Model-Based Design Toolbox S32K1xx Series

Release Notes

An Embedded Target for the S32K1xx Family of Processors
Version 4.1.0

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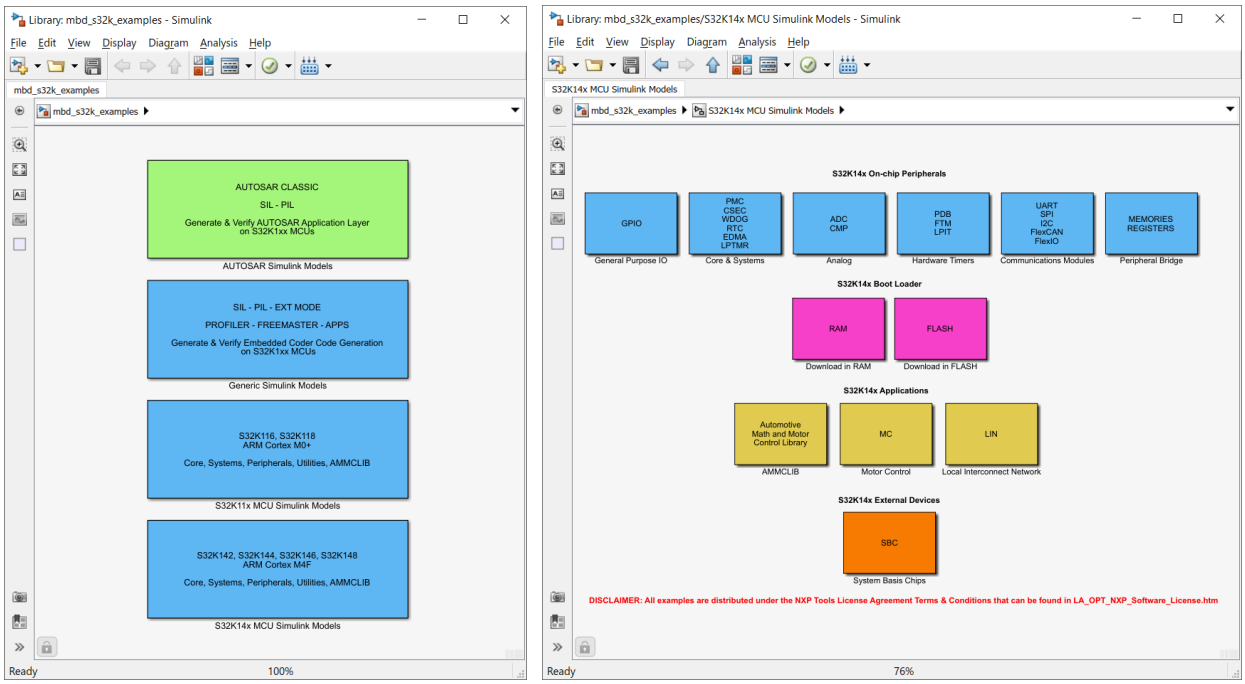
1 What is New in Version 4.1.0

The latest NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 is designed to support all S32K1xx microcontrollers and brings the following important enhancements compared with previous version (version 4.0.0 former known as version 2018.R1)

- Support for the **S32K116** / **S32K118** MCUs and their correspondent Evaluation Boards **S32K116EVB** and **S32K118EVB**;
- Integrates the **Automotive Math and Motor Control Library release 1.1.17** for:
    - S32K11x based on ARM M0+ cores;
    - S32K14x based on ARM M4F cores;
- Integrates the latest **S32K SDK version 3.0.1 RTM-SR** for S32K1xx MCU. NXP's Model-Based Design Toolbox generates codes based on standard SDK API, covering most of the functionalities exposed by SDK;
- Compatible with **S32 Design Studio 2018.R1** and **GCC 6.3**;
- Add support for **System Basis Chip** UJA113x configuration and control;
- Add support for **Three Phase Field Effect Transistor Pre-driver**, MC33GD3000, MC34GD3000, MC33937 and MC34937 configuration and control;
- Add support for **Local Interconnect Network (LIN)** configuration and control for S32K1xx MCU;
- Add support for AUTOSAR Blockset for S32K1xx parts to allow Processor-in-the-Loop simulation for Classic AUTOSAR Application Layer;
- Add support for Motor Control sensors direct read with HW support: HALL and Quadrature Encoder;
- Add support for PWM Software Control;
- Add support for ADC Interleave for S32K1xx microcontrollers;
- **Expand the example library to cover all Simulink Blocks** provided as part of the NXP Toolbox for S32K1xx devices. The **example library contains more than 200 examples** that covers a wide range of topics like:
    - I/O control: GPIO, Compare, Capture
    - Timers: Programmable (PIT), Low Power (LPTMR), Real Time Clock (RTC), Flex (FTM)
    - Motor Control: Pulse Width Modulation (PWM), Programmable Delay (PDB), Analogue Converter (ADC), Sensors (QEP and HALL)
    - Power Management Controller (PMC)
    - Communication: CAN/CAN-FD, SPI, I2C, UART, FlexIO, LIN
    - Security: CSEC
    - Core & Systems: DMA, Registers, Memories, Watch-Dog
    - Software-in-the-Loop, Processor-in-the-Loop and External Mode
    - SRAM and Flash Programming over UART
    - External Devices for CAN and MOSFET pre-drivers

The Simulink Models are saved in the NXP Toolbox root directory under `S32_Examples` folder and can be accessed easily from `mbd_s32k_examples.mdl` library file.



For more details about each of the topics highlighted above please refer to the following chapters.

2 S32K1xx MCU Support

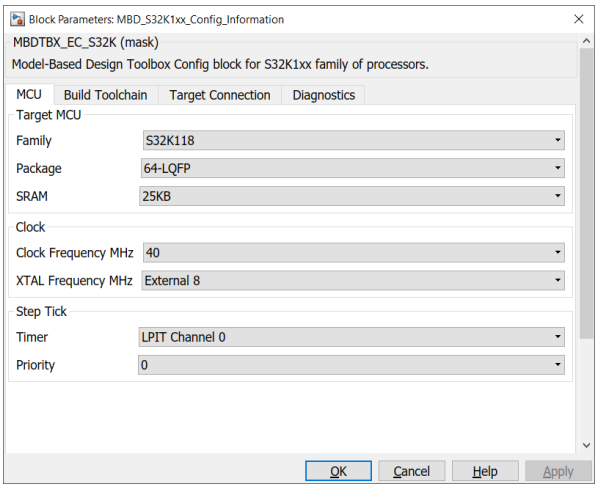
2.1 Packages & Derivatives

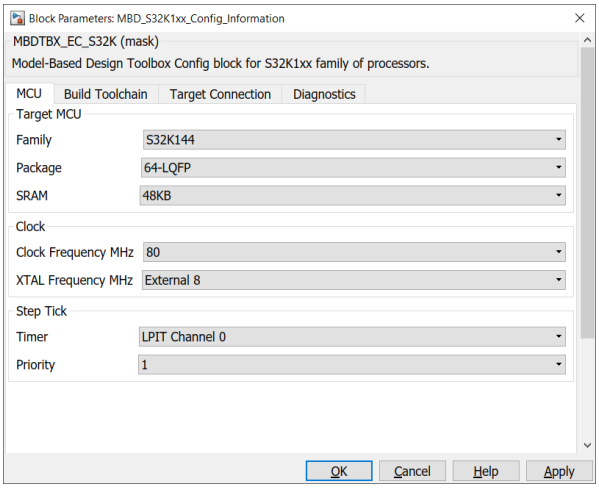
NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 supports:

- S32K116 MCU Packages with 17KB SRAM **(*new)**:
  - 32 QFP;
  - 48 LQFP;
- S32K118 MCU Packages with 25KB SRAM **(*new)**:
  - 48 LQFP;
  - 64 LQFP;
- S32K142 MCU Packages with 16/32KB SRAM **(*updated)**:
  - 48 LQFP;
  - 64 LQFP;
  - 100 LQFP;
- S32K144 MCU Packages with 48/64KB SRAM **(*updated)**:
  - 48 LQFP;
  - 64 LQFP;
  - 100 LQFP;
  - 100 BGA;
- S32K146 MCU Packages with 128KB SRAM:
  - 64 LQFP;
  - 100 LQFP;
  - 144 LQFP;
  - 100 BGA;
- S32K148 MCU Packages with 192/256KB SRAM **(*updated)**:
  - 144 LQFP;
  - 176 LQFP;
  - 100 QFP;
  - 100 BGA;

The toolbox supports operations with 8MHz and 40MHz external XTAL and MCU system clock configuration frequencies of 40/80/112MHz depending on the type of microcontroller selected.

Note: *Make sure the correct XTAL Frequency is selected based on the controller type. If other frequencies are needed, the toolbox provided an easy method to address such cases. In the ..\src\tools\ClockConfig\ you can find S32Design Studio project that can help to regenerate the clock configuration file for the toolbox*

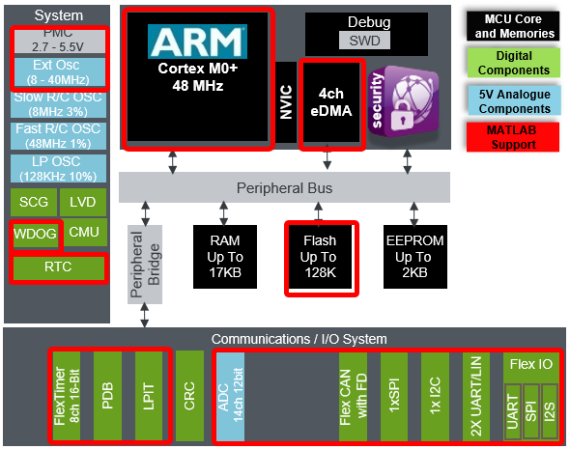




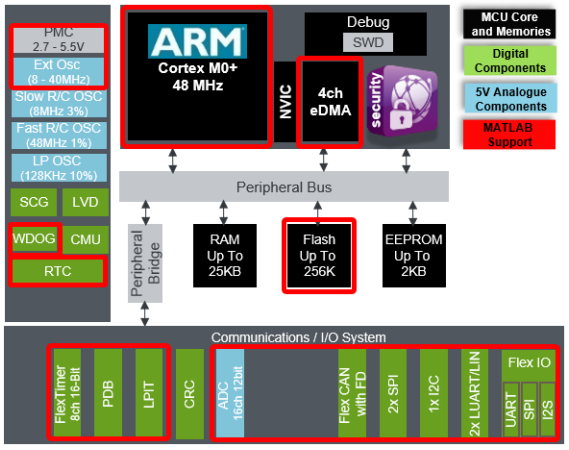
2.2 Peripherals & Devices

NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 supports the following peripherals and devices that are highlighted in red:

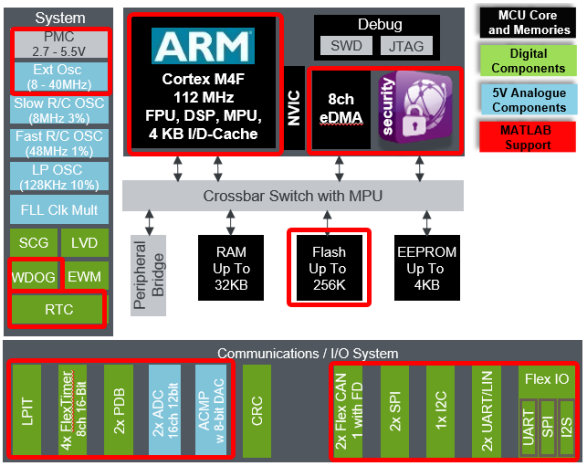
S32K116



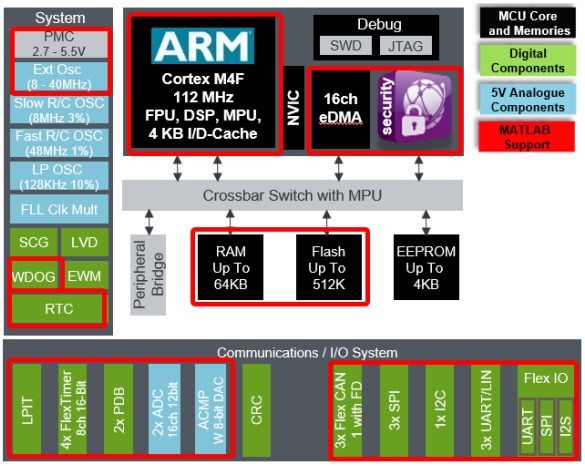
S32K118



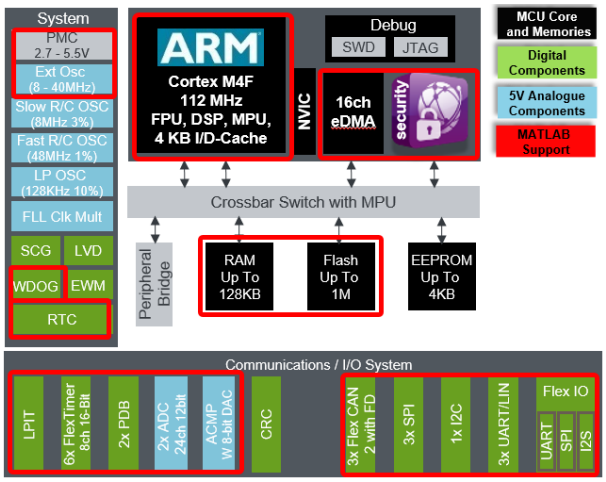
S32K142



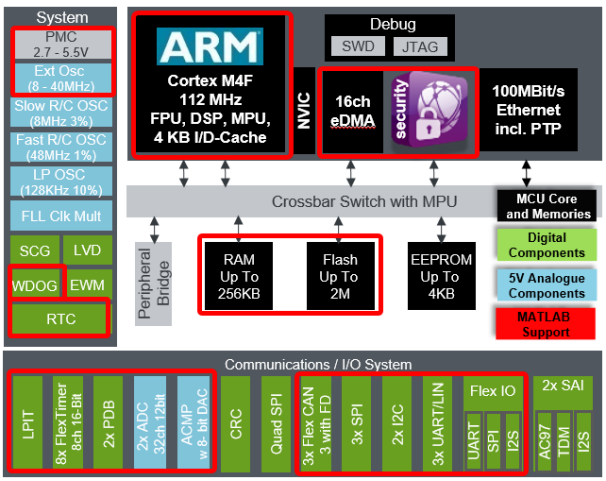
S32K144



S32K146



S32K148



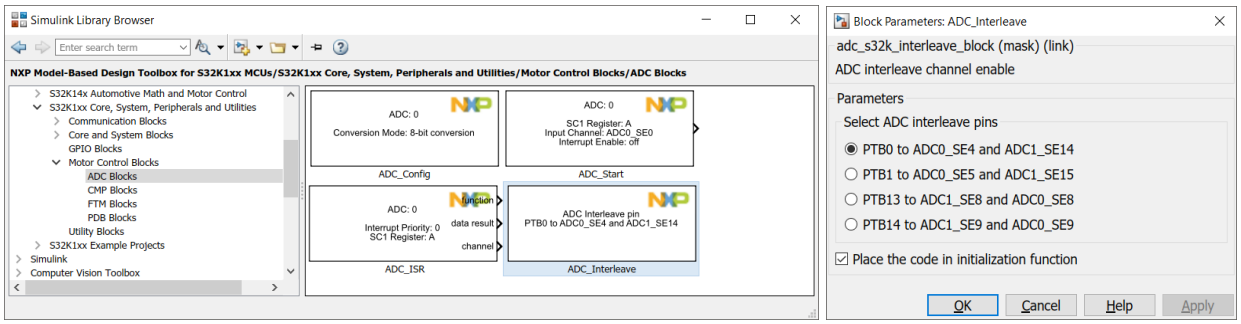
Note: *Model-Based Design Toolbox for S32K1xx Series do not support RAM targets and peripheral that needs RAM support on S32K116, S32K118 and S32K142 microcontrollers due to the limited RAM footprint.*

The NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 has been tested using the official NXP Evaluation Boards for S32K1xx:

- S32K116EVB rev X2, sch. Rev B
- S32K118EVB rev X2, sch. Rev B
- S32K142EVB rev X1, sch. Rev C
- S32K144EVB rev X3, sch. Rev B1
- S32K146EVB rev X1, sch. Rev B
- S32K148EVB rev X2, sch. Rev C

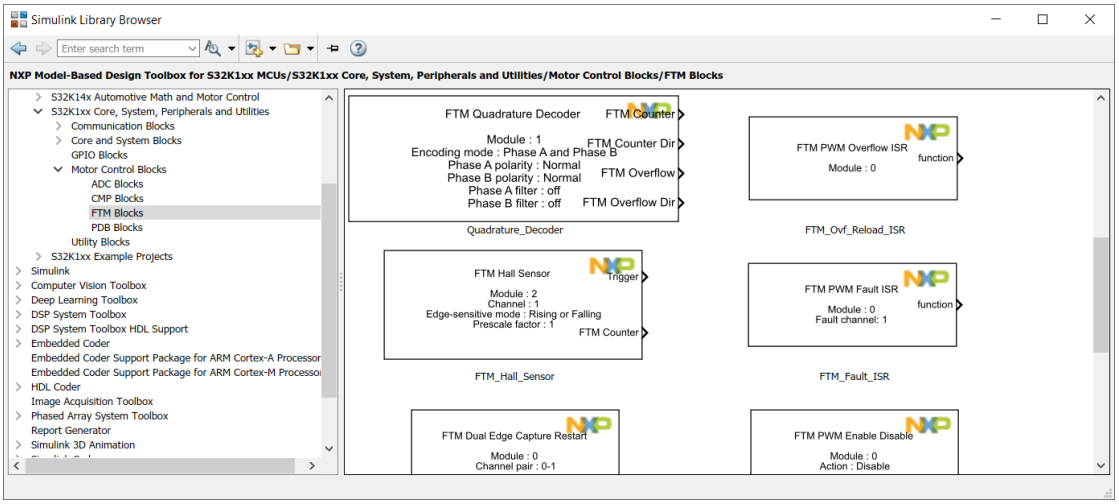
2.2.1 New ADC Interleave Block

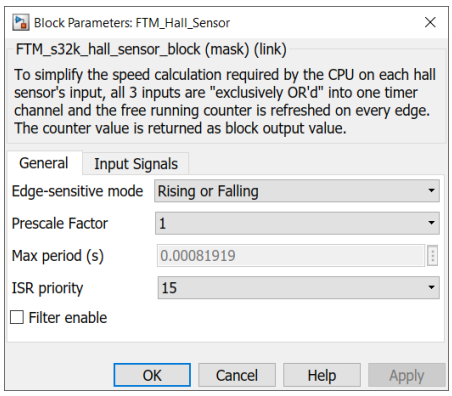
For advanced motor control rapid prototyping, where the ADC measurements must be synchronized properly, there is now a new Simulink block that allows users to use the S32K microcontrollers interleave properties to reroute signals directly from Simulink environment

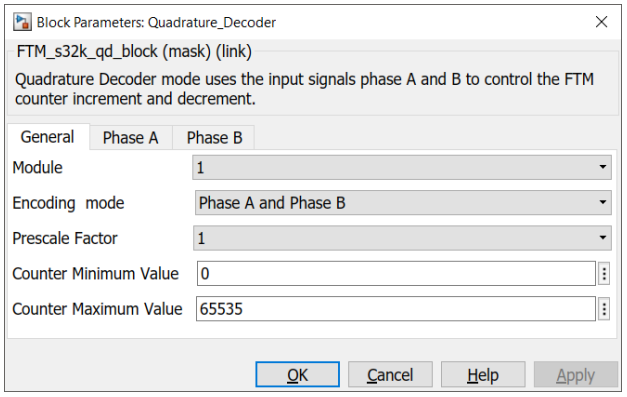


2.2.2 New blocks for Motor Control

To simply the speed computation required for closed loop motor control in case of BLDC or PMSM type of application, two new blocks were added into the Simulink library: FTM Hall Sensor and Quadrature Decoder.

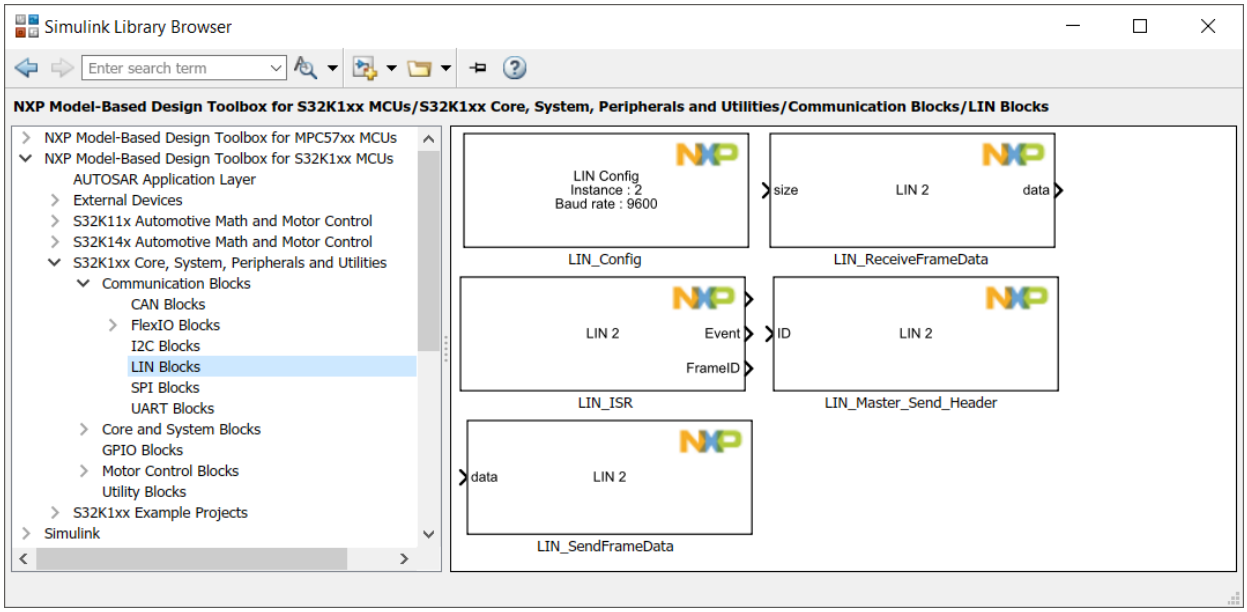






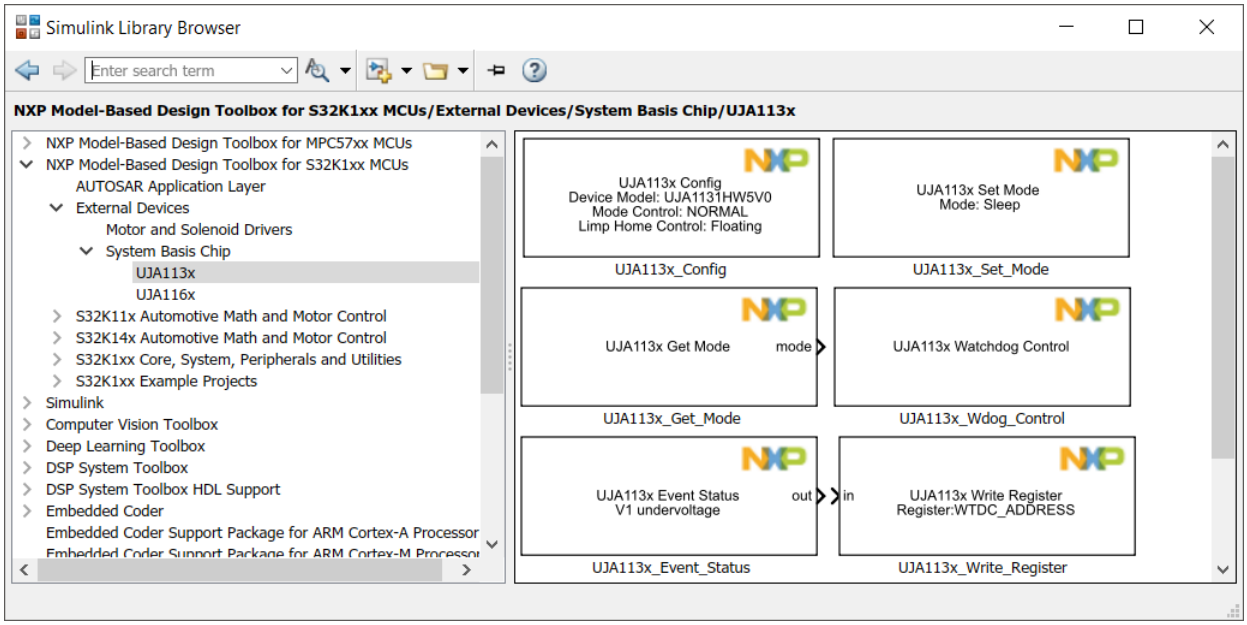
2.2.3 New Local Interconnect Network (LIN) Support

New Simulink blocks were added to support the configuration and control of LIN. Such applications can now be easily developed directly from Simulink and tested on S32K1xx microcontroller and NXP evaluation boards.

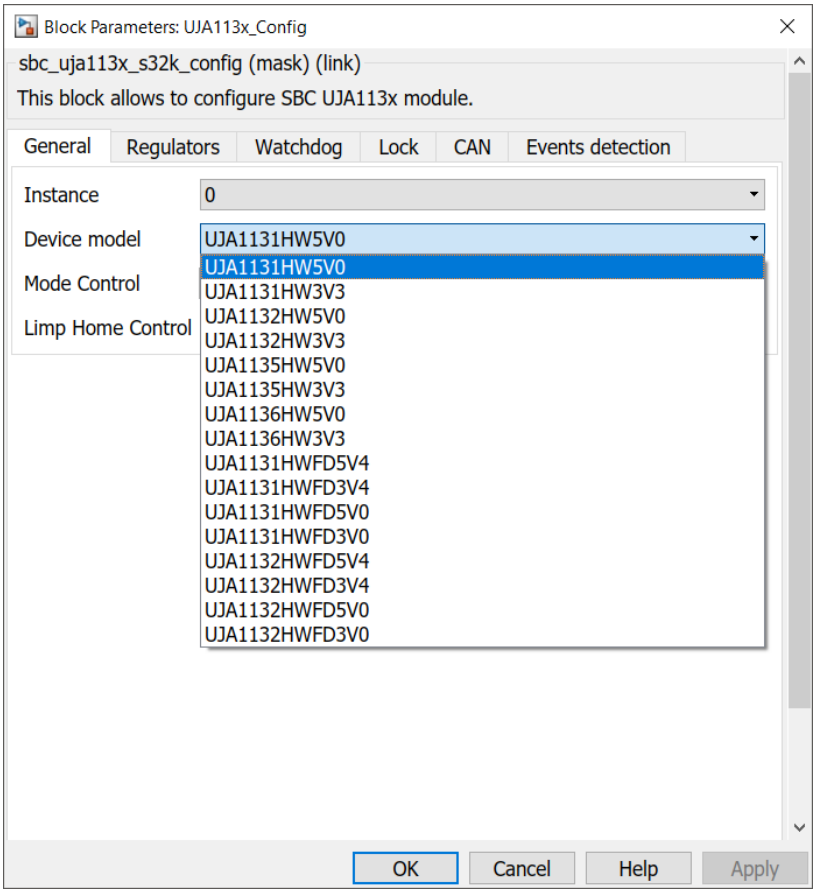


2.2.4 Updated External Devices Support

System Basis Chip (SBC) family featuring SMARTMOS technology combines several popular functions in automotive MCU-based systems. They support linear voltage regulation controlled through an SPI interface. They possess various power-saving modes such as standby, sleep, stop and other features such as wakeup, and watchdog timer. The NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 support now the UJA113x in addition to UJA116x



The main configuration block for SBC support various devices for UJA113x

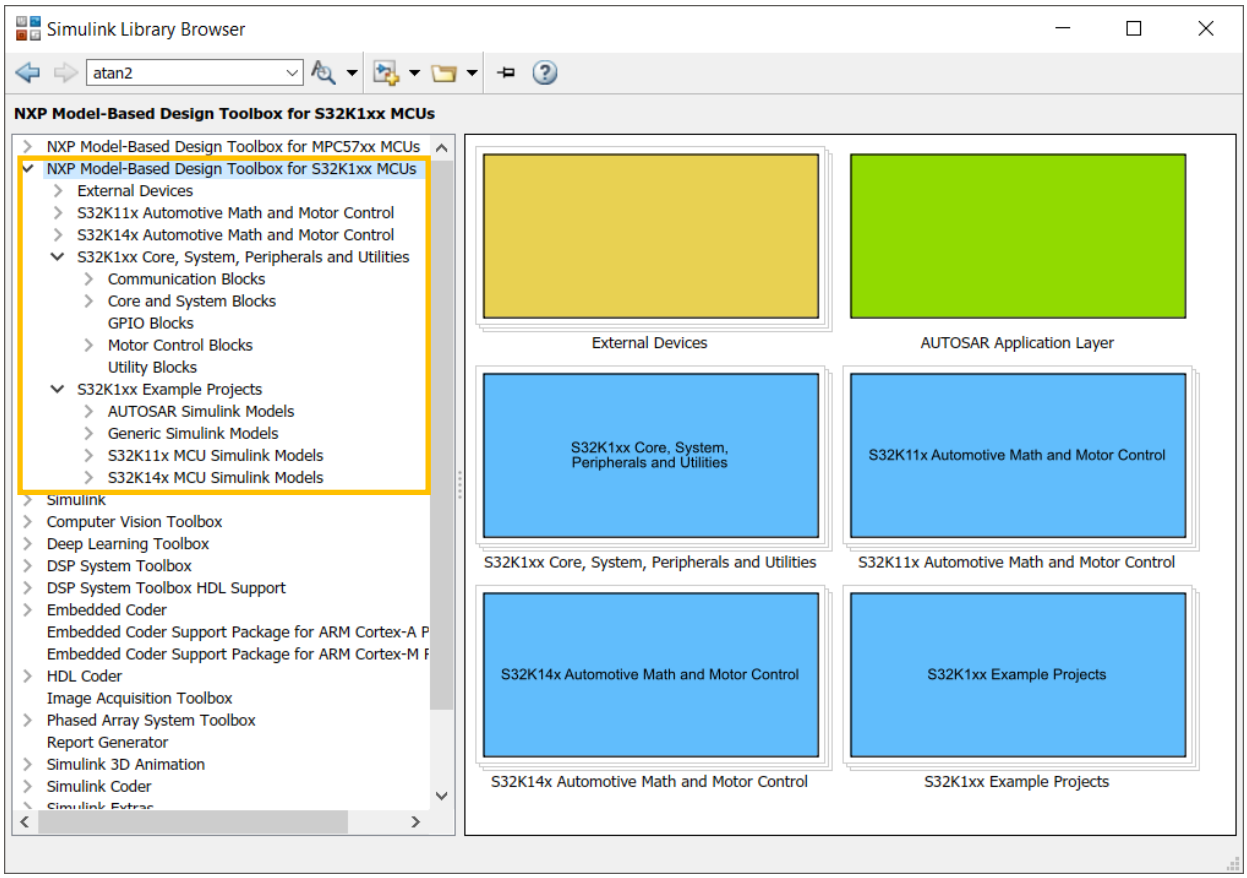

Block Parameters: UJA113x_Config
sbc_uja113x_s32k_config (mask) (link)
This block allows to configure SBC UJA113x module.
General
Regulators
Watchdog
Lock
CAN
Events detection
Instance
0
Device model
UJA1131HW5V0
Mode Control
Limp Home Control
UJA1131HW5V0
UJA1131HW3V3
UJA1132HW5V0
UJA1132HW3V3
UJA1135HW5V0
UJA1135HW3V3
UJA1136HW5V0
UJA1136HW3V3
UJA1131HWFD5V4
UJA1131HWFD3V4
UJA1131HWFD5V0
UJA1131HWFD3V0
UJA1132HWFD5V4
UJA1132HWFD3V4
UJA1132HWFD5V0
UJA1132HWFD3V0
OK
Cancel
Help
Apply

3 Model-Based Design Toolbox Features

NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 is delivered with a complete S32K1xx MCU Simulink Block Library as shown below.

There are six main categories:

- **S32K1xx Core, System, Peripherals and Utilities** which contains all blocks related with MCU configuration
- **S32K1xx Example Projects** which contains all the examples that exercise all the other blocks
- **S32K14x and S32K11x Automotive Math and Motor Control** which generic 16bit, 32bit and floating-point single precision blocks
- **External Devices** which contains blocks related with System Basis Chips and Three phase Pre-drivers configuration
- **AUTOSAR Application Layer** which contains configuration blocks for Classic AUTOSAR PIL simulations

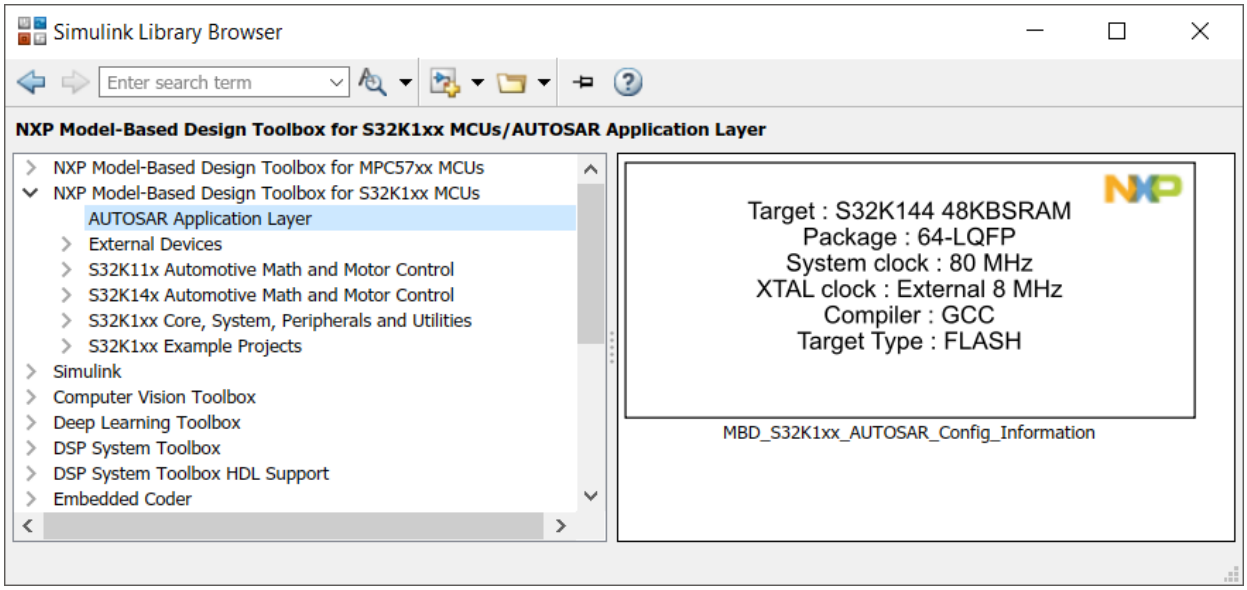


3.1 AUTOSAR Application Layer Support

With MATLAB 2019a, MathWorks introduced a new AUTOSAR Blockset to help with design and simulation of AUTOSAR Software.

Note: *The features from Embedded Coder® Support Package for AUTOSAR Standard is transitioned to new AUTOSAR Blockset. It is available with MATLAB and Simulink for model simulation. Embedded Coder is required to generate AUTOSAR C/C++ code and XML component descriptions for AUTOSAR Classic and Adaptive Platforms.*

NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 provides an easy way to test Classic AUTOSAR Application Layer directly on S32K1xx microcontroller in Processor-in-the-Loop simulations. Drag and Drop the MBD_S32K1xx_AUTOSAR_Config block into your models to configure PIL to run on the S32K1xx microcontrollers



Note: *This feature is designed to be used only for AUTOSAR Applications. It does not provides support for AUTOSAR BSW nor MCAL Layers.*

3.2 S32K1xx Automotive Math and Motor Control

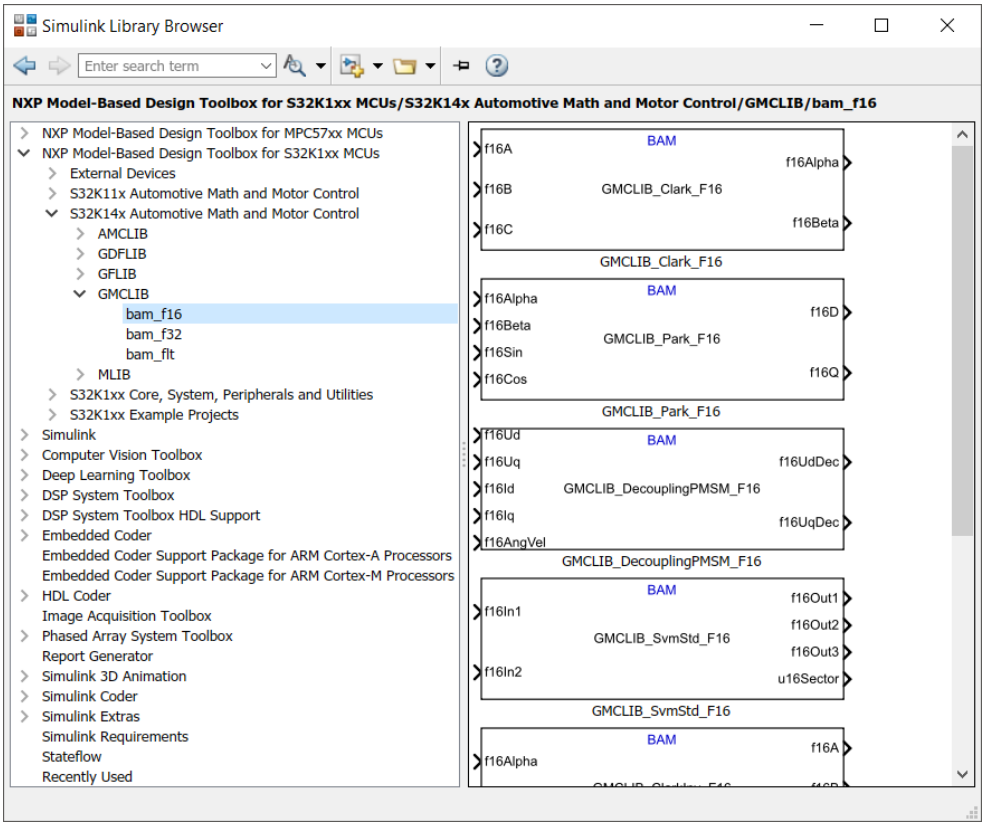
All functions in the Automotive Math and Motor Control Functions Library v1.1.17 are supported as blocks for simulation and embedded target code generation for:

- Bit Accurate Model for 16-bit fixed-point implementation;
- Bit Accurate Model for 32-bit fixed-point implementation;
- Bit Accurate Model for floating-point single precision implementation;

There are two different AMMCLIB libraries integrated with the NXP Model-Based Design Toolbox S32K1xx Simulink Library. Depending on the microcontroller in use, you need to select between:

- S32K11x Automotive Math and Motor Control
- S32K14x Automotive Math and Motor Control

Note: *Due to Simulink limitations it is not possible to mix the AMMCLIB blocks from S32K11x with the ones from S32K14x. Depending on the MCU selection made in main configuration block one version of the other of the AMMCLIB is active*



The main functionalities supported are:

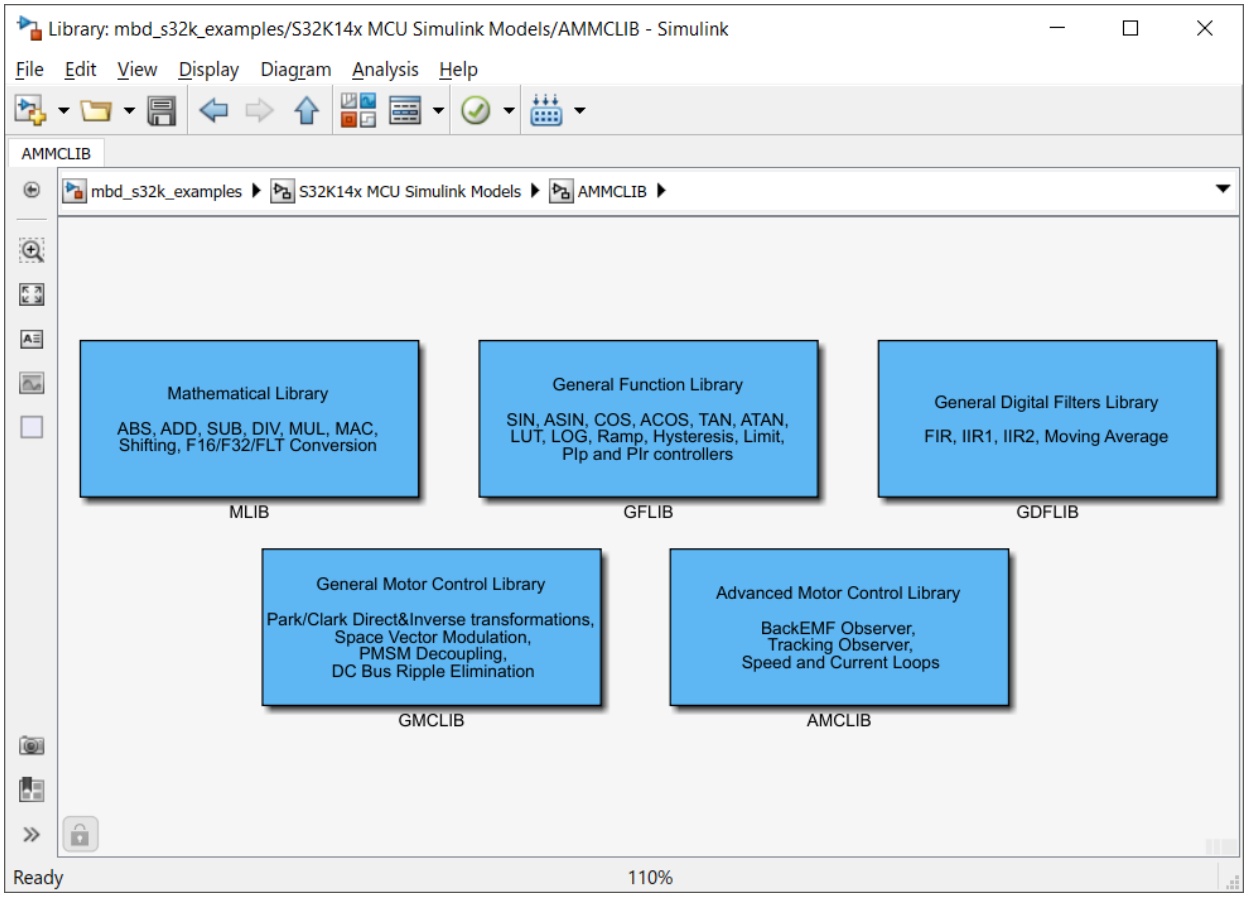
- Mathematical Function Library (MLIB) – supports basic mathematical operations such as addition, multiplication, etc;
- General Function Library (GFLIB) – supports basic trigonometric and general math functions such as sine, cosine, tan, hysteresis, limit, etc;
- General Digital Filters Library (GDFLIB) – comprising digital IIR and FIR filters designed to be used in a motor control application;

- General Motor Control Library (GMCLIB) – supports standard algorithms used for motor control such as Clarke/Park transformations, Space Vector Modulation, etc;
- Advanced Motor Control Function Library (AMCLIB) – comprising advanced algorithms used for motor control purposes;

For more details about the latest changes check the:

- `\mbdtbx_s32k11x\AMMCLIB_s32k11x\ S32K11x_AMMCLIB_RTM_1_1_17_ReleaseNotes.txt`
- `\mbdtbx_s32k14x\AMMCLIB_s32k14x\ S32K14x_AMMCLIB_RTM_1_1_17_ReleaseNotes.txt`

For each AMMCLIB block there is a Simulink Example available NXP Toolbox root directory `..\S32_Examples\common\` folder.

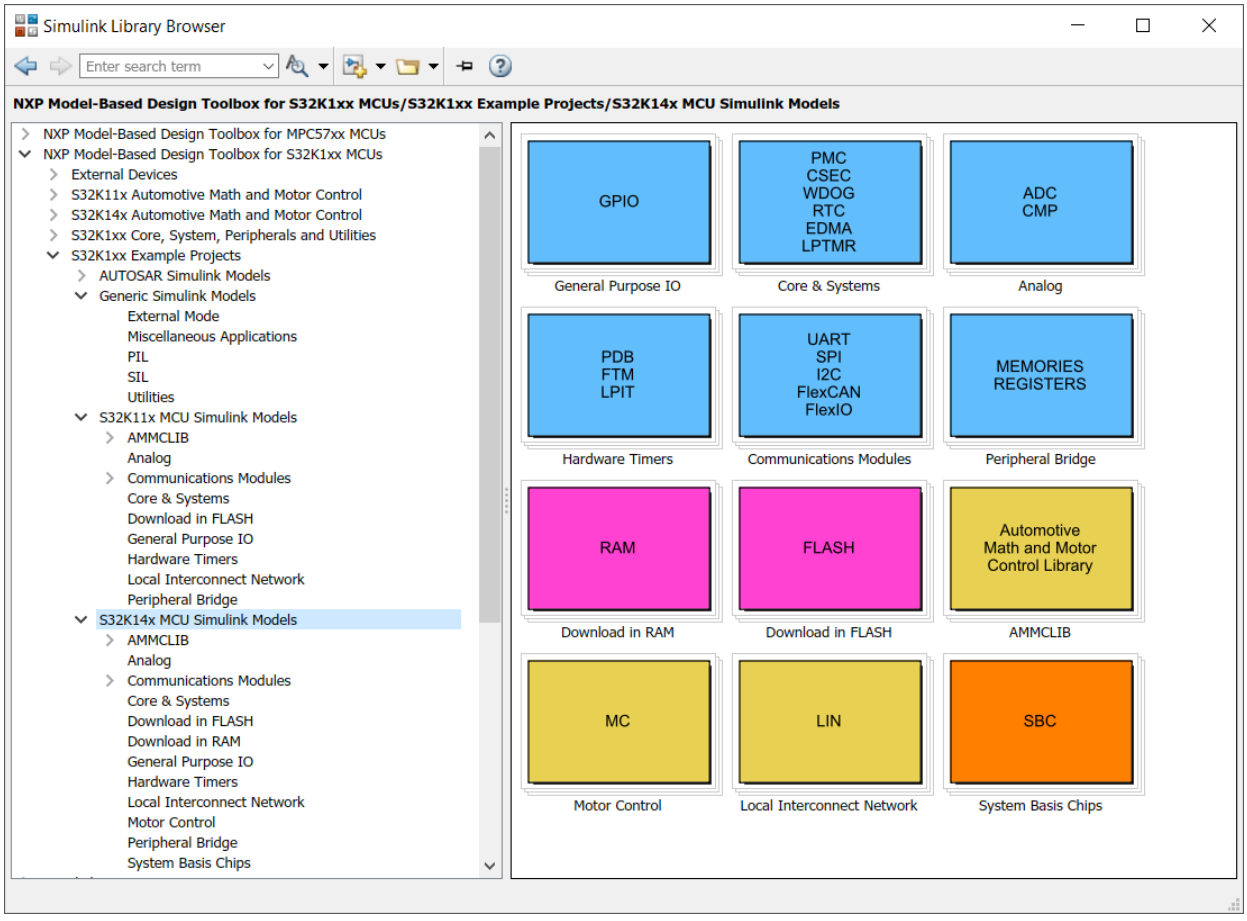


3.3 S32K1xx Example Library

S32K Examples Library represents a collection of Simulink models that let you test different MCU on-chip modules and run complex applications. The example library is split into four categories:

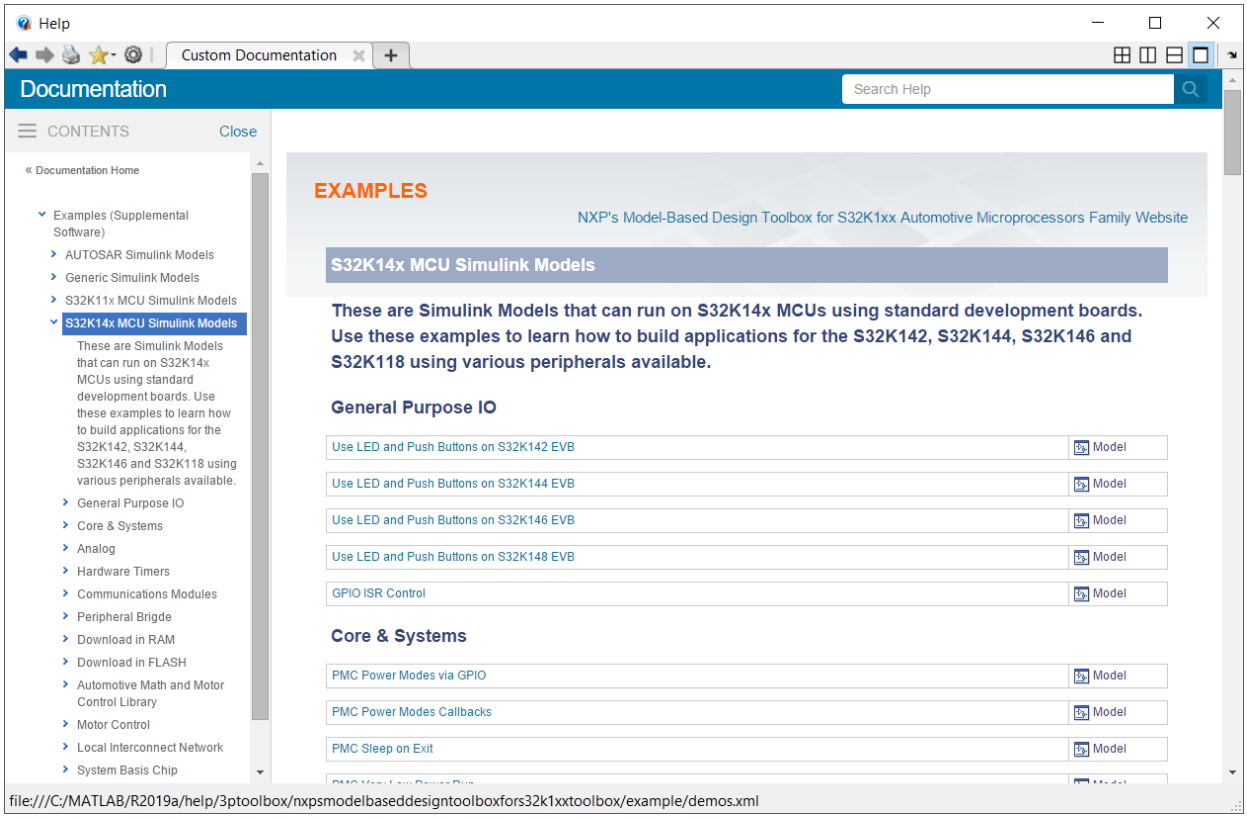
- AUTOSAR Simulink Models that allows PIL simulations for Classic AUTOSAR applications
- Generic Simulink Models that show how to configure the S32K1xx for SIL, PIL, External Mode and other applications that can run NXP devices
- S32K11x MCU Simulink Models that can be run on any of the S32K11x Evaluation Boards
- S32K14x MCU Simulink Models that can be run on any of the S32K14x Evaluation Boards

The examples are grouped in different layers that mimics a typical development flow: starting with basic building blocks that expose the MCU HW functionalities, build SIL and PIL models for verification and validation purposed and ending up with more complex applications that incorporates multiple building blocks.



The Simulink models shown as examples are enhanced with a comprehensive description to help users understand better the functionality that is exercised, hardware setup instructions whenever are necessary and a result validation section.

The examples are available from MATLAB help page too:



4 New Model-Based Design Toolbox Extras

NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 enables additional functionalities that are not MCU specific but could help faster prototyping, validation and verification of the developed models.

4.1 Processor-In-the-Loop Support (PIL)

The NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 provides PIL support for purposes of ASIL software development processes, "Model PIL Block" (Model Reference) and "PIL Block" modes of operation are supported "Top Model PIL" mode is not supported. PIL contains full support for Math and Motor Control Blocks, and limited support for peripheral blocks.

For PIL support you need to install the MATLAB Support for MinGW-w64 C/C++ Compiler toolbox All models, mex files generation and tests were developed using the MinGW Compiler

An alternative is Microsoft Windows SDK 7.1. Please refer to the following links for troubleshooting:

- https://www.mathworks.com/matlabcentral/answers/95039-why-does-the-sdk-7-1-installation-fail-with-an-installation-failed-message-on-my-windows-system
- https://www.mathworks.com/matlabcentral/answers/101105-how-do-i-install-microsoft-windows-sdk-7-1

4.2 Boot Loader

Internal Boot Loader is a standalone application which requires the Microsoft .NET Framework version 4.0 installed on PC. The board should be configured to work with BAM to use Internal Boot Loader. Please check board documentation.

The bootloader files located under `..\tools\BootLoader\RBF_Files\` have need updated to support all S32K1xx derivatives and allows applications to be downloaded via UART or CAN interfaces to the boards.

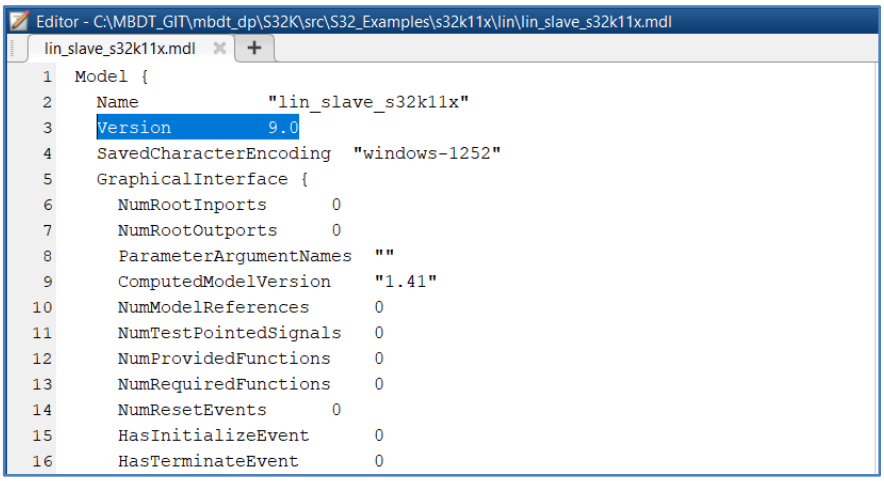
5 Prerequisites

5.1 MATLAB Releases and OSes Supported

This toolbox is developed and tested to supports the following MATLAB releases:

- R2017b;
- R2018a;
- R2018b;
- R2019a;

In general, older version of MATLAB may be supported with small updates that can be done after installation. As a rule, if you are planning to use an older version you need to update the Simulink version in every MDL file delivered with the toolbox



For a flowless development experience the minimum recommended PC platform is:

- *Windows® OS*: any x64 processor
- At least 4 GB of RAM
- At least 6 GB of free disk space.
- Internet connectivity for web downloads.

Operating System Supported

	SP Level	64-bit
Windows 7	SP1	X
Windows 10		X

5.2 Compiler Support

The following compilers are supported:

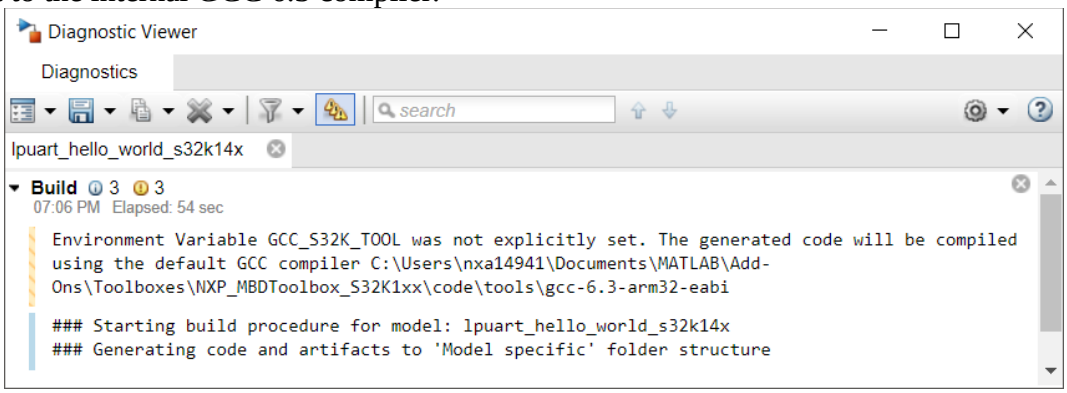
Compiler Supported	Release Version
GCC for ARM Embedded Processors	V6.3.1
IAR ANSI C/C++ Compiler (only for S32K14x)	V8.11.2
GreenHills MULTI for ARM	2017.1.4

The target compiler for Model-Based Design Toolbox needs to be configured. Use the notation below to setup these compiler environmental variables. Ensure a system environment variable called <COMPILER_STRING>_TOOL, corresponding to the compiler(s) you have installed, is defined to compiler path value as shown below:

```
GCC_S32K_TOOL = {Toolbox installation path}\tools\gcc-6.3-arm32-eabi
IAR_TOOL = {IAR installation path}/IAR Systems/Embedded_Workbench
GHS_TOOL = {GHS installation path}/multi
```

Note: Paths shown are for illustration, your installation path may be different. Once environmental variables are setup you will need to restart MATLAB for the IDE environment to see these system variables.

In case there is no compiler installed, the NXP's Model-Based Design Toolbox is going to default to the internal GCC 6.3 compiler.



6 Known Limitations

NXP's Model-Based Design Toolbox for S32K1xx version 4.1.0 has the following limitations:

- The version 4.1.0 cannot coexist with previously installed version of the NXP Model-Based Design Toolbox for S32K1xx. When the toolbox is install as Add-Ons the MATLAB will uninstall the previous version automatically. In case you have files, custom files saved with previous versions those will not be deleted.

  To avoid any complications, it is recommended to uninstall the previous toolboxes for S32K1xx manually from Add-on Manager prior of install the 4.1.0 release

- Download to target for Simulink is supported only via UART interface. For CAN download, you can use the RAppID Bootloader as a separate tool to load the generated application into target RAM/Flash Memories.
- Due to SRAM memory sizes available on S32K116, S32K118 and S32K142 the support for generating the application in RAM from Simulink has been disabled. There code size of the applications does not fit into the target SRAM memory.
- Once the CSEC is enabled the only reliable was to reprogram the target is to use the UART communication channel.
- For SBC testing the correct factory settings is require. FNMC bit must be disabled, SBC_UJA_SBC_SDMC_DIS must be disabled and Sleep Control Bit SLPC must be allowed. For running other applications is recommended to move the SBC in FNMC after running this example, otherwise CAN transceiver can be disabled because SBC goes in LIMP mode due to lack of watchdog feed. The S32K142 and S32K144 Evaluation might fail to exit from reset mode.
- All examples were tested by default on S32K144 Evaluation Board. Some examples might need manual settings when compiled and run for other version of the boards.

7 Support Information

For technical support please sign on to the following NXP's Model-Based Design Toolbox Community: https://community.nxp.com/community/mbdt

How to Reach Us:

Home Page:
www.nxp.com

Web Support:
www.nxp.com/support

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