Report for a LSM9DS0 Driver implemented in C

MicroelectromechanicalSystem from ST Microeletronics

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Contents

1 Main Page 1

2 License 3

3 Microchip License 7

4 Module Index 9

4.1 Modules . . . 9

5 Data Structure Index 11

5.1 Data Structures . . . 11

6 File Index 13

6.1 File List . . . 13

7 Module Documentation 15

7.1 Main . . . 15

7.1.1 Detailed Description . . . 15

7.1.2 Function Documentation . . . 15

7.1.2.1 __ISR . . . 15

7.1.2.2 InitTimer1 . . . 16

7.1.2.3 InitUART . . . 16

7.1.3 Variable Documentation . . . 16

7.1.3.1 acc_cal_matrix . . . 16

7.1.3.2 mag_cal_matrix . . . 16

7.2 LSM9DS0 Driver . . . 17

7.2.1 Detailed Description . . . 21

7.2.2 Macro Definition Documentation . . . 21

7.2.2.1 A_ODR100 . . . 21

7.2.2.2 A_ODR12_5 . . . 21

7.2.2.3 A_ODR1600 . . . 21

7.2.2.4 A_ODR200 . . . 21

7.2.2.5 A_ODR25 . . . 22

7.2.2.6 A_ODR3_125 . . . 22

7.2.2.7 A_ODR400 . . . 22
7.2.2.8 A_ODR50 . . . 22
7.2.2.9 A_ODR6_25 . . . 22
7.2.2.10 A_ODR800 . . . 22
7.2.2.11 ABW194 . . . 22
7.2.2.12 ABW362 . . . 22
7.2.2.13 ABW50 . . . 22
7.2.2.14 ABW773 . . . 22
7.2.2.15 ACC_OFF . . . 22
7.2.2.16 Act_DUR . . . 22
7.2.2.17 Act_THS . . . 23
7.2.2.18 Address_G . . . 23
7.2.2.19 Address_XM . . . 23
7.2.2.20 AUTORST_INT . . . 23
7.2.2.21 BDU_A_ENABLE . . . 23
7.2.2.22 BDU_G_ENABLE . . . 23
7.2.2.23 BIG_ENDIAN . . . 23
7.2.2.24 BW00 . . . 23
7.2.2.25 BW01 . . . 23
7.2.2.26 BW10 . . . 23
7.2.2.27 BW11 . . . 23
7.2.2.28 CLICK_CFG . . . 23
7.2.2.29 CLICK_SRC . . . 24
7.2.2.30 CLICK_THS . . . 24
7.2.2.31 CONTINUOUS_UPDATE . . . 24
7.2.2.32 CONTINUOUS_UPDATE . . . 24
7.2.2.33 CTRL_REG0_XM . . . 24
7.2.2.34 CTRL_REG1_G . . . 24
7.2.2.35 CTRL_REG1_XM . . . 24
7.2.2.36 CTRL_REG2_G . . . 24
7.2.2.37 CTRL_REG2_XM . . . 24
7.2.2.38 CTRL_REG3_G . . . 24
7.2.2.39 CTRL_REG3_XM . . . 24
7.2.2.40 CTRL_REG4_G . . . 24
7.2.2.41 CTRL_REG4_XM . . . 25
7.2.2.42 CTRL_REG5_G . . . 25
7.2.2.43 CTRL_REG5_XM . . . 25
7.2.2.44 CTRL_REG6_XM . . . 25
7.2.2.45 CTRL_REG7_XM . . . 25
7.2.2.46 ENABLE_ALL_AXES . . . 25

7.2.2.47 FIFO_CTRL_REG . . . 25
7.2.2.48 FIFO_SRC_REG . . . 25
7.2.2.49 FS_16_G . . . 25
7.2.2.50 FS_16_GAUSS . . . 25
7.2.2.51 FS_2000_DPS . . . 25
7.2.2.52 FS_245_DPS . . . 25
7.2.2.53 FS_2_G . . . 26
7.2.2.54 FS_2_GAUSS . . . 26
7.2.2.55 FS_4_G . . . 26
7.2.2.56 FS_4_GAUSS . . . 26
7.2.2.57 FS_500_DPS . . . 26
7.2.2.58 FS_6_G . . . 26
7.2.2.59 FS_8_G . . . 26
7.2.2.60 FS_8_GAUSS . . . 26
7.2.2.61 G_ODR190 . . . 26
7.2.2.62 G_ODR380 . . . 26
7.2.2.63 G_ODR760 . . . 26
7.2.2.64 G_ODR95 . . . 26
7.2.2.65 GYRO_OFF . . . 27
7.2.2.66 GYRO_ON . . . 27
7.2.2.67 HIGH_MAG_RES . . . 27
7.2.2.68 HPCF_00 . . . 27
7.2.2.69 HPCF_01 . . . 27
7.2.2.70 HPCF_02 . . . 27
7.2.2.71 HPCF_03 . . . 27
7.2.2.72 HPCF_04 . . . 27
7.2.2.73 HPCF_05 . . . 27
7.2.2.74 HPCF_06 . . . 27
7.2.2.75 HPCF_07 . . . 27
7.2.2.76 HPCF_0A . . . 27
7.2.2.77 HPCF_0B . . . 28
7.2.2.78 I2C_AUTO_INCREMENT . . . 28
7.2.2.79 INT1_CFG_G . . . 28
7.2.2.80 INT1_DURATION_G . . . 28
7.2.2.81 INT1_SRC_G . . . 28
7.2.2.82 INT1_TSH_XH . . . 28
7.2.2.83 INT1_TSH_XL . . . 28
7.2.2.84 INT1_TSH_YH . . . 28
7.2.2.85 INT1_TSH_YL . . . 28
7.2.2.86 INT1_TSH_ZH . . . 28

7.2.2.87 INT1_TSH_ZL . . . 28
7.2.2.88 INT_CTRL_REG_M . . . 28
7.2.2.89 INT_GEN_1_DURATION . . . 29
7.2.2.90 INT_GEN_1_REG . . . 29
7.2.2.91 INT_GEN_1_SRC . . . 29
7.2.2.92 INT_GEN_1_THS . . . 29
7.2.2.93 INT_GEN_2_DURATION . . . 29
7.2.2.94 INT_GEN_2_REG . . . 29
7.2.2.95 INT_GEN_2_SRC . . . 29
7.2.2.96 INT_GEN_2_THS . . . 29
7.2.2.97 INT_SRC_REG_M . . . 29
7.2.2.98 INT_THS_H_M . . . 29
7.2.2.99 INT_THS_L_M . . . 29
7.2.2.100 LITTLE_ENDIAN . . . 29
7.2.2.101 LOW_MAG_RES . . . 30
7.2.2.102 M_ODR100 . . . 30
7.2.2.103 M_ODR12_5 . . . 30
7.2.2.104 M_ODR25 . . . 30
7.2.2.105 M_ODR3_125 . . . 30
7.2.2.106 M_ODR50 . . . 30
7.2.2.107 M_ODR6_25 . . . 30
7.2.2.108 NORMAL_MODE . . . 30
7.2.2.109 NORMAL_MODE_RR . . . 30
7.2.2.110 OFFSET_X_H_M . . . 30
7.2.2.111 OFFSET_X_L_M . . . 30
7.2.2.112 OFFSET_Y_H_M . . . 30
7.2.2.113 OFFSET_Y_L_M . . . 31
7.2.2.114 OFFSET_Z_H_M . . . 31
7.2.2.115 OFFSET_Z_L_M . . . 31
7.2.2.116 OUT_TEMP_H_XM . . . 31
7.2.2.117 OUT_TEMP_L_XM . . . 31
7.2.2.118 OUT_X_H_A . . . 31
7.2.2.119 OUT_X_H_G . . . 31
7.2.2.120 OUT_X_H_M . . . 31
7.2.2.121 OUT_X_L_A . . . 31
7.2.2.122 OUT_X_L_G . . . 31
7.2.2.123 OUT_X_L_M . . . 31
7.2.2.124 OUT_Y_H_A . . . 31
7.2.2.125 OUT_Y_H_G . . . 32
7.2.2.126 OUT_Y_H_M . . . 32

7.2.2.127 OUT_Y_L_A . . . 32
7.2.2.128 OUT_Y_L_G . . . 32
7.2.2.129 OUT_Y_L_M . . . 32
7.2.2.130 OUT_Z_H_A . . . 32
7.2.2.131 OUT_Z_H_G . . . 32
7.2.2.132 OUT_Z_H_M . . . 32
7.2.2.133 OUT_Z_L_A . . . 32
7.2.2.134 OUT_Z_L_G . . . 32
7.2.2.135 OUT_Z_L_M . . . 32
7.2.2.136 Read . . . 32
7.2.2.137 REFERENCE_G . . . 33
7.2.2.138 REFERENCE_X . . . 33
7.2.2.139 REFERENCE_Y . . . 33
7.2.2.140 REFERENCE_Z . . . 33
7.2.2.141 RF_FILT . . . 33
7.2.2.142 SENSITIVITY_2000DPS . . . 33
7.2.2.143 SENSITIVITY_245DPS . . . 33
7.2.2.144 SENSITIVITY_500DPS . . . 33
7.2.2.145 SENSITIVITY_ACC_16G . . . 33
7.2.2.146 SENSITIVITY_ACC_2G . . . 33
7.2.2.147 SENSITIVITY_ACC_4G . . . 33
7.2.2.148 SENSITIVITY_ACC_8G . . . 33
7.2.2.149 SENSITIVITY_MAG_12G . . . 34
7.2.2.150 SENSITIVITY_MAG_2G . . . 34
7.2.2.151 SENSITIVITY_MAG_4G . . . 34
7.2.2.152 SENSITIVITY_MAG_8G . . . 34
7.2.2.153 STATUS_REG_A . . . 34
7.2.2.154 STATUS_REG_G . . . 34
7.2.2.155 STATUS_REG_M . . . 34
7.2.2.156 TEMP_EN . . . 34
7.2.2.157 TIME_LATENCY . . . 34
7.2.2.158 TIME_LIMIT . . . 34
7.2.2.159 TIME_WINDOW . . . 34
7.2.2.160 WHO_AM_I_G . . . 34
7.2.2.161 WHO_AM_I_XM . . . 35
7.2.2.162 WHOAMI_LSM9DS0_GYRO . . . 35
7.2.2.163 WHOAMI_LSM9DS0_XM . . . 35
7.2.2.164 Write . . . 35
7.2.2.165 X_ENABLE . . . 35
7.2.2.166 Y_ENABLE . . . 35

7.2.2.167 Z_ENABLE . . . 35
7.2.2.168 Gyroscope HighPassFilter Cutoff Frequency Table . . . 35
7.2.3 Function Documentation . . . 35
7.2.3.1 AccEnableConfig . . . 35
7.2.3.2 GetAccMagAddr . . . 36
7.2.3.3 GetGyroAddr . . . 36
7.2.3.4 GyroConfig . . . 36
7.2.3.5 GyroEnable . . . 37
7.2.3.6 MagEnableConfig . . . 37
7.2.3.7 ReadAccRaw . . . 38
7.2.3.8 ReadGyroRaw . . . 38
7.2.3.9 ReadMagRaw . . . 38
7.2.3.10 ReadTemp . . . 38
7.3 MARG driver . . . 40
7.3.1 Detailed Description . . . 40
7.3.2 Function Documentation . . . 40
7.3.2.1 InitMARG . . . 40
7.3.2.2 ReadAccXYZ . . . 41
7.3.2.3 ReadGyroXYZ . . . 41
7.3.2.4 ReadMagXYZ . . . 41
7.3.2.5 UpdateAccBias . . . 41
7.3.2.6 UpdateGyroBias . . . 42
7.3.3 Variable Documentation . . . 42
7.3.3.1 acc_cal_matrix . . . 42
7.3.3.2 acc_offsets . . . 42
7.3.3.3 gyro_offsets . . . 42
7.3.3.4 mag_cal_matrix . . . 42
7.3.3.5 mag_offsets . . . 42
7.4 UART Communications . . . 43

8 Data Structure Documentation **45**
8.1 data_xyz Struct Reference . . . 45
8.1.1 Detailed Description . . . 45
8.2 sensor_xyz Struct Reference . . . 45
8.2.1 Detailed Description . . . 46

9 File Documentation **47**
9.1 lsm9ds0.h File Reference . . . 47
9.1.1 Detailed Description . . . 51
9.2 main.c File Reference . . . 51
9.2.1 Detailed Description . . . 52

9.3 marg.h File Reference 52
9.3.1 Detailed Description 53
9.4 uart.h File Reference 53
9.4.1 Detailed Description 53

Chapter 1

Main Page

Project LSM9DS0

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Version

1.0

This report documents a simple driver developed for the LSM9DS0 MicroelectromechanicalSystem (MEMS) on chip, from ST Microelectronics. This was developed in the scope of "HERMES - Sistemas de Interatividade entre Consumidores e Conteúdos Digitais (Co-promoção 34149)" project.

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Chapter 4

Module Index

4.1 Modules

Here is a list of all modules:

Main 15
LSM9DS0 Driver 17
MARG driver 40
UART Communications 43

Chapter 5

Data Structure Index

5.1 Data Structures

Here are the data structures with brief descriptions:

data_xyz 45
sensor_xyz 45

Chapter 6

File Index

6.1 File List

Here is a list of all documented files with brief descriptions:

lsm9ds0.h 47
main.c 51
marg.h 52
uart.h 53

Chapter 7

Module Documentation

7.1 Main

Entry point and main control.

Files

- file main.c

Functions

- void InitUART (void)

  Inicialize UART.
- void InitTimer1 (void)

  Inicialize Timer 1 to measure sampling time.
- void __ISR (TIMER_1_INT_VECTOR, ipl2)
- int **main** (void)

Variables

- UINT8 **T1overflow** = 1
- float **acc_offsets** [3] = {0, 0, 0}
- float **acc_cal_matrix** [3][3]
- float **gyro_offsets** [3] = {0,0,0}
- float **mag_offsets** [3] = {0, 0, 0}
- float **mag_cal_matrix** [3][3]

7.1.1 Detailed Description

Entry point and main control.

7.1.2 Function Documentation

7.1.2.1 void __ISR (TIMER_1_INT_VECTOR , ipl2)

Timer 1 ISR Interrupt

Priority Level = 2

Vector 4

7.1.2.2 void InitTimer1 (void)

Inicialize Timer 1 to measure sampling time:

PreScaler - 256

Interrupts ON

Priority - 2

SubPriority - 0

Also Enables System MultiVectoredInterrupts

7.1.2.3 void InitUART (void)

Inicialize UART:

Interrupts OFF

Baudrate - 115200

Number of bits - 8

No parity bit

1 stop bits

7.1.3 Variable Documentation

7.1.3.1 float acc_cal_matrix

Initial value:

```
= {{1, 0, 0 },
   {0, 1, 0 },
   {0, 0, 1 }}
```

7.1.3.2 float mag_cal_matrix

Initial value:

```
= {{1, 0, 0 },
   {0, 1, 0 },
   {0, 0, 1 }}
```

7.2 LSM9DS0 Driver

Basic driver for lsm9ds0.

Files

- file lsm9ds0.h

Data Structures

- struct sensor_xyz

Functions

- void ReadGyroRaw (sensor_xyz *raw)

  Read gyro raw data.
- void ReadAccRaw (sensor_xyz *raw)

  Read accelerometer raw data.
- void ReadMagRaw (sensor_xyz *raw)

  Read magnetometer raw data.
- void ReadTemp (short *temperature)

  Read temperature raw data.
- void GyroEnable (char command)

  Enable Gyro sensor.
- void GyroConfig (char command)

  Configure Gyro sensor.
- void AccEnableConfig (char command1, char command2)

  Enable and Configure Acc sensor.
- void MagEnableConfig (char command1, char command2)

  Enable and Configure Mag sensor.
- UINT8 GetGyroAddr (void)

  Get Gyro module Address.
- UINT8 GetAccMagAddr (void)

  Get XM module Address.

Variables

- UINT8 buff [2]

  Auxiliary buffer.

LSM9DS0 Register

- #define OUT_TEMP_L_XM (0x05)
- #define OUT_TEMP_H_XM (0x06)
- #define STATUS_REG_M (0x07)
- #define OUT_X_L_M (0x08)
- #define OUT_X_H_M (0x09)
- #define OUT_Y_L_M (0x0A)
- #define OUT_Y_H_M (0x0B)
- #define OUT_Z_L_M (0x0C)

- #define OUT_Z_H_M (0x0D)
- #define WHO_AM_I_G (0x0F)
- #define WHO_AM_I_XM (0x0F)
- #define INT_CTRL_REG_M (0x12)
- #define INT_SRC_REG_M (0x13)
- #define INT_THS_L_M (0x14)
- #define INT_THS_H_M (0x15)
- #define OFFSET_X_L_M (0x16)
- #define OFFSET_X_H_M (0x17)
- #define OFFSET_Y_L_M (0x18)
- #define OFFSET_Y_H_M (0x19)
- #define OFFSET_Z_L_M (0x1A)
- #define OFFSET_Z_H_M (0x1B)
- #define REFERENCE_X (0x1C)
- #define REFERENCE_Y (0x1D)
- #define REFERENCE_Z (0x1E)
- #define CTRL_REG0_XM (0x1F)
- #define CTRL_REG1_XM (0x20)
- #define CTRL_REG1_G (0x20)
- #define CTRL_REG2_XM (0x21)
- #define CTRL_REG2_G (0x21)
- #define CTRL_REG3_XM (0x22)
- #define CTRL_REG3_G (0x22)
- #define CTRL_REG4_XM (0x23)
- #define CTRL_REG4_G (0x23)
- #define CTRL_REG5_XM (0x24)
- #define CTRL_REG5_G (0x24)
- #define CTRL_REG6_XM (0x25)
- #define REFERENCE_G (0x25)
- #define CTRL_REG7_XM (0x26)
- #define STATUS_REG_G (0x27)
- #define STATUS_REG_A (0x27)
- #define OUT_X_L_G (0x28)
- #define OUT_X_L_A (0x28)
- #define OUT_X_H_G (0x29)
- #define OUT_X_H_A (0x29)
- #define OUT_Y_L_G (0x2A)
- #define OUT_Y_L_A (0x2A)
- #define OUT_Y_H_G (0x2B)
- #define OUT_Y_H_A (0x2B)
- #define OUT_Z_L_G (0x2C)
- #define OUT_Z_L_A (0x2C)
- #define OUT_Z_H_G (0x2D)
- #define OUT_Z_H_A (0x2D)
- #define FIFO_CTRL_REG (0x2E)
- #define FIFO_SRC_REG (0x2F)
- #define INT1_CFG_G (0x30)
- #define INT_GEN_1_REG (0x30)
- #define INT1_SRC_G (0x31)
- #define INT_GEN_1_SRC (0x31)
- #define INT1_TSH_XH (0x32)
- #define INT_GEN_1_THS (0x32)
- #define INT1_TSH_XL (0x33)
- #define INT_GEN_1_DURATION (0x33)
- #define INT1_TSH_YH (0x34)

- #define INT_GEN_2_REG (0x34)
- #define INT1_TSH_YL (0x35)
- #define INT_GEN_2_SRC (0x35)
- #define INT1_TSH_ZH (0x36)
- #define INT_GEN_2_THS (0x36)
- #define INT1_TSH_ZL (0x37)
- #define INT_GEN_2_DURATION (0x37)
- #define INT1_DURATION_G (0x38)
- #define CLICK_CFG (0x38)
- #define CLICK_SRC (0x39)
- #define CLICK_THS (0x3A)
- #define TIME_LIMIT (0x3B)
- #define TIME_LATENCY (0x3C)
- #define TIME_WINDOW (0x3D)
- #define Act_THS (0x3E)
- #define Act_DUR (0x3F)

Auxiliary Register

- #define Read (0x01)
- #define Write (0x00)
- #define Address_XM (0x3A)
- #define Address_G (0xD6)
- #define I2C_AUTO_INCREMENT (0x80)

CTRL_GYRO_REG1

- #define GYRO_OFF (0x00)
- #define GYRO_ON (0x08)
- #define ENABLE_ALL_AXES (0x07)
- #define X_ENABLE (0x02)
- #define Y_ENABLE (0x01)
- #define Z_ENABLE (0x04)
- #define BW00 (0x00)
- #define BW01 (0x10)
- #define BW10 (0x20)
- #define BW11 (0x30)
- #define G_ODR95 (0x00)
- #define G_ODR190 (0x40)
- #define G_ODR380 (0x80)
- #define G_ODR760 (0xC0)

CTRL_GYRO_REG2

- #define NORMAL_MODE_RR (0x00)
- #define RF_FILT (0x10)
- #define NORMAL_MODE (0x20)
- #define AUTORST_INT (0x30)
- #define HPCF_00 (0x00)
- #define HPCF_01 (0x01)
- #define HPCF_02 (0x02)
- #define HPCF_03 (0x03)
- #define HPCF_04 (0x04)

- #define HPCF_05 (0x05)
- #define HPCF_06 (0x06)
- #define HPCF_07 (0x07)
- #define HPCF_0A (0x0A)
- #define HPCF_0B (0x0B)

CTRL_GYRO_REG4

- #define FS_245_DPS (0x00)
- #define FS_500_DPS (0x10)
- #define FS_2000_DPS (0x20)
- #define LITTLE_ENDIAN (0x00)
- #define BIG_ENDIAN (0x40)
- #define BDU_G_ENABLE (0x80)

CTRL_XM_REG1

- #define CONTINUOUS_UPDATE (0x00)
- #define CONTINUOUS_UPDATE (0x00)
- #define ACC_OFF (0x00)
- #define A_ODR3_125 (0x10)
- #define A_ODR6_25 (0x20)
- #define A_ODR12_5 (0x30)
- #define A_ODR25 (0x40)
- #define A_ODR50 (0x50)
- #define A_ODR100 (0x60)
- #define A_ODR200 (0x70)
- #define A_ODR400 (0x80)
- #define A_ODR800 (0x90)
- #define A_ODR1600 (0xA0)
- #define BDU_A_ENABLE (0x08)

CTRL_XM_REG2

- #define ABW773 (0x00)
- #define ABW194 (0x40)
- #define ABW362 (0x80)
- #define ABW50 (0xC0)
- #define FS_2_G (0x00)
- #define FS_4_G (0x08)
- #define FS_6_G (0x10)
- #define FS_8_G (0x18)
- #define FS_16_G (0x20)

CTRL_XM_REG5

- #define HIGH_MAG_RES (0x60)
- #define LOW_MAG_RES (0x00)
- #define M_ODR3_125 (0x00)
- #define M_ODR6_25 (0x04)
- #define M_ODR12_5 (0x08)
- #define M_ODR25 (0x0C)
- #define M_ODR50 (0x10)
- #define M_ODR100 (0x14)
- #define TEMP_EN (0x80)

CTRL_XM_REG6

- #define FS_2_GAUSS (0x00)
- #define FS_4_GAUSS (0x20)
- #define FS_8_GAUSS (0x40)
- #define FS_16_GAUSS (0x60)

Registers Contents

- #define WHOAMI_LSM9DS0_GYRO (0xD4)
- #define WHOAMI_LSM9DS0_XM (0x49)

Sensitivity

- #define SENSITIVITY_ACC_2G 0.00006103515625
- #define SENSITIVITY_ACC_4G 0.0001220703125
- #define SENSITIVITY_ACC_8G 0.000244140625
- #define SENSITIVITY_ACC_16G 0.00048828125
- #define SENSITIVITY_MAG_2G 0.00006103515625
- #define SENSITIVITY_MAG_4G 0.0001220703125
- #define SENSITIVITY_MAG_8G 0.000244140625
- #define SENSITIVITY_MAG_12G 0.00036621
- #define SENSITIVITY_245DPS 0.0074768
- #define SENSITIVITY_500DPS 0.015258789
- #define SENSITIVITY_2000DPS 0.06103515625

7.2.1 Detailed Description

Basic driver for lsm9ds0. The module is included to the code in this documentation but it should be removed int the final release.

7.2.2 Macro Definition Documentation

7.2.2.1 #define A_ODR100 (0x60)

Output Data Rate (ODR) = 100Hz

7.2.2.2 #define A_ODR12_5 (0x30)

Output Data Rate (ODR) = 12.5Hz

7.2.2.3 #define A_ODR1600 (0xA0)

Output Data Rate (ODR) = 1200Hz

7.2.2.4 #define A_ODR200 (0x70)

Output Data Rate (ODR) = 200Hz

7.2.2.5 #define A_ODR25 (0x40)

Output Data Rate (ODR) = 25Hz

7.2.2.6 #define A_ODR3_125 (0x10)

Output Data Rate (ODR) = 3.125Hz

7.2.2.7 #define A_ODR400 (0x80)

Output Data Rate (ODR)= 400Hz

7.2.2.8 #define A_ODR50 (0x50)

Output Data Rate (ODR) = 50Hz

7.2.2.9 #define A_ODR6_25 (0x20)

Output Data Rate (ODR) = 6.25Hz

7.2.2.10 #define A_ODR800 (0x90)

Output Data Rate (ODR) = 800Hz

7.2.2.11 #define ABW194 (0x40)

Anti-alias filter Bw = 194Hz

7.2.2.12 #define ABW362 (0x80)

Anti-alias filter Bw = 362Hz

7.2.2.13 #define ABW50 (0xC0)

Anti-alias filter Bw = 50 Hz

7.2.2.14 #define ABW773 (0x00)

Anti-alias filter Bw = 773Hz

7.2.2.15 #define ACC_OFF (0x00)

Switch Acelerometer OFF

7.2.2.16 #define Act_DUR (0x3F)

Sleep To Wake, Return to Sleep Duration

7.2.2.17 #define Act_THS (0x3E)

Sleep To Wake, Return to Sleep Activation TRESHOULD

7.2.2.18 #define Address_G (0xD6)

SAO_G TO VDD

7.2.2.19 #define Address_XM (0x3A)

SAO_MX TO VDD

7.2.2.20 #define AUTORST_INT (0x30)

Autoreset on interrupt event

7.2.2.21 #define BDU_A_ENABLE (0x08)

Output registers not updated until MSb and LSb read

7.2.2.22 #define BDU_G_ENABLE (0x80)

Block data update. Output registers not updated until MSb and LSb read

7.2.2.23 #define BIG_ENDIAN (0x40)

Big Endian Output

7.2.2.24 #define BW00 (0x00)

Defines cut-off according to ODR

7.2.2.25 #define BW01 (0x10)

Defines cut-off according to ODR

7.2.2.26 #define BW10 (0x20)

Defines cut-off according to ODR

7.2.2.27 #define BW11 (0x30)

Defines cut-off according to ODR

7.2.2.28 #define CLICK_CFG (0x38)

CLICK INTERRUPT CONFIG

7.2.2.29 #define CLICK_SRC (0x39)

CLICK INTERRUPT SOURCE

7.2.2.30 #define CLICK_THS (0x3A)

CLICK INTERRUPT TRESHOULD

7.2.2.31 #define CONTINUOUS_UPDATE (0x00)

Continuous block update

7.2.2.32 #define CONTINUOUS_UPDATE (0x00)

Continuous block update

7.2.2.33 #define CTRL_REG0_XM (0x1F)

Control REG0 MAG AND ACC

7.2.2.34 #define CTRL_REG1_G (0x20)

Control REG1 GYRO

7.2.2.35 #define CTRL_REG1_XM (0x20)

Control REG1 MAG AND ACC

7.2.2.36 #define CTRL_REG2_G (0x21)

Control REG2 GYRO

7.2.2.37 #define CTRL_REG2_XM (0x21)

Control REG2 MAG AND ACC

7.2.2.38 #define CTRL_REG3_G (0x22)

Control REG3 GYRO

7.2.2.39 #define CTRL_REG3_XM (0x22)

Control REG3 MAG AND ACC

7.2.2.40 #define CTRL_REG4_G (0x23)

Control REG4 GYRO

7.2.2.41 #define CTRL_REG4_XM (0x23)

Control REG4 MAG AND ACC

7.2.2.42 #define CTRL_REG5_G (0x24)

Control REG5 GYRO

7.2.2.43 #define CTRL_REG5_XM (0x24)

Control REG5 MAG AND ACC

7.2.2.44 #define CTRL_REG6_XM (0x25)

Control REG6 MAG AND ACC

7.2.2.45 #define CTRL_REG7_XM (0x26)

Control REG7 MAG AND ACC

7.2.2.46 #define ENABLE_ALL_AXES (0x07)

Enable all Gyro axis

7.2.2.47 #define FIFO_CTRL_REG (0x2E)

FIFO CONTROL REGISTER

7.2.2.48 #define FIFO_SRC_REG (0x2F)

FIFO SOURCE REGISTER

7.2.2.49 #define FS_16_G (0x20)

16g Full-scale (Accelerometer)

7.2.2.50 #define FS_16_GAUSS (0x60)

16gauss Full-scale (Magnetometer)

7.2.2.51 #define FS_2000_DPS (0x20)

2000 dps Full-scale (Gyroscope)

7.2.2.52 #define FS_245_DPS (0x00)

245 dps Full-scale

7.2.2.53 #define FS_2_G (0x00)

2 g Full-scale

7.2.2.54 #define FS_2_GAUSS (0x00)

2 gauss Full-scale

7.2.2.55 #define FS_4_G (0x08)

4 g Full-scale

7.2.2.56 #define FS_4_GAUSS (0x20)

4 gauss Full-scale

7.2.2.57 #define FS_500_DPS (0x10)

500 dps Full-scale

7.2.2.58 #define FS_6_G (0x10)

6 g Full-scale

7.2.2.59 #define FS_8_G (0x18)

8 g Full-scale

7.2.2.60 #define FS_8_GAUSS (0x40)

8 gauss Full-scale

7.2.2.61 #define G_ODR190 (0x40)

Output Data Rate = 190Hz

7.2.2.62 #define G_ODR380 (0x80)

Output Data Rate = 380Hz

7.2.2.63 #define G_ODR760 (0xC0)

Output Data Rate = 760Hz

7.2.2.64 #define G_ODR95 (0x00)

Output Data Rate = 95Hz

7.2.2.65 #define GYRO_OFF (0x00)

Power-down mode

7.2.2.66 #define GYRO_ON (0x08)

Normal Power mode

7.2.2.67 #define HIGH_MAG_RES (0x60)

High magnetic resolution

7.2.2.68 #define HPCF_00 (0x00)

option 00 from table 7.2.2.167

7.2.2.69 #define HPCF_01 (0x01)

option 01 from table 7.2.2.167

7.2.2.70 #define HPCF_02 (0x02)

option 02 from table 7.2.2.167

7.2.2.71 #define HPCF_03 (0x03)

option 03 from table 7.2.2.167

7.2.2.72 #define HPCF_04 (0x04)

option 04 from table 7.2.2.167

7.2.2.73 #define HPCF_05 (0x05)

option 05 from table 7.2.2.167

7.2.2.74 #define HPCF_06 (0x06)

option 06 from table 7.2.2.167

7.2.2.75 #define HPCF_07 (0x07)

option 07 from table 7.2.2.167

7.2.2.76 #define HPCF_0A (0x0A)

option 0A from table 7.2.2.167

7.2.2.77 #define HPCF_0B (0x0B)

option 0B from table 7.2.2.167

7.2.2.78 #define I2C_AUTO_INCREMENT (0x80)

For multiple byte read

7.2.2.79 #define INT1_CFG_G (0x30)

INTERRUPT CONFIG REG GYRO

7.2.2.80 #define INT1_DURATION_G (0x38)

MINIMUM INTERRUPT DURATION TIME GYRO

7.2.2.81 #define INT1_SRC_G (0x31)

INTERRUPT SOURCE REG GYRO

7.2.2.82 #define INT1_TSH_XH (0x32)

INTERRUPT TRESHOULD HIGH X AXIS GYRO

7.2.2.83 #define INT1_TSH_XL (0x33)

INTERRUPT TRESHOULD LOW X AXIS GYRO

7.2.2.84 #define INT1_TSH_YH (0x34)

INTERRUPT TRESHOULD HIGH Y AXIS GYRO

7.2.2.85 #define INT1_TSH_YL (0x35)

INTERRUPT TRESHOULD LOW Y AXIS GYRO

7.2.2.86 #define INT1_TSH_ZH (0x36)

INTERRUPT TRESHOULD HIGH Z AXIS GYRO

7.2.2.87 #define INT1_TSH_ZL (0x37)

INTERRUPT TRESHOULD LOW Z AXIS GYRO

7.2.2.88 #define INT_CTRL_REG_M (0x12)

INTERRUPT CTRL REG MAG

7.2.2.89 #define INT_GEN_1_DURATION (0x33)

MINIMUM INTERRUPT DURATION TIME XM

7.2.2.90 #define INT_GEN_1_REG (0x30)

INTERRUPT CONFIG REG XM

7.2.2.91 #define INT_GEN_1_SRC (0x31)

INTERRUPT SOURCE REG XM

7.2.2.92 #define INT_GEN_1_THS (0x32)

INTERRUPT TRESHOULD ALL AXES XM

7.2.2.93 #define INT_GEN_2_DURATION (0x37)

MINIMUM INTERRUPT DURATION TIME XM

7.2.2.94 #define INT_GEN_2_REG (0x34)

INTERRUPT CONFIG REG XM

7.2.2.95 #define INT_GEN_2_SRC (0x35)

INTERRUPT SOURCE REG XM

7.2.2.96 #define INT_GEN_2_THS (0x36)

INTERRUPT TRESHOULD ALL AXES XM

7.2.2.97 #define INT_SRC_REG_M (0x13)

INTERRUPT SOURCE REG MAG

7.2.2.98 #define INT_THS_H_M (0x15)

INTERRUPT TSH REG MAG

7.2.2.99 #define INT_THS_L_M (0x14)

INTERRUPT TSH REG MAG

7.2.2.100 #define LITTLE_ENDIAN (0x00)

Little Endian Output

7.2.2.101 #define LOW_MAG_RES (0x00)

Low magnetic resolution

7.2.2.102 #define M_ODR100 (0x14)

ODR = 100Hz

7.2.2.103 #define M_ODR12_5 (0x08)

ODR = 12.5Hz

7.2.2.104 #define M_ODR25 (0x0C)

ODR = 25Hz

7.2.2.105 #define M_ODR3_125 (0x00)

ODR = 3.125Hz

7.2.2.106 #define M_ODR50 (0x10)

ODR = 50Hz

7.2.2.107 #define M_ODR6_25 (0x04)

ODR = 6.25Hz

7.2.2.108 #define NORMAL_MODE (0x20)

Normal mode

7.2.2.109 #define NORMAL_MODE_RR (0x00)

Normal mode (reset reading HP_RESET_FILTER

7.2.2.110 #define OFFSET_X_H_M (0x17)

X AXIS OFFSET MSB REG MAG

7.2.2.111 #define OFFSET_X_L_M (0x16)

X AXIS OFFSET LSB REG MAG

7.2.2.112 #define OFFSET_Y_H_M (0x19)

Y AXIS OFFSET MSB REG MAG

7.2.2.113 #define OFFSET_Y_L_M (0x18)

Y AXIS OFFSET LSB REG MAG

7.2.2.114 #define OFFSET_Z_H_M (0x1B)

Z AXIS OFFSET MSB REG MAG

7.2.2.115 #define OFFSET_Z_L_M (0x1A)

Z AXIS OFFSET LSB REG MAG

7.2.2.116 #define OUT_TEMP_H_XM (0x06)

TEMPERATURE OUT MSB REGISTER

7.2.2.117 #define OUT_TEMP_L_XM (0x05)

TEMPERATURE OUT LSB REGISTER

7.2.2.118 #define OUT_X_H_A (0x29)

X AXIS OUT MSB REG ACC

7.2.2.119 #define OUT_X_H_G (0x29)

X AXIS OUT MSB REG GYRO

7.2.2.120 #define OUT_X_H_M (0x09)

X AXIS OUT MSB REG MAG

7.2.2.121 #define OUT_X_L_A (0x28)

X AXIS OUT LSB REG ACC

7.2.2.122 #define OUT_X_L_G (0x28)

X AXIS OUT LSB REG GYRO

7.2.2.123 #define OUT_X_L_M (0x08)

X AXIS OUT LSB REG MAG

7.2.2.124 #define OUT_Y_H_A (0x2B)

Y AXIS OUT MSB REG ACC

7.2.2.125 #define OUT_Y_H_G (0x2B)

Y AXIS OUT MSB REG GYRO

7.2.2.126 #define OUT_Y_H_M (0x0B)

Y AXIS OUT MSB REG MAG

7.2.2.127 #define OUT_Y_L_A (0x2A)

Y AXIS OUT LSB REG ACC

7.2.2.128 #define OUT_Y_L_G (0x2A)

Y AXIS OUT LSB REG GYRO

7.2.2.129 #define OUT_Y_L_M (0x0A)

Y AXIS OUT LSB REG MAG

7.2.2.130 #define OUT_Z_H_A (0x2D)

Z AXIS OUT MSB REG ACC

7.2.2.131 #define OUT_Z_H_G (0x2D)

Z AXIS OUT MSB REG GYRO

7.2.2.132 #define OUT_Z_H_M (0x0D)

Z AXIS OUT MSB REG MAG

7.2.2.133 #define OUT_Z_L_A (0x2C)

Z AXIS OUT LSB REG ACC

7.2.2.134 #define OUT_Z_L_G (0x2C)

Z AXIS OUT LSB REG GYRO

7.2.2.135 #define OUT_Z_L_M (0x0C)

Z AXIS OUT LSB REG MAG

7.2.2.136 #define Read (0x01)

Mask for Read

7.2.2.137 #define REFERENCE_G (0x25)

REFERENCE REG GYRO

7.2.2.138 #define REFERENCE_X (0x1C)

REF X AXIS

7.2.2.139 #define REFERENCE_Y (0x1D)

REF Y AXIS

7.2.2.140 #define REFERENCE_Z (0x1E)

REF Z AXIS

7.2.2.141 #define RF_FILT (0x10)

Reference signal for filtering

7.2.2.142 #define SENSITIVITY_2000DPS 0.06103515625

dps/LSB

7.2.2.143 #define SENSITIVITY_245DPS 0.0074768

dps/LSB

7.2.2.144 #define SENSITIVITY_500DPS 0.015258789

dps/LSB

7.2.2.145 #define SENSITIVITY_ACC_16G 0.00048828125

g/LSB

7.2.2.146 #define SENSITIVITY_ACC_2G 0.00006103515625

g/LSB

7.2.2.147 #define SENSITIVITY_ACC_4G 0.0001220703125

g/LSB

7.2.2.148 #define SENSITIVITY_ACC_8G 0.000244140625

g/LSB

7.2.2.149 #define SENSITIVITY_MAG_12G 0.00036621

gauss/LSB

7.2.2.150 #define SENSITIVITY_MAG_2G 0.00006103515625

gauss/LSB

7.2.2.151 #define SENSITIVITY_MAG_4G 0.0001220703125

gauss/LSB

7.2.2.152 #define SENSITIVITY_MAG_8G 0.000244140625

gauss/LSB

7.2.2.153 #define STATUS_REG_A (0x27)

STATUS REG ACC

7.2.2.154 #define STATUS_REG_G (0x27)

STATUS REG GYRO

7.2.2.155 #define STATUS_REG_M (0x07)

STATUS MAGNETOMETER

7.2.2.156 #define TEMP_EN (0x80)

Temperature sensor enable

7.2.2.157 #define TIME_LATENCY (0x3C)

TIME LATENCY REG

7.2.2.158 #define TIME_LIMIT (0x3B)

TIME LIMIT REG

7.2.2.159 #define TIME_WINDOW (0x3D)

TIME WINDOW REG

7.2.2.160 #define WHO_AM_I_G (0x0F)

WHO AM I GYRO

7.2.2.161 #define WHO_AM_I_XM (0x0F)

WHO AM I MAG AND ACC

7.2.2.162 #define WHOAMI_LSM9DS0_GYRO (0xD4)

Expected content for WAI register

7.2.2.163 #define WHOAMI_LSM9DS0_XM (0x49)

Expected content for WAI register

7.2.2.164 #define Write (0x00)

Mask for Write

7.2.2.165 #define X_ENABLE (0x02)

Enable X Gyro axis

7.2.2.166 #define Y_ENABLE (0x01)

Enable Y Gyro axis

7.2.2.167 #define Z_ENABLE (0x04)

Enable Z Gyro axis

7.2.2.168 Gyroscope HighPassFilter Cutoff Frequency Table

Defines gyroscope HighPassFilter Cutoff Frequency according to ODR

HPCF \ ODR	95 Hz	190Hz	380Hz	720Hz
opt. 00	7.2	13.5	27	51.4
opt. 01	3.5	7.2	13.5	27
opt. 02	1.8	3.5	7.2	13.5
opt. 03	0.9	1.8	3.5	7.2
opt. 04	0.45	0.9	1.8	3.5
opt. 05	0.18	0.45	0.9	1.8
opt. 06	0.09	0.18	0.45	0.9
opt. 07	0.045	0.09	0.18	0.45
opt. 0A	0.018	0.045	0.09	0.18
opt. 0B	0.009	0.018	0.045	0.09

7.2.3 Function Documentation

7.2.3.1 void AccEnableConfig (char *command1,* char *command2*)

Enable and Configure Acc sensor.

Parameters

in	*command1*	Configures CTRL_XM_REG1. Command1 : ACC_OFF - OFF A_ODR3_125 - Acelerometer Data Rate = 3.125Hz A_ODR6_25 - ODR = 6.25Hz A_ODR12_5 - ODR = 12.5Hz A_ODR25 - ODR = 25Hz A_ODR50 - ODR = 50Hz A_ODR100 - ODR = 100Hz A_ODR200 - ODR = 200Hz A_ODR400 - ODR = 400Hz A_ODR800 - ODR = 800Hz A_ODR1600 - ODR = 1600Hz CONTINUOUS_UPDATE - Continuous block update BDU_A_ENABLE - Output registers not updated until MSb and LSb read ENABLE_ALL_AXES - Enable all Acc axis X_ENABLE - Enable X Acc axis Y_ENABLE - Enable Y Acc axis Z_ENABLE - Enable Z Acc axis –> OR condition between command type
in	*command2*	Configures CTRL_XM_REG2. Command2 : FS_2_G - Set 2 g Full-scale FS_4_G - Set 4 g Full-scale FS_6_G - Set 6 g Full-scale FS_8_G - Set 8 g Full-scale FS_16_G - Set 16g Full-scale –> Just one option at the moment

7.2.3.2 void GetAccMagAddr (void)

Get XM module Address.

Returns

uint_8 Address.

7.2.3.3 void GetGyroAddr (void)

Get Gyro module Address.

Returns

uint_8 Address.

7.2.3.4 void GyroConfig (char *command*)

Configure Gyro sensor.

Parameters

in	*command*	Configures CTRL_GYRO_REG4. Command : FS_245_DPS - Set 245 dps Full-scale FS_500_DPS - Set 500 dps Full-scale FS_2000_DPS - Set 2000 dps Full-scale LITTLE_ENDIAN - Little Endian Data Output BIG_ENDIAN - Big Endian Data Output CONTINUOUS_UPDATE - Continuous Block Update BDU_G_ENABLE - Output registers not updated until MSb and LSb read –> OR condition between command type

7.2.3.5 void GyroEnable (char *command*)

Enable Gyro sensor.

Parameters

in	*command*	Configures CTRL_GYRO_REG1. Command1 : GYRO_OFF - Turn-off gyro module GYRO_ON - Normal Power mode ENABLE_ALL_AXES - Enable all Gyro axis X_ENABLE - Enable X Gyro axis Y_ENABLE - Enable Y Gyro axis Z_ENABLE - Enable Z Gyro axis BW00 - Defines cut-off according to ODR (See Datasheet) BW01 - Defines cut-off according to ODR BW10 - Defines cut-off according to ODR BW11 - Defines cut-off according to ODR G_ODR095 - ODR = 95Hz G_ODR190 - ODR = 190Hz G_ODR380 - ODR = 380Hz G_ODR760 - ODR = 760Hz -> OR condition between command type

7.2.3.6 void MagEnableConfig (char *command1*, char *command2*)

Enable and Configure Mag sensor.

Parameters

in	*command1*	Configures CTRL_XM_REG5. Command1 : M_ODR3_125 - Magnetometer Data Rate = 3.125Hz M_ODR6_25 - ODR = 6.25Hz M_ODR12_5 - ODR = 12.5Hz M_ODR25 - ODR = 25Hz M_ODR50 - ODR = 50Hz M_ODR100 - ODR = 100Hz Only if Accelerometer ODR>50Hz HIGH_MAG_RES - High magnetic resolution LOW_MAG_RES - Low magnetic resolution TEMP_EN - Enable Temperature sensor –> OR condition between command type
in	*command2*	Configures CTRL_XM_REG6. Command2 : FS_2_GAUSS - Set 2 gauss Full-scale FS_4_GAUSS - Set 4 gauss Full-scale FS_8_GAUSS - Set 6 gauss Full-scale FS_16_GAUSS - Set 16gauss Full-scale –> Just one option at the moment

7.2.3.7 void ReadAccRaw (sensor_xyz * *raw*)

Read accelerometer raw data.

Parameters

[in/out]	struct sensor_xyz pointer (type short (16bits)).

7.2.3.8 void ReadGyroRaw (sensor_xyz * *raw*)

Read gyro raw data.

Parameters

[in/out]	struct sensor_xyz pointer (type short (16bits)).

7.2.3.9 void ReadMagRaw (sensor_xyz * *raw*)

Read magnetometer raw data.

Parameters

[in/out]	struct sensor_xyz pointer (type short (16bits)).

7.2.3.10 void ReadTemp (short * *temperature*)

Read temperature raw data.

Parameters

[in/out]	temperature pointer (type short (16bits)).

7.3 MARG driver

Basic driver for data treatement.

Files

- file marg.h

Data Structures

- struct data_xyz

Functions

- void ReadGyroXYZ (data_xyz *data)

  Read gyroscope removing offsets.
- void ReadAccXYZ (data_xyz *data)

  Read accelerometer compensating distortion and removing offsets if using calibration matrix.
- void ReadMagXYZ (data_xyz *data)

  Read magnetometer compensating distortion and removing offsets if using calibration matrix.
- void InitMARG (void)

  Inicialization of the MARG with default values.
- void AutoCalibrateAcc (void)

  Takes a number off readings to calculate accelerometer offsets.
- void AutoCalibrateGyro (void)

  Takes a number off readings to calculate gyroscope offsets.
- void UpdateGyroBias (void)

  Can be used to ajust gyroscope offsets with time.
- void UpdateAccBias (void)

  Can be used to ajust accelerometer offsets with time.

Variables

- float gyro_offsets [3]
- float acc_offsets [3]
- float acc_cal_matrix [3][3]
- float mag_offsets [3]
- float mag_cal_matrix [3][3]

7.3.1 Detailed Description

Basic driver for data treatement.

7.3.2 Function Documentation

7.3.2.1 void InitMARG (void)

Inicialization of the MARG with default values.

By default:

For magnetometer inicialization:

TEMP_EN - Enables temperature module

HIGH_MAG_RES - High magnetic resolution

M_ODR100 - ODR = 100Hz

FS_2_GAUSS - 2 gauss Full-scale

For accelerometer inicialization:

CONTINUOUS_UPDATE - Continuous block update

ENABLE_ALL_AXES - Enable all Acc axis

A_ODR100 - ODR = 100Hz

ABW362 - Anti-alias filter Bw = 362Hz

FS_4_G - 4 g Full-scale

For gyroscope inicialization:

G_ODR190 - ODR = 190Hz

BW10 - Defines cut-off according to ODR

GYRO_ON - Normal Power mode

ENABLE_ALL_AXES - Enable all Gyro axis

FS_500_DPS - 500 dps Full-scale

LITTLE_ENDIAN - Little Endian Data Output

CONTINUOUS_UPDATE - Continuous Block Update

7.3.2.2 void ReadAccXYZ (data_xyz * *data*)

Read accelerometer compensating distortion and removing offsets if using calibration matrix.

Parameters

[in/out]	struct data_xyz pointer (type float (32bits)).

7.3.2.3 void ReadGyroXYZ (data_xyz * *data*)

Read gyroscope removing offsets.

Parameters

[in/out]	struct data_xyz pointer (type float (32bits)).

7.3.2.4 void ReadMagXYZ (data_xyz * *data*)

Read magnetometer compensating distortion and removing offsets if using calibration matrix.

Parameters

[in/out]	struct data_xyz pointer (type float (32bits)).

7.3.2.5 void UpdateAccBias (void)

Can be used to ajust accelerometer offsets with time.

Use carefully, you have to guarantee that the acc is stationary and z axis is pointing down to update mean

7.3.2.6 void UpdateGyroBias (void)

Can be used to ajust gyroscope offsets with time.

Use carefully, you have to guarantee that the gyro is stationary to update mean

7.3.3 Variable Documentation

7.3.3.1 float acc_cal_matrix[3][3]

Calibration matrix for the accelerometer.

7.3.3.2 float acc_offsets[3]

Saves accelerometer offsets in a vector ([0,1,2]=[x,y,z]).

7.3.3.3 float gyro_offsets[3]

Saves gyroscope offsets in a vector ([0,1,2]=[x,y,z]).

7.3.3.4 float mag_cal_matrix[3][3]

Calibration matrix for the magnetometer.

7.3.3.5 float mag_offsets[3]

Saves magnetometer offsets in a vector ([0,1,2]=[x,y,z]).

7.4 UART Communications

Sends data out.

Default UART configurations

UART Configuration	values
Baudrate	115200
Number of bits	8
Parity	NO
Stop bits	1

Chapter 8

Data Structure Documentation

8.1 data_xyz Struct Reference

`#include <marg.h>`

Data Fields

- float x

  x-axis treated data.
- float y

  y-axis treadted data.
- float z

  z-axis treated data.

8.1.1 Detailed Description

Saves calibrated data for all axis.

The documentation for this struct was generated from the following file:

- marg.h

8.2 sensor_xyz Struct Reference

`#include <lsm9ds0.h>`

Data Fields

- short x

  x-axis data.
- short y

  y-axis data.
- short z

  z-axis data.

8.2.1 Detailed Description

Saves Raw data from sensors.

The documentation for this struct was generated from the following file:

- lsm9ds0.h

Chapter 9

File Documentation

9.1 lsm9ds0.h File Reference

```
#include <plib.h>
```

Data Structures

- struct sensor_xyz

Macros

LSM9DS0 Register

- #define OUT_TEMP_L_XM (0x05)
- #define OUT_TEMP_H_XM (0x06)
- #define STATUS_REG_M (0x07)
- #define OUT_X_L_M (0x08)
- #define OUT_X_H_M (0x09)
- #define OUT_Y_L_M (0x0A)
- #define OUT_Y_H_M (0x0B)
- #define OUT_Z_L_M (0x0C)
- #define OUT_Z_H_M (0x0D)
- #define WHO_AM_I_G (0x0F)
- #define WHO_AM_I_XM (0x0F)
- #define INT_CTRL_REG_M (0x12)
- #define INT_SRC_REG_M (0x13)
- #define INT_THS_L_M (0x14)
- #define INT_THS_H_M (0x15)
- #define OFFSET_X_L_M (0x16)
- #define OFFSET_X_H_M (0x17)
- #define OFFSET_Y_L_M (0x18)
- #define OFFSET_Y_H_M (0x19)
- #define OFFSET_Z_L_M (0x1A)
- #define OFFSET_Z_H_M (0x1B)
- #define REFERENCE_X (0x1C)
- #define REFERENCE_Y (0x1D)
- #define REFERENCE_Z (0x1E)
- #define CTRL_REG0_XM (0x1F)
- #define CTRL_REG1_XM (0x20)
- #define CTRL_REG1_G (0x20)
- #define CTRL_REG2_XM (0x21)
- #define CTRL_REG2_G (0x21)
- #define CTRL_REG3_XM (0x22)

- #define CTRL_REG3_G (0x22)
- #define CTRL_REG4_XM (0x23)
- #define CTRL_REG4_G (0x23)
- #define CTRL_REG5_XM (0x24)
- #define CTRL_REG5_G (0x24)
- #define CTRL_REG6_XM (0x25)
- #define REFERENCE_G (0x25)
- #define CTRL_REG7_XM (0x26)
- #define STATUS_REG_G (0x27)
- #define STATUS_REG_A (0x27)
- #define OUT_X_L_G (0x28)
- #define OUT_X_L_A (0x28)
- #define OUT_X_H_G (0x29)
- #define OUT_X_H_A (0x29)
- #define OUT_Y_L_G (0x2A)
- #define OUT_Y_L_A (0x2A)
- #define OUT_Y_H_G (0x2B)
- #define OUT_Y_H_A (0x2B)
- #define OUT_Z_L_G (0x2C)
- #define OUT_Z_L_A (0x2C)
- #define OUT_Z_H_G (0x2D)
- #define OUT_Z_H_A (0x2D)
- #define FIFO_CTRL_REG (0x2E)
- #define FIFO_SRC_REG (0x2F)
- #define INT1_CFG_G (0x30)
- #define INT_GEN_1_REG (0x30)
- #define INT1_SRC_G (0x31)
- #define INT_GEN_1_SRC (0x31)
- #define INT1_TSH_XH (0x32)
- #define INT_GEN_1_THS (0x32)
- #define INT1_TSH_XL (0x33)
- #define INT_GEN_1_DURATION (0x33)
- #define INT1_TSH_YH (0x34)
- #define INT_GEN_2_REG (0x34)
- #define INT1_TSH_YL (0x35)
- #define INT_GEN_2_SRC (0x35)
- #define INT1_TSH_ZH (0x36)
- #define INT_GEN_2_THS (0x36)
- #define INT1_TSH_ZL (0x37)
- #define INT_GEN_2_DURATION (0x37)
- #define INT1_DURATION_G (0x38)
- #define CLICK_CFG (0x38)
- #define CLICK_SRC (0x39)
- #define CLICK_THS (0x3A)
- #define TIME_LIMIT (0x3B)
- #define TIME_LATENCY (0x3C)
- #define TIME_WINDOW (0x3D)
- #define Act_THS (0x3E)
- #define Act_DUR (0x3F)

Auxiliary Register

- #define Read (0x01)
- #define Write (0x00)
- #define Address_XM (0x3A)
- #define Address_G (0xD6)
- #define I2C_AUTO_INCREMENT (0x80)

CTRL_GYRO_REG1

- #define GYRO_OFF (0x00)
- #define GYRO_ON (0x08)
- #define ENABLE_ALL_AXES (0x07)
- #define X_ENABLE (0x02)

- #define Y_ENABLE (0x01)
- #define Z_ENABLE (0x04)
- #define BW00 (0x00)
- #define BW01 (0x10)
- #define BW10 (0x20)
- #define BW11 (0x30)
- #define G_ODR95 (0x00)
- #define G_ODR190 (0x40)
- #define G_ODR380 (0x80)
- #define G_ODR760 (0xC0)

CTRL_GYRO_REG2

- #define NORMAL_MODE_RR (0x00)
- #define RF_FILT (0x10)
- #define NORMAL_MODE (0x20)
- #define AUTORST_INT (0x30)
- #define HPCF_00 (0x00)
- #define HPCF_01 (0x01)
- #define HPCF_02 (0x02)
- #define HPCF_03 (0x03)
- #define HPCF_04 (0x04)
- #define HPCF_05 (0x05)
- #define HPCF_06 (0x06)
- #define HPCF_07 (0x07)
- #define HPCF_0A (0x0A)
- #define HPCF_0B (0x0B)

CTRL_GYRO_REG4

- #define FS_245_DPS (0x00)
- #define FS_500_DPS (0x10)
- #define FS_2000_DPS (0x20)
- #define LITTLE_ENDIAN (0x00)
- #define BIG_ENDIAN (0x40)
- #define BDU_G_ENABLE (0x80)

CTRL_XM_REG1

- #define CONTINUOUS_UPDATE (0x00)
- #define ACC_OFF (0x00)
- #define A_ODR3_125 (0x10)
- #define A_ODR6_25 (0x20)
- #define A_ODR12_5 (0x30)
- #define A_ODR25 (0x40)
- #define A_ODR50 (0x50)
- #define A_ODR100 (0x60)
- #define A_ODR200 (0x70)
- #define A_ODR400 (0x80)
- #define A_ODR800 (0x90)
- #define A_ODR1600 (0xA0)
- #define CONTINUOUS_UPDATE (0x00)
- #define BDU_A_ENABLE (0x08)

CTRL_XM_REG2

- #define ABW773 (0x00)
- #define ABW194 (0x40)
- #define ABW362 (0x80)
- #define ABW50 (0xC0)
- #define FS_2_G (0x00)
- #define FS_4_G (0x08)
- #define FS_6_G (0x10)

- #define FS_8_G (0x18)
- #define FS_16_G (0x20)

CTRL_XM_REG5

- #define HIGH_MAG_RES (0x60)
- #define LOW_MAG_RES (0x00)
- #define M_ODR3_125 (0x00)
- #define M_ODR6_25 (0x04)
- #define M_ODR12_5 (0x08)
- #define M_ODR25 (0x0C)
- #define M_ODR50 (0x10)
- #define M_ODR100 (0x14)
- #define TEMP_EN (0x80)

CTRL_XM_REG6

- #define FS_2_GAUSS (0x00)
- #define FS_4_GAUSS (0x20)
- #define FS_8_GAUSS (0x40)
- #define FS_16_GAUSS (0x60)

Registers Contents

- #define WHOAMI_LSM9DS0_GYRO (0xD4)
- #define WHOAMI_LSM9DS0_XM (0x49)

Sensitivity

- #define SENSITIVITY_ACC_2G 0.00006103515625
- #define SENSITIVITY_ACC_4G 0.0001220703125
- #define SENSITIVITY_ACC_8G 0.000244140625
- #define SENSITIVITY_ACC_16G 0.00048828125
- #define SENSITIVITY_MAG_2G 0.00006103515625
- #define SENSITIVITY_MAG_4G 0.0001220703125
- #define SENSITIVITY_MAG_8G 0.000244140625
- #define SENSITIVITY_MAG_12G 0.00036621
- #define SENSITIVITY_245DPS 0.0074768
- #define SENSITIVITY_500DPS 0.015258789
- #define SENSITIVITY_2000DPS 0.06103515625

Functions

- void ReadGyroRaw (sensor_xyz *raw)

  Read gyro raw data.
- void ReadAccRaw (sensor_xyz *raw)

  Read accelerometer raw data.
- void ReadMagRaw (sensor_xyz *raw)

  Read magnetometer raw data.
- void ReadTemp (short *temperature)

  Read temperature raw data.
- void GyroEnable (char command)

  Enable Gyro sensor.
- void GyroConfig (char command)

  Configure Gyro sensor.
- void AccEnableConfig (char command1, char command2)

  Enable and Configure Acc sensor.

- void MagEnableConfig (char command1, char command2)

  Enable and Configure Mag sensor.
- UINT8 GetGyroAddr (void)

  Get Gyro module Address.
- UINT8 GetAccMagAddr (void)

  Get XM module Address.

Variables

- UINT8 buff [2]

  Auxiliary buffer.

9.1.1 Detailed Description

Author

Miguel Rasteiro

Version

Version 1.0 Release 1

License

License

Date

Created on: 29 de January de 2014, 10:14 .C
Change History:

VERSION	DATE	AUTHORS	DESCRIPTION
1.0	29/1/2014	MR	First Release

9.2 main.c File Reference

```
#include <p32xxxx.h>
#include <plib.h>
#include "lsm9ds0.h"
#include "marg.h"
#include "uart.h"
```

Functions

- void InitUART (void)

  Inicialize UART.
- void InitTimer1 (void)

  Inicialize Timer 1 to measure sampling time.
- void __ISR (TIMER_1_INT_VECTOR, ipl2)
- int **main** (void)

Variables

- UINT8 **T1overflow** = 1
- float **acc_offsets** [3] = {0, 0, 0}
- float **acc_cal_matrix** [3][3]
- float **gyro_offsets** [3] = {0,0,0}
- float **mag_offsets** [3] = {0, 0, 0}
- float **mag_cal_matrix** [3][3]

9.2.1 Detailed Description

Author

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Version

1.0

License

License

Date

Created on 29 January 2014, 10:14

9.3 marg.h File Reference

Data Structures

- struct data_xyz

Functions

- void ReadGyroXYZ (data_xyz *data)

  Read gyroscope removing offsets.
- void ReadAccXYZ (data_xyz *data)

  Read accelerometer compensating distortion and removing offsets if using calibration matrix.
- void ReadMagXYZ (data_xyz *data)

  Read magnetometer compensating distortion and removing offsets if using calibration matrix.
- void InitMARG (void)

  Inicialization of the MARG with default values.
- void AutoCalibrateAcc (void)

  Takes a number off readings to calculate accelerometer offsets.
- void AutoCalibrateGyro (void)

  Takes a number off readings to calculate gyroscope offsets.
- void UpdateGyroBias (void)

  Can be used to ajust gyroscope offsets with time.
- void UpdateAccBias (void)

  Can be used to ajust accelerometer offsets with time.

Variables

- float gyro_offsets [3]
- float acc_offsets [3]
- float acc_cal_matrix [3][3]
- float mag_offsets [3]
- float mag_cal_matrix [3][3]

9.3.1 Detailed Description

Author

Miguel Rasteiro

Version

Version 1.0 Release 1

License

License

Date

Created on: 1 de February de 2014, 21:14
Change History:

VERSION	DATE	AUTHORS	DESCRIPTION
1.0	1/2/2014	MR	First Release

9.4 uart.h File Reference

9.4.1 Detailed Description

Author

Microchip Technology Inc.

Brief

Modified example from https://www.microchip.com/CodeExamplesByFunc.aspx

Date

1 de February de 2014, 21:14

License

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