# GROUND Lite Communications Protocol Specification
## Version 1.1.0

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## Contents

## 1  Overview

The GROUND (GAIA Radio OUtput Network Delivery) Lite protocol is a power and data efficiency optimized version of the original GROUND protocol. All data is serialized in little-endian format, meaning the least significant byte is sent first. For example, the number `0x1234` would be transmitted as `0x34 0x12`.

## 2  Packet Structure

A packet comprises the following fields:

| # | Field Name | Size |
|---|---|---|
| 1 | magic_number | 4 bytes |
| 2 | packet_number | 2 bytes |
| 3 | content_type | 1 bytes |
| 4 | content_size | 1 bytes |
| 5 | content | content_size bytes |

### Field Descriptions

`magic_number`: A constant value `0x67616961` (ASCII for `gaia`) that marks the start of a packet.

`content_type`: Specifies the type and structure of the data. Its definitions are listed in the table below.

| Value | Data Type | Type | Description |
|-------|-----------|------|-------------|
| 0x01 | float | GPS_POS[3] | GPS coordinates |
| 0x02 | float | G_FORCES[3] | G-force measurement |
| 0x03 | float | ROTATION[3] | Angle measurement |
| 0x04 | uint32_t | TIME | Time |
| 0x05 | uint32_t | GPS_FIX_AGE | Time in ms since last gps fix |
| 0x06 | float | GPS_HDOP | Horizontal Dilution of Precision |
| 0x07 | uint8_t | GPS_NUM_OF_SATS | Number of satellites in view |
| 0x08 | float | GPS_FAIL_PERCENTAGE | Percentage of GPS cheksums failed |
| 0x09 | uint16_t | CO2_CONCENTRATION | *UNUSED* $CO_2$ concentration in ppb |
| 0x0A | float | TEMPERATURE | Temperature in °C |
| 0x0B | float | PRESSURE | Pressure in Pa |
| 0x0C | uint16_t | DUST_CONCENTRATION | Dust concentration in $\mu g/m^3$ |
| 0x0D | float | UV_RADIATON | UV radiation in $mW/cm^2$ |

`content_size`: The number of bytes in the `content` field.

`content`: The actual data payload. Its interpretation depends on `content_type`.

## 3   Handling `magic_number` in Content

If the `magic_number` sequence 0x67616961 appears in the `content`, it must be escaped by appending a 0x00 byte immediately after. For example:

67 61 69 61 → 67 61 69 61 00

The escape byte contributes to `content_size` but should be removed during packet parsing.

## 4   Encoding order

The fields in a packet are encoded in the following order:

1. Check if the `magic_number` sequence appears in the `content` field. If so, escape it.

2. Calculate the content size.

3. Add the `magic_number` sequence, `content_type`, `content_size` and `content` fields.

4. Transmit the packet.

## 5   Examples

**Single Value**

Packet encoding a single 32-bit float with value 1013.25:

```
67 61 69 61 01 00 0B 04 00 50 7D 44
```

**Breakdown:**

```
67 61 69 61 // Magic number
01 00       // Packet number: 1
0B          // Content type: Pressure
04          // Content size: 4 bytes
00 50 7D 44 // Content: 1013.25 Pa
```

**Array**

Packet encoding GPS coordinates (Latitude, Longitude, Altitude) as three 32-bit floats:

```
67 61 69 61 02 00 03 0C 00 00 B4 42 9A 99 16 43 C3 F5 48 40
```

**Breakdown:**

```
67 61 69 61              // Magic number
02 00                    // Packet number: 2
03                       // Content type: Angle measurement (float ROTATION[3])
0C                       // Content size: 12 bytes
00 00 B4 42              // Angle 1: 90.0
9A 99 16 43              // Angle 2: 150.6
C3 F5 48 40              // Angle 3: 3.14
```

## Escaped Magic Number

GPS coordinates with a `magic_number` sequence in the content:

```
67 61 69 61 03 00 01 0E 67 61 69 61 00 00 00 00 20 40 67 61 69 61 00
```

**Breakdown:**

```
67 61 69 61              // Magic Number
03 00                    // Packet number: 3
01                       // Content type: GPS coordinates (float GPS_POS[3])
0E                       // Content size: 14 bytes
67 61 69 61 00           // Latitude with escaped magic number: 269069370000000000000
                             (this isn't actually possible with GPS coordinates
                             but you get the point it's for demonstration)
00 00 20 40              // Longitude: 2.5
67 61 69 61 00           // Altitude with escaped magic number: 269069370000000000000
                             (about 28441 light years above sea level)
```