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 always 0x00000000.

Contents

[Preface: 1](#_Toc156327637)

[Packet Structure: 1](#_Toc156327638)

[Payload Fields: 3](#_Toc156327639)

[BAT\_VOL\_REQ 3](#_Toc156327640)

[BAT\_VOL\_RES 3](#_Toc156327641)

[CONTINUITY\_REQ 3](#_Toc156327642)

[CONTINUITY \_RES 3](#_Toc156327643)

[FIRE\_DROGUE\_REQ 3](#_Toc156327644)

[FIRE\_DROGUE\_RES 4](#_Toc156327645)

[FIRE\_MAIN\_REQ 4](#_Toc156327646)

[FIRE\_MAIN\_RES 4](#_Toc156327647)

[GPS1\_STATE\_REQ 4](#_Toc156327648)

[GPS1\_STATE\_RES 4](#_Toc156327649)

[GPS2\_STATE\_REQ 5](#_Toc156327650)

[GPS2\_STATE\_RES 5](#_Toc156327651)

[ACCEL1\_STATE\_REQ 5](#_Toc156327652)

[ACCEL1\_STATE\_RES 5](#_Toc156327653)

[ACCEL2\_STATE\_REQ 6](#_Toc156327654)

[ACCEL2\_STATE\_RES 6](#_Toc156327655)

[GYRO1\_STATE\_REQ 6](#_Toc156327656)

[GYRO1\_STATE\_RES 6](#_Toc156327657)

[GYRO2\_STATE\_REQ 7](#_Toc156327658)

[GYRO2\_STATE\_RES 7](#_Toc156327659)

[MAG1\_STATE\_REQ 7](#_Toc156327660)

[MAG1\_STATE\_RES 7](#_Toc156327661)

[MAG2\_STATE\_REQ 8](#_Toc156327662)

[MAG2\_STATE\_RES 8](#_Toc156327663)

[BARO1\_STATE\_REQ 8](#_Toc156327664)

[BARO1\_STATE\_RES 8](#_Toc156327665)

[BARO2\_STATE\_REQ 9](#_Toc156327666)

[BARO2\_STATE\_RES 9](#_Toc156327667)

[FLASH\_MEMORY\_STATE\_REQ 9](#_Toc156327668)

[FLASH\_MEMORY\_STATE\_RES 10](#_Toc156327669)

[FLASH\_MEMORY\_CONFIG\_SET 10](#_Toc156327670)

[GPS\_TRACKING\_CONFIG\_REQ 10](#_Toc156327671)

[GPS\_TRACKING\_CONFIG\_RES 10](#_Toc156327672)

[GPS\_TRACKING\_CONFIG\_SET 10](#_Toc156327673)

[GPS\_TRACKING\_PACKET 11](#_Toc156327674)

[STREAM\_PACKET\_TYPE\_0 12](#_Toc156327675)

[STREAM\_PACKET\_TYPE\_1 13](#_Toc156327676)

[STREAM\_PACKET\_TYPE\_2 14](#_Toc156327677)

[STREAM\_PACKET\_TYPE\_3 14](#_Toc156327678)

[STREAM\_PACKET\_TYPE\_4 14](#_Toc156327679)

[STREAM\_PACKET\_TYPE\_5 14](#_Toc156327680)

[STREAM\_PACKET\_TYPE\_6 14](#_Toc156327681)

[STREAM\_PACKET\_TYPE\_7 14](#_Toc156327682)

# 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 | GPS good | Latitude | Longitude | Altitude | 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 | GPS good | Latitude | Longitude | Altitude | 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 | acc good | accX | accY | accZ |
| 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 | acc good | accX | accY | accZ |
| 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 | gyro good | gyroX | gyroY | gyroZ |
| 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 | gyro good | gyroX | gyroY | gyroZ |
| 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 | mag good | magX | magY | magZ |
| 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 | mag good | magX | magY | magZ |
| 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 | baro good | Pressure | Temperature | 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 | baro good | Pressure | Temperature | 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 | Write speed |
| Value | 0 – error, 1 - good | *Units of ‘Hz’* |
| Data type | uint8\_t | float32\_t |
| Length (bytes) | 1 | 4 |

## FLASH\_MEMORY\_CONFIG\_SET

Flash memory state response.

Identifier: 0x001E

Payload:

*TODO*

## 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 good | Chirp frequency |
| Value | 0 – error, 1 - good | *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 | Chirp frequency |
| Value | *Units of ‘Hz’* |
| Data type | float32\_t |
| Length (bytes) | 4 |

## GPS\_TRACKING\_PACKET

GPS tracking data packet.

Identifier: 0x0022

Payload:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Name | Latitude | Longitude | Altitude | 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\_PKT\_CONFIG\_SET

Configuration of data streaming

Identifier: 0x0023

Payload:

*<Start of payload>*

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

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Packet type 2 enable | Packet type 2 stream frequency | Packet type 3 enable | Packet type 3 stream frequency | Packet type 4 enable | Packet type 4 stream frequency |
| *1 or 0* | *Units of Hz* | *1 or 0* | *Units of Hz* | *1 or 0* | *Units of Hz* |
| uint8\_t | float32\_t | uint8\_t | float32\_t | uint8\_t | float32\_t |
| 1 | 4 | 1 | 4 | 1 | 4 |
| Packet type 5 enable | Packet type 5 stream frequency | Packet type 6 enable | Packet type 6 stream frequency | Packet type 7 enable | Packet type 7 stream frequency |
| *1 or 0* | *Units of Hz* | *1 or 0* | *Units of Hz* | *1 or 0* | *Units of Hz* |
| uint8\_t | float32\_t | uint8\_t | float32\_t | uint8\_t | float32\_t |
| 1 | 4 | 1 | 4 | 1 | 4 |

*<End of payload>*

## STREAM\_PACKET\_TYPE\_0

Data streaming packet.

Identifier: 0x0024

Payload:

*<Start of payload>*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Name | System time | Latitude | Longitude | GPS Altitude | 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 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Acceleration X | Acceleration Y | Acceleration Z | Velocity X | Velocity Y | Velocity Z |
| *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 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Barometer Altitude | Angular velocity X | Angular velocity Y | Angular velocity Z | 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 |

*<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:

## HEART\_BEAT\_CONFIG\_PACKET

Heart beat configuration packet.

Identifier: 0x002C

Payload:

|  |  |  |
| --- | --- | --- |
| Name | Transmit frequency |  |
| Value | *Units of ‘Hz’* |  |
| Data type | float32\_t |  |
| Length (bytes) | 4 |  |

## HEART\_BEAT\_PACKET

Heart beat packet.

Identifier: 0x002D

Payload:

## ARM\_DROGUE\_REQ

Request to arm system to fire main e-match.

Identifier: 0x002E

Payload:

*No payload fields.*

## ARM\_DROGUE\_RES

Fire drogue channel response.

Identifier: 0x002F

Payload:

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

## ARM\_MAIN\_REQ

Request to arm system to fire main e-match.

Identifier: 0x0030

Payload:

*No payload fields.*

## ARM\_MAIN\_RES

Fire drogue channel response.

Identifier: 0x0031

Payload:

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