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| **ABOV MCUs** |
| **I2C API User Guide** |

Application Note

Version 1.00

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# Overview

This document describes the firmware for the ABOV\_I2C\_Driver.

It has the goal of helping the developer to understand how this firmware works, and how to tailor the application.

# Function block diagram

## I2C Function Description

|  |
| --- |
|  |

Figure 1. I2C bus interface

1. START and STOP conditions are always generated by the master.

The bus is busy between START and STOP condition.

2. Every byte put on the SDAn line must be 8-bits long and it has to be followed by an ACK bit.

The transmitter releases the SDAn line(High) during the acknowledge clock pulse.

So the receiver is able to pull down the SDAn line during the acknowledge clock pulse.

3. The I2C is byte-oriented and interrupt-based. So byte complete, Interrupt is generated.

And clock line held low while interrupts are served by slave.

Data transfer continues when the slave is ready for another byte of data and releases clock line.

## I2C Master Mode

|  |
| --- |
| main.c    I2C IRQ |

Figure 2. I2C master mode diagram

## I2C Slave Mode

|  |
| --- |
| main.c    I2C IRQ |

Figure 3. I2C slave mode diagram

# How to use in main application

## Public Macro

The macros on the left side are user specific.

Modification is required for the user application.

|  |  |
| --- | --- |
| #define I2C\_DEVICE\_ADDRESS 0xA0  #define I2C\_SLAVE\_OWN\_ADDR 0xA0  #define I2C\_SPEED 10000  #define I2C\_MAX\_BUFFER\_SIZE 20  #define I2C\_MAX\_CHANNEL 2  #define I2C\_CH0 0  #define I2C\_CH1 1 | #define I2C\_ACK\_DISABLE 0  #define I2C\_ACK\_ENABLE 1  #define I2C\_WRITE\_MODE 0  #define I2C\_READ\_MODE 1  #define I2C\_IDLE 0  #define I2C\_BUSY 1  #define I2C\_FALSE 0  #define I2C\_TRUE 1 |

Figure 4. Example of public macro

## I2C Initialization

‘USI\_I2C\_Initial()’ function is required to use I2C functionality.

This function includes the following.

- Peri. Clock Enable / I2C Block Reset / I2C Interrupt Enable

- I2C Enable / I2C Ack Enable / Set Slave Own Address / Set I2C Speed / Set I2C Data Hold Time

|  |
| --- |
| [example of use]  USI\_I2C\_Initial(I2C\_CH0, I2C\_SPEED, I2C\_SLAVE\_OWN\_ADDR, I2C\_ACK\_ENABLE); |

Figure 5. I2C Initial API

## I2C Master – Write / Read

Using ‘USI\_I2C\_MasterTransferData()’ function, you can use both I2C Write and I2C Read functions.

This function includes the following parameter.

- I2C channel number / slave device address

- write data buffer / write data length / read data buffer / read data length

|  |
| --- |
| [example of use]  (case1) I2C Write 4-byte  🡪 USI\_I2C\_MasterTransferData(I2C\_CH0, I2C\_DEVICE\_ADDRESS, \*u8TxDat, 4, \*u8RxDat, 0);  (case2) I2C Read 4-byte  🡪 USI\_I2C\_MasterTransferData(I2C\_CH0, I2C\_DEVICE\_ADDRESS, \*u8TxDat, 0, \*u8RxDat, 4);  (case3) I2C Write 1-byte , Read 3-byte  🡪 USI\_I2C\_MasterTransferData(I2C\_CH0, I2C\_DEVICE\_ADDRESS, \*u8TxDat, 1, \*u8RxDat, 3); |

Figure 6. I2C Transfer API

## I2C Slave – Set Transmit Buffer

Using ‘USI\_I2C\_SetSlaveData()’ function, you can set transmit buffer data.

The buffer data can be modified by the user.

|  |
| --- |
| [example of use]  USI\_I2C\_SetSlaveData(I2C\_CH0); |

Figure 7. I2C Slave Set API

## Example of use in main application

This is example of use in main application.

|  |
| --- |
|  |

Figure 8. Example of main application

# How to port to other device

## Main (main.c)

1) Include header file 🡪 #include "DeviceName\_I2C\_API\_Vx.xx.h"

2) Call ‘USI\_I2C\_InterruptHandler()’ function at the I2C IRQ.

Example) void I2C0\_Handler(void){ USI\_I2C\_InterruptHandler(I2C\_CH0); }  
 void I2C1\_Handler(void){ USI\_I2C\_InterruptHandler(I2C\_CH1); }

3) Use functions as below in user application.

Example) USI\_I2C\_Initial(I2C\_CH0,I2C\_SPEED,I2C\_SLAVE\_OWN\_ADDR,I2C\_ACK\_ENABLE);  
 USI\_I2C\_MasterTransferData(I2C\_CH0,I2C\_DEVICE\_ADDRESS,\*u8TxDat, 4,\*u8RxDat, 0);  
 USI\_I2C\_SetSlaveData(I2C\_CH1);

## Header file (DeviceName\_I2C\_API\_Vx.xx.h)

It needs to change public typedef as below.

I2C Control Register and I2C Status Register may differ from product to product,

So the corresponding bits must be checked.

|  |
| --- |
|  |

Figure 9. Example of header file

## Source file (DeviceName\_I2C\_API\_Vx.xx.c)

8-bit MCU and 32-bit MCU comparison

1) void USI\_I2C\_Initial(uint8\_t ch, uint32\_t speed, uint8\_t addr, uint8\_t ack)

It needs to change name of the register below to match the device.

>> I2CSAR(I2C Slave Address), I2CSCLHR(SCL High Period Register), I2CSCLLR(SCL Low Period Register)  
 I2CSDAHR(SDA Hold Time Register)  
 >> For 32-bit MCU, It needs to add peripheral clock enable register.

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 10. Example of i2c initial function

2) void USI\_I2C\_SoftwareReset(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> For 8-bit MCU, I2CMR(I2C Mode Control Register) has reset function bit.  
 >> For 32-bit MCU, It needs to add SCU register configure.

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 11. Example of i2c reset function

3) void USI\_I2C\_Enable(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> I2CMR(I2C Mode Control Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 12. Example of i2c enable function

4) void USI\_I2C\_ConfigureInterrupt(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> For 8-bit MCU, It can configure interrupt by I2CMR and IE1.  
 >> For 32-bit MCU, It can configure interrupt by NVIC.

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 13. Example of i2c interrupt configure function

5) void USI\_I2C\_ConfigureAcknowledge(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> I2CMR(I2C Mode Control Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 14. Example of i2c acknowledge configure function

6) void USI\_I2C\_Start(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> I2CMR(I2C Mode Control Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 15. Example of i2c start function

7) void USI\_I2C\_Stop(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> I2CMR(I2C Mode Control Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 16. Example of i2c stop function

8) void USI\_I2C\_Send7bitAddress(uint8\_t ch, uint8\_t dev\_addr, uint8\_t direction)

It needs to change name of the register below to match the device.

>> I2CDR(I2C Data Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 17. Example of i2c send7bitaddress function

9) void USI\_I2C\_MasterTransferData(uint8\_t ch, uint8\_t dev\_addr, uint8\_t \*write\_data, uint8\_t write\_len, uint8\_t \*read\_data, uint8\_t read\_len)

It needs to change name of the register below to match the device.

>> I2CSR(I2C Status Register)

|  |
| --- |
| \* 8-bit MCU |
| \* 32-bit MCU |

Figure 18. Example of i2c transfer function

10) void USI\_I2C\_InterruptHandler(uint8\_t ch)

It needs to change name of the register below to match the device.

>> I2CSR(I2C Status Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 19. Example of i2c interrupt handler

11) static void USI\_I2C\_MasterProcess(uint8\_t ch)

It needs to change name of the register below to match the device.

>> I2CSR(I2C Status Register), I2CDR(I2C Data Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 20. Example of i2c master process function

12) void USI\_I2C\_SetSlaveData(uint8\_t ch)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 21. Example of i2c set slave data function

13) static void USI\_I2C\_SlaveProcess(uint8\_t ch)

It needs to change name of the register below to match the device.

>> I2CSR(I2C Status Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 22. Example of slave process function

14) uint8\_t USI\_I2C\_GetInterruptStatus(uint8\_t ch)

It needs to change name of the register below to match the device.

>> I2CSR(I2C Status Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 23. Example of get interrupt status function

15) void USI\_I2C\_ConfigureGerneralCall(uint8\_t ch, uint8\_t enable)

It needs to change name of the register below to match the device.

>> I2CSAR(I2C Slave Address Register)

|  |  |
| --- | --- |
| \* 8-bit MCU | \* 32-bit MCU |

Figure 24. Example of general call configure function

# APPENDIX

## Example code for I2C Master Function with I2C BUS EEPROM

1) Devices

- Example 1) Master : MC97FGx16 (ABOV 8-bit MCU)

Slave : BR24G01-3 I2C BUS EEPROM (ROHM)

- Example 2) Master : A31G12x (ABOV 32-bit MCU)

Slave : BR24G01-3 I2C BUS EEPROM (ROHM)

2) Function Description

- Write Cycle

: Arbitrary data can be written to this EEPROM. When writing only 1 byte,

Byte Write is normally used, and when writing continuous data of 2 bytes or more,

simultaneous write is possible by Page Write cycle. The maximum number of bytes is specified

per device of each capacity. Up to 8 arbitrary bytes can be written.

\* Byte Write

|  |
| --- |
|  |

Figure 25. Byte Write Procedure

\* Page Write

|  |
| --- |
|  |

Figure 26. Page Write Procedure

- Read Cycle

: Read cycle is when data of EEPROM is read. Read cycle could be random read cycle

or current read cycle. Random read cycle is a command to read data by designating a specific

address, and is used generally. Current read cycle is a command to read data of internal address

register without designating an address, and is used when to verify just after write cycle.

In both the read cycles, sequential read cycle is available where the next address data can be

read in succession.

\* Random Read

|  |
| --- |
|  |

Figure 27. Random Read Procedure

\* Current Read

|  |
| --- |
|  |

Figure 28. Current Read Procedure

\* Sequential Read

|  |
| --- |
|  |

Figure 29. Sequential Read Procedure

# Revision history

|  |  |  |
| --- | --- | --- |
| Version | Date | Revision list |
| V1.00 | 20.03.11 | Document created |
|  |  |  |
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