RSDK 1.4.0 RTM for S32R274 and S32R372
Release Notes

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1 Read Me First

We are glad to announce 1.4.0 RTM release of **RadarSDK** for S32R274 and S32R372, this is compliant with ISO 26262 with limitation from chapter 2.4 (see SPT2.0 Assembler limitation note). The purpose of this release is to provide software enablement for the NXP S32R274 and S32R372 SPT accelerators and TEF810x radar transceivers.

This release can be used by any party interested in accessing SPT and radar transceiver functionalities from the Power Arhitecture Z4/Z7 host processor of S32R274 and S32R372, in OS-free environment.

If you are new to RadarSDK, please start by getting familiarized with the User Manual (html format, located in /Docs folder RSDK User Manual) and example applications (located in /Apps folder: /Apps/1RF_4Antennas_demo and /Apps/SPT_Example). For details about applications provided, please consult Sample Apps UserGuide.

A **Troubleshooting Guide** is also included, on main page of **RSDK User Manual**.

1.1 Environment Requirements

The following tools are used for building and executing the binaries in the software package:

Software:

- S32 Design Studio for Power Architecture, Version: 2.1 Build id: 190624 with all online updates (gcc S32R274 & S32R372 version 4.9.4 201906241759, SPT 2.0&2.5 assembler version 1.0.0.201906071259)
- Wind River Diab for Power PC 5.9.6.7 (alternative build toolchain)
- SPI driver of MCAL for S32R274/S32R372 RTM 2.0.0 ASR 4.2
- Platform SDK v3.0.2, included in S32 Design Studio for Power Architecture
- (optional) Lauterbach Trace32 PowerView for PowerPC™, Version: R.2019.07.000110413, release Jul 2019 (64 bit)
- (optional) Matlab R2016b 64bit
- (optional) Matlab Signal Processing Toolbox v7.3 and Model-Based Design SPT Toolbox v1.3.0, used by the Matlab bit-exact model

Hardware:

- Host PC running Windows 10
- S32R274/S32R372 RRU EVB development board with
  - (for SPT_Example demo application) PS32R274, chip cut 1.2, 2N58R
  - (for both SPT_Example and 1RF_4Antennas demo application) PS32R372, 0N36U
  - Setups with radar frontend:
    - NXP TEF810x DCC integrating BEST3-S1 ES3 and S32R274 (chip cut 1.2, 2N58R)
- Debugger
  - Lauterbach Power Debug Interface and DEBUG-MPC5XXX-AUTO debug cable, or
  - (from Design Studio) PEmicro USB Multilink/Multilink FX

1.2 Support information

Technical Contact:

Please contact your friendly sales representative or access https://www.nxp.com/ support page.

When reporting problems (we thank you for that!), please include:

- RSDK release ID
- tools used for building the RSDK artefacts
- target hardware platform (e.g. S32Rxxx and radar front-end revision/versions, board revision)
- any dependencies or modifications you may have added or applied to create your environment

2 Release Description

2.1 List of Modules

DELIVERABLE	LOCATION	STATUS
Example applications	/Apps/1RF_4Antennas_demo	Updated
	/Apps/RSDK_Demo	Updated
	/Apps/SPT_example	Updated
CPU algos example library	/CPU_algos/PPC_algo	Unchanged
User manual	/Docs/Doxygen/RSDK_User_Manual/index.html	Updated
SPT driver	/SPT/SPT_driver	Updated
SPT reference kernels	/SPT/SPT_kernels	Unchanged
SPT bit-exact matlab kernel models	/Tools/SPT_bitexact_model	Unchanged
Radar Front-End (RFE) abstraction driver	/RFE_abstract/RFE_driver	Updated
	/CSI2	Unchanged
	/RFE_abstract/SPI*	Updated

*An SPI driver is needed for RFE Abstraction usage and it must be plugged-in at application level, via a glue layer – see documentation accompanying this release. An MCAL SPI implementation is provided with this radar SDK package as example, via a glue layer that is owned at application level. Another option is to use the SPI driver that comes with S32SDK_PA. See chapter 1.1 for the exact versions of these drivers.

*MR3003 is not supported any more

A detailed description of release content and incremental changes is given in 2.3 and 2.2.3.

2.2 What's New

2.2.1New Features

All modules:

- Integration of radarSDK with S32SDK for S32R372 device
- Improved ease of use for antenna calibration tool

RFE abstract:

- Implemented RFBIST for TEF810X (low level driver and via RFE Abstract), this is supported only on S32R274
- Implemented API routines to update/refresh shadow registers of TX, RX, Central control and chirp modules (RS-403 requirement of the Dolphin Safety Manual)

- Implemented TEF810X RFE reinit function when the device signals an error through the Error N pin

2.2.2Regressions

There are no known regressions in this release.

2.2.3Fixed Issues

ID	Module	Description
RSDK-1673	RFE Abstract (TEF810X)	Missing timeout for while statement on hal_es3_ISM_FIT
RSDK-2286	RFE Abstract (TEF810X)	Wrong condition of if statement on SPI_TEF810X_xferFifoMode at line 333: (pDrvState->eventsParams.signalsMask & RFE_EVT_MSK_TEF810X_ERRORN_PIN_ACIVE) == 1U)
RSDK-2262	RFE Abstract (TEF810X)	VCO Enable function delay correction
RSDK-1919	RFE Abstract (TEF810X)	Inconsistent use of TEF810X_CFG_CIF_LVDS_SUPPORT (cosmetic)
RSDK-2104	RFE Abstract (TEF810X)	Wrong return error status of RsdkRfeFrameConfig
RSDK-2053	RFE Abstract (TEF810X)	Tef810XDigitalOutputConfig() does not check return code of callees
RSDK-2211	1RF4Ant sample application	Antenna calibration generates issues with rsdk_constants.c file
RSDK-2360	1RF4Ant sample application	No switch between TX antennas in TD-MIMO use-case of Sample App
RSDK-2369	RFE Abstract (TEF810X)	TEF810 Frame Config TX PON config error (only profile 0 gets enabled when using multi profile chirps with different TXs)

2.3 List of Supported Features

Module	Features	Introduced in release	Testing approach
SPT driver	Provide an interface to access the SPT functionalities (implemented via SPT kernels), exposed on Power Architecture based host processor. Single core usage. OS free (bareboard). Blocking and non-blocking operating modes.	0.1 (0.4.0)	Review. Unit testing (no hardware). Integration testing on hardware.
	API function for reporting SDMA statistics: RsdkSptCommand()	0.4.1	Review. Unit testing (no hardware).

Module	Features	Introduced in release	Testing approach
	API function for controlled disabling and reinitialization of SPT hardware: RsdkSptStop()	0.4.1	Review. Unit testing (no hardware). Integration testing on hardware.
	New SPT Driver library for S32R274 e200 Z7 core	0.4.2	Review. Integration testing on hardware.
	Support for SPT of S32R372	1.1.0	Review. Integration testing on hardware
	Added API option to configure the size of SDMA acquisition buffer Detection mechanism for spurious STOP interrupts Optional check for SPT kernel watermark instruction Replaced interrupt registration callback with direct external call to RsdkGlueIrqHandlerRegister()	1.3.0	Review. Integration testing on hardware
	Added software workaround for SPT 2.x silicon errata e10997 and e11329	1.3.1	Review. Unit testing on hardware
SPT kernels library	Example (functional and optimized) SPT assembly code to perform various flavors or range and Doppler FFT operations using the SPT accelerator. Visible to host PowerPC processor via SPT driver: Range 512 and Doppler 128 point FFT Range 256 and Doppler 256 point FFT	0.1 (0.4.0)	Review. Validation using matlab non-bitexact models. Integration testing on hardware.

Module	Features	Introduced in release	Testing approach
	Now SPT kernels use WAIT instructions to sync with system events. New kernels: Magnitude calculation and non-coherent combining. 2D peak search using fixed array(input) for threshold. 3rd FFT on azimuth axis, magnitude calculation. "3D" Peak search based on max calculation on DOA axis and 2D peak search. Fixed array for threshold.	0.4.1	
	Use same buffer for Doppler FFT input/output Add support for real-time SDMA data acquisition in SPT Range kernel Peak Search kernels produce histogram for threshold calculation Add binary data files containing twiddles and window coefficients Bit-exact matlab equivalents for all SPT kernels	0.4.2	Review. Unit testing
	2D and 3D Peak search kernels split into Non Coherent Combining/3DFFT and Peak Search kernels. New 128 chirps, 1024 samples/chirp kernels with CP4D PDMA compression New Digital BeamForming + Direction of Arrival kernels(with/without compression) New 256 chirps, 256samples/chirp, TD-MIMO kernels New API scaling parameter for Range and Doppler kernels(without compression) Speed optimization for Doppler/NonCoherentCombining/3DFFT/Peak Search kernels For more details consult SPT Kernels API	0.9.0	Review. Validation using matlab non-bitexact models. Integration testing on hardware.
	Macro provided in SPT kernel API to return kernel size value.	1.0.0	Review.
	Support for SPT on S32R372	1.1.0	Review. Validation using matlab non-bitexact models.

Module	Features	Introduced in release	Testing approach
			Integration testing on hardware.
	3Tx TD-MIMO kernels for 256 samples, 128 chirps/Tx slot, 4 channels: Initialization, Range, Doppler, Non-Coherent Combining, 3D FFT(Coherent Combining), 2D Peak Search, Digital Beamforming and Direction of Arrival.	1.3.0	Review. Validation using matlab non-bitexact models. Integration testing on hardware.
	Kernels for checking the sanity of persistent TRAM, for all RSDK use-cases: 512 samples/chirp, 128 chirps, 4 physical channels 256 samples/chirp, 256 chirps, 4 physical channels 1024 samples/chirp, 128 chirps, 4 physical channels 256 samples/chirp, 256 chirps, 4 physical channels, 2TX TD-MIMO 256 samples/chirp, 128 chirps, 4 physical channels, 3TX TD-MIMO	1.3.0	Review. Validation using matlab non-bitexact models. Integration testing on hardware.
	Kernel for RFBIST: 2048 samples, 1 chirp, 4 channels	1.4.0	Review. Validation using matlab non-bitexact models. Integration testing on hardware.
RFE Abstract	Provides an interface to access the functionalities of a generic radar front-end device. Supporting: - NXP MR3003 ES2+RF front-end - SPI and CSI2 support for configuration and data exchange between front-end and S32R274 - Simple chirp modulation, no chirp changes during a frame	0.4.2	Review. Integration testing on hardware.
	Support for multiple chirp shapes per frame Z7 core support TD-MIMO support for MR3003 For more details consult RFE abstraction Doc	0.9.0	Review. Integration testing on hardware.

Module	Features	Introduced in release	Testing approach
	Support for CSI2 and SPI on S32R372 Support for soft reset of MR3003 frontend Support for TEF810x radar transceiver (early access release level)	1.1.0	Review. Integration testing on hardware
	Support for TEF810x ES2 radar transceiver NB: support for ES2 has been removed starting with 1.2.1 release, when ES3 has been added	1.2.0	Review. Testing on hardware.
	Support for MR3003 ES3.1 radar transceiver	1.2.0	Review. Testing on hardware.
	MR3003 DFMEA improvements: - interrupts are configured and activated at device initialization - added function to report device status - in case a device fault is detected, the driver goes into fault state and only certain operations are permitted	1.2.0	Review. Testing on hardware.
	CSI driver monitors and reports all HW error related interrupts and offers support for spurious interrupts	1.2.0	Review. Testing on hardware.
	Support for TEF810X ES3 radar transceiver (non-SPICE), synchronized with version 5.2.2 of its low level driver	1.2.1	Review. Smoke testing on hardware.
	Exposed RFBIST related functions of TEF810X low level driver into API	1.3.0	Review. Testing on hardware.
	Support for TEF810X ES3 radar transceiver (A-SPICE), synchronized with version 5.2.3 of its low level driver and software override for OPT settings on antenna existence plus Lock Window Settings.	1.3.0	Review. Testing on hardware.
	CSI2 driver provided as standalone driver, invoked from RFE Abstract as link-time available C API functions	1.3.0	Review. Testing on hardware.
	MR3003 frontend no longer supported	1.3.1	N/A
	Incorporated v5.3.0 TEF810X low level driver	1.3.1	Review. Testing on hardware.

Module	Features	Introduced in release	Testing approach
	RFBIST for TEF810X (low level driver and via RFE Abstract)	1.4.0	Review. Testing on hardware.
SPT Example application	Demonstrates the integration of SPT Driver and kernels library. Baseband radar samples acquisition emulated by the CPU reading data files from host PC through the T32 debugger.	0.1 (0.4.0)	Review. Testing on hardware.
	Integrate 2D and 3D Peak Search SPT kernels	0.4.1	Review. Testing on hardware.
	Integrate new SPT Driver and Kernel features	0.4.2	Review. Testing on hardware.
	Integrated new SPT Driver features and SPT Kernels.	0.9.0 ... 1.3.1	Review. Testing on hardware.
"1RF 4Antennas demo" and "RSDK_Demo" applications	Sample app demonstrating how to integrate all RadarSDK modules on the RFBeam Microwave MR3003_RD-NXP device	0.4.2	Review. Testing on hardware.
	Sample app add support for BeamForming and DOA and CFAR threshold computation. ETH Communication now is made on Z4 using a new feature called proxy intercom and radar processing is done on Z7 For more details consult Sample Apps UserGuide.	0.9.0	Review. Testing on hardware.
	TD-MIMO sample application was integrated in this demo. Also, configuration file was added for easier usage. For more details consult Sample Apps UserGuide.	1.0.0	Review. Testing on hardware.
	Support for S32R372 and TEF810x	1.1.0	Review. Smoke testing on hardware
	Added RTP streaming support (experimental feature)	1.2.0	Review Smoke testing on hardware
	Monitoring TEF810X errors NB: not production tested	1.2.1	Review

Module	Features	Introduced in release	Testing approach
			Smoke testing on hardware
	Integrated 3 Tx MIMO SPT kernels	1.3.0	Review Smoke testing on hardware
	Provide sample implementation for glue layers needed by RSDK production components	1.3.0	Review Smoke testing on hardware
	New host-side matlab-based visualizer, making use of RTP over UDP data streaming from target board	1.3.0	Review Smoke testing on hardware
	Added RSDK_Demo sample application to demonstrate integration of radarSDK with S32 SDK, for S32R274 silicon	1.3.0	Review. Smoke testing on hardware.
	Added support for v3.0.1 S32 SDK in RSDK Demo sample application	1.3.1	Review. Smoke testing on hardware.
	Added support for S32 SDK on S32R372 silicon and S32R27 reference hardware	1.3.1	Review. Smoke testing on hardware.
Tools	Basic platform setup code needed for sample applications.	0.4.1	Review. Testing on hardware.
	Add Interrupt priority and Core ID to the interrupt handler registration function.	0.4.2	Review. Testing on hardware.
	Improved platform setup Easy to use linker files Multicore easy to use and robust mechanism: proxy intercom For more details consult Application support tools	0.9.0	Review. Testing on hardware.
	The folder structure was modified to assure a better and clear view over source files.	1.0.0	Review. Testing on hardware.
	Improved TFTP client robustness and latency. Added ARP support. Added experimental RTP streaming support.	1.1.0	Review. Smoke testing on hardware.

Module	Features	Introduced in release	Testing approach
	NB: not production tested		
	Added experimental UART driver NB: not production tested	1.1.0	Review. Smoke testing on hardware.
	Added app level glue layers for RFE abstract dependencies: timers, GPIO, SPI and CSI2 NB: not production tested	1.3.0	Review. Smoke testing on hardware.
	Added ability to compile S32R274 libs and 1RF 4 Antenna app with diab for PPC 5.9.6.4 NB: not production tested	1.3.0	Review. Smoke testing on hardware.
	Added offline antenna calibration procedure for 4 Rx	1.3.1	Review. Smoke test on hardware.
	Integration of radarSDK with S32SDK for S32R372 device	1.4.0	Review. Smoke test on hardware.

2.4 Known Issues and Limitations

ID	Affected Modules	Description
RSDK-1232	SPT Driver	Software workaround not implemented for hardware issue S32R274_2N58R_Errata_Rev1 e10459: "Spurious CS_AHB_ERR can be generated in the SPT_DMA_ERR_STATUS register"
	RFE_Abstract	(pertains to low level driver of TEF810X only) LVDS and CIF interfaces of low level driver are not maintained (only CSI2 is). No MISRA analysis has been performed on these.
	RFE_Abstract	(pertains to low level driver of TEF810X only) OPALKELLY source code branch is not maintained/MISRA analyzed. Thus, deci parameter of chip_ISM_Init() is hardcoded to invalid value of 0, as it is not used on S32R274 during Init_Act_16(), but only on OPALKELLY branch
	SPT 2.0 Assembler	This build tool is not qualified for Automotive ISO 26262 safety process

3 Upgrading from the Previous Release

3.1 Regardless of previously used version

- In your build and execution environment: the tool versions described in section 1.1.
- In your custom application source code:
  - update names of the libraries and API header files for SPT Driver, Kernels and common code
  - update names of changed API functions and data structures (check headers in */<Module>/api/* and */api* for changes)

configure the new API fields and function calls

3.2 Moving from 1.3.1 RSDK release to 1.4.0

Mind the minor API changes of SPT-bit-exact models, due to upgrade to the Model-Based Design SPT Toolbox v1.3.0

3.3 Moving from 1.3.0 RSDK release to 1.3.1

- New error codes have been added for the SPT driver.
- SPI glue layer now propagates return error codes to application level, in the case of MCAL SPI driver.

3.4 Moving from 1.2.0 RSDK release to 1.3.0

- Mind addition of application-level glue layers (GPIO pins, IRQ registering, timer, SPI) and standalone CSI2 driver – for an example, see 1RF4Antenna sample application.
- There's a new naming convention for RSDK SPT kernels:
  RsdkSpt<*Function*><*NoSamples*>**smp**<*NoChirps*>**crp4ch**<*TdMimoType*><*CompressionType*>
  Function: Init, Range, Doppler, Ncc, 3Dfft, PeakSearch, CheckTram
  NoSamples: 256, 512, 1024
  NoChirps: 128, 256
  TdMimoType: 2TxTdMimo, 3TxTdMimo or none.
  CompressionType: Cp4d or none.
- SPT kernels used for ADC acquisition are discontinued starting with RTM1.3.0. Their functionality is now handled by the SPT Driver.

3.5 Moving from bare TEF810X low level driver to RSDK release 1.3.1

If you have used bare TEF810X low level driver until now, following changes are required at your side:

- mind limitations marked with *"pertains to TEF810X"* mentioned in chapter Known Issues and Limitations
- LVDS and CIF interfaces of low level driver are not maintained (only CSI2 is)

- Non-const global variables have been replaced/united into a state variable named gRfeDriverPersistentMem of rfeDriverPersistentMem_t-> rfeTef810XPersistentMem_t type. See /RFE_abstract/RFE_driver/include/rfe_driver_state.h and rfe_driver_state.c
- Proper pin configuration must be performed during initialization, radarSDK provides such a routine in Siul2Config() of platform_setup/src/PPC/platform_setup_basic.c. Mind to *#define BOARD_DCC* and *FRONTEND_TEF810X*.
- Initialization of the frontend unit requires special configuration for timer, GPIO, CSI2 and SPT. As an example, one can mimic 1RF_4Antenna_demo sample application present in the Apps/ folder of the release package.
- Glue layers: Timer (delay and timeout), GPIO, SPI and CSI2 drivers for the S32R2xx device are required and radarSDK does provide such drivers. As an example, one can mimic 1RF_4Antenna_demo sample application present in the Apps/ folder of the release package.
- Direct use of STM0 hw timer has been replaced by a compile-time glue layer injection approach. See RsdkGlueTimerDelayUs() example implementation in /platform_setup/src/PPC/ Timer glue code provided as example makes use of STM timer close to S32R274/372 core, mind initializing it before using by calling RsdkSTMInit() and mind proper set of STM_0 reference clock to 60MHz.
- HAL_ERRORCODE is no longer used – it has been replaced by propagation of erroneous conditions via return value of functions, up to API functions
- Value of MAKE_CSI2_OUTPUT_UNSIGNED #define has been set to 0 (using signed samples)
- READY_INT_CFG is currently not #defined for S32R274, resulting in ready int signal not being configured
- TEF810X_CFG_SPI_CMD_TX_CRCCHK_ENABLE and TEF810X_CFG_SPI_CMD_RX_CRCCHK_ENABLE #defines are enabled for ES3

4 Appendix A: Document History

Version	Date	Author	Description
1.0	14Feb2020	Cristian Macarascu	New in this release, known issues and upgrade from previous release chapters

5 Appendix B: Release History

Release version	Date	Description
0.1 (0.4.0)	31Mar2017	First release. Prototype
0.4.1 “SPT”	30Jun2017	“Early Access” for SPT
0.4.2 “RRU”	29Sep2017	“Early Access” for RRU SPT and mr3003 front-end
0.9.0 “RRU”	30Jan2018	Beta release
1.0.0 “RRU”	13Jun2018	RTM release
1.1.0 “S32R274 and S32R372”	30Aug2018	RTM release with EAR support for TEF810x transceiver
1.1.1 “S32R274 and S32R372”	03Sept2018	RTM release with EAR support for TEF810x transceiver
1.2.0 “S32R274 and S32R372”	29Nov2018	RTM release with RFE Abstract changes (support for TEF810x ES2 and MR3003 ES3.1 front-ends, all error related interrupts from the MR3003 front-end and CSI2 are enabled and monitored)
1.2.1 “S32R274 and S32R372”	12Apr2019	Patch release with RFE Abstract changes (support for TEF810x ES3)
1.3.0 “S32R274 and S32R372”	05Jul2019	RTM 1.3.0 for S32R274 and S32R372
1.3.1 “S32R274 and S32R372”	16Sept2019	RTM 1.3.1 for S32R274 and S32R372
1.4.0 “S32R274 and S32R372”	14Feb2020	RTM 1.4.0 for S32R274 and S32R372