Strelka Ground Station RF Protocol

# Preface:

This document outlines the radio protocol implemented using the LoRa modulation technique for communications between the Strelka device and the ground station.

# Packet Structure:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Identifier** | **Protocol version** | **Sender unique ID** | **Receiver unique ID** | **Payload** | **CRC32** |
| **Data type** | uint16\_t | uint8\_t | uint32\_t | uint32\_t | uint8\_t | uint32\_t |
| **Length (bytes)** | 2 | 1 | 4 | 4 | variable | 4 |
| **Description** | Signify the packet type | Signifies the protocol version | Hardware ID of transmitting device | Hardware ID of receiving device | Fields containing fixed length payloads | 32-bit CRC checksum |

The unique ID of the Strelka can be obtained from the first 32 bits of the hardware ID contained in the STM32’s ROM. The ground station must know this ID so that it can choose which nodes it is speaking to.

The unique ID of the ground station is aways 0x00000000.

Add heartbeat req res packet.

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# Payload Fields:

## BAT\_VOL\_REQ

Request battery voltage.

Identifier: 0x0000

Payload:

*No payload fields.*

## BAT\_VOL\_RES

Battery voltage response.

Identifier: 0x0001

Payload:

|  |  |
| --- | --- |
| Name | Battery voltage |
| Value | - |
| Data type | float32\_t |
| Length (bytes) | 4 |

## CONTINUITY\_REQ

Request continuity.

Identifier: 0x0002

Payload:

*No payload fields.*

## CONTINUITY \_RES

Continuity response.

Identifier: 0x0003

Payload:

|  |  |  |
| --- | --- | --- |
| Name | Drogue e-match state | Main e-match state |
| Value | *ematchState* | *ematchState* |
| Data type | uint8\_t | uint8\_t |
| Length (bytes) | 1 | 1 |

*ematchState*

|  |  |
| --- | --- |
| Value | Result |
| 0 | *OPEN\_CIRCUIT* |
| 1 | *SHORT\_CIRCUIT* |
| 2 | *GOOD* |
| 3 | *EMATCH\_ERROR* |

## FIRE\_DROGUE\_REQ

Fire drogue channel request.

Identifier: 0x0004

Payload:

*No payload fields.*

## FIRE\_DROGUE\_RES

Fire drogue channel response.

Identifier: 0x0005

Payload:

|  |  |
| --- | --- |
| Name | Fire drogue result |
| Value | 0 – success, 1 - error |
| Data type | uint8\_t |
| Length (bytes) | 1 |

## FIRE\_MAIN\_REQ

Fire main channel request.

Identifier: 0x0006

Payload:

*No payload fields.*

## FIRE\_MAIN\_RES

Fire main channel response.

Identifier: 0x0007

Payload:

|  |  |
| --- | --- |
| Name | Fire main result |
| Value | 0 – success, 1 - error |
| Data type | uint8\_t |
| Length (bytes) | 1 |

## GPS1\_STATE\_REQ

Request GPS 1 state.

Identifier: 0x0008

Payload:

*No payload fields.*

## GPS1\_STATE\_RES

GPS 1 state response.

Identifier: 0x0009

Payload:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | GPS1 good | GPS 1 latitude | GPS 1 longitude | GPS1 altitude | GPS1 satellites tracked |
| Value | 0 – error, 1 - good | *Decimal degrees* | *Decimal degrees* | *Units of ‘m’* | - |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t | uint8\_t |
| Length (bytes) | 1 | 4 | 4 | 4 | 1 |

## GPS2\_STATE\_REQ

Request GPS 2 state.

Identifier: 0x000A

Payload:

*No payload fields.*

## GPS2\_STATE\_RES

GPS 2 state response.

Identifier: 0x000B

Payload:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | GPS2 good | GPS2 latitude | GPS2 longitude | GPS2 altitude | GPS2 satellites tracked |
| Value | 0 – error, 1 - good | *Decimal degrees* | *Decimal degrees* | *Units of ‘m’* | - |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t | uint8\_t |
| Length (bytes) | 1 | 4 | 4 | 4 | 1 |

## ACCEL1\_STATE\_REQ

Request accelerometer 1 state.

Identifier: 0x000C

Payload:

*No payload fields.*

## ACCEL1\_STATE\_RES

Accelerometer 1 state response.

Identifier: 0x000D

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | acc1 good | acc1X | acc1Y | acc1Z |
| Value | 0 – error, 1 - good | *Units of ‘g’* | *Units of ‘g’* | U*nits of ‘g’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## ACCEL2\_STATE\_REQ

Request accelerometer 2 state.

Identifier: 0x000E

Payload:

*No payload fields.*

## ACCEL2\_STATE\_RES

Accelerometer 2 state response.

Identifier: 0x000F

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | acc2 good | acc2X | acc2Y | acc2Z |
| Value | 0 – error, 1 - good | *Units of ‘g’* | *Units of ‘g’* | U*nits of ‘g’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## GYRO1\_STATE\_REQ

Request gyroscope 1 state.

Identifier: 0x0010

Payload:

*No payload fields.*

## GYRO1\_STATE\_RES

Gyroscope 1 state response.

Identifier: 0x0011

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | gyro1 good | gyro1X | gyro1Y | gyro1Z |
| Value | 0 – error, 1 - good | *Units of ‘deg/s’* | *Units of ‘deg/s’* | *Units of ‘deg/s’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## GYRO2\_STATE\_REQ

Request gyroscope 2 state.

Identifier: 0x0012

Payload:

*No payload fields.*

## GYRO2\_STATE\_RES

Gyroscope 2 state response.

Identifier: 0x0013

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | gyro2 good | gyro2X | gyro2Y | gyro2Z |
| Value | 0 – error, 1 - good | *Units of ‘deg/s’* | *Units of ‘deg/s’* | *Units of ‘deg/s’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## MAG1\_STATE\_REQ

Request magnetometer 1 state.

Identifier: 0x0014

Payload:

*No payload fields.*

## MAG1\_STATE\_RES

Magnetometer 1 state response.

Identifier: 0x0015

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | mag1 good | mag1X | mag1Y | mag1Z |
| Value | 0 – error, 1 - good | *Units of ‘uT’* | *Units of ‘uT’* | *Units of ‘uT’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## MAG2\_STATE\_REQ

Request magnetometer 2 state.

Identifier: 0x0016

Payload:

*No payload fields.*

## MAG2\_STATE\_RES

Magnetometer 1 state response.

Identifier: 0x0017

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | mag2 good | mag2X | mag2Y | mag2Z |
| Value | 0 – error, 1 - good | *Units of ‘uT’* | *Units of ‘uT’* | *Units of ‘uT’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## BARO1\_STATE\_REQ

Request barometer 1 state.

Identifier: 0x0018

Payload:

*No payload fields.*

## BARO1\_STATE\_RES

Barometer 1 state response.

Identifier: 0x0019

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | baro1 good | Baro1 pressure | Baro1 temperature | Baro1 altitude |
| Value | 0 – error, 1 - good | *Units of ‘Pa’* | *Units of ‘deg C’* | *Units of ‘m’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## BARO2\_STATE\_REQ

Request barometer 2 state.

Identifier: 0x001A

Payload:

*No payload fields.*

## BARO2\_STATE\_RES

Barometer 2 state response.

Identifier: 0x001B

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | baro2 good | Baro2 pressure | Baro2 temperature | Baro2 altitude |
| Value | 0 – error, 1 - good | *Units of ‘Pa’* | *Units of ‘deg C’* | *Units of ‘m’* |
| Data type | uint8\_t | float32\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 | 4 |

## FLASH\_MEMORY\_STATE\_REQ

Request flash memory state.

Identifier: 0x001C

Payload:

*No payload fields.*

## FLASH\_MEMORY\_STATE\_RES

Flash memory state response.

Identifier: 0x001D

Payload:

|  |  |  |  |
| --- | --- | --- | --- |
| Name | flash good | Flash write speed | Available flash memory |
| Value | 0 – error, 1 - good | *Units of ‘Hz’* | Units of Kbytes |
| Data type | uint8\_t | float32\_t | float32\_t |
| Length (bytes) | 1 | 4 | 4 |

## FLASH\_MEMORY\_CONFIG\_SET

Flash memory state response.

Identifier: 0x001E

Payload:

|  |  |  |
| --- | --- | --- |
| Name | flash logging enabled | Flash write speed |
| Value | 0 – diabled, 1 - enabled | *Units of ‘Hz’* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

## GPS\_TRACKING\_CONFIG\_REQ

Request GPS tracking configuration.

Identifier: 0x001F

Payload:

*No payload fields.*

## GPS\_TRACKING\_CONFIG\_RES

GPS tracking configuration response.

Identifier: 0x0020

Payload:

|  |  |  |
| --- | --- | --- |
| Name | GPS tracking enabled | GPS tracking chirp frequency |
| Value | 0 – disabled, 1 - enabled | *Units of ‘Hz’* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

## GPS\_TRACKING\_CONFIG\_SET

Set GPS tracking configuration.

Identifier: 0x0021

Payload:

|  |  |  |
| --- | --- | --- |
| Name | GPS tracking enabled | GPS tracking chirp frequency |
| Value | *0 – disabled, 1- enabled* | *Units of ‘Hz’* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

## GPS\_TRACKING\_PACKET

GPS tracking data packet.

Identifier: 0x0022

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | GPS1 latitude | GPS1 longitude | GPS1 altitude | GPS1 satellites tracked |
| Value | *Decimal degrees* | *Decimal degrees* | *Units of ‘m’* | - |
| Data type | float32\_t | float32\_t | float32\_t | uint8\_t |
| Length (bytes) | 4 | 4 | 4 | 1 |

STREAM\_PACKET\_CONFIG\_SET

Configuration of data streaming

Identifier: 0x0023

Payload:

|  |  |  |
| --- | --- | --- |
| Name | Packet type enabled | Packet stream frequency |
| Value | *Value from 0-7* | *Units of Hz* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

## STREAM\_PACKET\_TYPE\_0

Data streaming packet.

Identifier: 0x0024

Payload:

*<Start of payload>*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | Timestamp | GPS1 latitude | GPS1 longitude | GPS1 altitude | GPS1 satellites tracked |
| Value | *Milliseconds since boot* | *Decimal degrees* | *Decimal degrees* | *Units of ‘m’* | - |
| Data type | uint32\_t | float32\_t | float32\_t | float32\_t | uint8\_t |
| Length (bytes) | 4 | 4 | 4 | 4 | 1 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Acc1X | Acc1Y | Acc1Z | VelX | VelY | VelZ |
| *Units of ‘g’* | *Units of ‘g’* | *Units of ‘g’* | *Units of m/s* | *Units of m/s* | *Units of m/s* |
| float32\_t | float32\_t | float32\_t | float32\_t | float32\_t | float32\_t |
| 4 | 4 | 4 | 4 | 4 | 4 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Baro1 altitude | gyro1X | gyro1Y | gyro1Z | Quaternion 1 | Quaternion 2 |
| *Units of m* | *Units of rad/s* | *Units of rad/s* | *Units of rad/s* | *q1* | *q2* |
| float32\_t | float32\_t | float32\_t | float32\_t | float32\_t | float32\_t |
| 4 | 4 | 4 | 4 | 4 | 4 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Quaternion 3 | Quaternion 4 | Battery voltage | Flight State | Ambient temperature | Available flash memory |
| *q3* | *q4* | *Units of V* | *Enum defined below* | Units of deg C | Units of Kbytes |
| float32\_t | float32\_t | float32\_t | uint8\_t | float32\_t | float32\_t |
| 4 | 4 | 4 | 1 | 4 | 4 |

|  |
| --- |
| GPS1 good |
| 1 – true, 0 - fase |
| uint8\_t |
| 1 |

*<End of payload>*

***Flight State:***

|  |  |
| --- | --- |
| State description | Value |
| Idle on pad | 0 |
| Launched | 1 |
| Burnout | 2 |
| Apogee | 3 |
| Main chute deploy | 4 |
| Landed | 5 |

## STREAM\_PACKET\_TYPE\_1

Data streaming packet.

Identifier: 0x0025

Payload:

## STREAM\_PACKET\_TYPE\_2

Data streaming packet.

Identifier: 0x0026

Payload:

## STREAM\_PACKET\_TYPE\_3

Data streaming packet.

Identifier: 0x0027

Payload:

## STREAM\_PACKET\_TYPE\_4

Data streaming packet.

Identifier: 0x0028

Payload:

## STREAM\_PACKET\_TYPE\_5

Data streaming packet.

Identifier: 0x0029

Payload:

## STREAM\_PACKET\_TYPE\_6

Data streaming packet.

Identifier: 0x002A

Payload:

## STREAM\_PACKET\_TYPE\_7

Data streaming packet.

Identifier: 0x002B

Payload:

STREAM\_PACKET\_CONFIG\_REQ

Request configuration of data streaming

Identifier: 0x002C

Payload:

*No payload*

STREAM\_PACKET\_CONFIG\_RES

Request configuration of data streaming

Identifier: 0x002D

Payload:

*<Start of payload>*

|  |  |  |
| --- | --- | --- |
| Name | Packet type enabled | Packet stream frequency |
| Value | *Value from 0-7*  *Else – No stream packets enabled* | *Units of Hz* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

HEART\_BEAT\_CONFIG\_PACKET\_SET

Heart beat configuration packet.

Identifier: 0x002E

Payload:

|  |  |  |
| --- | --- | --- |
| Name | Heart beat enabled | Heart beat chirp frequency |
| Value | *0 – disabled, 1- enabled* | *Units of ‘Hz’* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

HEART\_BEAT\_PACKET

Heart beat packet.

Identifier: 0x002F

Payload:

|  |  |
| --- | --- |
| Name |  |
| Value |  |
| Data type |  |
| Length (bytes) |  |

ARM\_DROGUE\_REQ

Request to arm system to fire main e-match.

Any value provided other than 0 or 1 is interpreted as a request for the current drogue arming state.

Identifier: 0x0030

Payload:

|  |  |
| --- | --- |
| Name | Drogue arm state set |
| Value | *0 – Disarmed,*  *1 – Armed,*  *Else – Arm state request* |
| Data type | uint8\_t |
| Length (bytes) | 1 |

ARM\_MAIN\_REQ

Request to arm system to fire drogue e-match.

Any value provided other than 0 or 1 is interpreted as a request for the current main arming state.

Identifier: 0x0031

Payload:

|  |  |
| --- | --- |
| Name | Main arm state set |
| Value | *0 – Disarmed,*  *1 – Armed,*  *Else – Arm state request* |
| Data type | uint8\_t |
| Length (bytes) | 1 |

ARM\_MAIN\_RES

Response to request to arm main e-match.

Identifier: 0x0032

Payload:

|  |  |
| --- | --- |
| Name | Arm main state |
| Value | *1 – armed, 0 - disarmed* |
| Data type | uint8\_t |
| Length (bytes) | 1 |

ARM\_DROGUE\_RES

Response to request to arm drogue e-match.

Identifier: 0x0033

Payload:

|  |  |
| --- | --- |
| Name | Arm drogue state |
| Value | *1 – armed, 0 - disarmed* |
| Data type | uint8\_t |
| Length (bytes) | 1 |

SYSTEM\_STATE\_PACKET\_REQ

Requests system state packet.

Identifier: 0x0034

Payload:

|  |  |
| --- | --- |
| Name | State packet type |
| Value | *Values 0 – 7* |
| Data type | uint8\_t |
| Length (bytes) | 1 |

SYSTEM\_STATE\_PACKET\_TYPE\_0\_RES

Requests system state packet.

Identifier: 0x0035

*Payload:*

*<Start of payload>*

|  |  |  |
| --- | --- | --- |
| Name | Timestamp | Battery voltage |
| Value | *Milliseconds since boot* |  |
| Data type | uint32\_t | float32\_t |
| Length (bytes) | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| Drogue e-match state | Main e-match state | Arm drogue state | Arm main state |
| *Flight State* | *Flight State* | *1 – armed, 0 - disarmed* | *1 – armed, 0 - disarmed* |
| uint8\_t | uint8\_t | uint8\_t | uint8\_t |
| 1 | 1 | 1 | 1 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| GPS1 good | GPS1 latitude | GPS1 longitude | GPS1 altitude | GPS1 satellites tracked |
| 0 – error, 1 - good | *Decimal degrees* | *Decimal degrees* | *Units of ‘m’* | - |
| uint8\_t | float32\_t | float32\_t | float32\_t | uint8\_t |
| 1 | 4 | 4 | 4 | 1 |

|  |  |  |  |
| --- | --- | --- | --- |
| acc1 good | acc1X | acc1Y | acc1Z |
| 0 – error, 1 - good | *Units of ‘g’* | *Units of ‘g’* | U*nits of ‘g’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| acc2 good | acc2X | acc2Y | acc2Z |
| 0 – error, 1 - good | *Units of ‘g’* | *Units of ‘g’* | U*nits of ‘g’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| gyro1 good | gyro1X | gyro1Y | gyro1Z |
| 0 – error, 1 - good | *Units of ‘deg/s’* | *Units of ‘deg/s’* | *Units of ‘deg/s’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| gyro2 good | gyro2X | gyro2Y | gyro2Z |
| 0 – error, 1 - good | *Units of ‘deg/s’* | *Units of ‘deg/s’* | *Units of ‘deg/s’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| mag1 good | mag1X | mag1Y | mag1Z |
| 0 – error, 1 - good | *Units of ‘uT’* | *Units of ‘uT’* | *Units of ‘uT’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| baro1 good | Baro1 pressure | Baro1 temperature | Baro1 altitude |
| 0 – error, 1 - good | *Units of ‘Pa’* | *Units of ‘deg C’* | *Units of ‘m’* |
| uint8\_t | float32\_t | float32\_t | float32\_t |
| 1 | 4 | 4 | 4 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| flash good | Flash write speed | Available flash memory | GPS tracking enabled | GPS tracking chirp frequency |
| 0 – error, 1 - good | *Units of ‘Hz’* | Units of Kbytes | 0 – disabled, 1 - enabled | *Units of ‘Hz’* |
| uint8\_t | float32\_t | float32\_t | uint8\_t | float32\_t |
| 1 | 4 | 4 | 1 | 4 |

|  |  |  |  |
| --- | --- | --- | --- |
| Stream packet type enabled | Packet stream frequency | Heart beat enabled | Heart beat chirp frequency |
| *Value from 0-7* | *Units of Hz* | *0 – disabled, 1- enabled* | *Units of ‘Hz’* |
| uint8\_t | float32\_t | uint8\_t | float32\_t |

|  |  |  |  |
| --- | --- | --- | --- |
| Flash logging enabled | Flight state |  |  |
| *0 – disabled*  *1 - enabled* | *See flight state enum* |  |  |
| uint8\_t | unit8\_t |  |  |

SYSTEM\_STATE\_PACKET\_TYPE\_1\_RES

Requests system state packet.

*Identifier: 0x0036*

SYSTEM\_STATE\_PACKET\_TYPE\_2\_RES

Requests system state packet.

*Identifier: 0x0037*

SYSTEM\_STATE\_PACKET\_TYPE\_3\_RES

Requests system state packet.

*Identifier: 0x0038*

SYSTEM\_STATE\_PACKET\_TYPE\_4\_RES

Requests system state packet.

*Identifier: 0x0039*

SYSTEM\_STATE\_PACKET\_TYPE\_5\_RES

Requests system state packet.

*Identifier: 0x003A*

SYSTEM\_STATE\_PACKET\_TYPE\_6\_RES

Requests system state packet.

*Identifier: 0x003B*

SYSTEM\_STATE\_PACKET\_TYPE\_7\_RES

Requests system state packet.

*Identifier: 0x003C*