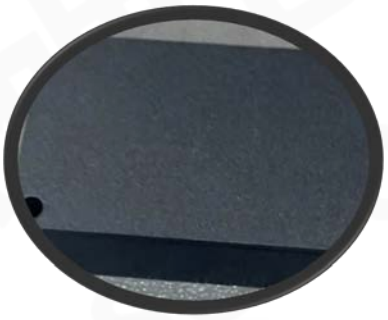
HGPM01



ESD 警告

ESD(静电放电)敏感器件。
带电器件和电路板可能会在没有察觉的情况下放电。
尽管本产品具有专有保护电路，但在遇到高能量ESD时，
器件依然可能会被损坏。因此，应当采取适当的
ESD防范措施，以避免器件性能下降或功能丧失。

免责申明

免责声明及有限赔偿责任

We shall not be liable, under any Circumstances, For any special, indirect, incidental, consequential, Or contingent damages For any reason, whether or not the buyer Has been advised of the Possibility of such damages.

产品描述

HGPM01 是基于高性能陀螺仪陀传感器和加速度计开发的模组，内置 3 轴陀螺仪和 3 轴加速度计传感器。依赖于高精度的传感器、高性能的处理器和高级的数字信号处理算法，该模组输出非常稳定的角速度值，加速度值。模块可以支持 SPI 或 UART 数据通讯，产品总体尺寸：
37.70 * 24.15 * 9.50 mm

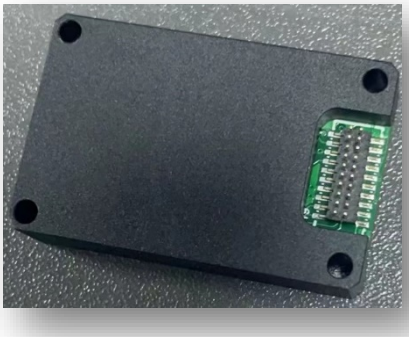
产品特性

- ●高精度 6 轴陀螺仪模组
- ●输出三轴加速度值，三轴角速度值,温度
- ●数字通讯接口 SPI 或 UART
- ●产品尺寸：37.70 * 24.15 * 9.50 mm
- ●低功耗

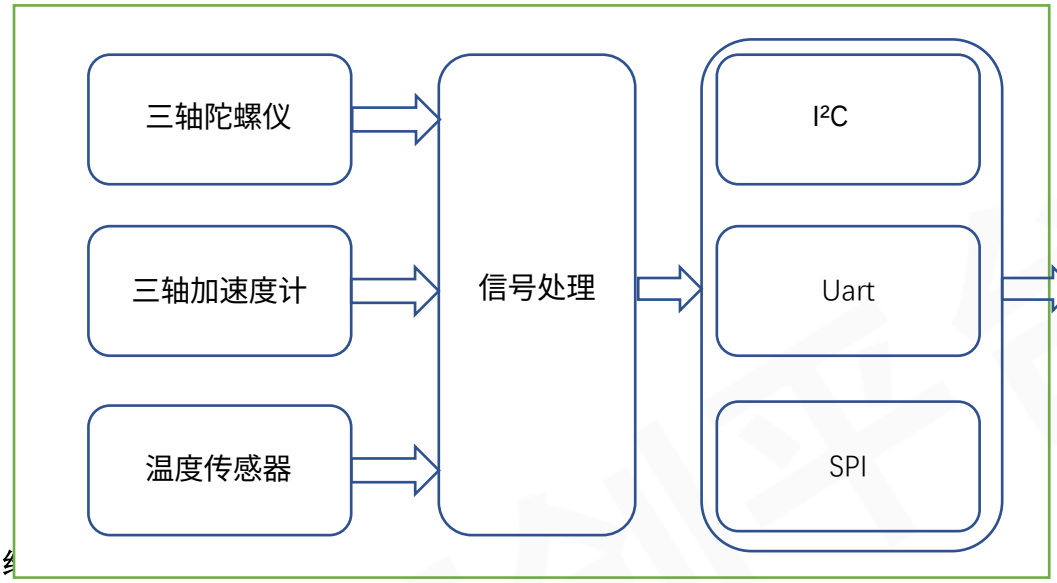
	陀螺仪	加速度计
Dynamic Rane:	±400 dps	±/16G
Bias Instability:	3.0 deg/hr	0.07mG
Random Walk:	0.2 deg/ √ hr	0.03(m/sec) / √ hr
Initial Bias Error:	0.3 deg/s (1 σ)	10mG
Output Interface:	SPI/UART	
Data Output Rate:	400Hz max	
Temperature Range:	-40℃ ~ +85℃	
Power Supply Voltage:	3.3V	
Current Consumption:	22mA	
Size:	37.70 X 24.15 X 9.50mm	
Weight:	12gram	

应用

- ●惯性导航系统



产品框图



绝

- 工作温度范围：-40 ～ +85 摄氏度
- 存储工作温度范围：-40 ～ +85 摄氏度
- 绝对工作电压 VCC-GND：-0.3V ～ +4.5V

推荐工作参数

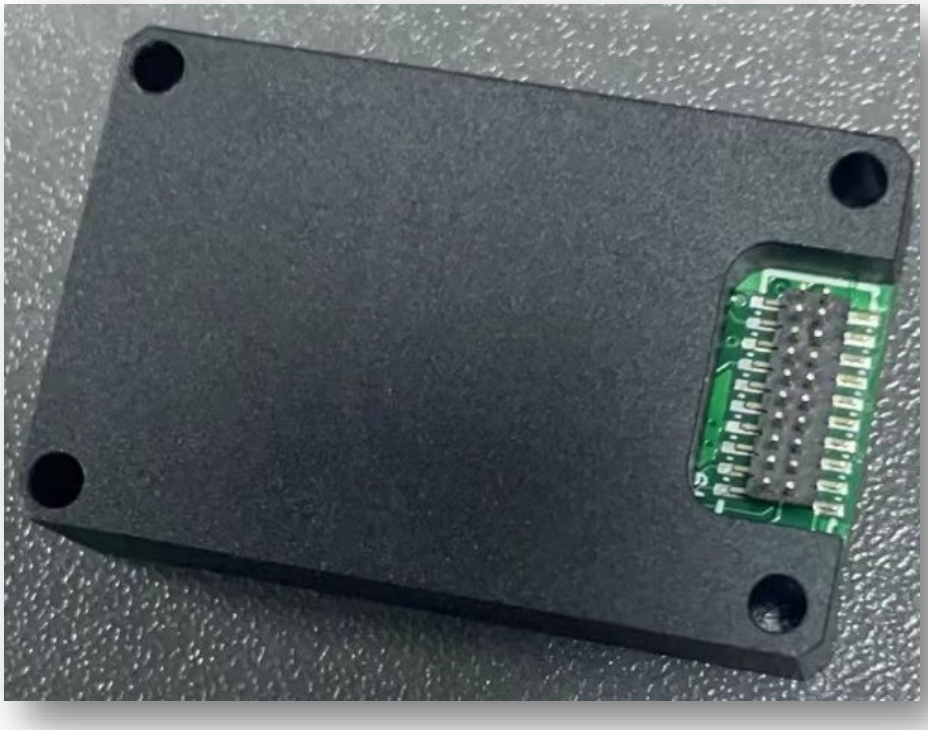
- 工作温度范围：-40 ～ +85 摄氏度
- 存储工作温度：0 ～ 40 摄氏度
- 推荐工作电压：3.3V +/-0.15V

规格参数

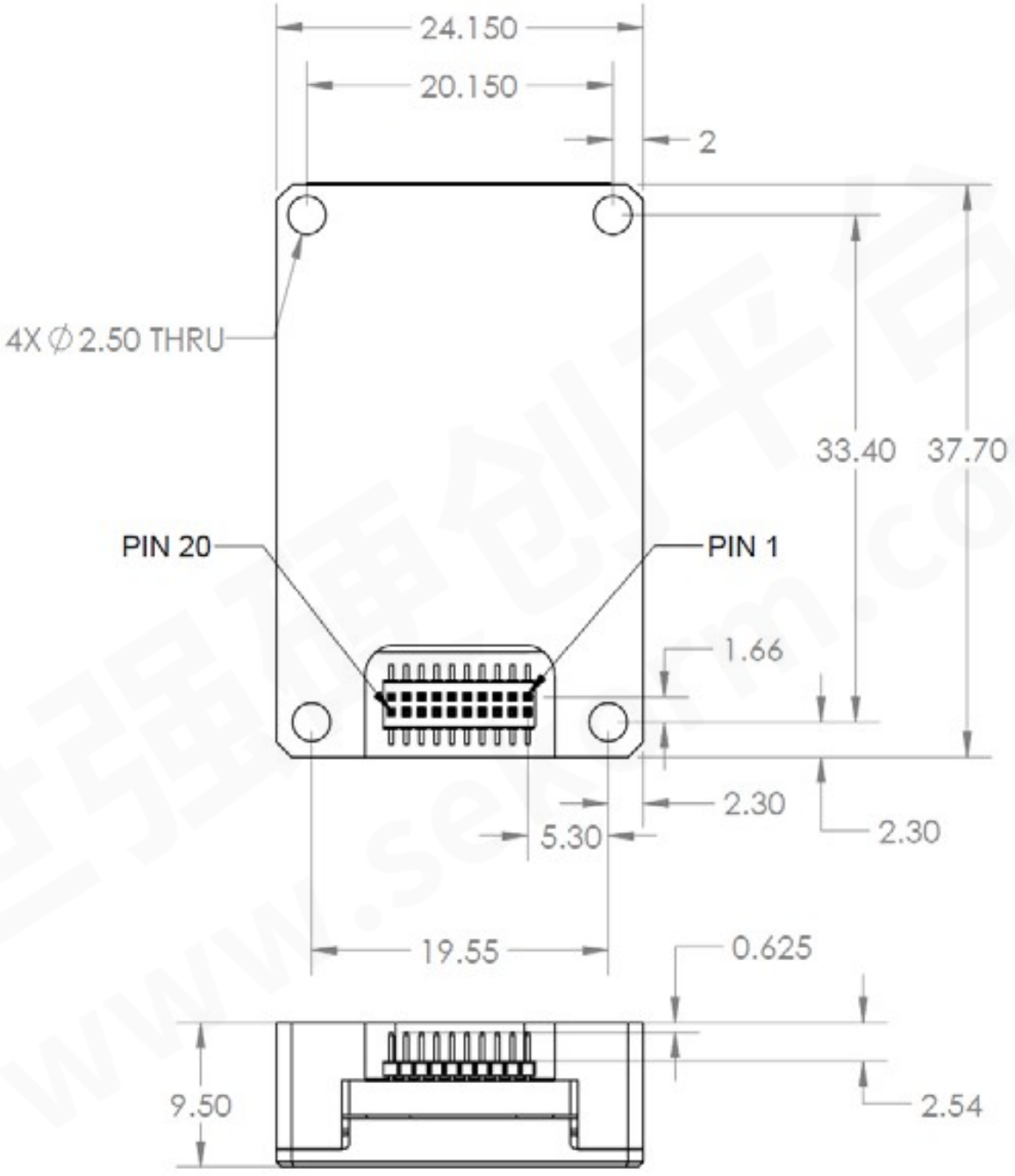
Ambient Temperature (T_A) = -20° C to 70° C, V_{cc} = 3.15V to 3.45V, Angular Rate = 0° /s, unless otherwise stated.

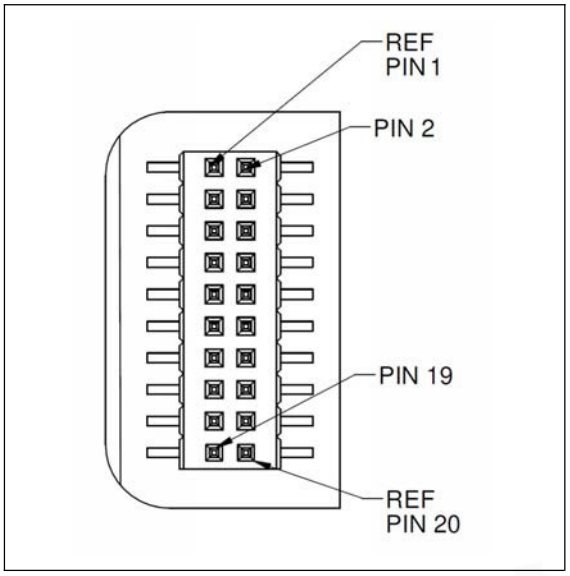
Parameter	Symbol	Condition	Standard			Unit
			Min	Type	Max	
ACC Range	AR	Ta = +25° C	2		16	G
Gyroscope Range	RR	Ta = +25° C	-400	-	+400	° /s
Scale factor	SF	Ta = +25° C	-0.5		+0.5	%
Gyro Bias Instability	BI	Ta = +25° C	-	3.5	-	° /hr
ACC Bias Instability	ADE	Ta = +25° C	-	0.1	-	mg
Cross axis	CS	Ta = +25° C	-0.5		+0.5	%
Current consumption	Iop			22		mA
Bandwidth	Bw			25	-	Hz
Data rate	Dr				400	Hz
Startup time	ST		-	3	-	s

产品外观



产品外观尺寸图


24.150
20.150
2
4X ∅2.50 THRU
33.40
37.70
PIN 20
PIN 1
1.66
2.30
2.30
5.30
19.55
0.625
9.50
2.54



管脚定义

引脚编号	助记符	类型	描述
1	STI	O	采样信号指示
2	Sync	I	同步时钟输入
3	SPI_SCK	I	SPI 时钟
4	SPI_MISO	I/O	SPI MISO
5	SPI_MOSI	I/O	SPI MOSI
6	SPI_SS	I	SPI 片选
7	DATA READY	O	数据准备好
8	nRST	I	复位引脚
9	NC	S	保留
10,11,12	VCC	I	3.3V-5.0V
13,14,15	GND	S	GND
16	485_OE	O	485 发送使能
17	Reserve	I	保留
18	UART_TX	O	串口发送
19	Reserve		保留
20	UART_RX	I	串口接收

1) 引脚类型 I:输入，O:输出，I/O:输入/输出，S:电源
2) 如果没有使用/RST 引脚，请将引脚保持悬空。

操作模式

该设备有两种接口模式，分别是 SPI 模式和 UART 模式。

SPI 模式

HGPM01 提供 SPI 通信接口.

本节将介绍相关的接口寄存器和相应的访问方法。

此 IMU 工作于从模式，主控制器必须按照如下的配置进行工作：

- Data transferred in 16-bit word-length and MSB-first
- $f_{CLK} \leq 10.0$ MHz
- CPOL = 1 (clock polarity) and CPHA = 1 (clock phase)

HGPM01 Register Map

Name	Read/Write	Address	Default	Function
Reserved	N/A	0x00 to 0x03	N/A	N/A
X_RATE	R	0x04	N/A	X-Axis Rate-Sensor Output
Y_RATE	R	0x06		Y-Axis Rate-Sensor Output
Z_RATE	R	0x08		Z-Axis Rate-Sensor Output
X_ACCEL	R	0x0A		X-Axis Accelerometer Output
Y_ACCEL	R	0x0C		Y-Axis Accelerometer Output
Z_ACCEL	R	0x0E		Z-Axis Accelerometer Output
ODR	W	0x36		Output Data Rate set
STNDRD_BURST	R	0x3E	N/A	Command to perform a burst-read of the standard data-packet
Flash Write	W	0x76		Flash data write

SPI Register Read Methodology

The HGPM01 SPI port uses registers to store information such as:

- Sensor data
- Configuration/Status information

A SPI master accesses information via the SPI bus in one of two ways:

- Polled-Mode
- Burst-Mode

In polled-mode, the HGPM01 transfers information from any register back to the master in two (or more) SPI cycles. In Burst-Mode, the HGPM01 transfers predefined blocks of data in one contiguous group of nine to twenty SPI cycles.

SPI Port Polled-Mode Read

In polled-mode, data transfer begins when the SPI master sets the chip-select line (nSS) low and clocks a 16-bit word, comprised of the register-address byte and a zero-byte, across the MOSI line. For example, to request the unit's serial number, stored in register 0x58, the master sends the command 0x5800. The unit returns information from this address across the MISO line during the following 16 clock-cycles.

Subsequent SPI-master commands sent to the unit consist of either:

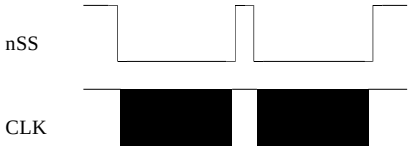
- Sixteen zero-bits (0x0000) to complete the read of a single register.
- The address of another register followed by a zero-byte. This permits back-to-back reads of data-registers.

Single-Register Polled-Read

Figure 6 illustrates a polled-mode read of a single register (x-axis rate-sensor data), which is composed of two bytes, starting at register address 0x04.

In this example, the SPI-master initiates a register read by clocking in the address followed by 0x00, i.e. 0x0400, via MOSI; this combination is referred to as a read-command[5]. This is followed by 16 zero-bits to complete the SPI data-transfer cycle.

As the master transmits the read command over MOSI, the unit transmits information back over MISO. In this transmission, the first data-word sent by the unit (as the read-command is sent) consists of 16-bits of non-applicable data. The subsequent 16-bit message contains the x-axis rate-sensor information (most significant byte followed by least-significant byte). Note that the nSS line can be de-activated between each 16-bit word (as shown in Figure 9), or it can be held low for the entire duration of the polled read.



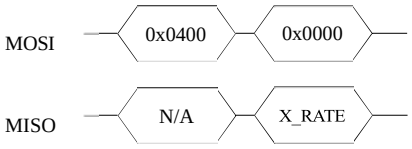


Figure 6 Single Register Read via Polled-Mode

Multiple-Register Polled-Read

Figure 7 illustrates a polled-mode read of multiple registers. In this case, the SPI-master transmits an initial read-command (the desired register-address appended by 0x00) across MOSI followed by any number of additional read-commands (one for each register of interest). The unit transfers the requested information concurrently across MISO to the master. To complete the data transfer, the final read-command must be followed by an additional 16 clock cycles to transfer the last 16-bits of data.

In this example, the master requests data from four separate registers: x-axis rate (0x0400), y-axis rate (0x0600), z-axis acceleration (0x0E00), and sample counter (0x3C00). The transfer of 0x0000 across MOSI completes the read by returning the status data via the MISO line. Note that the nSS line can be de-activated between each 16-bit word (as shown in Figure 10), or it can be held low for the entire duration of the polled read.

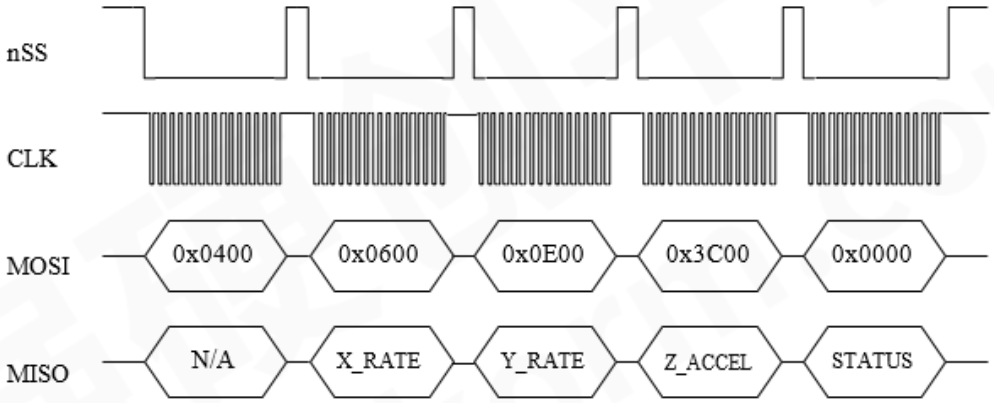


Figure 7 Multiple Register Read via Polled-Mode

SPI Port Burst-Mode Read

In burst-mode, the unit returns predefined blocks of data in single groups, referred to as data-packets, without the need to send multiple read commands. These groups vary from eight to ten words in length, depending on the packet selected. Table 4 lists the data-packets available for the unit. The data packets are described in more detail, including data-ordering and conversion factor information, in Section 6.4. Burst-reads and polled-reads should be initiated when data-ready signal indicates that new data is available.

Table 4 Burst-Mode Data-Packets

Data-Packet	Register Address	Number of 16-bit Words	Pertinent Section	Description
Standard	0x3E	8	4.2.2	Rates, Accelerations, and Temperature

Burst-Read of Standard Data-Packet

The standard data-packet comprises data from eight predefined registers. Table 5 lists the data contained in a standard packet along with the corresponding registers. The registers are listed in the order in which they are sent during a burst-mode read.

Table 5 Burst-Mode Output Registers

Register Name	Register Address	Description
Counter	0x3C	Sample Counter
X_RATE	0x04	Rate Sensor Output (X-Axis)
Y_RATE	0x06	Rate Sensor Output (Y-Axis)
Z_RATE	0x08	Rate Sensor Output (Z-Axis)
X_ACCEL	0x0A	Accelerometer Output (X-Axis)
Y_ACCEL	0x0C	Accelerometer Output (Y-Axis)
Z_ACCEL	0x0E	Accelerometer Output (Z-Axis)
BOARD_TEMP	0x18	System Temperature

Burst-mode begins when the master requests a read from a burst-mode data-packet (i.e. 0x3E). Eight additional SPI cycles complete the read (one for each word in the standard data-packet). Figure 8 illustrates the burst-mode sequence. Note: if the incorrect number of SPI cycles follow the burst-mode command, the SPI transfer will either complete early or remain in burst-mode; subsequent reads/writes will be out of sync with the SPI transfer cycle of the unit.

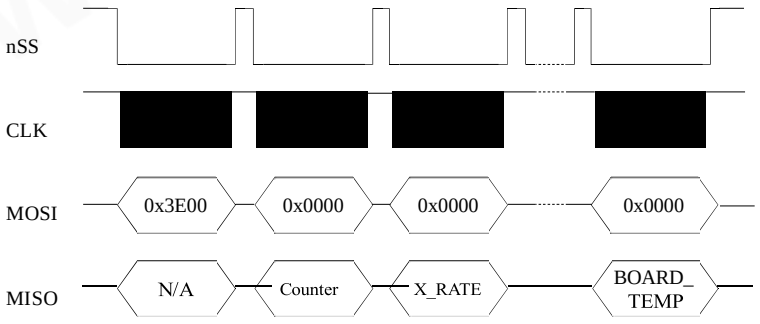


Figure 8 Multiple Register Read via Burst-Mode

Table 7 HGPM01 Data Output Registers

Name	Read Address	Function
X_RATE	0x04	X, Y, Z-axis rate-sensor information, twos complement format, conversion factor: 200 LSB/[°/sec] (default); changes with selected dynamic range (Table 14)
Y_RATE	0x06	
Z_RATE	0x08	
X_ACCEL	0x0A	X, Y, Z-axis accelerometer information, twos complement format, conversion factor: 4000 LSB/g (default) ; changes with selected dynamic range (Table17)
Y_ACCEL	0x0C	
Z_ACCEL	0x0E	

Burst-Read of Standard Data-Packet

The standard data-packet comprises data from eight predefined registers. Table 5 lists the data contained in a standard packet along with the corresponding registers. The registers are listed in the order in which they are sent during a burst-mode read.

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Y_RATE	0x06	Rate Sensor Output (Y-Axis)
Z_RATE	0x08	Rate Sensor Output (Z-Axis)
X_ACCEL	0x0A	Accelerometer Output (X-Axis)
Y_ACCEL	0x0C	Accelerometer Output (Y-Axis)
Z_ACCEL	0x0E	Accelerometer Output (Z-Axis)
BOARD_TEMP	0x18	System Temperature

Burst-mode begins when the master requests a read from a burst-mode data-packet (i.e. 0x3E). Eight additional SPI cycles complete the read (one for each word in the standard data-packet). Figure 8 illustrates the burst-mode sequence. Note: if the incorrect number of SPI cycles follow the burst-mode command, the SPI transfer will either complete early or remain in burst-mode; subsequent reads/writes will be out of sync with the SPI transfer cycle of the unit.

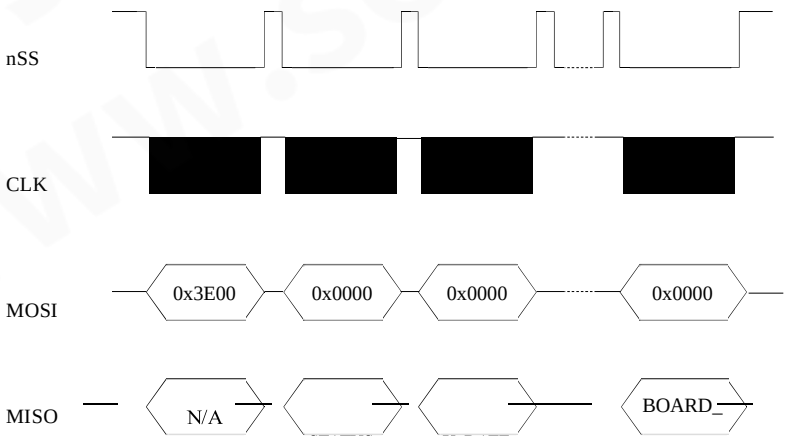

Figure 8 Multiple Register Read via Burst-Mode

关于数据解析：

1， 陀螺仪 range: +/-400dps，陀螺仪感度因子：0.005

2， 加速度 Range：+/-16G，加速度感度因子：0.00025f.

3， 温度感度因子：0.01

```
gx = (float)pollData[1]*.005f;
gy = (float)pollData[2]*0.005f;
gz = (float)pollData[3]*0.005f;
ax = (float)pollData[4]*0.00025f;
ay = (float)pollData[5]*0.00025f;
az = (float)pollData[6]*0.00025f;
boardTemperature = (float)pollData[7] * 0.01f;
```

UART 通讯模式。

1、 UART 接口

Parameter	Set value
Transfer rate	115200 bps
Start	1 bit
Data	8 bits
Stop	1 bit
Parity	None

数据格式：

	HEAD		Counter		status	
offset	0	1	2	3	4	5
code	**0x80**	**0x01**	L	H	L	H

	gyroX		gyroY		gyroZ	
offset	6	7	8	9	10	11
code	L	H	L	H	L	H

	accX		accY		accZ	
offset	12	13	14	15	16	17
code	L	H	L	H	L	H

	pitch		roll		yaw	
offset	18	19	20	21	22	23
code	L	H	L	H	L	H

	temperature		checksum		end	
offset	24	25	26	27	28	29
code	L	H	L	H	**0x0D**	**0x0A**

数据说明：
实际的角速度 = 输出值/64（度/秒）
实际的加速度 = 输出值（mg）
实际的姿态角 = 输出值/100(度)
参考温度 = 输出值/100(摄氏度)
checksum = Bytes2 + Bytes3 + … + Bytes24 + Bytes25.

串口控制命令：

bytes offset	0	1	2	3	4	5	6	7	命令说明
控制命令 1	0xFF	0x07	0x00	0x06	0x00	0x00	0x41	0xD5	停止自动发送
控制命令 2	0xFF	0x07	0x00	0x00	0x00	0x00	0xA1	0xD4	开始自动发送
控制命令 3	0xFF	0x1C	0x00	0x00	0x00	0x00	0xC5	0xD6	陀螺零偏校准
控制命令 4	0xFF	0x1E	0x02	0x00	0x00	0x00	0xBD	0xAE	Yaw 角度清零
波特率设置	0xFF	0x09	0x02	0x00	0x00	0x00	0xC9	0xAD	波特率 115200*
波特率设置	0xFF	0x09	0x01	0x00	0x00	0x00	0xC9	0xE9	波特率 256000*
波特率设置	0xFF	0x09	0x00	0x00	0x00	0x00	0xC8	0x15	波特率 460800*
Flash 更新	0xFF	0x1B	0x00	0x00	0x00	0x00	0x70	0x16	更新保存 Flash

***：发送波特率设置命令以后，必须后面再发送 Flash 更新命令，用以保存新的设置，新的设置在器件重新上电或者复位后生效。**

应用注意事项：

模组的安装角度，请尽量水平安装，模组的法线和机器的旋转轴平行

模组务必可靠安装，保证工作过程中不松动

模组尽量不要靠近热源，发热大的或者发热变化大的区域，比如电源功率部分，马达驱动功率部分，主 MCU，这些地方通常发热比较厉害，而且冷热不均匀

运行过程中，尽量平稳，避免大的碰撞，避免突然之间大角度的旋转， 尽量按照（停止，加速，匀速，减速，停止）这样的运动行为保证运动的平滑性

End