InvenSense Inc.
1197 Borregas Ave, Sunnyvale, CA 94089 U.S.A.
Tel: +1 (408) 988-7339 Fax: +1 (408) 988-8104
Website: www.invensense.com

Document Number: RM-ITG-3200A-00
Revision: 1.0
Release Date: 06/06/2011

ITG-3200
Register Map & Register Descriptions
Revision 1.0

CONTENTS

1 DOCUMENT INFORMATION 3

1.1 REVISION HISTORY 3
1.2 PURPOSE AND SCOPE 4
1.3 PRODUCT OVERVIEW 4
1.4 SOFTWARE SOLUTIONS 4

2 REGISTER MAP 6

3 REGISTER DESCRIPTION 7

3.1 REGISTER 0 – WHO AM I 7
3.2 REGISTER 21 – SAMPLE RATE DIVIDER 7
3.3 REGISTER 22 – DLPF, FULL SCALE 8
3.4 REGISTER 23 – INTERRUPT CONFIGURATION 10
3.5 REGISTER 26 – INTERRUPT STATUS 10
3.6 REGISTERS 27 TO 34 – SENSOR REGISTERS 11
3.7 REGISTER 62 – POWER MANAGEMENT 11

1 Document Information

1.1 Revision History

Revision Date	Revision	Description
06/06/11	1.0	Initial Release Separated Register Map and Register Descriptions from Product Spec Sec. 3.1 Clarified bit0

1.2 Purpose and Scope

This document provides information regarding the register map and register descriptions for the ITG-3200™.

1.3 Product Overview

The ITG-3200 is the world's first single-chip, digital-output, 3-axis MEMS gyro IC optimized for gaming, 3D mice, and 3D remote control applications. The part features enhanced bias and sensitivity temperature stability, reducing the need for user calibration. Low frequency noise is lower than previous generation devices, simplifying application development and making for more-responsive remote controls.

The ITG-3200 features three 16-bit analog-to-digital converters (ADCs) for digitizing the gyro outputs, a user-selectable internal low-pass filter bandwidth, and a Fast-Mode I^2C (400kHz) interface. Additional features include an embedded temperature sensor and a 2% accurate internal oscillator. This breakthrough in gyroscope technology provides a dramatic 67% package size reduction, delivers a 50% power reduction, and has inherent cost advantages compared to competing multi-chip gyro solutions.

By leveraging its patented and volume-proven Nasiri-Fabrication platform, which integrates MEMS wafers with companion CMOS electronics through wafer-level bonding, InvenSense has driven the ITG-3200 package size down to a revolutionary footprint of 4x4x0.9mm (QFN), while providing the highest performance, lowest noise, and the lowest cost semiconductor packaging required for handheld consumer electronic devices. The part features a robust 10,000*g* shock tolerance, as required by portable consumer equipment.

For power supply flexibility, the ITG-3200 has a separate VLOGIC reference pin, in addition to its analog supply pin, VDD, which sets the logic levels of its I^2C interface. The VLOGIC voltage may be anywhere from 1.71V min to VDD max.

1.4 Software Solutions

This section describes the MotionApps™ software solutions included with the InvenSense MPU™ (MotionProcessing Unit™) and IMU (Inertial Measurement Unit) product families. Please note that the products within the IDG, IXZ, and ITG families do not include these software solutions.

The MotionApps Platform is a complete software solution that in combination with the InvenSense IMU and MPU MotionProcessor™ families delivers robust, well-calibrated 6-axis and/or 9-axis sensor fusion data using its field proven and proprietary MotionFusion™ engine. Solution packages are available for smartphones and tablets as well as for embedded microcontroller-based devices.

The MotionApps Platform provides a turn-key solution for developers and accelerates time-to-market. It consists of complex 6/9-axis sensor fusion algorithms, robust multi-sensor calibration, a proven software architecture for Android and other leading operating systems, and a flexible power management scheme.

The MotionApps Platform is integrated within the middleware of the target OS (the sensor framework), and also provides a kernel device driver to interface with the physical device. This directly benefits application developers by providing a cohesive set of APIs and a well-defined sensor data path in the user-space.

The table below describes the MotionApps software solutions included with the InvenSense MPU and IMU product families.

InvenSense MotionProcessor Devices and Included MotionApps Software

Feature	Included Software				Notes
	MotionApps	Embedded MotionApps	MotionApps Lite	Embedded MotionApps Lite	
Part Number	MPU-3050™ MPU-6050™		IMU-3000™		
Processor Type	Mobile Application Processor	8/16/32-bit Microcontroller	Mobile Application Processor	8/16/32-bit Microcontroller	
Applications	Smartphones, tablets	TV remotes, health/fitness, toys, other embedded	Smartphones, tablets	TV remotes, health/fitness, toys, other embedded	
6-Axis MotionFusion	Yes		Yes		< 2% Application Processor load using on-chip Digital Motion Processor (DMP). Reduces processing requirements for embedded applications
9-Axis MotionFusion	Yes		No		
Gyro Bias Calibration	Yes		Yes		No-Motion calibration and temperature calibration
3rd Party Compass Cal API	Yes		No		Integrates 3rd party compass libraries
Gyro-Assisted Compass Calibration (Fast Heading)	Yes		No		Quick compass calibration using gyroscope
Magnetic Anomaly Rejection (Improved Heading)	Yes		No		Uses gyro heading data when magnetic anomaly is detected

The table below lists recommended documentation for the MotionApps software solutions.

Software Documentation

Platform	MotionApps and MotionApps Lite	Embedded MotionApps and Embedded MotionApps Lite
Software Documentation	• Installation Guide for Linux and Android MotionApps Platform, v1.9 or later • MPL Functional Specifications	• Embedded MotionApps Platform User Guide, v3.0 or later • Embedded MPL Functional Specifications

For more information about the InvenSense MotionApps Platform, please visit the Developer's Corner or consult your local InvenSense Sales Representative.

2 Register Map

Addr Hex	Addr Decimal	Register Name	R/W	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	0	WHO_AM_I	R/W	-	ID						-
15	21	SMPLRT_DIV	R/W	SMPLRT_DIV							
16	22	DLPF_FS	R/W	-	-	-	FS_SEL		DLPF_CFG		
17	23	INT_CFG	R/W	ACTL	OPEN	LATCH_ INT_EN	INT_ ANYRD_ 2CLEAR	-	ITG_RDY _EN	-	RAW_ RDY _ EN
1A	26	INT_STATUS	R	-	-	-	-	-	ITG_RDY	-	RAW_ DATA_ RDY
1B	27	TEMP_OUT_H	R	TEMP_OUT_H							
1C	28	TEMP_OUT_L	R	TEMP_OUT_L							
1D	29	GYRO_XOUT_H	R	GYRO_XOUT_H							
1E	30	GYRO_XOUT_L	R	GYRO_XOUT_L							
1F	31	GYRO_YOUT_H	R	GYRO_YOUT_H							
20	32	GYRO_YOUT_L	R	GYRO_YOUT_L							
21	33	GYRO_ZOUT_H	R	GYRO_ZOUT_H							
22	34	GYRO_ZOUT_L	R	GYRO_ZOUT_L							
3E	62	PWR_MGM	R/W	H_RESET	SLEEP	STBY_XG	STBY_YG	STBY_ZG	CLK_SEL		

3 Register Description

This section details each register within the InvenSense ITG-3200 gyroscope. Note that any bit that is not defined should be set to zero in order to be compatible with future InvenSense devices.

The register space allows single-byte reads and writes, as well as burst reads and writes. When performing burst reads or writes, the memory pointer will increment until either (1) reading or writing is terminated by the master, or (2) the memory pointer reaches certain reserved registers between registers 33 and 60.

3.1 Register 0 – Who Am I

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
0	0	-	ID						-

Description:

This register is used to verify the identity of the device.

Parameters:

ID Contains the 6-bit I^2C address of the device. The Power-On-Reset value of Bit6: Bit1 is 110 100.

Bit0 is reserved. (May be 0 or 1)

3.2 Register 21 – Sample Rate Divider

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default Value
15	21	SMPLRT_DIV								00h

Description:

This register determines the sample rate of the ITG-3200 gyros. The gyros outputs are sampled internally at either 1kHz or 8kHz, determined by the *DLPF_CFG* setting (see register 22). This sampling is then filtered digitally and delivered into the sensor registers after the number of cycles determined by this register. The sample rate is given by the following formula:

$F_{sample} = F_{internal} / (divider+1)$, where $F_{internal}$ is either 1kHz or 8kHz

As an example, if the internal sampling is at 1kHz, then setting this register to 7 would give the following:

$F_{sample} = 1kHz / (7 + 1) = 125Hz$, or 8ms per sample

Parameters:

SMPLRT_DIV Sample rate divider: 0 to 255

3.3 Register 22 – DLPF, Full Scale

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default Value
16	22	-			FS_SEL		DLPF_CFG			00h

Description:

This register configures several parameters related to the sensor acquisition.

The *FS_SEL* parameter allows setting the full-scale range of the gyro sensors, as described in the table below. The power-on-reset value of *FS_SEL* is 00h. **Set to 03h for proper operation.**

FS_SEL

FS_SEL	Gyro Full-Scale Range
0	Reserved
1	Reserved
2	Reserved
3	±2000°/sec

The *DLPF_CFG* parameter sets the digital low pass filter configuration. It also determines the internal sampling rate used by the device as shown in the table below.

DLPF_CFG

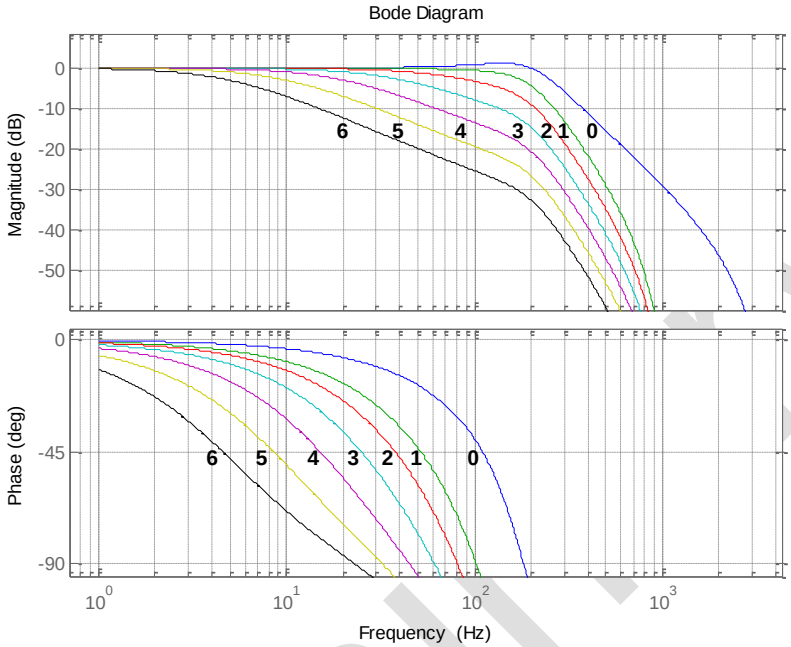
DLPF_CFG	Low Pass Filter Bandwidth	Internal Sample Rate
0	256Hz	8kHz
1	188Hz	1kHz
2	98Hz	1kHz
3	42Hz	1kHz
4	20Hz	1kHz
5	10Hz	1kHz
6	5Hz	1kHz
7	Reserved	Reserved

Parameters:

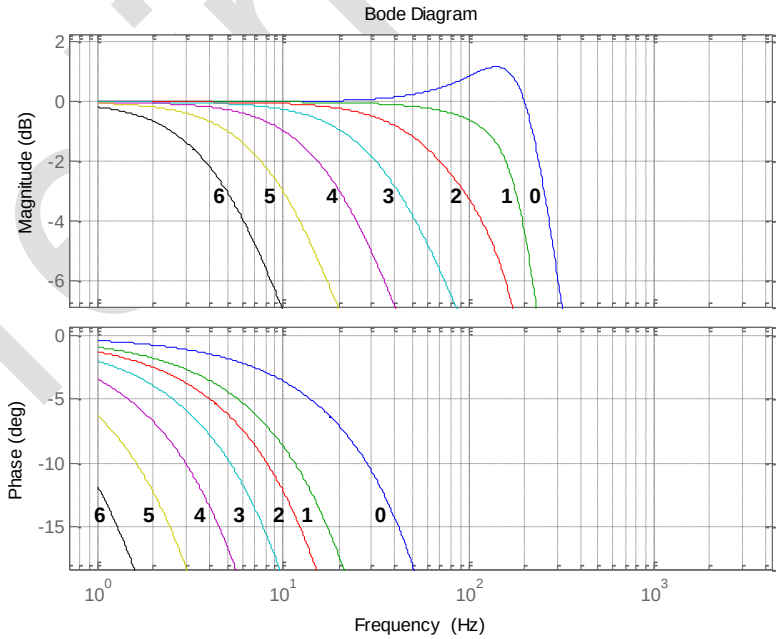
FS_SEL Full scale selection for gyro sensor data

DLPF_CFG Digital low pass filter configuration and internal sampling rate configuration

DLPF Characteristics: The gain and phase responses of the digital low pass filter settings (*DLPF_CFG*) are shown below:



Gain and Phase vs. Digital Filter Setting



Gain and Phase vs. Digital Filter Setting, Showing Passband Details

3.4 Register 23 – Interrupt Configuration

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default Value
17	23	ACTL	OPEN	LATCH_ INT_EN	INT_ ANYRD_ 2CLEAR	-	ITG_RDY _EN	-	RAW_ RDY _ EN	00h

Description:

This register configures the interrupt operation of the device. The interrupt output pin (INT) configuration can be set, the interrupt latching/clearing method can be set, and the triggers for the interrupt can be set.

Note that if the application requires reading every sample of data from the ITG-3200 part, it is best to enable the raw data ready interrupt (*RAW_RDY_EN*). This allows the application to know when new sample data is available.

Parameters:

ACTL	Logic level for INT output pin – 1=active low, 0=active high
OPEN	Drive type for INT output pin – 1=open drain, 0=push-pull
LATCH_INT_EN	Latch mode – 1=latch until interrupt is cleared, 0=50us pulse
INT_ANYRD_2CLEAR	Latch clear method – 1=any register read, 0=status register read only
ITG_RDY_EN	Enable interrupt when device is ready (PLL ready after changing clock source)
RAW_RDY_EN	Enable interrupt when data is available

3.5 Register 26 – Interrupt Status

Type: Read only

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default Value
1A	26	-	-	-	-	-	ITG_RDY	-	RAW_ DATA_ RDY	00h

Description:

This register is used to determine the status of the ITG-3200 interrupts. Whenever one of the interrupt sources is triggered, the corresponding bit will be set. The polarity of the interrupt pin (active high/low) and the latch type (pulse or latch) has no affect on these status bits.

Use the Interrupt Configuration register (23) to enable the interrupt triggers. If the interrupt is not enabled, the associated status bit will not get set.

In normal use, the *RAW_DATA_RDY* interrupt is used to determine when new sensor data is available in either the sensor registers (27 to 32).

Interrupt Status bits get cleared as determined by INT_ANYRD_2CLEAR in the interrupt configuration register (23).

Parameters:

ITG_RDY	PLL ready
RAW_DATA_RDY	Raw data is ready

3.6 Registers 27 to 34 – Sensor Registers

Type: Read only

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0
1B	27	TEMP_OUT_H							
1C	28	TEMP_OUT_L							
1D	29	GYRO_XOUT_H							
1E	30	GYRO_XOUT_L							
1F	31	GYRO_YOUT_H							
20	32	GYRO_YOUT_L							
21	33	GYRO_ZOUT_H							
22	34	GYRO_ZOUT_L							

Description:

These registers contain the gyro and temperature sensor data for the ITG-3200 parts. At any time, these values can be read from the device; however it is best to use the interrupt function to determine when new data is available.

Parameters:

TEMP_OUT_H/L 16-bit temperature data (2's complement format)
GYRO_XOUT_H/L 16-bit X gyro output data (2's complement format)
GYRO_YOUT_H/L 16-bit Y gyro output data (2's complement format)
GYRO_ZOUT_H/L 16-bit Y gyro output data (2's complement format)

3.7 Register 62 – Power Management

Type: Read/Write

Register (Hex)	Register (Decimal)	Bit7	Bit6	Bit5	Bit4	Bit3	Bit2	Bit1	Bit0	Default Value
3E	62	H_RESET	SLEEP	STBY_XG	STBY_YG	STBY_ZG	CLK_SEL			00h

Description:

This register is used to manage the power control, select the clock source, and to issue a master reset to the device.

Setting the *SLEEP* bit in the register puts the device into very low power sleep mode. In this mode, only the serial interface and internal registers remain active, allowing for a very low standby current. Clearing this bit puts the device back into normal mode. To save power, the individual standby selections for each of the gyros should be used if any gyro axis is not used by the application.

The *CLK_SEL* setting determines the device clock source as follows:

CLK_SEL

CLK_SEL	Clock Source
0	Internal oscillator
1	PLL with X Gyro reference
2	PLL with Y Gyro reference
3	PLL with Z Gyro reference
4	PLL with external 32.768kHz reference
5	PLL with external 19.2MHz reference
6	Reserved
7	Reserved

On power up, the ITG-3200 defaults to the internal oscillator. It is highly recommended that the device is configured to use one of the gyros (or an external clock) as the clock reference, due to the improved stability.

Parameters:

H_RESET	Reset device and internal registers to the power-up-default settings
SLEEP	Enable low power sleep mode
STBY_XG	Put gyro X in standby mode (1=standby, 0=normal)
STBY_YG	Put gyro Y in standby mode (1=standby, 0=normal)
STBY_ZG	Put gyro Z in standby mode (1=standby, 0=normal)
CLK_SEL	Select device clock source