Model-Based Design Toolbox

Release Notes

An Embedded Target for the S32K1xx Family of Processors
Version 2018.R1
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1 What is New in 2018.R1

The latest NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 is designed to support S32K14x MCU and brings the following important enhancements compared with previous version v.3.0.0:

- Support for the S32K146 / S32K148 MCUs and their correspondent Evaluation Boards S32K146EVB and S32K148;
- Integrates the Automotive Math and Motor Control Library release 1.1.13 for ARM M4 cores;
- Integrates the latest S32K SDK version 2.0.0 RTM for S32K14x 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;
- Enable MATLAB Profiler support for PIL targets;
- Enable MATLAB External Mode support for S32K Targets;
- A complete redesign of NXP Target Configuration Block which enhance the S32K14x selection process and Target communication;
- A complete redesign of the FTM Configuration block to support more PWM configuration modes;
- Add support for DMA configuration;
- Add support for Real Time Clock peripheral configuration;
- Add support for S32K14x Registers configuration directly from Simulink;
- Add support for System Basic Chip UJA116x configuration
- **Expand the example library to cover all Simulink Blocks** provided as part of the NXP Toolbox for S32K14x devices. The example library contains 115 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)
  - Power Management Controller (PMC)
  - Communication: CAN/CAN-FD, SPI, I2C, UART, FlexIO
  - 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
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 S32K14x MCU Support

2.1 Packages & Derivatives

NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 supports:

- S32K142 MCU Packages with 16/32KB SRAM (*updated):
  - 64 LQFP;
  - 100 LQFP;

- S32K144 MCU Packages with 48/64KB SRAM:
  - 100 BGA;
  - 64 LQFP;
  - 100 LQFP;

- S32K146 MCU Packages with 128KB SRAM (*new):
  - 100 BGA;
  - 64 LQFP;
  - 100 LQFP;
  - 144 LQFP;

- S32K148 MCU Packages with 192/256KB SRAM (*new):
  - 100 BGA;
  - 144 LQFP;
  - 176 LQFP;

The toolbox supports operation with 8MHz and 40MHz external XTAL and MCU system clock configuration frequencies of 80MHz and 112MHz.
2.2 Peripherals & Devices

NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 supports the following peripherals and devices that are highlighted in red:

- **S32K142**
- **S32K144**
- **S32K146**
- **S32K148**

The NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 has been tested using the official NXP Evaluation Boards for S32K14x:

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

Model-Based Design Toolbox 2018.R1
Release Notes for S32K1xx family of processors
2.2.1 **New DMA Support**

The new DMA Configuration and Transfer Simulink blocks are designed to help with configuration of the individual channels, set their priority, request source and what type of arbitration the DMA should be used.

With these new blocks you can speed up applications by offloading the CPU during data transfers. The built in models shows how to configure data transfers via DMA and compare the results against the CPU operation as shown below.
2.2.2 New RTC Support
The Real Time Clock Module is an independent timer that keeps track of the exact date and time with no software overhead and low power usage. The NXP toolbox allows Real Time Clock Configuration and Control for various scenarios:

- Obtain the absolute time;
- Implement alarms and timers;

The main configuration block for the RTC is shown below.

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2.2.3 New REGISTER Support
For unsupported peripherals, there is now an easy way to configure them from MATLAB/Simulink with the help of REGISTER READ/WRITE blocks. For each platform supported, a list of all available platform registers is available for read or write operations.

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2.2.4 Updated FTM Support

To address complex scenarios the FTM configuration block was redesigned to be in sync with SDK 2.0.0 RTM drivers. The new configuration block follows now the overall NXP MBDT design philosophy to have a single configuration block per each peripheral. From the new FTM configuration block you can:

- Configure PWM to operate in various modes
- Assign output and input pins
- Control the faults and triggers
2.2.5 **New 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 2018.R1 support now the UJA169x

The main configuration block for SBC support various devices for UJA169x
3 Model-Based Design Toolbox Features

NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 is delivered with a complete S32K MCU Simulink Block Library as shown below.

There are three main categories:

- **S32K14x Core, System, Peripherals and Utilities** which contains all blocks related with MCU configuration
- **S32K14x Automotive Math and Motor Control** which generic 16bit, 32bit and floating point single precision blocks
- **S32K14x Example Projects** which contains all the examples that exercise all the other blocks

```
NOTE
In preparation for supporting multiple derivatives of S32K the Simulink Library for S32K14x has been redesigned. The Simulink models created with previous releases need be converted manually from Simulink to work with the newest version.
```
3.1 New MBD S32K Configuration Block

For addressing the increased number of MCU and options the main toolbox configuration block has been completely redesigned. In the newest version of the NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 this is a standalone block with its own user interface designed to address four main scenarios:

3.1.1 New MCU Support

The MCU Tab allows the configuration of the S32K Platform used for code generation. In this tab the selection of the MCU, Package and Clock have a global influence over the Simulink Model.

![Configuration Block S32K14x](image)

**NOTE** When changing the MCU or package the I/O pins might be reset to defaults in case the corresponding pins are not available from one. Make sure you check your model after changing the MCU and/or package.
3.1.2 **New Target Connection**

Connection with a NXP S32K target is now easier. For both Serial and OpenSDA the MBD Toolbox has a discovery features that allows you to detect the ports automatically. Just click on Refresh button to get a list of available connections.
3.1.3 **New Diagnostics**

The Diagnostics panels allow various checking for the correct usage of the Simulink blocks and dependencies between them:

- Checks if pins are shares across various Simulink blocs within the model;
- Checks if incorrect instances of a configured peripheral are used;
- Consistency checks between the block options;
3.2 S32K14x Automotive Math and Motor Control

All functions in the Automotive Math and Motor Control Functions Library v1.1.13 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;

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, hysterisis, 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;

Check the `mbdtbx_s32k14x\AMMCLIB_s32k14x\S32K14x_AMMCLIB_RTM_1_1_13_ReleaseNotes.txt` for details about the latest changes.
For each AMMCLIB block there is a Simulink Example available NXP Toolbox root directory `..\S32_Examples\common\` folder.
### 3.3 S32K14x 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:

- S32K14x Generic examples that can be run on any of the S32K Evaluation Boards
- S32K14x Targeted examples that are configured for a single target.

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.
4 New Model-Based Design Toolbox Extras

NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1 enables additional functionalities that are not MCU specific but could help faster prototyping, validation and verification of the developed models.

4.1 New External Mode Support

External mode enables Simulink on your host computer to communicate with the deployed model on your hardware board during runtime. This is an alternative to FreeMASTER.

To use this mode, you need to enable the External Mode support in Model Configuration Parameters.

![Configuration Parameters](image)

Build and Download the Simulink model as normal and once the application was downloaded to the target you can connect to it by pressing the Connect To Target button.

![Simulink model](image)

Once a target connection has been established you can use the MATLAB scope and gauges to control and check the application behavior.
4.2 New Code Profiling

NXP Model-Based Design Toolbox for S32K1xx provides blocks to be used for On-Target function profiling that returns results in units of clock cycles of execution per execution iteration. In 2018.R1 release you can enable MATLAB profile to measure the task and functions execution time when using Processor-in-the-Loop Mode.
The reports are automatically displayed in MATLAB.
4.3 Processor-In-the-Loop Support (PIL)

The NXP Model-Based Design Toolbox for S32K 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. No support for interrupts exist in supported PIL modes of execution, therefore no blocks with interrupts are supported in PIL mode.

For PIL support you need to install the Microsoft Windows SDK 7.1. Please refer to the following links for troubleshooting:

- [https://www.mathworks.com/matlabcentral/answers/101105-how-do-i-install-microsoft-windows-sdk-7-1](https://www.mathworks.com/matlabcentral/answers/101105-how-do-i-install-microsoft-windows-sdk-7-1)

4.4 Boot Loader

Internal Boot Loader is a standalone application which requires the Microsoft .NET Framework version 4.0 installed on PC. It may be required to download the package from [http://www.microsoft.com/download](http://www.microsoft.com/download) and install if you are going to use PIL and internal Boot Loader. The board should be configured to work with BAM to use Internal Boot Loader. Please check board documentation.

The bootloader files have need updated to support all S32K14x 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 support the following MATLAB releases:
- R2016B;
- R2017A;
- R2017B;
- R2018A;

In general, the toolbox may be used for older or newer versions of the MATLAB without any major issues.

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

<table>
<thead>
<tr>
<th>Operating System</th>
<th>SP Level</th>
<th>64-bit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Windows 7</td>
<td>SP1</td>
<td>X</td>
</tr>
<tr>
<td>Windows 10</td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

5.2 Compiler Support

The following compilers are supported:

<table>
<thead>
<tr>
<th>Compiler Supported</th>
<th>Release Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>GCC for ARM Embedded Processors</td>
<td>V6.3.1</td>
</tr>
<tr>
<td>IAR ANSI C/C++ Compiler</td>
<td>V8.11.1</td>
</tr>
<tr>
<td>GreenHills MULTI for ARM</td>
<td>2015.1.4</td>
</tr>
</tbody>
</table>

The target compiler for Model-Based Design Toolbox needs to be configured. Use the notation below to set up 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}
- IAR_TOOL = {IAR installation path}/IAR Systems/Embedded Workbench 7.3
- GHS_TOOL = {GHS installation path}/multi517

Note: Paths shown are for illustration, your installation path may be different. Once environmental variables are set up 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.
Environment Variable GCC_S32K_TOOL was not explicitly set. The generated code will be compiled using the default GCC compiler C:\Users\xaxa14941\Documents\VASTLAB\AddOns\Toolboxes\VXP_MBDToolbox_S32K1xx\code\tools\gcc-5.3-arm32-ebi

### Starting build procedure for model: ipuart_hello_world_s32k14x
### Generating code and artifacts to 'Model specific' folder structure
6 Known Limitations

**NXP’s Model-Based Design Toolbox for S32K1xx version 2018.R1** has the following limitations:

- The 2018.R1 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 2018.R1 release

- The Simulink Function-Call Split block cannot be mixed with Model-Based Design Toolbox blocks.

- PIL support was tested only with Microsoft Windows SDK 7.1. For any other x64 bit host compiler the support might fail.

- Download to target for Simulink is supported only via UART interface. For CAN download, you can use the RAAppID Bootloader as a separate tool to load the generated application into target RAM/Flash Memories.

- Due to SRAM memory sizes available on 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.

- In case of migrating a project from an earlier toolbox version to the latest 2018.R1 the user needs to manually check each Simulink model and relink the blocks to new Simulink Library available.

- In case of the FTM functionalities the migration needs to be done manually.

- FTM Configuration block support a limited number of functionalities. In the next release the FTM will be enhanced to cover all SDK driver options.

- FTM interrupt handles can only be installed for odd channels.

- I2C Interrupt Disable Simulink block does not work for disabling the LPI2C_MASTER_TRANSMIT_DATA_INT and LPI2C_MASTER_END_PACKET_INT interrupts.

- 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 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