WT9011DCL-BT50 Communication Protocol

contents

1. Data output instructions

The module outputs data of Flag=0x61 (acceleration angular velocity angle) by default.

Flag=0x71 (magnetic field) requires sending a command to read the corresponding register before it can be returned.

Bluetooth upload data format: The maximum amount of data uploaded via Bluetooth is 20 Bytes each time.

1.1. Acceleration angular velocity angle data packet (default output)

Data packet header 1 Byte	Flag bit 1 Byte	AXL	AXH	AYL	AYH	AZL	AZH	WXL	WXH	WYL	WYH	WZL	WZH	RollL	RollH	PitchL	PitchH	YawL	YawH
0x55	Flag	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN

Note: Flag = 0x61 Data content 18Byte is displacement, displacement speed, angle

0xNN is the specific value received. The order of data return is acceleration XYZ, angular velocity XYZ, angle XYZ, with low byte first and high byte last.

0x55	Packet header

0x61	Flags
AXL	X-axis acceleration lower 8 bits
AXH	X-axis acceleration high 8 bits
AYL	Y-axis acceleration lower 8 bits
YYH	Y-axis acceleration high 8 bits
AZL	Z-axis acceleration lower 8 bits
AZH	Z-axis acceleration high 8 bits
WXL	X-axis angular velocity lower 8 bits
Wlq	X-axis angular velocity high 8 bits
Wl	Y-axis angular velocity lower 8 bits
Wlq	Y-axis angular velocity high 8 bits
Wl	Z axis angular velocity lower 8 bits
Wlq	Z axis angular velocity high 8 bits
RollL	X-axis angle lower 8 bits
RollH	X-axis angle high 8 bits
PitchL	Y-axis angle low 8 bits
PitchH	Y-axis angle high 8 bits
YawL	Z-axis angle low 8 bits

Yaw	Z-axis angle high 8 bits

1.2. Displacement, displacement, speed and angle data packet (output when the value of register 0x96 is 1)

Data packet header 1 Byte	Flag bit 1 Byte	POSEL	POSEH	POSNL	POSNH	POSUL	POSUH	VELEL	VELEH	VELNL	VELNH	VELUL	VELUH	RollL	RollH	PitchL	PitchH	YawL	Yaw
0x55	Flag	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN

0x55	Packet header
0x61	Flags
POSEL	X-axis shift lower 8 bits
POSEH	X-axis displacement high 8 bits
POSNL	Y-axis shift lower 8 bits
POSNH	Y axis shift high 8 bits

POSUL	Z axis displacement lower 8 bits
POSUH	Z axis displacement high 8 bits
VELEL	X-axis displacement speed low 8 bits
VELEH	X-axis displacement speed high 8 bits
VELNL	Y axis displacement speed low 8 bits
VELNH	Y axis displacement speed high 8 bits
VELUL	Z axis displacement speed low 8 bits
VELUH	Z axis displacement speed high 8 bits
RollL	X-axis angle low 8 bits
RollH	X-axis angle high 8 bits
PitchL	Y-axis angle low 8 bits
PitchH	Y-axis angle high 8 bits
YawL	Z-axis angle low 8 bits
Yaw	Z-axis angle high 8 bits

Note:

Flag = 0x61 Data content 18Byte is displacement, displacement speed, angle

0xNN is the specific value received. The order of data return is displacement XYZ, displacement speed XYZ, angle XYZ, with low byte first and high byte last.

1.3. Acceleration angular velocity timestamp data packet (output when the value of register 0x96 is switched to 2)

Data packet header 1 Byte	Flag bit 1 Byte	AXL	AXH	AYL	YYH	AZL	AZH	WXL	WIq	WI	WIq	WI	WIq	MS1	MS2	MS3	MS4
0x55	Flag	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN

1.4. Displacement displacement speed timestamp data packet (output when the 0x96 register value is switched to 3)

Data packet header 1 Byt	Flag bit 1 Byte	POSEL	POSEH	POSNL	POSNH	POSUL	POSUH	VELEL	VELEH	VELNL	VELNH	VELUL	VELUH	MS1	MS2	MS3	MS4

e																	
0x55	Flag	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN	0xNN

2. Data analysis

2.1. Acceleration calculation method: unit g

AX=((AXH<<8)|AXL)/32768*16g (g is the acceleration due to gravity, which can be 9.8m/s2)

AY=((AYH<<8)|AYL)/32768*16g (g is the acceleration due to gravity, which can be 9.8m/s2)

AZ=((AZH<<8)|AZL)/32768*16g (g is the acceleration due to gravity, which can be 9.8m/s2)

2.2. Angular velocity calculation method: unit °/s

WX=((WXH<<8)|WXL)/32768*2000(°/s)

WY=((WXH<<8)|WXL)/32768*2000(°/s)

WZ=((WXH<<8)|WXL)/32768*2000(°/s)

2.3. Angle calculation method: Unit: °

Roll angle (X axis) Roll = ((RollH<<8)|RollL)/32768*180(°)

Pitch angle (Y axis) Pitch = ((PitchH<<8)|PitchL)/32768*180(°)

Yaw angle (Z axis) Yaw = ((YawH<<8)|YawL)/32768*180(°)

2.4. Displacement calculation method: unit: mm

POSE=((POSEH<<8)|POSEL)（mm）

POSN=((POSNH<<8)|POSNL) (mm)

POSU=((POSUH<<8)|POSUL)（mm）

2.5. Displacement speed calculation method: unit: mm/s

VELE=((VELEH<<8)|VELEL)（mm/s）

VELN=((VELNH<<8)|VELNL)（mm/s）

VELU=((VELUH<<8)|VELUL)（mm/s）

2.6. Timestamp calculation method: unit: ms

MS=MS4<<24 | MS3<<16 | MS2<<8 | MS1

Note:

1. The coordinate system used for attitude angle calculation is the northeast celestial coordinate system. The module is placed in the positive direction, as shown in "4 Pin Description"

The X axis is to the left, the Y axis is to the front, and the Z axis is to the top. The rotation order of the coordinate system when the Euler angle represents the posture

It is defined as ZYX, that is, it rotates around the Z axis first, then around the Y axis, and then around the X axis.

2. Although the roll angle range is ±180 degrees, in fact, since the coordinate rotation order is ZYX,

When the pitch angle (Y axis) is in the range of ±90 degrees, it will change to less than 90 degrees after exceeding 90 degrees.

Let the angle of the X axis be greater than 180 degrees. For detailed principles, please search for relevant information about Euler angles and attitude representation on Baidu.

3. Since the three axes are coupled, they will only show independent changes at small angles. At large angles, the posture

The angle will change in a coupled manner. For example, when the Y axis is close to 90 degrees, even if the posture only rotates around the Y axis, the angle of the X axis

There will also be significant changes, which is an inherent characteristic of Euler angles in representing posture.

illustrate:

1. Data is sent in hexadecimal format, not ASCII code.

2. Each data is transmitted in sequence as low byte and high byte, and the two are combined into a signed short type data.

For example, the X-axis acceleration data Ax, where AxL is the low byte and AxH is the high byte. The conversion method is as follows:

Assume that Data is the actual data, DataH is its high byte part, and DataL is its low byte part, then: Data = ((short)DataH<<8)|DataL. It must be noted that DataH needs to be forced to be converted to a signed short first.

The data type of Data is also a signed short type, so that it can be expressed negative number.

2.7. Single return register data packet

A single return data packet needs to send a read register instruction first. The instruction format is as follows:

FF AA 27 XX 00

--XX refers to the corresponding register number. The register number is a reference. The sending command example is as follows:

Function	instruction
Reading magnetic fields	FF AA 27 3A 00
Read four elements	FF AA 27 51 00
Reading Temperature	FF AA 27 40 00
Reading power	FF AA 27 64 00

Read the version number	FF AA 27 2E 00 FF AA 27 2F 00

After sending this command, the module will return a data packet starting with 0x55 0x71, which contains the corresponding start register address data, the start register address and the following 7 register data (8 registers are fixedly uploaded). The return data format is as follows:

Start register (2Byte) + register data (16Byte, 8 registers)

Baotou	Logo	Start register address low	Start register address high	Start (1st) register data low	Open (1st) register number high bit	......	The 8th register data low bit	The 8th register data high bit
0x55	0x71	RegL	RegH	0xNN	0xNN	......	0xNN	0xNN

Note: 0xNN is the specific value received, with the low byte first and the high byte last.

2.8. Magnetic field output

Note: The unit of magnetic field data calculated from raw data is milligauss, which is different from the unit displayed by the PC software . If you need to convert the unit to the same as the PC software , you need to calculate it according to the following method.

0x55	0x71	0x3A	0x00	HkDJ	HkDJ	HkDJ	HkDJ	Hz	HzH.....

Calculation method: Unit: uT

Magnetic field (x axis) Hx=((HxH<<8)|HxL)/150

Magnetic field (y axis) Hy=((HyH <<8)| HyL)/150

Magnetic field (z axis) Hz =((HzH<<8)| HzL)/150

Example: Send a command to read the magnetic field on the APP: FF AA 27 3A 00 (refer to 7.2.8 Reading register values)

The module sends back data to APP: 55 71 3A 00 68 01 69 00 7A 00 00 00 00 00 00 00 00 00 00 00 00, a total of 20 bytes.

For the 5th to 10th bytes, solve as above, the magnetic field is x=2.4uT, y=0.7uT, z=0.813uT.

2.9. Quaternion Output

0x55	0x71	0x51	0x00	QUR	QUR	QUR	QUR	QUR	QzH.....

Calculation method:

Q0=((Q0H<<8)|Q0L)/32768

Q1=((Q1H<<8)|Q1L)/32768

Q2=((Q2H<<8)|Q2L)/32768

Q3=((Q3H<<8)|Q3L)/32768

Checksum:

Sum=0x55+0x59+Q0L+Q0H+Q1L +Q1H +Q2L+Q2H+Q3L+Q3H

2.10. Temperature output

0x55	0x71	0x40	0x00	TL	TH	......

Temperature calculation formula:

T=((TH<<8)|TL) /100 ℃

2.11. Version number output

0x55	0x71	0x2E	0x00	Version1L	Version1H	......
0x55	0x71	0x2F	0x00	Version2L	Version2H	......

Version number calculation formula:

Version1=((Version1H<<8)|VersionL1)

VERSION=Version1.Version2H.Version2L

3. Setting Instructions

Sending instruction process:

First step to unlock: FF AA 69 88 B5 (command to complete the modification within 10 seconds)

The second step is to send the command that needs to be modified . For example, if you want to perform acceleration calibration, send: FF AA 01 01 00

The third step is to save the command : FF AA 00 00 00

3.1. Read register value

FF AA 27 XX 00	Read register value

--XX refers to the corresponding register , for example:

Read magnetic field: FF AA 27 3A 00

Read four elements: FF AA 27 51 00

Read temperature: FF AA 27 40 00

After sending this command, the module will return a data packet starting with 0x55 0x71, which contains the corresponding start register address data, the start register address and the following 7 register data (fixed upload 8 registers). The return data format refers to:

55 71 3A 00 68 01 69 00 7A 00 00 00 00 00 00 00 00 00 00 00 00 20 bytes in total.

3.2. Acceleration Calibration and Magnetic Field Calibration

FF AA 01 01 00	Accelerometer Calibration
FF AA 01 07 00	Magnetic field calibration
FF AA 01 00 00	Complete magnetic field calibration

3.3. Save Configuration

FF AA 00 SAVE 00	Save Configuration

SAVE: Settings

0: Save the current configuration

1: Restore the default configuration and save

3.4. Set the return rate

FF AA 03 RATE 00	Set the return rate RATE: return rate 0x01: 0.1Hz 0x02: 0.5Hz 0x03: 1Hz 0x04: 2Hz 0x05: 5Hz 0x06: 10Hz (default) 0x07: 20Hz 0x08: 50Hz 0x09: 100Hz 0x0B: 200Hz

3.5. Set Angle Reference

FF AA 01 08 00	Set Angle Reference

After sending, you need to send a save instruction

3.6. Set the Z-axis angle to zero

FF AA 01 04 00	Set the z-axis angle to zero

Before sending this command, you need to switch the six-axis algorithm first for it to take effect.

3.7. Set the installation direction

FF AA 23 ORIENT 00	Set the installation direction

ORIENT : Installation direction

0(0x00) : Horizontal installation

1(0x01) : Vertical installation (the Y-axis arrow of the coordinate axis must face upward)

3.8. Setting up the algorithm

FF AA 24 AXIS6 00	Setting up the algorithm
AXIS6	Setting up the algorithm 0(0x00): 9-axis algorithm (magnetic field solution navigation angle, absolute heading angle) 1(0x01): 6-axis algorithm (integral solution of navigation angle, relative heading angle)

3.9. Setting bandwidth

Register Name: BANDWIDTH
Register address: 31 (0x1F)
Read/write direction: R/W
Default value: 0x0004

Bit	NAME	FUNCTION
15:4		
3:0	BANDWIDTH[3:0]	Setting bandwidth 0000(0x00): 256Hz 0001(0x01): 188Hz 0010(0x02): 98Hz 0011(0x03): 42Hz 0100(0x04): 20Hz 0101(0x05): 10Hz 0110(0x06): 5Hz

Example: FF AA 1F 01 00 (set bandwidth to 188 Hz)

3.10. Reading power

FF AA 27 64 00	Read module power

The corresponding relationship between voltage and power percentage is:

Register Value	Voltage value	Battery percentage
>396	> 3.96V	100%
393-396	3.93V-3.96V	90%
387-393	3.87V-3.93V	75%
382-387	3.82V-3.87V	60%
379-382	3.79V-3.82V	50%
377-379	3.77V-3.79V	40%
373-377	3.73V-3.77V	30%
370-373	3.70V-3.73V	20%
368-370	3.68V-3.70V	15%
350-368	3.50V-3.68V	10%
340-350	3.40V-3.50V	5%
<340	<3.40V	0%

3.11. Set output content

FF AA 96 AGPVSEL 00	Set output content
AGPVS	55 61 Data packet output data content: 0(0x00): acceleration + angular velocity + angle (default output) 1(0x01): displacement + displacement speed + angle 2(0x02): acceleration + angular velocity + timestamp 3(0x03): displacement + displacement speed + timestamp
Example: FF AA 96 01 00 (output displacement + displacement speed + angle)	

3.12. Set Bluetooth name

For example, if the Bluetooth name is set to: WT12345678 , the command to be sent is: WT WT12345678 \r\n

Note: The first WT is the protocol header, and the second WT is the Bluetooth name. In order to filter Bluetooth devices, the APP will display the Bluetooth devices starting with WT to avoid searching for many irrelevant Bluetooth devices.

protocol	illustrate
WT	Protocol header, cannot be modified
WT	The Bluetooth name cannot be modified, otherwise the APP will not be able to search
Bluetooth name editable part	14 bytes are the changeable part of the Bluetooth name
\r\n	Line break, end character

4. Register Address Table

address	symbol	meaning
0x00	SAVE	Save the current configuration
0x01	CALSW	calibration
0x02	reserve	
0x03	RATE	Return data rate
0x04	BAUD	Serial port baud rate
0x05	AXOFFSET	X-axis acceleration zero bias
0x06	AYOFFSET	Y-axis acceleration zero bias
0x07	AZOFFSET	Z-axis acceleration zero bias
0x08	GXOFFSET	X-axis angular velocity zero bias
0x09	GYOFFSET	Y-axis angular velocity zero bias
0x0a	GZOFFSET	Z-axis angular velocity zero bias
0x0b	HXOFFSET	X-axis magnetic field bias
0x0c	HYOFFSET	Y-axis magnetic field bias
0x0d	HZOFFSET	Z-axis magnetic field bias
0x0e	D0MODE	D0 Mode

0x0f	D1MODE	D1 Mode
0x10	D2MODE	D2 Mode
0x11	D3MODE	D3 Mode
0x12	reserve	
0x13	reserve	
0x14	reserve	
0x15	reserve	
0x16	reserve	
0x17	reserve	
0x18	reserve	
0x19	reserve	
0x1a	reserve	
0x1b	reserve	
0x2e	VERSION1	Version Number
0x2f	VERSION2	Firmware version number branch hardware version number
......	......	......
0x30	YYMM	years
0x31	DDH	Day and time
0x32	MMSS	Minutes, seconds
0x33	MS	millisecond
0x34	AX	X-axis acceleration
0x35	AY	Y-axis acceleration
0x36	AZ	Z-axis acceleration
0x37	GX	X-axis angular velocity
0x38	GY	Y-axis angular velocity
0x39	GZ	Z-axis angular velocity
0x3a	HX	X-axis magnetic field

0x3b	HY	Y-axis magnetic field
0x3c	HZ	Z-axis magnetic field
0x3d	Roll	X-axis angle
0x3e	Pitch	Y-axis angle
0x3f	Yaw	Z-axis angle
0x40	TEMP	Module temperature
0x49	reserve	
0x4a	reserve	
0x4b	reserve	
0x4c	reserve	
0x4d	reserve	
0x4e	reserve	
0x4f	reserve	
0x50	reserve	
0x51	Q0	Four Elements Q0
0x52	Q1	Four Elements Q1
0x53	Q2	Four Elements Q2
0x54	Q3	Four Elements Q3
0x96	AGPVSEL	Output data content: 0: acceleration + angular velocity + angle 1: Displacement + displacement speed + angle 2: Acceleration + angular velocity + timestamp 3: Displacement + displacement speed + timestamp