# **Application Note**

# <u>UART\_RECEIVE</u> (UART-C)

Arm and Keil are registered trademarks of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

All other company names, product names, and service names mentioned herein may be trademarks of their respective companies.

## **Table of Contents**

Table of Contents	2
1. Preface	3
2. Technical Term	3
3. Reference Document	3
4. Target Sample Program	4
5. Configuration Diagram	4
6. Sample Program:UART_RECEIVE	5
6.1. Outlines of Operation	. 5
6.2. Function to Use	. 5
6.3. Interrupt to Use	. 5
6.4. Configuration	. 5
6.5. Example of Terminal Emulator Output	. 5
6.6. How to switch DMAC function	. 6
6.6.1. IAR Embedded Workbench	6
6.6.2. Keil μVision	8
6.6.3. SEGGER Embedded Studio	10
7. Activity diagram	12
7.1. main	12
7.2. variable_initalize	14
7.3. driver_initialize	14
7.4. driver_finalize	15
7.5. driver_dma_initialize	15
7.6. driver_dma_finalize	16
7.7. application_initialize	16
7.8. application_finalize	17
7.9. clear_input_data	18
7.10. uart_initialize	19
7.11. Interrupt	20
8. Revision History	21
RESTRICTIONS ON PRODUCT USE	22

### 1. Preface

This application note describes the sample software for UART\_RECEIVE using Universal Asynchronous Receiver Transmitter (UART).

This document helps the user check operation of a product under development and develop its program.

### 2. Technical Term

Term/Abbreviation	Definition
BSP	Board Support Package
CG	Clock Control and Operation Mode
DMA	Direct Memory Access
UART	Universal Asynchronous Receiver Transmitter

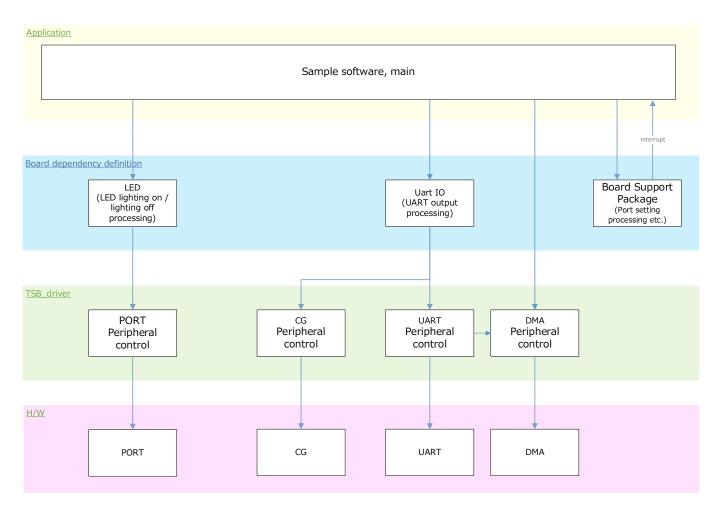
### **3. Reference Document**

Document	Notes
Data sheet	Refer to the data sheet of MCU to be used.
Reference manual	Refer to the reference manual of each IP to be used.
Application note MCU User Guide	Refer to the MCU user guide to be used.

### 4. Target Sample Program

Sample Program	Outline
UART_RECEIVE	Sample program of UART function (UART Receive)

### 5. Configuration Diagram



### 6. Sample Program:UART\_RECEIVE

This sample software that receives the character string input from the terminal emulator using the receive function of the UART communication function and turn on LED every time it matches the character string 1.

#### 6.1. Outlines of Operation

Wait for the input of the character string of the terminal emulator.

If BSP\_LED\_3 is turn on, it will turn off.

When a character string is input, the character string 1 is compared with the received character string, and when the character strings match, BSP\_LED\_1 is turn on.

If there is a mismatch, turn off BSP\_LED\_1.

When error occurs, turn on BSP\_LED\_3 and turn off BSP\_LED\_1.

#### 6.2. Function to Use

The functions to use are as follows:

For the Port assignment of each BSP channel, refer to the MCU user guide.

IP	Channel	Objective
UART	BSP_UART_1	For terminal emulator communication
	BSP_LED_1	For operation check
PORT(LED)	BSP_LED_3	For operation check

#### 6.3. Interrupt to Use

Interrupt	Outlines
*1	UART receive interrupt
*2	UART error interrupt

\*1 For SBK-M4KN/SBK-M4KN10, "INTSCORX", for AdBun-M3HQF10/AdBun-M3HQA, "INTUARTORX"

\*2 For SBK-M4KN/SBK-M4KN10, "INTSC0ERR", for AdBun-M3HQF10/AdBun-M3HQA, "INTUART0ERR"

### 6.4. Configuration

"main.c" configuration setting.

Configuration	Current Value	Description
Character string 1	*1	Comparison target of character strings input from terminal emulator
Communication control selection	*2 NODMAC	Switchable between NODMAC (does not use DMAC) and DMA (uses DMAC)

\*1 For SBK-M4KN/SBK-M4KN10, "TMPM4KNFYA¥n" For AdBun-M3HQF10, "TMPM3HQF10"

\*2 For details on how to switch when using DMAC, see Chapter 6.6.

### 6.5. Example of Terminal Emulator Output

Nothing.

For AdBun-M3HQA, "TMPM3HQFDA"

### 6.6. How to switch DMAC function

Follow the steps below to enable/disable the DMAC function.

#### 6.6.1. IAR Embedded Workbench

Category:					Factory Settings
General Options	] 🗌 Multi-file Co	ompilation			
Static Analysis	Discar	d Unused Publics			
Runtime Checking					
C/C++ Compiler	Language		2 Code	Optimization	ns Output
Assembler	List	Preprocessor	Diagnostics	s Encodings	Extra Options
Output Converter					
Custom Build	Ignore :	standard include di	rectories		
Build Actions	Additional	include directories	: (one per line	e)	
Linker	\$PROJ DI		× 1		
Debugger		R\$¥¥¥¥¥Utility	¥inc		1 ····
Simulator		R\$¥¥¥¥¥BSP¥S		:	
CADI		R\$¥¥¥¥¥MCU¥			
CMSIS DAP	\$PROJ_DI	R\$¥¥¥¥¥MCU¥	CMSIS¥startu	p¥iar	
GDB Server	Preinclude	file:			
I-jet					
J-Link/J-Trace					
TI Stellaris	Defined sy	mbols: (one per lin	e)		
Nu-Link	NODMAC			Preprocessor outp	out to file
PE micro	UART_DM/	A_TRANSFER_USE		Preserve comm	nents
ST-LINK				🔽 Generate #line	directives
Third-Party Driver			•		
TI MCD FFT					

Open "Project"  $\rightarrow$  "Options"  $\rightarrow$  "C/C++ Compiler"  $\rightarrow$  "Preprocessor". Change "Defined symbol" as follows: • If you do not use DMAC: "NODMAC"

- When using DMAC: "DMA", "UART\_DMA\_TRANSFER\_USE"



Workspace	<b>▲</b> 廿 ×	
Sample_FYAx	~	
Files ■ <b>UART_RECEIV</b> ■ <b>APP</b> ■ <b>BSP</b>   ■ <b>BSP</b>   ■ <b>BSP</b> .c   ■ <b>BSP</b> .config.   ■ <b>BSP</b> .config.	_sbk	
He Startup	Options Make Compile Rebuild All Clean	٦
	C-STAT Static Analysis Stop Build	>
	Add	>
UART_RECEIVE	Nemove	

egory: atic Analysis	Override inherited settings			Factory Setting
ntime Checking /C++ Compiler ustom Build	List Preprocessor D	Diagnostics	Encodings	Extra Options
astorn baild	Language 1 Language 2	Code	Optimizatio	ns Output
	Language C C++ Auto (extension-based)	O Sta	age conformanc andard with IAR andard rict	
	C dialect C C89 Standard C Allow VLA C++ inline semantics Require prototypes	En	ptions able exceptions able RTTI estroy static obje	cts

Right-click the file you want to configure, open options, and change "Exclude from build". If you want to use the file, uncheck "Exclude from build", otherwise uncheck "Exclude from build".

#### DMAC disabled:

bsp_config_sbk_m4xn_uart_io.c	Use files
bsp_config_sbk_m4xn_uart_io_dma.c	Don't use files
DMAC enabled: bsp_config_sbk_m4xn_uart_io.c bsp_config_sbk_m4xn_uart_io_dma.c	Don't use files Use files

Please build after changing the settings.

#### 6.6.2. Keil µVision

Options for Target 'Sample_FVAx'		×	
Device   Target   Output   Listing   User	C/C++ Asm Linker Debug Utilities		
Preprocessor Symbols		_	
Define: NODMAC,UART_DMA_TRA	NSFER_USE		
Undefine:			
Language / Code Generation			
Execute-only Code	Strict ANSIC Warnings: All Warnings 💌		
Optimization: Level 1 (-01) -	🔲 Enum Container always int 👘 Thumb Mode		
Coptimize for Time	🔽 Plain Char is Signed 🗌 No Auto Includes		
Split Load and Store Multiple	☐ Read-Only Position Independent		
✓ One ELF Section per Function	☐ Read-Write Position Independent ☐ GNU extensions		
Paths Misc	ART¥UART_RECEIVE;¥¥¥¥Utility¥inc;¥¥¥¥¥MCU¥Driver		
Compiler control string			
ОК	Cancel Defaults Help		

Open "Project"  $\rightarrow$  "Options for Target 'Sample'"  $\rightarrow$  "C/C++". Change "Define:" of "Preprocessor Symbols" as shown below.

- · If you do not use DMAC, select "NODMAC"
- "DMA" and "UART\_DMA\_TRANSFER\_USE" when using DMAC



Project 📮 🗵			
Project: UART_RECEIVE			
🗄 ᇶ Sample_FYAx			
🕀 🚂 APP			
BSP			
bsp.c			
bsp_config_sbk_m4kn_uart io c bsp_config_sbk_m4kn_uart io c bsp_config_sbk_m4kn_uart io c	sbk m4kn uart io.c' Alt+F7		
Startup     Startup			
Manage Project tens			
Open bsp_config_sbk_m4kn_uart_io.c     Open bsp_config_sbk_m4kn_uart_io.c			
Rebuild all target files			
Build Target F7			
Translate bsp_config_sbk_m4	Translate bsp_config_sbk_m4kn_uart_io.c		
Show Include File Dependencies			
Show include File Dependencies			
Options for File 'bsp_config_sbk_m4kn_uart_io.c'	×		
Presenting to (our)			
Properties C/C++	1		
Path:	uart_io.c		
File Type: C Source file	✓ Include in Target Build		
Size: 19873 Bytes	Aiways Build		
last change: Thu Mar 7 15:40:42 2024	Generate Assembler SRC File		
last change. Thu Mar 7 13.40.42 2024	Assemble SRC File		
Stop on Exit Code: Not specified	✓ Image File Compression		
Custom Arguments:			
Memory Assignment:			
Code / Const: <a></a>			
Zero Initialized Data: <a href="https://www.default&gt;">www.default&gt;</a>			
Other Data: <a>default&gt;</a>			
Layer: <not assigned=""></not>			
OK Cancel Det	faults Help		

Right-click the file you want to configure, open Options for File 'xxxx.c' and change "Include in Target Build". If you want to use the file, check "Include in Target Build", otherwise uncheck "Include in Target Build".

#### DMAC disabled:

bsp\_config\_sbk\_m4xn\_uart\_io.c bsp\_config\_sbk\_m4xn\_uart\_io\_dma.c

#### DMAC enabled:

bsp\_config\_sbk\_m4xn\_uart\_io.c bsp\_config\_sbk\_m4xn\_uart\_io\_dma.c Don't use files Use files

Don't use files

Use files

Please build after changing the settings.

#### 6.6.3. SEGGER Embedded Studio

👈 🧅 🕄 Sample_FYAx 🛛 👻	Search Options	Show Modified Option	ns On
Code	Option	Value	
Assembler			
Build	▲ ■ Preprocessor		
Code Analyzer	<ul> <li>Add Property Group Options</li> </ul>	Yes	•
Code Generation	Ignore Includes	No	
Compiler	Include Files		
Compiler Warning	Include Files Assembler Only		
External Build	Include Files C Compiler Only		
File	Include Files C++ Compiler Only		
Libraries	Macro Files     Macro Files Assembler Only		
Library	Macro Files Assembler Only     Macro Files C Compiler Only		
Linker	Macro Files C compiler Only     Macro Files C++ Compiler Only		-
Preprocessor	Preprocessor Definitions	NODMAC;UART_DMA_TRANSFER	2115
Printf/Scanf	Preprocessor Definitions     Preprocessor Definitions	NODIMAC, OAKT_DIMA_INANSI EI	0.00
Runtime Memory Area	Preprocessor Definitions C Compiler Only		_
Section	Preprocessor Definitions C++ Compiler Only		
	Preprocessor Undefinitions		
Source Code			
User Build Step	Add Property Group Options		
ø Debug			
Debugger	Supply the defines and includes that are selected by the property group.		
GDB Server			
J-Link			
Loader			

 $\label{eq:open_project} \mbox{Open "Project"} \ \rightarrow \ \mbox{"Options"} \ \rightarrow \ \mbox{"Preprocessor"}.$ 

Change "Preprocessor Definitions" as shown below.

- · If you do not use DMAC, select "NODMAC"
- "DMA" and "UART\_DMA\_TRANSFER\_USE" when using DMAC

\* Change "Common" as well as "Sample\_xxx".

Value	
DMA;UART DMA TRANSFER USE modified;inherits	
ve macro expansion applied to it.	
	DMA;UARI_DMA_IRANSFER_USE modified(inherits)

Project Explorer					×
🕄 Sample_F10Ax 🔹 🔄 🖆 🖸		>	1	7 4	Þ
Project Items			Code	Data+R	20
<ul> <li>Solution 'UART_RECEIVE'</li> <li>Project 'UART_RECEIVE'</li> <li>Setup 1 file</li> <li>Sourse Files 15 files</li> <li>APP 1 file</li> <li>BSP 4 files</li> <li>bsp.c</li> <li>bsp_config_sbk_m4kn_led.c</li> <li>bsp_config_sbk_m4kn_uart_io.c</li> </ul>					
bsp_config_sbk_m4kn_uart_io_dm		Options	Alt+Return		
<ul> <li>TSB_driver 9 files</li> <li>Utility 1 file</li> <li>System 4 files</li> </ul>	e L	Compile Export Build Analyze Open Binary Editor Show Preprocessor Output Show Preprocessor Defines Format Code	Ctrl+F7		
		Exclude From Build Import Copy Full Path Select in File Explorer Flag	> ,		
	× 1	Cut Copy Remove	Ctrl+X Ctrl+C		

Right-click the file you want to configure and change "Exclude From Build". If you want to use a file, uncheck "Exclude From Build", otherwise check "Exclude From Build".

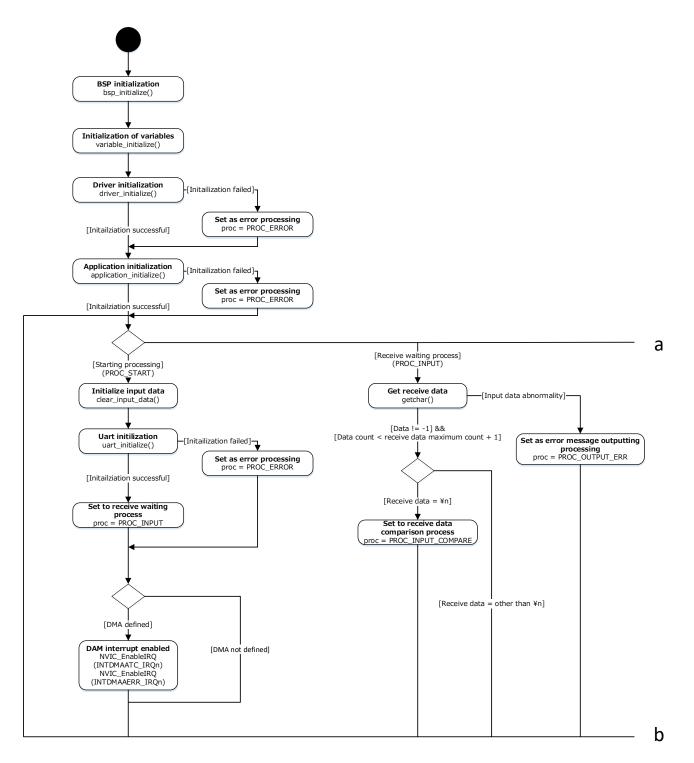
#### DMAC disabled:

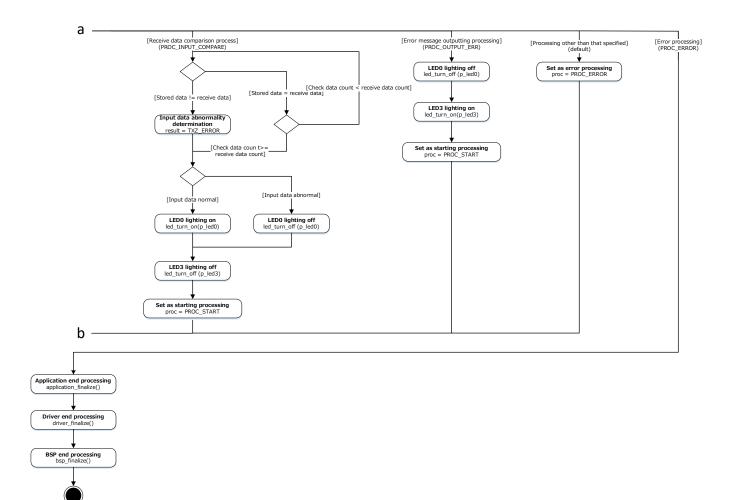
osp_config_sbk_m4xn_uart_io.c osp_config_sbk_m4xn_uart_io_dma.c	Use files Don't use files
abled: osp_config_sbk_m4xn_uart_io.c osp_config_sbk_m4xn_uart_io_dma.c	Don't use files Use files

Please build after changing the settings.

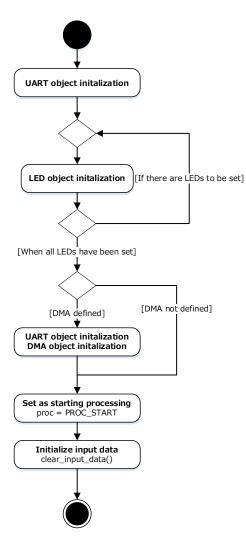
### 7. Activity diagram

7.1. main

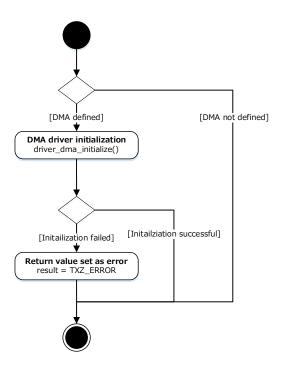




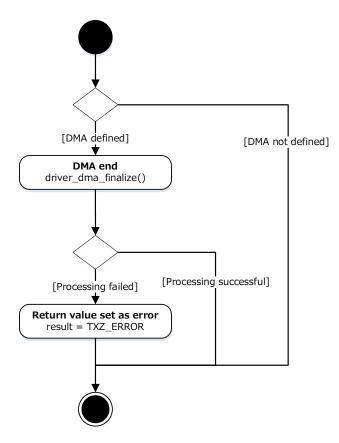
### 7.2. variable\_initalize



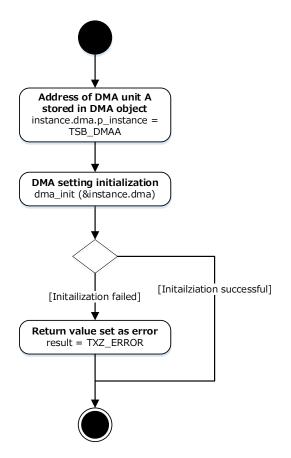
### 7.3. driver\_initialize



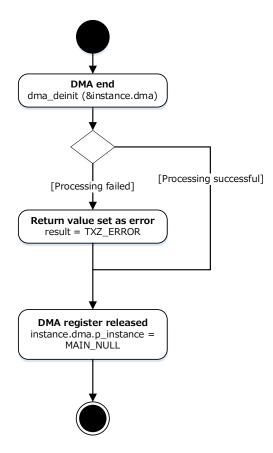
### 7.4. driver\_finalize



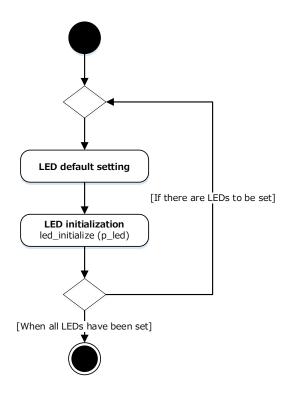
### 7.5. driver\_dma\_initialize



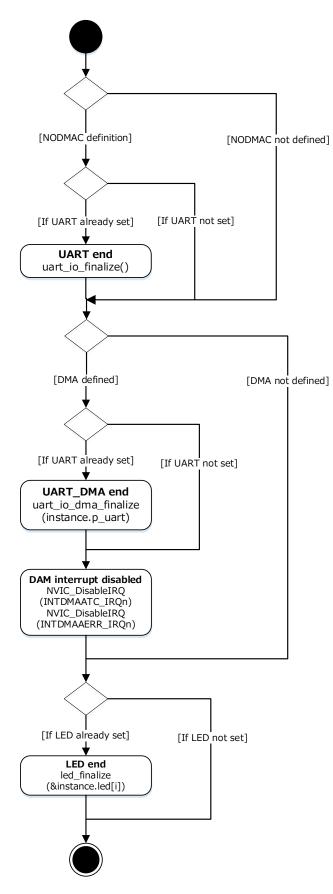
### 7.6. driver\_dma\_finalize



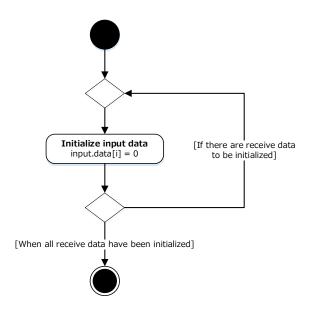
### 7.7. application\_initialize



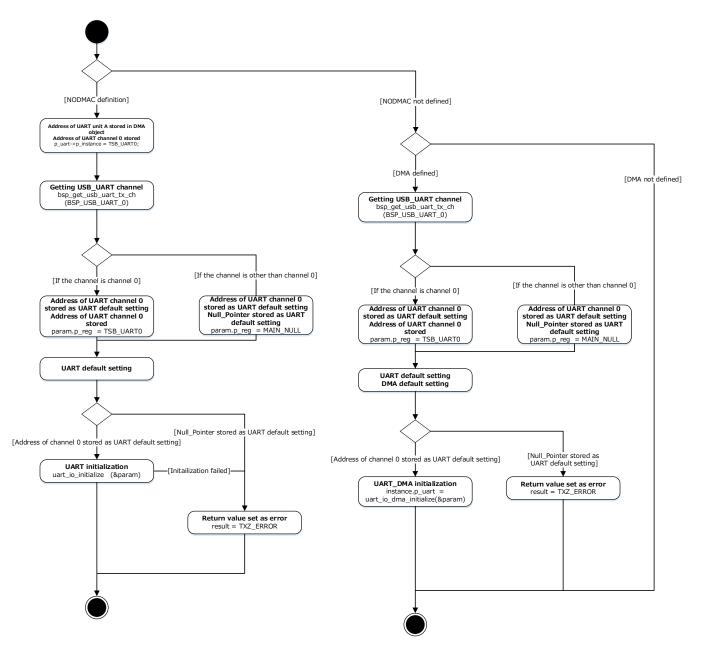
### 7.8. application\_finalize



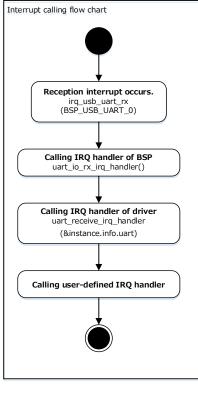
### 7.9. clear\_input\_data

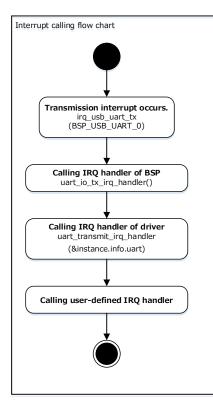


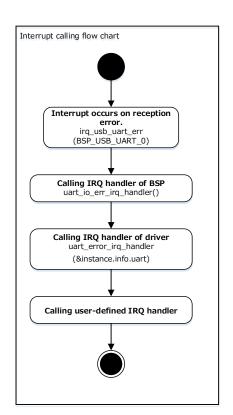
### 7.10. uart\_initialize

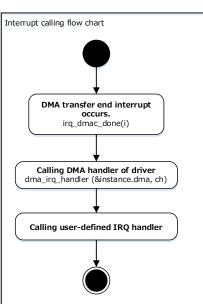


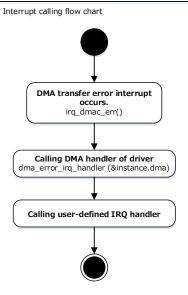
### 7.11. Interrupt











### 8. Revision History

Revision	Date	Description
1.0	2023-10-16	First release
1.1	2024-03-25	Added method to switch DMAC function
1.2	2024-07-16	Added detailed description of DMAC function switching

### **RESTRICTIONS ON PRODUCT USE**

Toshiba Corporation and its subsidiaries and affiliates are collectively referred to as "TOSHIBA". Hardware, software and systems described in this document are collectively referred to as "Product".

- TOSHIBA reserves the right to make changes to the information in this document and related Product without notice.
- This document and any information herein may not be reproduced without prior written permission from TOSHIBA. Even with TOSHIBA's
  written permission, reproduction is permissible only if reproduction is without alteration/omission.
- Though TOSHIBA works continually to improve Product's quality and reliability, Product can malfunction or fail. Customers are responsible for complying with safety standards and for providing adequate designs and safeguards for their hardware, software and systems which minimize risk and avoid situations in which a malfunction or failure of Product could cause loss of human life, bodily injury or damage to property, including data loss or corruption. Before customers use the Product, create designs including the Product, or incorporate the Product into their own applications, customers must also refer to and comply with (a) the latest versions of all relevant TOSHIBA information, including without limitation, this document, the specifications, the data sheets and application notes for Product and the precautions and conditions set forth in the "TOSHIBA Semiconductor Reliability Handbook" and (b) the instructions for the application with which the Product will be used with or for. Customers are solely responsible for all aspects of their own product design or applications, including but not limited to (a) determining the appropriateness of the use of this Product in such design or applications; (b) evaluating and determining the applicability of any information contained in this document, or in charts, diagrams, programs, algorithms, sample application circuits, or any other referenced documents; and (c) validating all operating parameters for such designs and applications. TOSHIBA ASSUMES NO LIABILITY FOR CUSTOMERS' PRODUCT DESIGN OR APPLICATIONS.
- PRODUCT IS NEITHER INTENDED NOR WARRANTED FOR USE IN EQUIPMENTS OR SYSTEMS THAT REQUIRE EXTRAORDINARILY HIGH LEVELS OF QUALITY AND/OR RELIABILITY, AND/OR A MALFUNCTION OR FAILURE OF WHICH MAY CAUSE LOSS OF HUMAN LIFE, BODILY INJURY, SERIOUS PROPERTY DAMAGE AND/OR SERIOUS PUBLIC IMPACT ("UNINTENDED USE"). Except for specific applications as expressly stated in this document, Unintended Use includes, without limitation, equipment used in nuclear facilities, equipment used in the aerospace industry, lifesaving and/or life supporting medical equipment, equipment used for automobiles, trains, ships and other transportation, traffic signaling equipment, equipment used to control combustions or explosions, safety devices, elevators and escalators, and devices related to power plant. IF YOU USE PRODUCT FOR UNINTENDED USE, TOSHIBA ASSUMES NO LIABILITY FOR PRODUCT. For details, please contact your TOSHIBA sales representative or contact us via our website.
- Do not disassemble, analyze, reverse-engineer, alter, modify, translate or copy Product, whether in whole or in part.
- Product shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable laws or regulations.
- The information contained herein is presented only as guidance for Product use. No responsibility is assumed by TOSHIBA for any infringement of patents or any other intellectual property rights of third parties that may result from the use of Product. No license to any intellectual property right is granted by this document, whether express or implied, by estoppel or otherwise.
- ABSENT A WRITTEN SIGNED AGREEMENT, EXCEPT AS PROVIDED IN THE RELEVANT TERMS AND CONDITIONS OF SALE FOR PRODUCT, AND TO THE MAXIMUM EXTENT ALLOWABLE BY LAW, TOSHIBA (1) ASSUMES NO LIABILITY WHATSOEVER, INCLUDING WITHOUT LIMITATION, INDIRECT, CONSEQUENTIAL, SPECIAL, OR INCIDENTAL DAMAGES OR LOSS, INCLUDING WITHOUT LIMITATION, LOSS OF PROFITS, LOSS OF OPPORTUNITIES, BUSINESS INTERRUPTION AND LOSS OF DATA, AND (2) DISCLAIMS ANY AND ALL EXPRESS OR IMPLIED WARRANTIES AND CONDITIONS RELATED TO SALE, USE OF PRODUCT, OR INFORMATION, INCLUDING WARRANTIES OR CONDITIONS OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, ACCURACY OF INFORMATION, OR NONINFRINGEMENT.
- Do not use or otherwise make available Product or related software or technology for any military purposes, including without limitation, for the design, development, use, stockpiling or manufacturing of nuclear, chemical, or biological weapons or missile technology products (mass destruction weapons). Product and related software and technology may be controlled under the applicable export laws and regulations including, without limitation, the Japanese Foreign Exchange and Foreign Trade Law and the U.S. Export Administration Regulations. Export and re-export of Product or related software or technology are strictly prohibited except in compliance with all applicable export laws and regulations.
- Please contact your TOSHIBA sales representative for details as to environmental matters such as the RoHS compatibility of Product. Please
  use Product in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances, including
  without limitation, the EU RoHS Directive. TOSHIBA ASSUMES NO LIABILITY FOR DAMAGES OR LOSSES OCCURRING AS A RESULT
  OF NONCOMPLIANCE WITH APPLICABLE LAWS AND REGULATIONS.

### **Toshiba Electronic Devices & Storage Corporation**

https://toshiba.semicon-storage.com/