Ethernet
		USB 2.0 full speed port
		Virtual serial-port

Example “Blinky”

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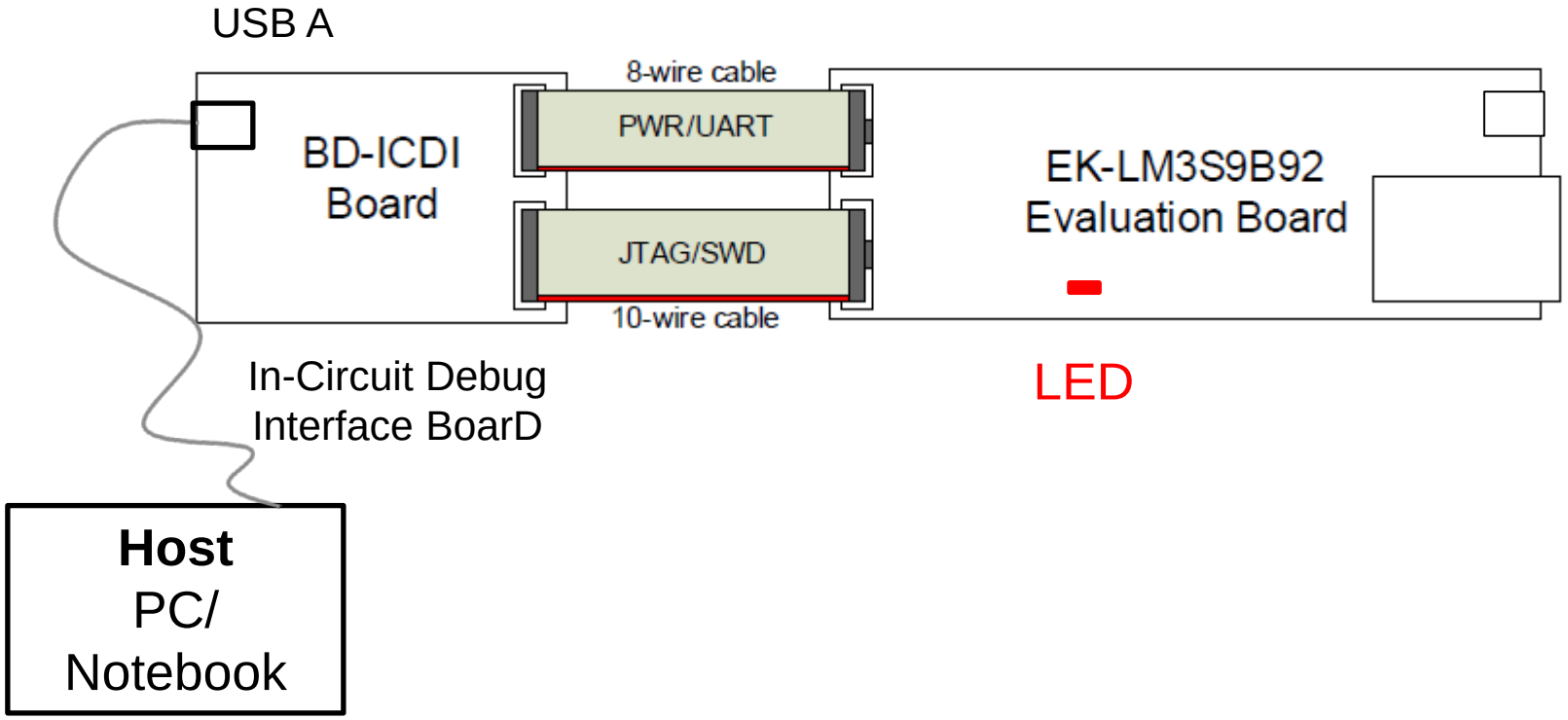
- Description
  - A very simple example that blinks the on-board LED.
- Learning elements
  - Microcontroller (Stellaris)
    - Timing with loop
    - GPIO
  - Evaluation Board
    - On-board LED
- Functional test (debugging)
  - Blinking on-board LED
- Link: see lab “lab51a.zip”

Example “Blinky”: Setup



- Link: see Chapter 5.1
  “From Stellaris® 1000 family to Stellaris® 9000 family”

Theory Communications

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- Basics Communications (theory)
- Basics Serial Interfaces Peripherals
  - Ethernet
  - USB
  - CAN
  - I^2S
- Stellaris® Features
  - Ethernet
  - USB
  - CAN
  - I^2S
- Link: Chapter 2.4 “Peripherals” introduces the serial interface peripherals like UART, SSI, I^2C of the LM3S1968.

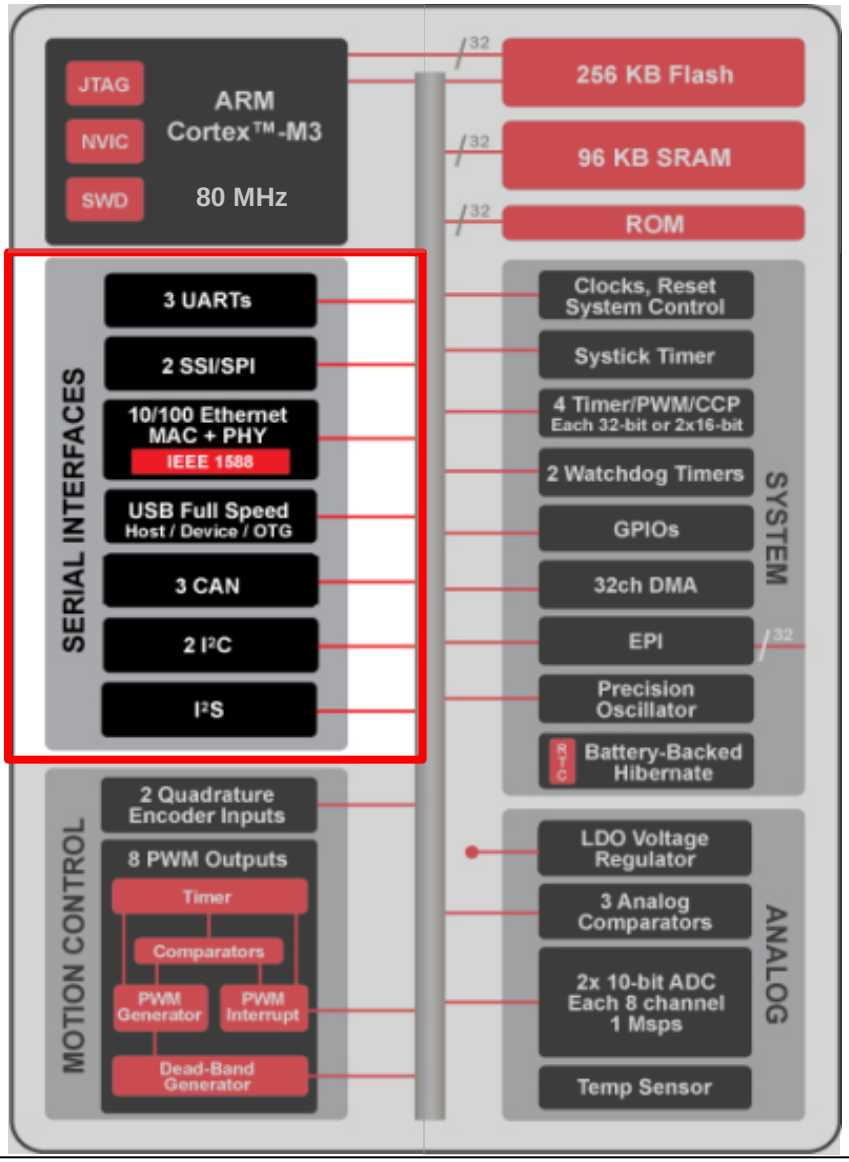
ISO/OSI Model

- International Standard Organisation/Open System Interconnection (ISO/OSI)
- The ISO/OSI Model is a prescription of characterizing and standardizing the functions of Communications Systems.
  It is subdivided in seven layers.
- Link: see Chapter 5.2 “Serial interfaces: Ethernet”
- Link: see Chapter 5.3 “Serial interfaces: USB”

ISO/OSI Model (cont.)

Layer	Name	Function
7	Application Layer	network process to application
6	Presentation Layer	data conversion, data encryption and decryption
5	Session Layer	communication between computers
4	Transport Layer	reliability and flow control
3	Network Layer	logical addressing, path determination
2	Data Link Layer	physical addressing
1	Physical Layer	binary and signal transmission

Overview: Stellaris®



Explanations based on Stellaris® LM3S9B92

Basics Serial Interfaces: Ethernet

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- Ethernet
  - Is a technology for Local Area Networks (LAN).
  - It is standardized in the IEEE 802.3.
- Performance
  - There are different standards, representing different phases in its development history:
    - 10-Mbit/s-Ethernet
    - 100-Mbit/s-Ethernet
    - Gigabit-Ethernet
- Applications
  - Computer networks:
    - Local Area Networks (LAN)
    - Metropolitan Area Networks (MAN)
- Link: see Chapter 5.2 “Serial interfaces: Ethernet”

Stellaris® Features: Ethernet

- Conforms to the IEEE 802.3-2002 specification
  - 10BASE-T/100BASE-TX IEEE-802.3 compliant. Requires only a dual 1:1 isolation transformer interface to the line
  - 10BASE-T/100BASE-TX ENDEC, 100BASE-TX scrambler/descrambler
  - Full-featured auto-negotiation
- Multiple operational modes
  - Full- and half-duplex 100 Mbps
  - Full- and half-duplex 10 Mbps
  - Power-saving and power-down modes
- Highly configurable
  - Programmable MAC address
  - LED activity selection
  - Promiscuous mode support
  - CRC error-rejection control

Stellaris® Features: Ethernet

- Physical media manipulation
  - MDI/MDI-X cross-over support through software assist
  - Register-programmable transmit amplitude
  - Automatic polarity correction and 10BASE-T signal reception
- Efficient transfers using Micro Direct Memory Access Controller (µDMA)
  - Separate channels for transmit and receive
  - Receive channel request asserted on packet receipt
  - Transmit channel request asserted on empty transmit FIFO

Basics Serial Interfaces: USB

- Universal Serial Bus (USB)
  - USB is an industry standard developed in the mid-1990s to connect a PC to a peripheral to support communication and provide a supply power.
- Performance
  - As USB has developed over the years, there have been improvements in performance:
    - USB 1.0/1.1: 1.5 Mbit/s up to 12 Mbit/s
    - USB 2.0: 480 Mbit/s
    - USB 3.0: 4.8 Gbit/s
- Applications
  - Communication between PC and peripherals like keyboards, cameras and mass storages
  - Power supply to charge cameras and other portable devices
- Link: see Chapter 5.3 “Serial Interface: USB”

Stellaris® Features: USB

- Complies with USB-Interface certification standards
- USB 2.0 full-speed (12 Mbps) and low-speed (1.5 Mbps) operation
- Integrated Physical Layer (PHY)
- 4 transfer types: Control, Interrupt, Bulk, and Isochronous
- 32 endpoints
- 1 dedicated control IN endpoint and 1 dedicated control OUT endpoint
- 15 configurable IN endpoints and 15 configurable OUT endpoints
- 4 KB dedicated endpoint memory: one endpoint may be defined for double-buffered 1023-byte

Stellaris® Features: USB

- Isochronous packet size
- VBUS droop and valid ID detection and interrupt
- Efficient transfers using Micro Direct Memory Access Controller (µDMA)
- Separate channels for transmit and receive for up to three IN endpoints and three OUT endpoints
- Channel requests asserted when FIFO contains required amount of data

Basics Serial Interfaces: CAN

- The Controller Area Network (CAN) is a serial communications protocol.
- CAN is widely used in automotive electronics for engine control, communication between modules, sensors etc. Popular for process control.
- CAN properties:
  - Multicast reception with time synchronization: Multiple nodes can simultaneously receive the frame.
  - Multimaster: When the bus is free, any unit may start to transmit a message. The unit with the message of higher priority to be transmitted gains bus access.
  - Prioritization of messages: Depending on the importance of messages, the priorities will be given to the different messages.
  - Automatic retransmission of corrupted messages as soon as the bus is idle again.

Source: [7]

Basics Serial Interfaces: CAN

- Hardware: All the hard work is done in the Physical Layer 1 in the CAN hardware – error correction, bit stuffing etc.
- Bit rate: The speed of CAN message transfer may be different in different systems. But for a given system the bitrate is uniform and fixed.
- Acknowledgement: All receivers check the consistency of the message being received. Receivers acknowledge the correct message reception at the transmitter by sending a dominant bit in the acknowledgement field.

Source: [7]

Basics Serial Interfaces: CAN

- Different Types of CAN:
  - There are two types of CAN implementations depending in the size of the identifier field.
    - STANDARD: 11-bit wide identifier field (adequate for many purposes).
    - EXTENDED: 29-bit wide identifier field.
  - The identifier field determines the priority.
    - 0000 0000 00 binary = highest priority
    - 1111 1111 11 binary = lowest priority
  - If two nodes send a message at exactly the same time, the lowest priority node drops out.

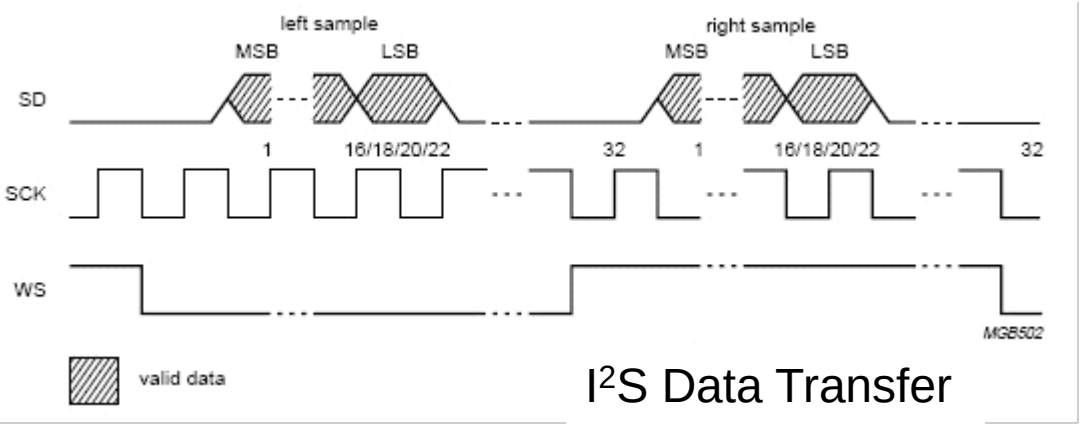
Source: [7]

Stellaris® Controller Area Network

- Stellaris Integrates Controller Area Network (CAN)
  - Up to 3 Bosch-licensed CAN controllers
  - Each supports CAN protocol version 2.0 part A/B
  - Bit rates up to 1Mb/s
  - 32 message objects, each with own identifier mask
  - Maskable interrupt
  - Disable automatic retransmission mode for TTCAN
  - Programmable loop-back mode for self test operation
- Stellaris collaterals
  - Over 50 CAN-enabled Stellaris ARM Cortex-M3 microcontrollers
  - The EK-LM3S2965 CAN-network-in-a-CAN evaluation kit
  - The EK-LM3S8962 CAN-network-plus-Ethernet evaluation kit
  - Access to CAN quick start applications and software examples from CAN stack providers.

Basics Serial Interfaces: I²S

- I²S Bus, Inter-IC Sound Bus (IIS, or I²S) is a serial bus designed for digital audio devices. The I²S design handles audio data separately from clock signals.
- An I²S bus design consists of three serial bus lines: a line with two time-division multiplexing (TDM) data channels [SD], a word select line [WS], and a clock line [SCK].



I²S Data Transfer

Source: [8]

Basics Serial Interfaces: I²S

- One chip in the I²S Bus system generates a Master clock, while all other devices derive their internal clocks from this reference.
- Standard clock rates include: 32 kHz, 44.1 kHz, or 48 kHz [or multiples of these].
- Data may be sent MSB first or LSB first. The word length is adjustable up to 28 bits.
- Synchronization with the data words may also be set to either the rising or falling edge of the clock.
- The Master drives SCK, and WS. Either the Transmitter, Receiver, or Controller may be the Master.
- The I²S bus can be found on Stereo CODECs, DACs and micro-processors.

Source: [8]

Stellaris® I²S

- Four modes: Stereo, Mono, Compact 16-bit Stereo and Compact 8-Bit Stereo.
- I²S, Left-justification, and Right-justification
- Sample size from 8 to 32 bits
- Mono and Stereo support
- 8-bit, 16-bit, and 32-bit FIFO interface for packing memory
- Independent transmit and receive 8-entry FIFOs
- Configurable FIFO-level interrupt and µDMA requests
- Independent transmit and receive MCLK direction control

Stellaris® I²S (cont.)

- Transmit and receive internal MCLK sources
- Independent transmit and receive control for serial clock and word select
- MCLK and SCLK can be independently set to master or slave
- Configurable transmit zero or last sample when FIFO empty
- Efficient transfers using Micro Direct Memory Access Controller (µDMA)
  - Separate channels for transmit and receive
  - Burst requests
  - Channel requests asserted when FIFO contains required amount of data

Stellaris® UART

- The Stellaris® Family features up to 3 UARTs
  - Provides fully programmable, 16C550-type serial interface characteristics
- Each UART has the following features
  - Separate transmit and receive FIFOs
  - Programmable FIFO length
  - FIFO trigger levels of 1/8, 1/4, 1/2, 3/4, and 7/8
  - Programmable baud-rate generator allowing rates up to 12.5 Mbps
  - Standard asynchronous communication bits for start, stop and parity
  - False start bit detection
  - Line-break generation and detection

Stellaris® UART (cont.)

- Fully programmable serial interface characteristics
  - 5, 6, 7, or 8 data bits
  - Even, odd, stick, or no-parity bit generation/detection
  - 1 or 2 stop bit generation
- IrDA serial-IR (SIR) encoder/decoder providing:
  - Programmable use of IrDA Serial InfraRed (SIR) or UART input/output
  - Support of IrDA SIR encoder/decoder functions for data rates up to 115.2 Kbps half-duplex
  - Support of normal 3/16 and low-power (1.41 µs to 2.23 µs) bit duration
  - Programmable internal clock generator enabling division of reference clock by 1 to 256, for low-power mode bit duration
- ISO 7816 Support (SmartCard communication) on tempest devices

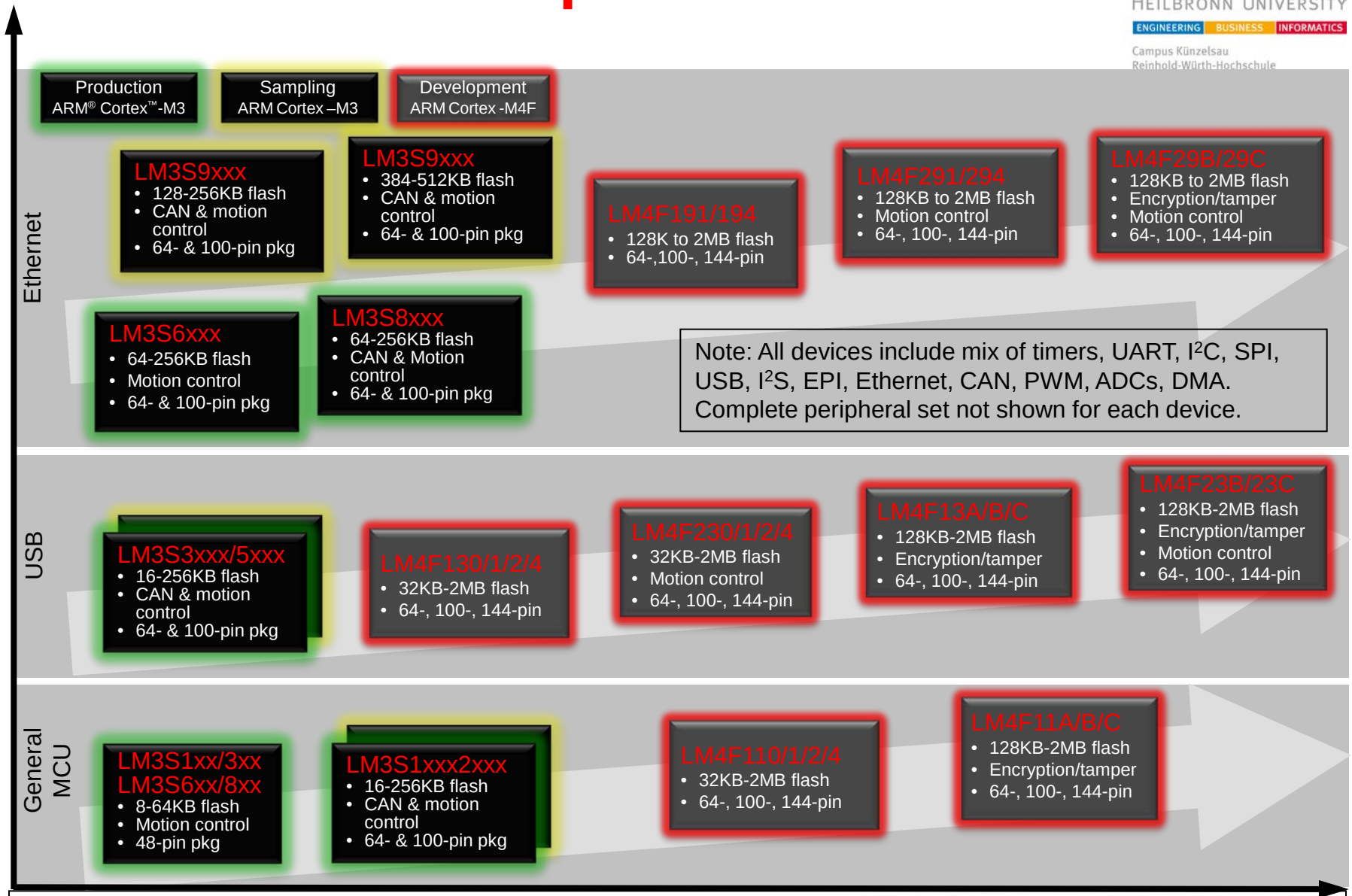
Stellaris® I²C

- Master or Slave
- Simultaneous operation as both a master and a slave
- There are a total of four I²C modes
  - Master Transmit, Master Receive
  - Slave Transmit, Slave Receive
- Standard (100 Kbps) and Fast (400 Kbps) speed support
- Master and slave interrupts support
  - I²C master generates interrupts when a transmit or receive operation completes (or aborts).
  - I²C slave generates interrupts when data has been sent or requested by a master.

Stellaris® SSI / SPI

- Programmable interface operation for Freescale SPI, MICROWIRE, or Texas Instruments
- Synchronous serial interfaces
- Master runs up to sys_clk/2 (25Mb @ 50MHz)
- Slave runs up to sys_clk/12 (4.1667Mb @ 50MHz)
- Programmable clock bit rate and pre-scaler
- Separate transmit and receive FIFOs, 16 bits wide, 8 locations deep
- Programmable interface operation for usual synchronous serial interfaces
- Programmable data frame size from 4 to 16 bits
- Internal loopback test mode for diagnostic/debug testing

Stellaris® Roadmap



Questions and Exercises

Hochschule Heilbronn
Heilbronn University
ENGINEERING BUSINESS INFORMATICS
Campus Künzelsau
Reinhold-Würth-Hochschule

1. What are the advantages of the LM3S9B92 over the LM3S1968?
2. Which serial interfaces are found on the LM3S9B92?
3. Explain an UART interface.
4. What is a I^2C interface?
5. What is a SPI interface?

- Exercise
  1. Run the example “Blinky” on the EKS-LM3S9B92
  2. Change the LED frequency of example “Blinky”

Summary and Outlook

Hochschule Heilbronn
Heilbronn University
ENGINEERING BUSINESS INFORMATICS
Campus Künzelsau
Reinhold-Würth-Hochschule

- Summary
  - From the Stellaris® 1000 family to the Stellaris® 9000 series
    - Comparison LM3S1986 to LM3S9B92
    - Different Stellaris® families
    - Porting
  - Features of the EKS-LM3S9B92
  - Example “blinky”
  - Theory of communication
    - Communication features of Stellaris®
- Outlook/How to go on?
  - The following chapters describe the Ethernet and the USB connectivity using the EKS-LM3S9B92

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