HASP – Student Payload Interface Manual Flight Year 2025

I. Introduction

This document describes the mechanical, electrical, power, and data interfaces between HASP and student payloads. Your payload must conform to HASP interface standards and not exceed the specified payload limits.

Exceptions to these limits may be approved on a case-by-case basis by HASP Management via the special request waiver procedure described in Section VII. Special Requests of the Call for Payloads(CFP). Teams should not assume their request will be granted until they receive explicit approval. Questions and special requests may be submitted to HASP management via email at hasp@lsu.edu.

II. HASP - Student Payload Mechanical Interface

When a team is accepted for a flight, they will receive a payload plate that will provide the mechanical and electrical interfaces between HASP and student payloads. All of parts of **the payload must be secured to remain intact and attached to the mounting plate under a 10 g vertical and 5 g horizontal shock**. It is advised that appropriate analyses and/or test data be collected to provide evidence that your payload and mounting will satisfy this requirement.

Payloads will be classified as "**large**" or "**small**". Teams may not modify these plates outside the designated "student payload" area. These areas will be marked visibly with an etched mark and a black line. The black line will be considered part of the student payload area.

The mechanical interface mounting plate is composed of ¼" thick white PVC. Attached to the plate are two connectors with wires (pigtails) for electrical connections. Teams may connect the pigtails as needed. Removal or modification of the connectors is not permitted. The forbidden area extends vertically both above and below the plate. The pigtail wires or connectors teams choose to connect to those wires may enter the forbidden area. Any other mechanical or electrical components inside the forbidden area will require an approved waiver. Dimensioned drawings for the small (Figure 1) and large (Figure 2) can be found below.

Payloads must also remain within a certain vertical distance from the payload plate. Large and small payloads must be less than 30 cm above the top surface of their payload plate. Since large payloads sit on the HASP frame, any structure below their plate(such as bolt heads) must be less than 0.25 cm in or 0.625 cm from the surface. Since small payloads are mounted on outrigger booms, they may have components as low as 30 cm below the bottom surface of their plate.

Payloads must weigh less than a maximum weight allowance. For small payloads, the limit is 3 kg, and for large payloads,20 kg. All components attached to the mounting plate by the student team (e.g., payload, support structure, bolts, DC converters, antennas, etc) must be included in the weight budget and total less than the maximum allowed for the payload class. The plate and pigtails provided are not counted towards the maximum weight.

The constraints on payload mass, footprint, height, and extension below the payload plate are listed in Table 1. Note that these constraints are maximums that your payload shall not exceed any limit without the approval of a waiver request; see HASP CFP for the waiver procedure.

Table 1: Vertical and weight limitations for student payloads

Class	Mass	Height	Extension below plate
Small	3 kg	30 cm	30 cm
Large	20 kg	30 cm	0.625 cm (mounting structure only)

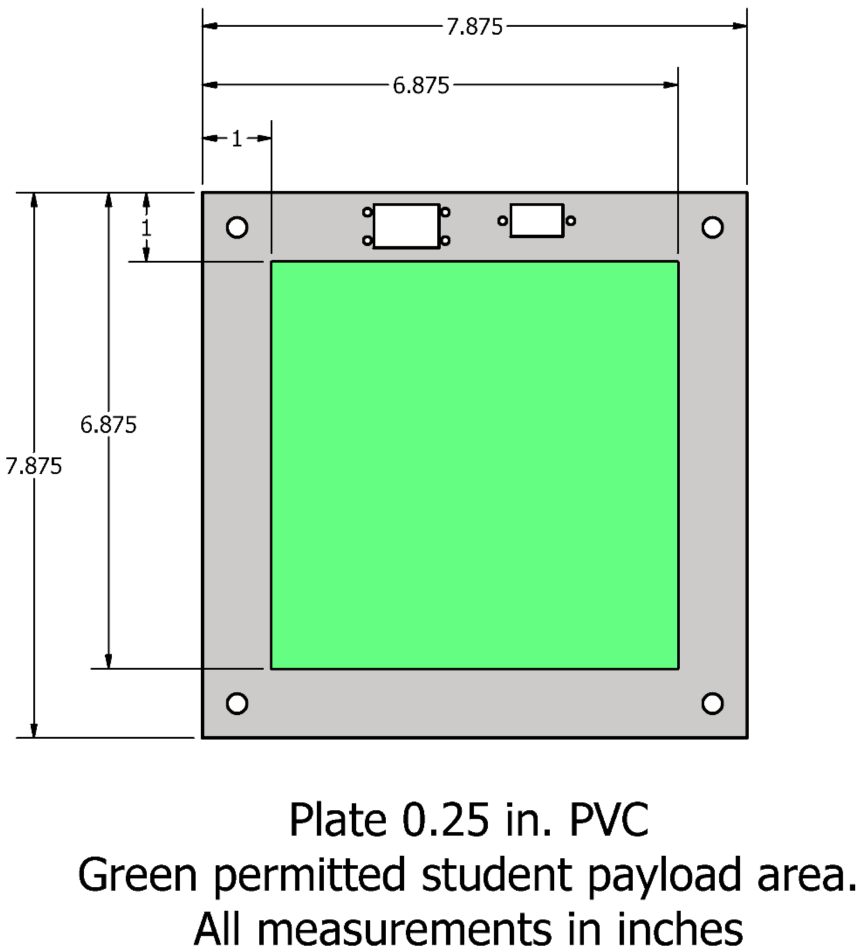

Figure 1: Small student payload interface plate.

Payloads plate is keyed to a particular position on HASP. Your position number is given as the "Payload ID Number" on the Payload Summary sheet, and the standard HASP positions are shown in Figure 3 Payload positions as viewed from above. During flight, however, any side can be located toward or away from the sun or flight path, since the gondola will slowly rotate throughout the flight. In addition to identifying your physical location on HASP, the ID number is also used to tag your downlinked telemetry stream as well as to route uplinked commands to your payload.

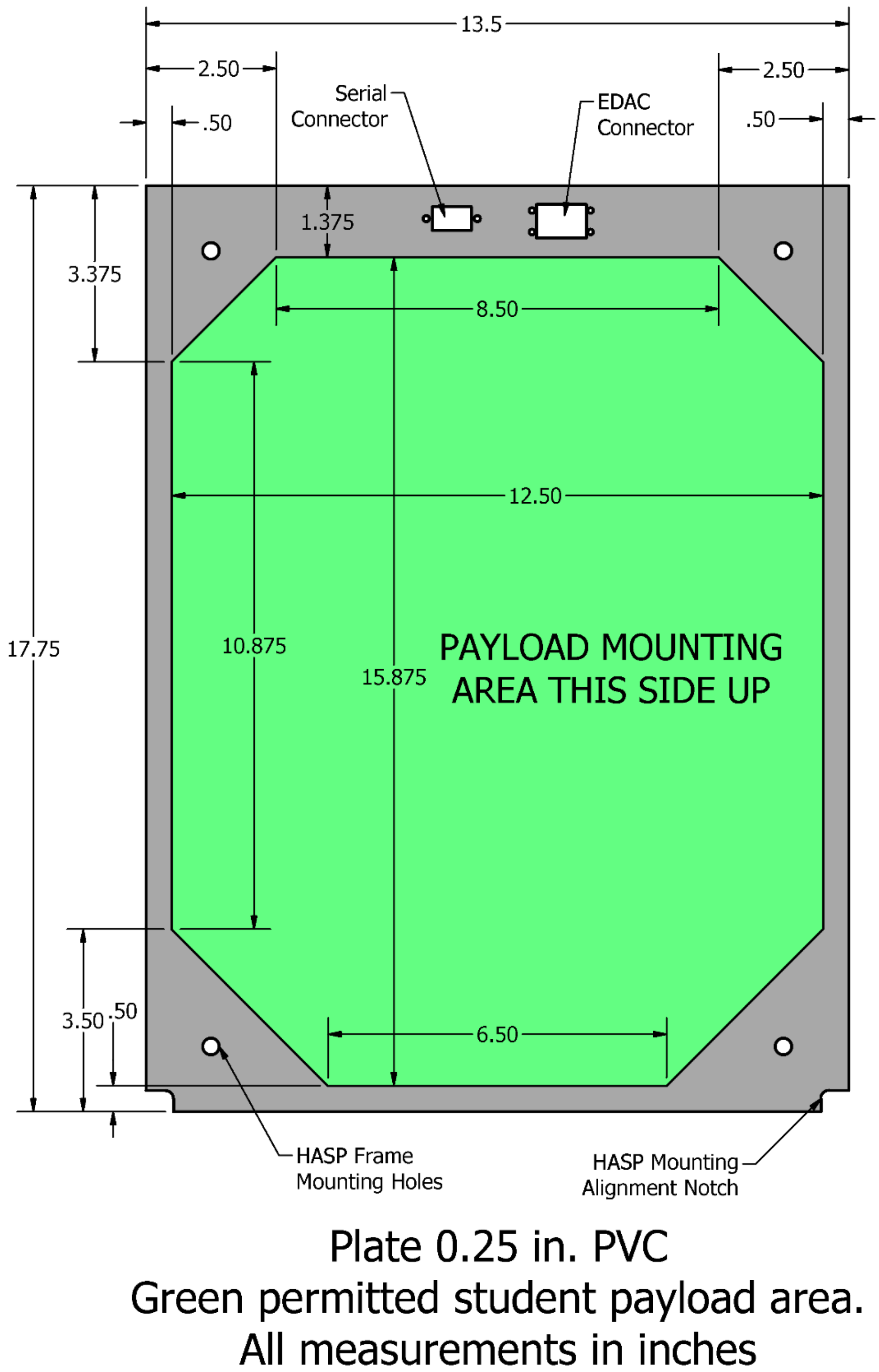

Figure 2 :Large student payload mechanical interface plate.

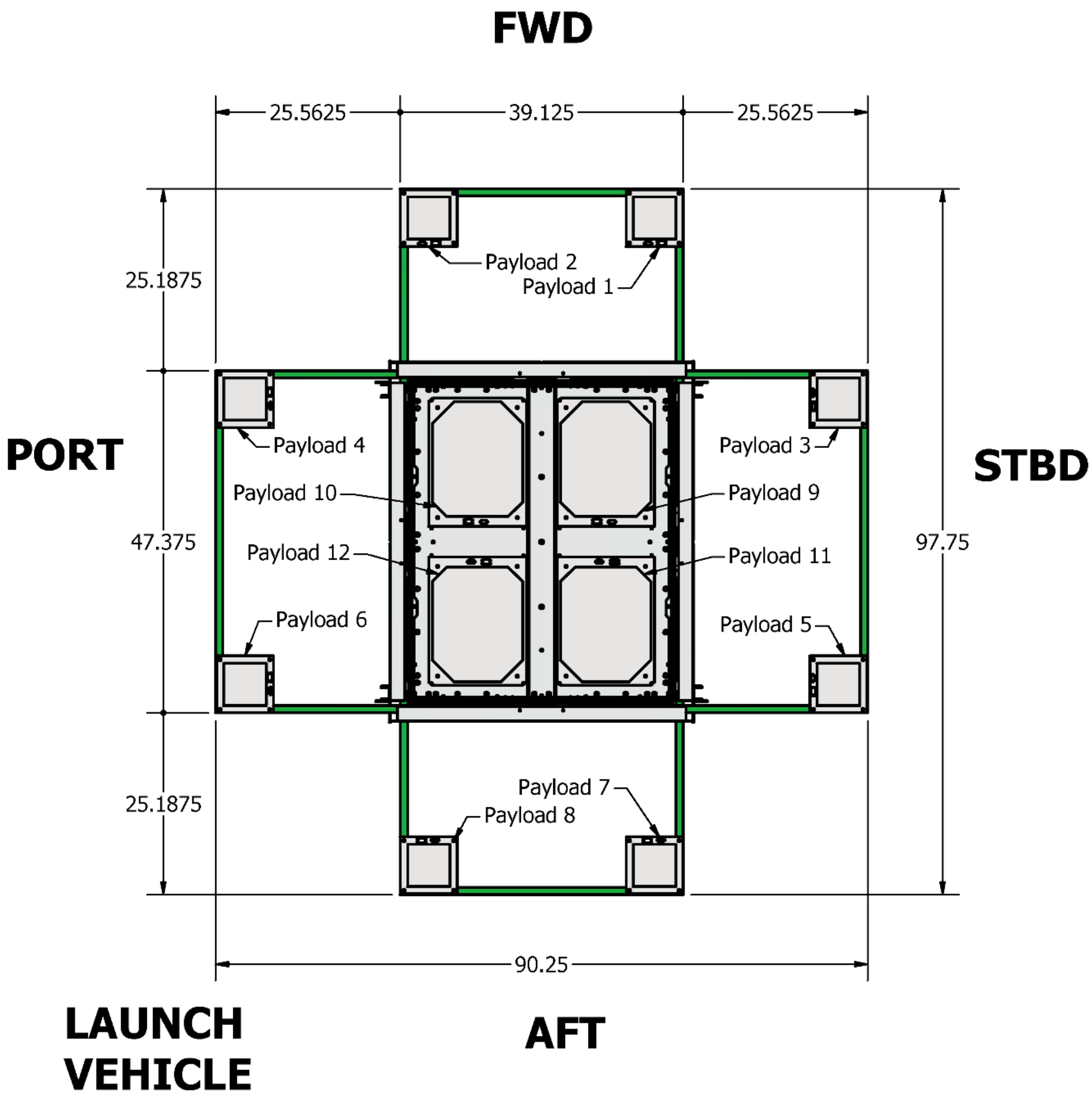

Figure 3 Payload positions as viewed from above. Dimensions are given in inches.

III. HASP – Student Payload Mounting Plate Connectors

Your payload mounting plate includes two connectors. A 9-pin D-sub connector(DB-9) for serial uplink and downlink and a gray 20-pin EDAC 516 series connector(EDAC) for power, discrete commands, and analog output. Both connectors already include a 24” wire pigtail from the topside of the mounting plate. Teams may not modify, remove, or disassemble the connectors mounted to the payload plate. These pigtails can be fitted with your own connectors or wired directly to the internal components of your payload. HASP will interface to both connectors on the bottom of the plate, so care should be taken to avoid damaging the pins.

A. Serial Connector

The data connection between HASP and student payloads is a UART Serial connection using the RS-232 Standard for pinout and logic levels. **The serial settings are 8 data bits, no parity, 1 stop bit, and no flow control. Large payloads shall use a 4800 baud rate, and small payloads 1200 baud.**

Logic levels shall comply with the RS-232 standard, i.e., -5 to -15V for logical 1 and +5 to +15V for logical 0. Most common microcontrollers (Arduino, Raspberry Pi, etc.) will use 3.3V or 5V logic levels. **This means an appropriate level shifter is required.** It is recommended teams use a level shifter that uses an RS232 transceiver chip such as MAX232 or SM3232 and avoid designs that use two transistors as drivers.

The physical interface will consist of 9-pin DSUB connector (DB9) mounted to the student payload plate. The DB-9 will be wired with a three-wire pigtail for team usage. The pigtail will consist of a white wire connected to pin 5, an orange wire connected to pin 3, and a purple wire connected to pin 2.

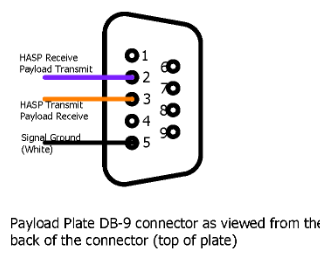

Figure 4: DB9 pins used for the HASP serial interface.

HASP is configured as a DTE device. This means it will transmit data to student payloads on pin 3 (orange wire) and will receive student payload data on pin 2 (purple wire). **This means teams should connect the orange wire to their receive pin and the purple wire to their transmit pin.**

B. The EDAC 516 Connector

The EDAC connector is a twenty-pin EDAC 516 series connector(manufacture number 516-020-000-301). In addition to the electrical pins, the connector also has two orientation keys on the side and a threaded locking pin in the center. The HASP team will remove locking pin to prevent damage during shipment and payload development. It will be reinstalled at integration.

In the current configuration, only 4 out of the 20 pins will be utilized. +28VDC power will be supplied to pin A. Ground will be connected to Pin X. The ground pin is used for both the power and the analog. A diagram of the EDAC receptacle is shown in Figure 5. Pins are labeled A through X. The functional assignments and corresponding wire colors are listed in Table 2 and described in the following sections.

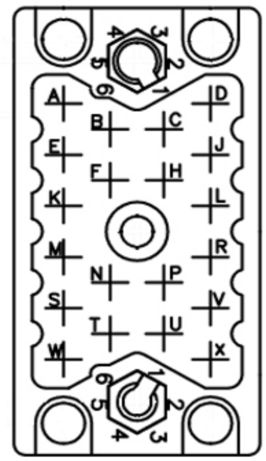

Figure 5: The EDAC 516-020 receptacle pin layout

Table 2: Pin layout and wiringt of EDAC Connector

Function	EDAC Pins	Wire Color
+28 VDC	A	White with red stripe
Ground	X	White with black stripe
Analog	K	Blue
Discrete	F	Green

IV. HASP – Student Payload Power Limits

+28VDC Power is provided through the EDAC 516 on pin A. Pin X is connected to the ground. **Note that power is fused for a maximum current draw of 0.5 amps for a small class payload and 2.5 amps for a large class payload.** Teams must ensure that these limits are not exceeded during payload operation. While brief transients above the 0.5A/2.5A limit may not immediately blow the fuse, there is no way to correct a blown fuse in flight so teams should ensure current remains below the limit at all times. The payload will be responsible for internally converting the +28 VDC to whatever voltages are required. **NOTE: Compared to previous +30V battery packs, teams should expect to draw higher current due to a decreased voltage. A higher amperage limit may requested but may not be approved.**

NOTE: Even though the power bus is referred to as delivering +28 VDC, the actual voltage provided by the batteries during the flight may vary from +30 to +26 VDC over the course of the flight due to battery discharge and cell temperature.

V. HASP – Student Payload Analog Download Interface

One 0 to 5 VDC analog channel will be available through the EDAC 516 connector. This will be sampled at ~1 sec and downlinked with the general HASP housekeeping data(temperature, voltage, current, etc.). This ADC reading will be available via the HASP website, both in real-time during flight and post-flight, as a timestamped data log.

Analog channels will be sampled through a voltage buffer and 1 KHz low pass filter. Additionally, the HASP ADC is protected by a Transient Voltage Suppressor (TVS) diode. If an excessively high voltage is supplied to the analog pin by a student payload, an increase in current draw by the payload will occur, leading to a blown fuse.

VI. HASP – Student Payload Discrete Command Interface

All payloads can be supplied with a discrete command on pin F of the EDAC connector. However, there are not enough available discrete for all payloads to have a discrete at the same time. Historically, only one or two payloads per flight have requested the use of discrete commanding. Therefore, it is important that teams desiring to use discrete commands explicitly request that capability in their application and PSIP so they can be properly configured.

The discrete signals are provided as open-collector command outputs that can sink a maximum of 200mA at a maximum of 50 volts. During idle operation, the discrete will act like an open circuit. When the command is sent, the output of the open collector is pulled low for 100 milliseconds when a command is sent. The discrete signals can be used as inputs to logic circuitry with an appropriate user-supplied VCC voltage and pull-up resistor. Note VCC and Pull up resistor must be provided by the payload and not HASP. An example interface circuit for the discrete signals is shown in Figure 7: Conditioning circuit for discrete command line interface..

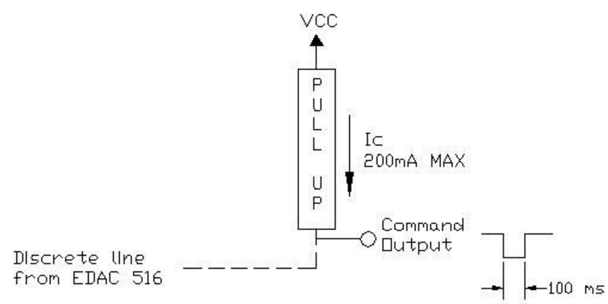

Figure 6: Conditioning circuit for discrete command line interface.

VII. HASP – Student Payload Serial Communication

This section describes the serial data downlink communication and uplink serial commanding between the student payloads and the HASP flight computers. Also described is the command record format, how data on the ground is retrieved by the student payload groups and in minor detail, how the HASP flight system will handle student payload data.

B. Data Downlink

There is **no required data format** that the student payloads will have to adhere to when sending data to the HASP serial I/O process. HASP will merely record the sequence of bytes received at its serial port and downlink that data to the ground station. As previously stated, the baud rates are 1200 baud for small class payloads and 4800 baud for large class payloads. New data will be made available to student teams via the HASP website every 5 to 10 minutes.

It is recommended that teams send as much meaningful data as frequently as possible as is feasible. A gap of no longer than a few (<5) minutes is strongly recommended.

Teams receive new data approximately every 10 minutes from the HASP website. These data files will be available under the Payload Data Sets the HASP website under the "Flight Information" page (http://laspace.lsu.edu/hasp/Flightinfo.html).

Teams should be prepared for their data stream to be broken into multiple data files that need to be concatenated. Since HASP cannot know all possible student data formats, any required error checking or data validation must be performed by the teams themselves. In previous flights, data errors and dropouts have been infrequent but have been observed. We do have several recommendations that will likely reduce some of your post-flight data analysis problems. First, uncontrollable events that occur during data transmission to ground can result in bit loss or other forms of corruption. Therefore, it is recommended that you implement some type of record format that includes a checksum, timestamp or record counter, and other housekeeping information. Second, if you are not anticipating using the serial stream at the full rate, consider transmitting multiple copies of the same record. This would provide you with a backup in case a record is corrupted. Third, know the size of your records. This will enable us to make the size of the HASP records that are transmitted to the ground such that your payload record will not be broken across files.

In addition to payload data, students will be able to download other HASP flight information, including environmental (temperature) data, NMEA (GPS) data strings, other HASP status information, and position tracking through Google Maps.

C. Serial Command Uplink

In addition to discrete commands, student teams may uplink 2 byte commands over the serial link to the payload. These serial commands provide flexibility in experiment control during flight. Serial commands will be issued to the HASP operator for uplink to HASP during operations. The command request interface will use the team's payload ID number to direct the command to the proper payload. It is the same as your seat number.

To request a command uplink, you will need to provide the HASP operator with your payload ID number and the two bytes, in **hexadecimal format(note both bytes are required even if one is 0x00)**, that you wish to be transmitted. To avoid miscommunication, teams will submit commands via a web interface. Teams will only be able to enter commands for their payload.

Once your command is transmitted and received onboard the balloon-craft, HASP will format and route a command string to your payload over the serial link. **Each command string will include 7 bytes and the format of this string is shown in Table 3. Note: The payload command bytes are included as bytes 3 and 4 in this string.** After reading the string you should validate the format, extract your command byte and process the command. [You may also find it useful to include in your downlink data record a section devoted to the last command

Table 3: HASP command string format, as transmitted to student payloads

Byte	Hex Value	Description
1	1	Start of Heading (SOH)
2	2	Start of Text (STX)
3	command byte 1	First byte of the command transmitted from the ground
4	command byte 2	Second byte of the command transmitted from the ground
5	3	End of Text (ETX)
6	D	Carriage Return (CR)
7	A	Line Feed (LF)

received and its current status. This will provide you with the ability to determine if your commands have been received and executed by your payload.]

The HASP operator will transmit commands for a limited time each hour. Each command takes about 1 minute to execute and to receive the command response. The HASP operator will submit commands on a first come, first serve, but be aware that there is a potential slowdown if an excessive number of commands are being requested. There could be as many as 12 student groups that need to issue commands and, thus, there could be a 12-minute delay between commands directed to your payload. Therefore, it is highly recommended that you design your instrument so that it doesn't need to be constantly commanded.

Further, while we attempt to ensure commands are only sent to the payload requesting the command it is possible that a command may be improperly routed or corrupted during uplink, and it is the responsibility of the student payload to identify and validate the received commands. We, therefore, recommend that you implement some type of checksum and/or identification bit string that will uniquely identify commands that you receive from the HASP flight system. An example would be to use the 4 least significant bits to encode your payload number.

D. Requested GPS Time and Position Data

Student payload groups can request to receive GPS time and position data records from the HASP flight system. If requested, the data will be sent via the serial connection to your payload at a set period, specified in your "Payload Specification & Integration Plan" and finalized during integration in Palestine, TX. This time period must be an integer number and must be greater than two (2) seconds.

The transmitted string will be the most recent GGA string received by HASP from its own GPS. A sample GGA string is shown below.

*$GPGGA,202212.00,3024.7205,N,09110.7264,W,1,06,1.69,00061,M,-025,M,,*51,*

HASP GPS GGA string is consistent with the NMEA 0183 standard. The GGA string begins with "$GPGGA" and terminates with "*51". The components within the GGA string are defined as follows:

$GPGGA,<1>,<2>,<3>,<4>,<5>,<6>,<7>,<8>,<9>,M,<11>,<12>,<13><CR><LF>

1) UTC time of position fix, hhmmss.ss format
2) Latitude, ddmm.mmmm format.
3) Latitude hemisphere, N or S.
4) Longitude, dddmm.mmmm format.
5) Longitude hemisphere, E or W.
6) Position Fix Indicator,

    1. 0 = fix not available or invalid.
    2. 1 = GPS SPS Mode, fix valid.
    3. 2 = Differential GPS, SPS Mode, fix valid.
    4. 3 = GPS PPS Mode, fix valid.

7) Number of satellites in use for tracking, 00 to 12.
8) Horizontal Dilution of Precision, 0.5 to 99.9.
9) MSL Altitude, -9999.9 to 99999.9 meters.
10) Geoidal height, -999.9 to 9999.9 meters.
11) Differential GPS (RTCM SC-104) data age, number of seconds since last valid RTCM transmission (nu1l if non-DGPS).
12) Differential Reference Station ID, 0000 to 1023. (null if non-DGPS)
13) Checksum, Hex result calculated as the bitwise XOR of the characters of the GPS string.

NOTE: The HASP GPS receiver is a multi-constellation GNSS receiver, so instead of $GPGGA it may instead start with $GNGGA, indicating that non-GPS (GLOSNASS, Galileo, etc.) satellites are being tracked. The interpretation of the remaining data is unchanged.