G-Port Gimbal Communication Protocol

1. Frame Structure Definition

Frame Header	Version	Length	Command	Header Verify	Data	Data Verify

Frame structure field explanation

Field	Byte	Data type	Remarks
Frame Header	1	uint8_t	Starting value of a data frame, fixed at 0XAE
Version	1	uint8_t	Protocol version, currently 0x01
Length	1	uint8_t	Length of the data segment content
Command	1	uint8_t	Different commands correspond to different functions
Header Vertify	1	uint8_t	Version, length, and command checksum
Data	N		Different messages have different meanings, see the detailed explanation of **Protocol Detail**
Data Verify	4	uint32_t	CRC32 value of the data segment content.No data field means no CRC32 content. See **CRC32.C**for CRC32 calculation code.

Unless otherwise specified, the fields are all little-endian bytes.The Assistant software/flight control/RC car is downlink, otherwise it is uplink.

2. Protocol Details

2.1、Gimbal Function Read

Command：0x13

Data Field：None

Data Flow Direction：Downlink

Transmission Example：AE 01 00 13 14

Example Description：There is no data field, so there is no need to add CRC32 check. The same applies to the following.

2.2、Gimbal Function Read Return

Command：0x14

Data Field：Length 15 bytes

Index	Type	Function description	Remarks
0-10		Reserve	No practical use yet
11	uint8_t	Dead zone range	0-255
12	uint8_t	Follow speed	When it is 0, it does not follow the aircraft head, and other values follow the aircraft head

13	int8_t	Gimbal inverted	-1 means inverted, 1 means upright
14		Reserve	No practical use yet

Data Flow Direction：Uplink

Response Example：AE 01 0F 14 24 00 00 00 00 00 00 00 00 00 00 00 32 0A FF 00 26 37 1B BA

Example Description：**Dead Zone Range 32=50；Follow Speed 0A=10；FF=-1 Inverted**

2.3、Gimbal Function Settings

Command：0x15

Data Field：Length 15 bytes

Index	Type	Function description	Remarks
0-10		Reserve	No practical use yet
11	uint8_t	Dead zone range	0-255
12	uint8_t	Follow speed	When it is 0, it does not follow the aircraft head, and other values follow the aircraft head
13	int8_t	Gimbal inverted	1 means inverted, 1 means upright
14		Reserve	No practical use yet

Data Flow Direction：Downlink

Response Example：AE 01 0F 15 25 00 00 00 00 00 00 00 00 00 00 00 32 0A FF 00 26 37 1B BA

Example Description：**Dead Zone Range 32=50；Follow Speed 0A=10；FF=-1 Inverted**

2.4、Gimbal Function Setting Response

Command：0x16

Data Field：None

Data Flow Direction：Uplink

Response Example：AE 01 00 16 17

2.5、Gimbal Control Command

Command：0x85

Data Field：Length 13 bytes

Index	Type	Function description	Remarks
0	int8_t	Control mode	1、speed control 2、angle control 3、Gimbal return to center 4、lock mode
1-2	int16_t	Roll angle control parameters	angle unit is 0.01°

3-4	int16_t	Pitch angle control parameters	angle unit is 0.01°
5-6	int16_t	Yaw angle control parameters	angle unit is 0.01°
7-8	int16_t	Roll speed control parameters	Speed Unit is 0.01°/s
9-10	int16_t	Pitch speed control parameters	Speed Unit is 0.01°/s
11-12	int16_t	Yaw speed control parameters	Speed Unit is 0.01°/s

Data Flow Direction: Downlink

Transmission Example:

Speed Control - Yaw at 30°/s: AE 01 0D 85 93 01 00 00 00 00 00 00 00 00 00 00 B8 0B CC F5 E1 63

Angle Control - Rotate Yaw to 30°: AE 01 0D 85 93 02 00 00 00 00 B8 0B 00 00 00 00 00 00 76 AB AF 70

Gimbal Return to Center: AE 01 0D 85 93 03 00 00 00 00 00 00 00 00 00 00 00 00 44 06 BE 68

Explanation: Speed control is similar to joystick control. If only one command is sent, the gimbal will move at the specified speed for one second and then stop. To achieve continuous control, it is recommended to send speed control commands to the gimbal at a frequency of 10Hz. Additionally, if you want to stop the gimbal immediately, you need to send a speed control command with a speed value of 0. Otherwise, the gimbal will continue to move at the speed specified in the last command for one second before stopping.

2.6、Camera Control command

command：0x86

Data Field：Length 1 bytes

Index	Type	Function description	Remarks
0	int8_t	Take Photo/Record Video	1. The first send starts recording, the second send stops recording 2. Take photos

Data Flow Direction：Downlink

Transmission Example：AE 01 01 86 88 01 CC C0 C5 C3

Example Description：Send recording command

2.7、Gimbal Angle Transmission

Command：0x87

Data Field：Length 12 bytes

Index	Type	Function description	Remarks
0-1	int16_t	IMU_ROLL	IMU Roll angle*100
2-3	int16_t	IMU_PICTH	IMU Pitch angle*100
4-5	int16_t	IMU_YAW	IMU Yawangle*100
6-7	int16_t	Hall angle_ROLL	Hall Roll angle*100

8-9	int16_t	Hall angle_PITCH	Hall Pitch angle*100
10-11	int16_t	Hall angle_YAW	Hall Yaw angle*100

Data Flow Direction：Uplink

Response Example：AE 01 0C 87 94 00 00 00 00 A7 F0 7F F8 F0 FF D2 01 44 0D AD 53

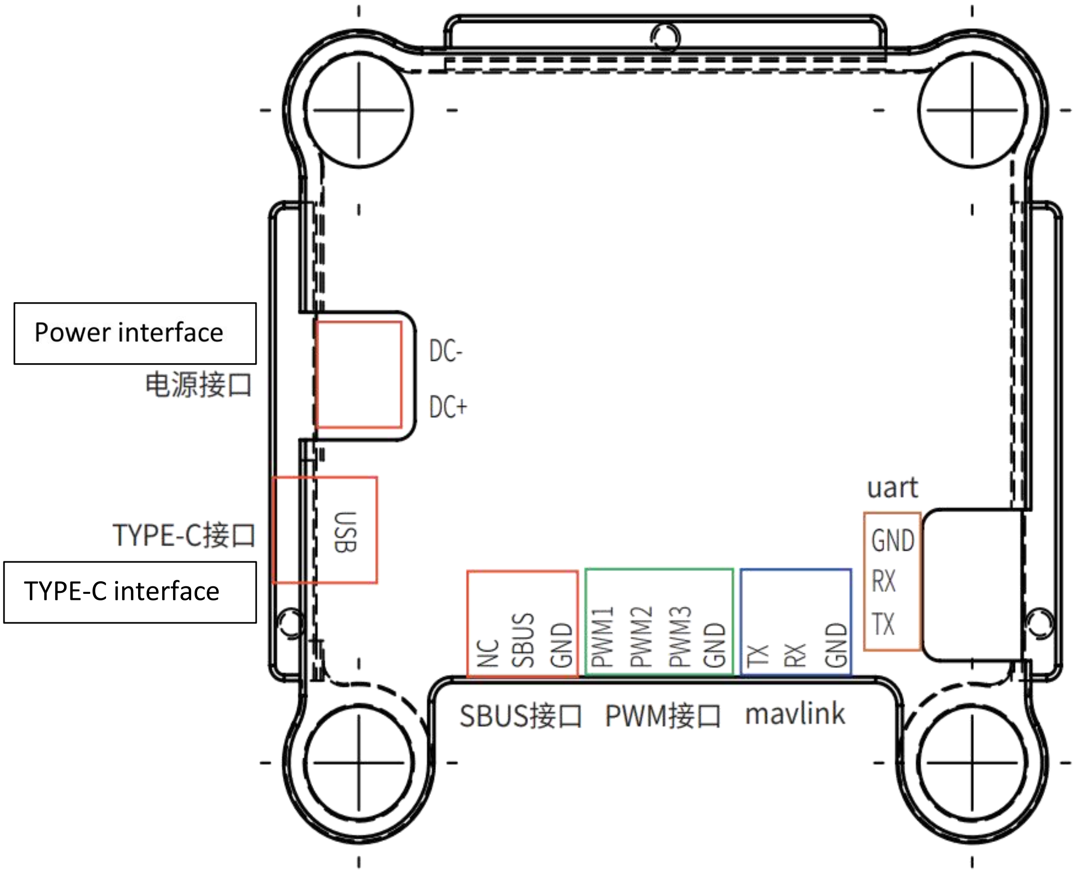
Example Description：

IMU Roll angle 00 00 =0；IMU Pitch angle 00 00 =0；IMU Yaw angle A7 F0 =-3929=-39.29*100；

Hall Roll angle 7F F8 =-1921=-19.21；Hall Pitch angle F0 FF =-16=-0.16*100；Hall Yaw angle D2 01 =466=4.66*100；

3.G-port serial communication Notes

The communication interface is the UART port shown in the figure below; baud rate 115200; data bit 8bt, stop bit 1; no parity check; if the wiring and configuration are correct, the serial port will always receive the gimbal attitude report starting with AE.



Appendix:CRC32 Calculation (C Language version)

```
uint32 Crc32Table[ 256 ] =
{
  0x00000000, 0x04C11DB7, 0x09823B6E, 0x0D4326D9, 0x130476DC, 0x17C56B6B,
  0x1A864DB2, 0x1E475005, 0x2608EDB8, 0x22C9F00F, 0x2F8AD6D6, 0x2B4BCB61,
  0x350C9B64, 0x31CD86D3, 0x3C8EA00A, 0x384FBDBD, 0x4C11DB70, 0x48D0C6C7,
0x4593E01E, 0x4152FDA9, 0x5F15ADAC, 0x5BD4B01B, 0x569796C2, 0x52568B75,
0x6A1936C8, 0x6ED82B7F, 0x639B0DA6, 0x675A1011, 0x791D4014, 0x7DDC5DA3,
0x709F7B7A, 0x745E66CD, 0x9823B6E0, 0x9CE2AB57, 0x91A18D8E, 0x95609039,
0x8B27C03C, 0x8FE6DD8B, 0x82A5FB52, 0x8664E6E5, 0xBE2B5B58, 0xBAEA46EF,
0xB7A96036, 0xB3687D81, 0xAD2F2D84, 0xA9EE3033, 0xA4AD16EA, 0xA06C0B5D,
0xD4326D90, 0xD0F37027, 0xDDB056FE, 0xD9714B49, 0xC7361B4C, 0xC3F706FB,
0xCEB42022, 0xCA753D95, 0xF23A8028, 0xF6FB9D9F, 0xFBB8BB46, 0xFF79A6F1,
0xE13EF6F4, 0xE5FFEB43, 0xE8BCCD9A, 0xEC7DD02D, 0x34867077, 0x30476DC0,
0x3D044B19, 0x39C556AE, 0x278206AB, 0x23431B1C, 0x2E003DC5, 0x2AC12072,
0x128E9DCF, 0x164F8078, 0x1B0CA6A1, 0x1FCDBB16, 0x018AEB13, 0x054BF6A4,
0x0808D07D, 0x0CC9CDCA, 0x7897AB07, 0x7C56B6B0, 0x71159069, 0x75D48DDE,
0x6B93DDDB, 0x6F52C06C, 0x6211E6B5, 0x66D0FB02, 0x5E9F46BF, 0x5A5E5B08,
0x571D7DD1, 0x53DC6066, 0x4D9B3063, 0x495A2DD4, 0x44190B0D, 0x40D816BA,
0xACA5C697, 0xA864DB20, 0xA527FDF9, 0xA1E6E04E, 0xBFA1B04B, 0xBB60ADFC,
0xB6238B25, 0xB2E29692, 0x8AAD2B2F, 0x8E6C3698, 0x832F1041, 0x87EE0DF6,
0x99A95DF3, 0x9D684044, 0x902B669D, 0x94EA7B2A, 0xE0B41DE7, 0xE4750050,
0xE9362689, 0xEDF73B3E, 0xF3B06B3B, 0xF771768C, 0xFA325055, 0xFEF34DE2,
0xC6BCF05F, 0xC27DEDE8, 0xCF3ECB31, 0xCBFFD686, 0xD5B88683, 0xD1799B34,
0xDC3ABDED, 0xD8FBA05A, 0x690CE0EE, 0x6DCDFD59, 0x608EDB80, 0x644FC637,
0x7A089632, 0x7EC98B85, 0x738AAD5C, 0x774BB0EB, 0x4F040D56, 0x4BC510E1,
0x46863638, 0x42472B8F, 0x5C007B8A, 0x58C1663D, 0x558240E4, 0x51435D53,
0x251D3B9E, 0x21DC2629, 0x2C9F00F0, 0x285E1D47, 0x36194D42, 0x32D850F5,
0x3F9B762C, 0x3B5A6B9B, 0x0315D626, 0x07D4CB91, 0x0A97ED48, 0x0E56F0FF,
0x1011A0FA, 0x14D0BD4D, 0x19939B94, 0x1D528623, 0xF12F560E, 0xF5EE4BB9,
0xF8AD6D60, 0xFC6C70D7, 0xE22B20D2, 0xE6EA3D65, 0xEBA91BBC, 0xEF68060B,
0xD727BBB6, 0xD3E6A601, 0xDEA580D8, 0xDA649D6F, 0xC423CD6A, 0xC0E2D0DD,
0xCDA1F604, 0xC960EBB3, 0xBD3E8D7E, 0xB9FF90C9, 0xB4BCB610, 0xB07DABA7,
0xAE3AFBA2, 0xAAFBE615, 0xA7B8C0CC, 0xA379DD7B, 0x9B3660C6, 0x9FF77D71,
0x92B45BA8, 0x9675461F, 0x8832161A, 0x8CF30BAD, 0x81B02D74, 0x857130C3,
0x5D8A9099, 0x594B8D2E, 0x5408ABF7, 0x50C9B640, 0x4E8EE645, 0x4A4FFBF2,
0x470CDD2B, 0x43CDC09C, 0x7B827D21, 0x7F436096, 0x7200464F, 0x76C15BF8,
0x68860BFD, 0x6C47164A, 0x61043093, 0x65C52D24, 0x119B4BE9, 0x155A565E,
0x18197087, 0x1CD86D30, 0x029F3D35, 0x065E2082, 0x0B1D065B, 0x0FDC1BEC,
0x3793A651, 0x3352BBE6, 0x3E119D3F, 0x3AD08088, 0x2497D08D, 0x2056CD3A,
0x2D15EBE3, 0x29D4F654, 0xC5A92679, 0xC1683BCE, 0xCC2B1D17, 0xC8EA00A0,
0xD6AD50A5, 0xD26C4D12, 0xDF2F6BCB, 0xDBEE767C, 0xE3A1CBC1, 0xE760D676,
0xEA23F0AF, 0xEEE2ED18, 0xF0A5BD1D, 0xF464A0AA, 0xF9278673, 0xFDE69BC4,
0x89B8FD09, 0x8D79E0BE, 0x803AC667, 0x84FBDBD0, 0x9ABC8BD5, 0x9E7D9662,
  0x933EB0BB, 0x97FFAD0C, 0xAFB010B1, 0xAB710D06, 0xA6322BDF, 0xA2F33668,
  0xBCB4666D, 0xB8757BDA, 0xB5365D03, 0xB1F740B4 };
//lookup table method
uint32 crc_32(uint8 *pData, uint16 Length)
{

  uint32 nReg; //CRC Register
  uint32 nTemp = 0;
  uint16 i, n;

  nReg = 0xFFFFFFFF; //
  for ( n = 0; n < Length; n++ )
  {
    nReg ^= (uint32) pData[ n ];

    for ( i = 0; i < 4; i++ )
    {
      nTemp = Crc32Table[ ( uint8 )( ( nReg >> 24 ) & 0xff ) ]; //Take a byte and look up the table
      nReg <<= 8; //Discard the previous calculated BYTE
      nReg ^= nTemp; //XOR with the result of the previous BYTE
    }
  }
  return nReg;
}
```