# 1 惯导数据通讯协议

表1.1 接口及传输标准

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **传感器** | **接口形式** | **频率** | **波特率** | **数据位** | **奇偶校验** | **停止位** |
| FSINS | RS-232/422 | 100Hz（可设置） | 230400 | 8 | 无 | 1 |

## 1.1发送

### 1）110个字节（无USBL，适合各类载荷，标黄部分建议存储，或者原始报文存储）

表1.2 发送报文格式

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Message <F0><F1><F2>…..<F36><CRC> | | | | | |
|  | Byte 0~3 | 0xAA 55 5A A5 |  | 帧头 | |
|  | Byte 4 | 0xXX |  | 设备ID，跟型号一致  0x2B=43表示4X水面(3) | |
|  | Byte 5 | 0x6E |  | 报文长度110 | |
|  | Bytes 6 to 9 | *Latitude* (纬度) | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” North of equator | |
|  | Bytes 10 to 13 | *Longitude* (经度) | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” East of Greenwich | |
|  | Bytes 14 to 17 | *Altitude* (高度) | Signed 32 bits integer | in mm | |
|  | Bytes 18 to 19 | *Heave* (升沉) | Signed 16 bits short | in mm  Sign “+” in down direction | |
|  | Bytes 20 to 21 | *VN* | Signed 16 bits short | in mm/s | |
|  | Bytes 22 to 23 | *VE* | Signed 16 bits short |
|  | Bytes 24 to 25 | *VD* | Signed 16 bits short |
|  | Bytes 26 to 27 | *Roll* (横滚) | Signed 16 bits short | in ° (+/- 215= +/- 180°),Sign “+” when port side up | “北-东-地”  坐标系 |
|  | Bytes 28 to 29 | *Pitch* (俯仰) | Signed 16 bits short | in ° (+/- 215= +/- 180°),Sign “+” when bow up |
|  | Bytes 30 to 31 | *Heading* (航向) | Unsigned 16 bits short | in ° (216= 360°) |
|  | Bytes 32 to 33 | INS *Status* | Unsigned 16 bits short | 见表1.4 | |
|  | Bytes 34 to 37 | GPS *Latitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” North of equator | |
|  | Bytes 38 to 41 | GPS *Longitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°))  Sign “+” East of Greenwich | |
|  | Bytes 42 to 45 | GPS *Altitude* | Signed 32 bits integer | in mm | |
|  | Bytes 46 to 47 | GPS *VEL* | Signed 16 bits short | in mm/s | |
|  | Bytes 48 to 49 | GPS *Heading* | Unsigned 16 bits short | in ° (216= 360°) | |
|  | Byte 50 | GPS *Status* | Unsigned 8 bits | GPS状态：0初始化, 1单点定位, 2码差分, 3无效PPS, 4固定解， 5浮点解, 6正在估算, 7人工输入固定值, 8模拟模式, 9WAAS差分, 10有数据无效, 11无数据, 15 配置GPS | |
|  | Bytes 51 to 52 | DVL *Vx* | Signed 16 bits short | in mm/s  对地速度 | |
|  | Bytes 53 to 54 | DVL *Vy* | Signed 16 bits short |
|  | Bytes 55 to 56 | DVL *Vz* | Signed 16 bits short |
|  | Bytes 57 to 60 | DVL *Altitude* | Signed 32 bits integer | in mm，对水底高度 | |
|  | Byte 61 | DVL *Status* | Unsigned 8 bits | 0 无数据  1 有数据,但无效  2 有数据,对地有效  3 有数据,对水有效  4 有数据,对地、对水都有效  15 配置DVL | |
|  | Bytes 62 to 65 | *Gx*角速度 | Signed 32 bits integer | in 0.000001°/s  （10-6） | “前-右-下”  坐标系 |
|  | Bytes 66 to 69 | *Gy*角速度 | Signed 32 bits integer |
|  | Bytes 70 to 73 | *Gz*角速度 | Signed 32 bits integer |
|  | Bytes 74 to 77 | *Ax*加速度 | Signed 32 bits integer | in 0.0000001m/s2  （10-7） |
|  | Bytes 78 to 81 | *Ay*加速度 | Signed 32 bits integer |
|  | Bytes 82 to 85 | *Az*加速度 | Signed 32 bits integer |
|  | Bytes 86 to 87 | *Tempreture* | Signed 16 bits short | in 0.01°C | |
|  | Bytes 88 to 89 | IMU *Status* | Unsigned 16 bits | 见表1.5 | |
|  | Bytes 90 to 92 | YYMMDD | 24 bits unsigned integer | 年月日 | |
|  | Byte 93 to 95 | HHMMSS | 24 bits unsigned integer | 时分秒 | |
|  | Byte 96 to 97 | *ms* | 16 bits unsigned integer | 毫秒 | |
|  | Bytes 98 to 99 | DVL *Vx* | Signed 16 bits short | in mm/s, 对水速度 | |
|  | Bytes 100 to 101 | DVL *Vy* | Signed 16 bits short |
|  | Bytes 102 to 103 | DVL *Vz* | Signed 16 bits short |
|  | Bytes 104 to 106 | Depth | Signed 24 bits float | 压力计测量的深度, in mm；  如果没有深度计，Bytes 104-105做为发送计数器（低字节在前），Bytes 106为0 | |
|  | Bytes 107 | 显示GPS/DVL信息更新状态 |  | Bit 0: GPS位置更新  Bit 1: GPS速度更新  Bit 2: 0  Bit 3: DVL对底速度更新  Bit 4: DVL对水速度更新  Bit 5: 手动更新位置  Bit 6: 手动更新速度  Bit 7: 备用0 | |
|  | Bytes 108 to 109 | Checksum | Unsigned 16 bits | 求和 (Bytes 0 to 107) | |

### 2）140个字节（有USBL，载荷不用这个，只有数据存储才存这个）

表1.3 发送报文格式

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Message <F0><F1><F2>…..<F36><CRC> | | | | | |
|  | Byte 0~3 | 0xAA 55 5A A5 |  | 帧头 | |
|  | Byte 4 | 0xXX |  | 设备ID，跟型号一致  0x2B=43表示4X水面(3) | |
|  | Byte 5 | 0x8C |  | 报文长度140个字节 | |
|  | Bytes 6 to 9 | *Latitude* (纬度) | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” North of equator | |
|  | Bytes 10 to 13 | *Longitude* (经度) | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” East of Greenwich | |
|  | Bytes 14 to 17 | *Altitude* (高度) | Signed 32 bits integer | in mm | |
|  | Bytes 18 to 19 | *Heave* (升沉) | Signed 16 bits short | in mm  Sign “+” in down direction | |
|  | Bytes 20 to 21 | *VN* | Signed 16 bits short | in mm/s | |
|  | Bytes 22 to 23 | *VE* | Signed 16 bits short |
|  | Bytes 24 to 25 | *VD* | Signed 16 bits short |
|  | Bytes 26 to 27 | *Roll* (横滚) | Signed 16 bits short | in ° (+/- 215= +/- 180°),Sign “+” when port side up | “北-东-地”  坐标系 |
|  | Bytes 28 to 29 | *Pitch* (俯仰) | Signed 16 bits short | in ° (+/- 215= +/- 180°),Sign “+” when bow up |
|  | Bytes 30 to 31 | *Heading* (航向) | Unsigned 16 bits short | in ° (216= 360°) |
|  | Bytes 32 to 33 | INS *Status* | Unsigned 16 bits short | 见表1.4 | |
|  | Bytes 34 to 37 | GPS *Latitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” North of equator | |
|  | Bytes 38 to 41 | GPS *Longitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°))  Sign “+” East of Greenwich | |
|  | Bytes 42 to 45 | GPS *Altitude* | Signed 32 bits integer | in mm | |
|  | Bytes 46 to 47 | GPS *VEL* | Signed 16 bits short | in mm/s | |
|  | Bytes 48 to 49 | GPS *Heading* | Unsigned 16 bits short | in ° (216= 360°) | |
|  | Byte 50 | GPS *Status* | Unsigned 8 bits | GPS状态：0初始化, 1单点定位, 2码差分, 3无效PPS, 4固定解， 5浮点解, 6正在估算, 7人工输入固定值, 8模拟模式, 9WAAS差分, 10有数据无效, 11无数据, 15 配置GPS | |
|  | Bytes 51 to 52 | DVL/OCTANS *Vx* | Signed 16 bits short | in mm/s对地速度  或OCTANS速度 | |
|  | Bytes 53 to 54 | DVL/OCTANS *Vy* | Signed 16 bits short |
|  | Bytes 55 to 56 | DVL/OCTANS *Vz* | Signed 16 bits short |
|  | Bytes 57 to 60 | DVL *Altitude* | Signed 32 bits integer | in mm | |
|  | Byte 61 | DVL *Status* | Unsigned 8 bits | 0 无数据  1 有数据,但无效  2 有数据,对地有效  3 有数据,对水有效  4 有数据,对地、对水都有效  15 配置DVL | |
|  | Bytes 62 to 65 | *Gx*角速度 | Signed 32 bits integer | in 0.000001°/s  （10-6） | “前-右-下”  坐标系 |
|  | Bytes 66 to 69 | *Gy*角速度 | Signed 32 bits integer |
|  | Bytes 70 to 73 | *Gz*角速度 | Signed 32 bits integer |
|  | Bytes 74 to 77 | *Ax*加速度 | Signed 32 bits integer | in 0.0000001m/s2  （10-7） |
|  | Bytes 78 to 81 | *Ay*加速度 | Signed 32 bits integer |
|  | Bytes 82 to 85 | *Az*加速度 | Signed 32 bits integer |
|  | Bytes 86 to 87 | *Tempreture* | Signed 16 bits short | in 0.01°C | |
|  | Bytes 88 to 89 | IMU *Status* | Unsigned 16 bits | 见表1.5 | |
|  | Bytes 90 to 92 | YYMMDD | 24 bits unsigned integer | 年月日 | |
|  | Byte 93 to 95 | HHMMSS | 24 bits unsigned integer | 时分秒 | |
|  | Byte 96 to 97 | *ms* | 16 bits unsigned integer | 毫秒 | |
|  | Bytes 98 to 99 | DVL *Vx* | Signed 16 bits short | in mm/s, 对水速度 | |
|  | Bytes 100 to 101 | DVL *Vy* | Signed 16 bits short |
|  | Bytes 102 to 103 | DVL *Vz* | Signed 16 bits short |
|  | Bytes 104 to 107 | Depth | Signed 32 bits float | 压力计测量的深度， in mm | |
|  | Bytes 108 to 111 | USBL/*Latitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°)  Sign “+” North of equator | |
|  | Bytes 112 to 115 | USBL/*Longitude* | Signed 32 bits integer | in °(+/-231 = +/- 180°))  Sign “+” East of Greenwich | |
|  | Bytes 116 to 119 | USBL/*Altitude* | Signed 32 bits integer | in mm | |
|  | Byte 120 | USBL *Status* | Unsigned 8 bits | USBL 状态：0初始化, 1有效, 10有数据无效, 11无数据, 15 配置USBL | |
|  | Bytes 121 to 122 | 波束0 velocity | Signed 16 bits short | Velocity in the direction of the transducer (mm/s) | |
| 或 横荡速度Vx |
|  | Bytes 123 to 124 | 波束1 velocity | Signed 16 bits short |
| 或 纵荡速度Vy |
|  | Bytes 125 to 126 | 波束2 velocity | Signed 16 bits short |
| 或 垂荡速度Vz |
|  | Bytes 127 to 128 | 波束3 velocity  或 主航向 | Signed 16 bits short |
|  | Bytes 129 to 130 | 波束0 distance | Signed 16 bits short | Distance (parallel to the transducer beam, i.e. not the vertical distance) to the reflecting surface from this transducer (mm) | |
| 或 横荡 |
|  | Bytes 131 to 132 | 波束1 distance | Signed 16 bits short |
| 或 纵荡 |
|  | Bytes 133 to 134 | 波束2 distance | Signed 16 bits short |
| 或 垂荡（即升沉） |
|  | Bytes 135 to 136 | 波束3 distance | Signed 16 bits short |
|  | Bytes 137 | 显示  GPS/USBL/DVL信息更新状态 |  | Bit 0: GPS位置更新  Bit 1: GPS速度更新  Bit 2: USBL位置更新  Bit 3: DVL对底速度更新  Bit 4: DVL对水速度更新  Bit 5: 手动更新位置  Bit 6: 手动更新速度  Bit 7: 备用0 | |
|  | Bytes 138 to 139 | Checksum | Unsigned 16 bits | 求和 (Bytes 0 to 137) | |

### 3）INS状态

表1.4 INS状态

|  |  |  |
| --- | --- | --- |
| **第N位** | **对应位为“1”时表示状态** | **备注** |
|  | 准备 | INS工作状态：  1）准备（待机）  2）对准（粗、精对准）  3）导航（纯惯性、组合GNSS、组合DVL、组合GNSS+DVL等）  注释：GNSS全球卫星导航系统包括GPS、北斗等 |
|  | 粗对准 |
|  | 精对准 |
|  | 纯惯性导航 |
|  | GNSS组合导航 |
|  | DVL组合导航 |
|  | GNSS+DVL组合导航 |
|  | 无位置参考 | 参考位置修正 |
|  | 装订位置 |
|  | GNSS位置 |
|  | 无速度参考 | 参考速度修正  注释：长时间没有GNSS和DVL信息修正，系统自动进入零速修正 |
|  | 零速 |
|  | GNSS速度 |
|  | DVL速度 |
|  | INS数据有效 | 注释：对准以后（静基座5分钟，动基座10分钟）INS数据有效。但一般情况下，粗对准后（20sec）惯导的数据即可用，如果需要保证精度，应在精对准后 |
|  | 故障 | IMU采样或导航计算异常导致故障 |

### 4）IMU状态

表1.5 IMU状态

|  |  |  |
| --- | --- | --- |
| **第N位** | **对应位为“1”时表示状态** | **备注** |
|  | ***Ax*** | 超量程  根据飞行器、车、船、水下机器人应用环境设置 |
|  | ***Ay*** |
|  | ***Az*** |
|  | ***Gx*** |
|  | ***Gx*** |
|  | ***Gx*** |
|  | ***Ax*** | 1sec之内90%的采样值不变 |
|  | ***Ay*** |
|  | ***Az*** |
|  | ***Gx*** |
|  | ***Gx*** |
|  | ***Gx*** |
|  | Temperature | 超量程 |
|  | Temperature | 1min之内值不变 |
|  | 采样丢帧 | 帧号（0~255）不连续 |
|  | 漏水 | 接口板发来的漏水报警信号 |