Application Report

Industrial Communication Protocols Supported on Sitara™ Processors

ABSTRACT

This document shows the industrial communication protocols supported by each of the devices in the Sitara™ Arm® Cortex®-A processor portfolio, as well as where and how to get these protocols.

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1 Introduction

Industrial communication is typically handled by the Programmable Real-Time Unit Industrial Communication Subsystem (PRU-ICSS) in Sitara processors. The PRU-ICSS is a co-processor subsystem containing Programmable Real-Time (PRU) cores and Ethernet media access controllers (EMACs), which implement industrial Ethernet and fieldbus protocols through firmware. PRU cores are primarily used for industrial communication, and can also be used for other applications such as motor control and custom interfaces. The PRU-ICSS frees up the main Arm cores in the device for other functions, such as control and data processing.

This document describes protocols directly supported by TI, supported by TI firmware with a third party stack, as well as several other protocols supported by third party partners. This document is not a comprehensive list of all possible protocols that can be supported by the PRU-ICSS. The PRU-ICSS is flexible and powerful enough to support most industrial communications protocols. Currently the Sitara devices support 100-Mb versions of the protocols, but the AM6x family features an upgraded PRU-ICSS that supports gigabit speeds. TI is continuously working both at TI and with their third party partners to expand their offerings, so if a specific protocol is not explicitly shown in this document, reach out to TI through E2E or contact your local TI sales representative.

For protocols supported by TI firmware with third party stack, firmware and drivers are available directly from TI as add-on packages that run on top of the Processor SDK-RTOS, or come integrated as part of the Processor SDK-Linux. Protocol stacks are typically purchased through one of TI's third party partners. Figure 1-1 shows a typical use case for industrial communications on Sitara processors for protocols supported by TI firmware with third party stack .

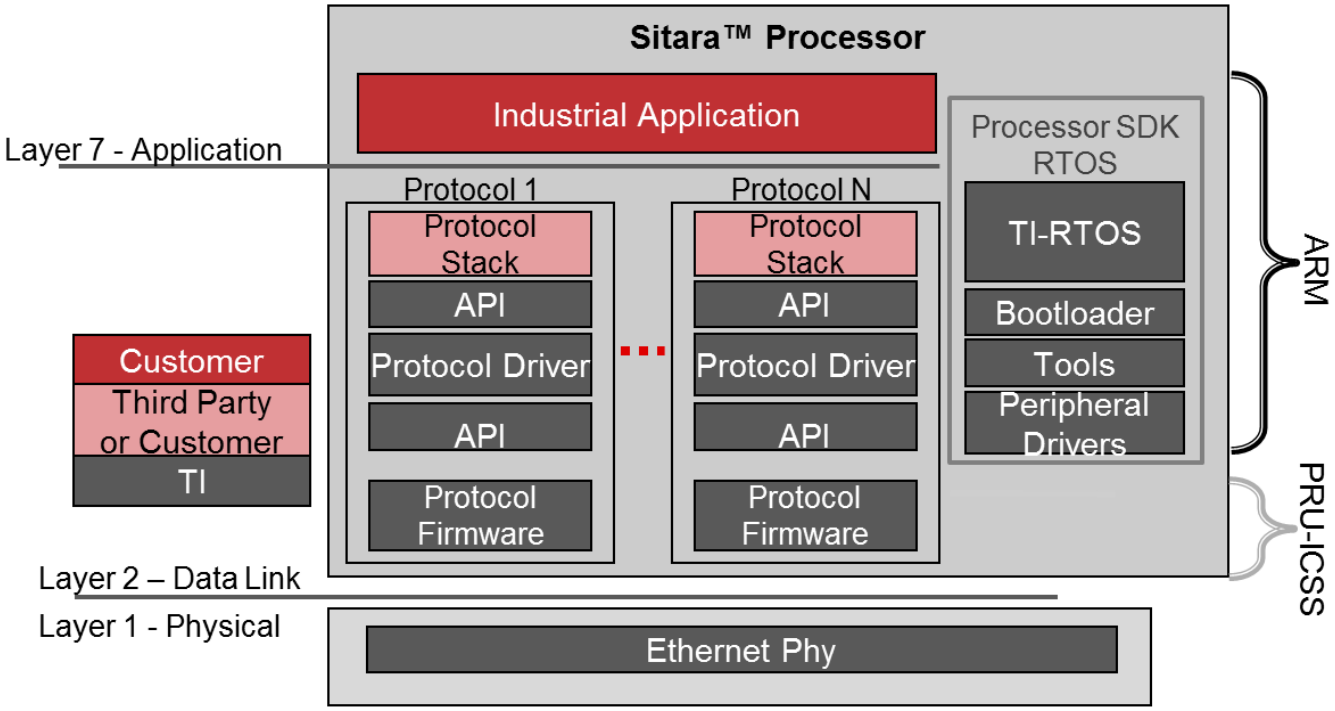

Figure 1-1. Software Implementation Using the PRU-ICSS and a Third Party or Customer stack

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2 Industrial Communication Partners

KUNBUS – KUNBUS offers the broadest support of multiple industrial communication protocols in one package. KUNBUS offers a full suite of services and expertise related to industrial communication applications, including hardware evaluation kits, hardware modules, software customization, and certification support for Sitara processors.

Acontis – Acontis offers EtherCAT master solutions for Sitara processors. The solutions can be found here.

Matrikon – Matrikon offers the OPC UA stack for Sitara processors on Linux RT.

Be.Services – Be.Services offers openPowerlink on Sitara processors through Codesys on Linux RT.

CC-Link Partner Association (CLPA) – The CLPA provides the stack for CC-Link IE Field Basic for Linux RT and RTOS.

Systec – Systec offers the entire Mechatrolink III solution, including firmware and software stack on RTOS. Macnica offers these services for Systec outside of Japan. For licensing, contact AtdSpl@macnica.co.jp.

Molex – Molex supplies production master stacks for PROFINET and EtherNet/IP on Sitara processors on RTOS.

TMG – TMG TE supplies production slave stacks for PROFINET and EtherNet/IP on Sitara processors on RTOS. For more information on the products visit www.tmgte.de/en, or for licensing contact willems@tmgte.de.

CouthIT – CouthIT offers integration of the BiSS C encoder for Sitara processors. For more information, contact Krishna@CouthIT.com.

The following sections show currently released protocol stack solutions, and do not include solutions in development.

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3 Ethernet-Based Protocols

3.1 PROFINET®

Sitara processor families currently have support for PROFINET® RT and IRT, as specified in Table 3-1. An evaluation version of the device stack is available in the Processor SDK directly or through the PROFINET firmware add-on package for the RTOS version of Processor SDK. For production licenses, contact TMG. Some of the documentation refers to Molex, but the ownership has moved to TMG.

Table 3-1. PROFINET Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x	AM64x (1)
Linux	Controller				All	All
	Device					
RTOS	Controller					
	Device	All	AM3356/7/8/9	AM4376/7/8/9	All	All

(1) For more information on exact part number that enables ICSS and protocols, see the device-specific data sheet.

Additional resources:

- White paper
- TI Design
- PROFINET Product Downloads
- PROFINET specification

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3.2 EtherCAT®

Sitara processors currently have support for EtherCAT®, as specified in Table 3-2. An evaluation version of the slave stack is available in the Processor SDK directly or in the EtherCAT slave firmware add-on package for the RTOS version of the Processor SDK. The EtherCAT slave stack is available for free for EtherCAT Group (ETG) members, and can be found on their website. Optionally, integration partners such as KUNBUS and TMG can provide full EtherCAT slave solutions for the PRU-ICSS to simplify the development process. The EtherCAT master stack is available for both the PRU-ICSS (AM335x, AM57x) and CPSW (AM335x, AM437x, AM57x, AM64x) Ethernet peripherals through Acontis.

Table 3-2. EtherCAT Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x(1)	AM64x(1) (1)
Linux	Master		AM3357/9	AM4377/9	All	All
	Slave					
RTOS	Master		AM3357/9	AM4377/9	All	
	Slave	All	AM3357/9	AM4377/9	All	All

(1) For EtherCAT support, you must use the EtherCAT version of each device. Consult the data sheet for EtherCAT-enabled device nomenclature.

Additional resources:

- White paper
- TI Design
- EtherCAT Product Downloads
- EtherCAT specification

3.3 EtherNet/IP®

Sitara processors currently support EtherNet/IP®, as specified in Table 3-3. An evaluation version of the adapter stack is available in the Processor SDK directly or in the EtherNet/IP firmware add-on package for the RTOS version of the Processor SDK. For production licenses, contact TMG. For EtherNet/IP scanner can be implemented on any Sitara processor through the use of open source stacks, and TI's Ethernet MAC using either PRU-ICSS or CPSW.

Table 3-3. EtherNet/IP Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x	AM64x(1)
Linux	Scanner					
	Adapter					
RTOS	Scanner					
	Adapter	All	AM3356/7/8/9	AM4376/7/8/9	All	All

Additional Resources:

- White paper
- TI Design
- EtherNet/IP Product Downloads
- EtherNet/IP Overview

3.4 OPC UA

Sitara processors currently support OPC UA server (device or endpoint), as specified in Table 3-4. Matrikon provides an evaluation version as well as the production version of the required software. For more information on the OPC UA server support on Sitara, visit Matrikon's website. AM64x Linux SDK also includes OPC UA client (controller) and server (device) stack from open62541.org.

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Table 3-4. Supported Devices for OPC UA

OS		AMIC	AM335x	AM437x	AM57x	AM64x
Linux	Client					All
	Server				All	All
RTOS	Client					
	Server					

Additional Resources:

- TI Design
- Documentation on open62541.org stack

3.5 CC-Link IE Field Basic

Sitara processors currently support CC-Link IE Field Basic, as specified in Table 3-5. The CC-Link Partner Association provides an evaluation version as well as the production version of the stacks. For an overview of the product development process with CC-Link, see the CLPA website.

Table 3-5. CC-Link IE Field Basic Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x	AM64x
Linux	Master	All	AM3356/7/8/9	AM4376/7/8/9	All	All
	Slave	All	AM3356/7/8/9	AM4376/7/8/9	All	All
RTOS	Master	All	AM3356/7/8/9	AM4376/7/8/9	All	All
	Slave	All	AM3356/7/8/9	AM4376/7/8/9	All	All

3.6 Mechatrolink III

Sitara processors currently support Mechatrolink III, as specified in Table 3-6. The solution is available from Systec in Japan, or Macnica for outside of Japan. For more information, contact Macnica at AtdSpl@macnica.co.jp.

Table 3-6. Mechatrolink III Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x	AM64x
Linux	Master					
	Slave					
RTOS	Master					
	Slave	AMIC110				

Additional Resources:

- Macnica's Mechatrolink III IP specifications

3.7 Modbus TCP/IP

Though not yet certified on Sitara, Modbus TCP/IP can be implemented on any Sitara processor through the use of open source stacks, and TI's Ethernet MAC using either PRU-ICSS or CPSW. Linked below are examples of open source stacks that could potentially be used. For help in getting this running in your design, ask our experts at e2e.ti.com.

Additional resources:

- Modbus for Linux: https://libmodbus.org/
- Modbus for RTOS: https://github.com/cwalter-at/freemodbus

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3.8 Simple Open Real-Time Ethernet (SORTE)

Sitara processors currently support SORTE using PRU-ICSS, as specified in Table 3-7. SORTE is an open-source protocol developed by TI and available through the Processor SDK. AM64x SDK includes a gigabit version of SORTE.

Table 3-7. SORTE Supporting Devices

OS		AMIC	AM335x	AM437x	AM57x	AM64x
Linux	Master					
	Slave					
RTOS	Master		AM3356/7/8/9		All	All
	Slave		AM3356/7/8/9		All	All

3.9 Parallel Redundancy Protocol (PRP)

Sitara processors currently support 100M PRP using ICSS, as specified in Table 3-8. Evaluation and production software is available through the HSR/PRP firmware add-on package for the RTOS version of the Processor SDK, or through the Linux version of the Processor SDK. The ICSS based solution offloads the duplicate removal on receive.

Table 3-8. PRP Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux		AM3356/7/8/9	AM4376/7/8/9	All	Will be released later
RTOS	All	AM3356/7/8/9	AM4376/7/8/9	All	

Additional resources:

- http://www.ti.com/tool/TIDEP0054 (RTOS TI Design)
- http://www.ti.com/tool/TIDEP-0103 (Linux TI Design)

3.10 High-Availability Seamless Redundancy (HSR)

Sitara processors currently support 100M HSR using ICSS, as specified in Table 3-9. Evaluation and production software is available through the HSR/PRP firmware add-on package for the RTOS version of the Processor SDK, or through the Linux version of the Processor SDK. The ICSS based solution offloads the duplicate removal on receive and the maintenance of the node table.

Table 3-9. HSR Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux		AM3356/7/8/9	AM4376/7/8/9	All	Will be released later
RTOS	All	AM3356/7/8/9	AM4376/7/8/9	All	

Additional resources:

- http://www.ti.com/tool/TIDEP0053 (RTOS TI Design)
- http://www.ti.com/tool/TIDEP-0096 (Linux TI Design)

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4 Position Encoders

The firmware for each of the supported encoders below is offered as open source.

4.1 EnDat 2.2

Sitara processors currently support EnDat, 2.2 as specified in Table 4-1. Evaluation and production software is available through the industrial drives firmware add-on package for the TI-RTOS version of the Processor SDK.

Table 4-1. EnDat 2.2 Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux					
RTOS	AMIC120		AM4376/7/8/9		All

4.2 HIPERFACE DSL®

Sitara processors currently support HIPERFACE DSL®, as specified in Table 4-2. Evaluation and production software is available through the industrial drives firmware add-on package for the TI-RTOS version of the Processor SDK.

Table 4-2. HIPERFACE DSL Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux					
RTOS	AMIC120		AM4376/7/8/9		All

4.3 Tamagawa

Sitara processors currently support Tamagawa, as specified in Table 4-3. Evaluation and production software is available through the industrial drives firmware add-on package for the TI-RTOS version of the Processor SDK.

Table 4-3. Tamagawa Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux					
RTOS	AMIC120		AM4376/7/8/9		Will be released later

4.4 BiSS®- C

Sitara processors currently support BiSS, as specified in Table 4-4. The BiSS® C encoder solution is available from CouthIT. For licensing or evaluation, contact CouthIT.

Table 4-4. BiSS C Supporting Devices

OS	AMIC	AM335x	AM437x	AM57x	AM64x
Linux					
RTOS	AMIC120		AM4376/7/8/9		All

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision B (January 2019) to Revision C (January 2021)	Page
• Updated the numbering format for tables, figures and cross-references throughout the document	3

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
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