Application Note

BNO055
UART interface

Bosch Sensortec

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User Motion → BNO 055 →
- Quaternion
- Linear Acceleration
- Rotation
- Gravity
- Robust Heading

Contents

1. Introduction

As described in the datasheet of the BNO055, the application processor can be connected to the BNO055 using 3 different interfaces: I2C, HID-over-I2C and UART. This application note describes the UART interface of the BNO055 in more detail.

UART mode is enabled by setting the protocol select (PS) pins accordingly, i.e. PS0 to GND signal and PS1 to VDDIO signal (see table 4-4, page 89 in the datasheet of BNO055, version 1.2). Figure 10 of the datasheet shows how to connect the BNO055 to enable UART mode.

2. BNO055 UART Protocol

The BNO055 support UART interface with the following settings: 115200 bps, 8N1 (8 data bits, no parity bit, one stop bit). The maximum length support for read and write is 128 Byte.

2.1 Write command

With this command, one or more bytes can be send to the BNO055 register map. The start address is given in byte 3. Byte 4 contains the number of bytes to be written to, whereby the write address is incremented by 1 after each written byte.

Command:

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	.....	Byte (n+4)
Start Byte	Write	Reg addr	Length	Data 1	…..	Data n
0xAA	0x00	<..>	<..>	<..>	…..	<..>

2.1.1 Examples

Task	Required register map modifications	UART command (hexadecimal format)
Select Page 0	Write 0x00 to register 0x07	AA 00 07 01 00
Set power mode to "normal mode"	write 0x00 to register 0x3E	AA 00 3E 01 00
Set operation mode to "NDOF"	Write 0x0C to register 0x3D	AA 00 3D 01 0C
Set accelerometer offset values for x, y, z channel: accel_offset_x = 0x0102, accel_offset_y = 0x0304, accel_offset_z = 0x0506[1]	Write the following content to the following register: Reg. 0x55: (uint8_t) 0x0102 Reg. 0x56: (uint8_t) (0x0102 >> 8) Reg. 0x57: (uint8_t) 0x0304 Reg. 0x58: (uint8_t) (0x0304 >> 8) Reg. 0x59: (uint8_t) 0x0506 Reg. 0x5A: (uint8_t) (0x0506 >> 8)	AA 00 55 06 02 01 04 03 06 05

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[1] The given values are for demonstrational purposes only and therefore write the appropriate accelerometer offset value. Accelerometer offset value is only required when the sensor needs to be calibrated immediately after power-on without any calibration movement

2.1.2 Write command response

The BNO055 sends a response message to acknowledge the write command. The structure of the response message is the following.

Acknowledge Response:

Byte 1	Byte 2
Response Header	Status
0xEE	0x01: WRITE_SUCCESS 0x03: WRITE_FAIL 0x04: REGMAP_INVALID_ADDRESS 0x05: REGMAP_WRITE_DISABLED 0x06: WRONG_START_BYTE 0x07: BUS_OVER_RUN_ERROR 0x08: MAX_LENGTH_ERROR 0x09: MIN_LENGTH_ERROR 0x0A: RECEIVE_CHARACTER_TIMEOUT

The different status values have the following meaning:

Status	Meaning	Solution
0x01	Write successfully	Everything worked as expected, no action is required
0x03	Write failed.	Check connection, protocol settings and operation mode of the BNO
0x04	Invalid register address.	Check the register is addressable. For example in Page0, should be from 0x38 to 0x6A.
0x05	Register is read only	Check the property of register.
0x06	The start byte is not '0xAA'.	Check if the first byte send is 0xAA.
0x07	The BNO055 was not able to clear the receive buffer in time for the next send data, this can happen, since UART is an asynchronous protocol.	Resend the command
0x08	The Max length of data more than 128 (0x80)	Split the command, so that a single frame has less than 128 Bytes
0x09	The Min length of data less than 1.	Send a valid frame
0x0A	If a character arrives and the next character doesn't arrive in the timeframe of 100ms after that	Decrease waiting time between sending of two bytes of one frame

2.2 Read command

With this 4 Byte command, one or more bytes can be read from the BNO055 register map. The start address is given in byte 3. Byte 4 contains the number of bytes to be read whereby the read address is incremented by 1 after each read byte.

Command:

Byte 1	Byte 2	Byte 2	Byte 3
Start Byte	Read	Reg addr	Length
0xAA	0x01	<..>	<..>

2.2.1 Examples

Task	Required register map modifications	UART command (hexadecimal format)
Check the calibration status	Read register CALIB_STAT (register 0x35 on page 0)	AA 01 35 01
Read quaternion data	Read from register 0x20 to 0x27 (on page 0)	AA 01 20 08

2.2.2 Read command response

On success, the BNO055 will respond and provide the requested data in the following format. The typical time to acknowledge the write command is 1ms and the maximum is 4ms.

Read Success Response:

Byte 1	Byte 2	Byte 3	.....	Byte (n+2)
ResponseByte	length	Data 1	.....	Data n
0xBB	<..>			

In case of an error, the BNO055 will respond with an error message and a status information:

Acknowledge Response:

Byte 1	Byte 2
Response Header	Status
0xEE	0x01: WRITE_SUCCESS 0x03: WRITE_FAIL 0x04: REGMAP_INVALID_ADDRESS 0x06: WRONG_START_BYTE 0x07: BUS_OVER_RUN_ERROR 0x08: MAX_LENGTH_ERROR 0x09: MIN_LENGTH_ERROR 0x0A: RECEIVE_CHARACTER_TIMEOUT

The different status values have the following meaning:

Status	Meaning	Solution
0x01	Write successfully	Everything worked as expected, no action is required
0x03	Write failed.	Check connection, protocol settings and operation mode of the BNO
0x04	Invalid register address.	Check the register is addressable. For example in Page0, should be from 0x38 to 0x6A.
0x06	The start byte is not '0xAA'.	Check if the first byte send is 0xAA.
0x07	The BNO055 was not able to clear the receive buffer in time for the next send data, this can happen, since UART is an asynchronous protocol.	Resend the command
0x08	The Max length of data is more than 128 (0x80)	Split the command, so that a single frame has less than 128 Bytes
0x09	The Min length of data is less than 1.	Send a valid frame
0x0A	If a character arrives and the next character doesn't arrive in the timeframe of 100ms after that	Decrease waiting time between sending of two bytes of one frame

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4. Document history and modifications

Rev. No	Chapter	Description of modification/changes	Date
1.0	all	Clarifications and corrections	25.06.2015
0.1		Initial version	25.03.2015