

HASP – Student Payload Interface Manual
Flight Year 2027

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 should be submitted to HASP management in writing via email to 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 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.

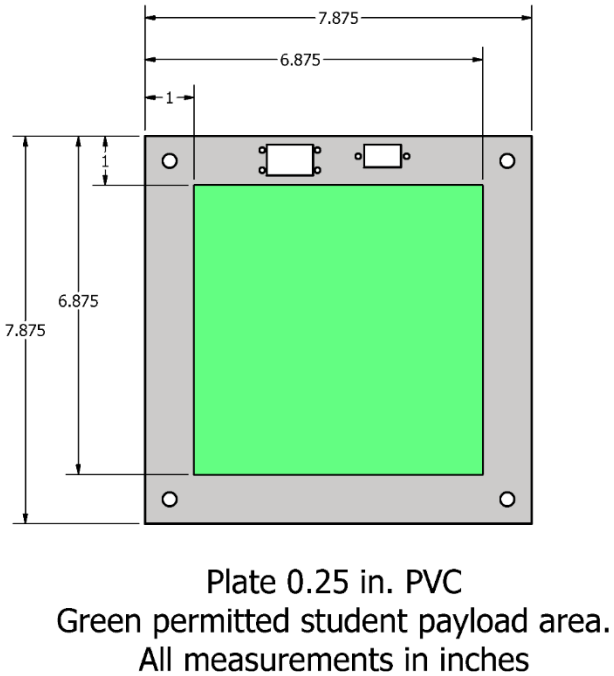


Figure 1: Small student payload interface plate.

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 should connect the pigtail wires to their payload as needed. The wires may be shortened if trimmed or shortened if desired. Removal or modification of the connectors themselves is not permitted. The forbidden(keep out) 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, but no other portions of the payload may enter those areas unless a formal exception is granted. This includes rotating parts, deployed booms, and antennae. Teams that require mechanical or

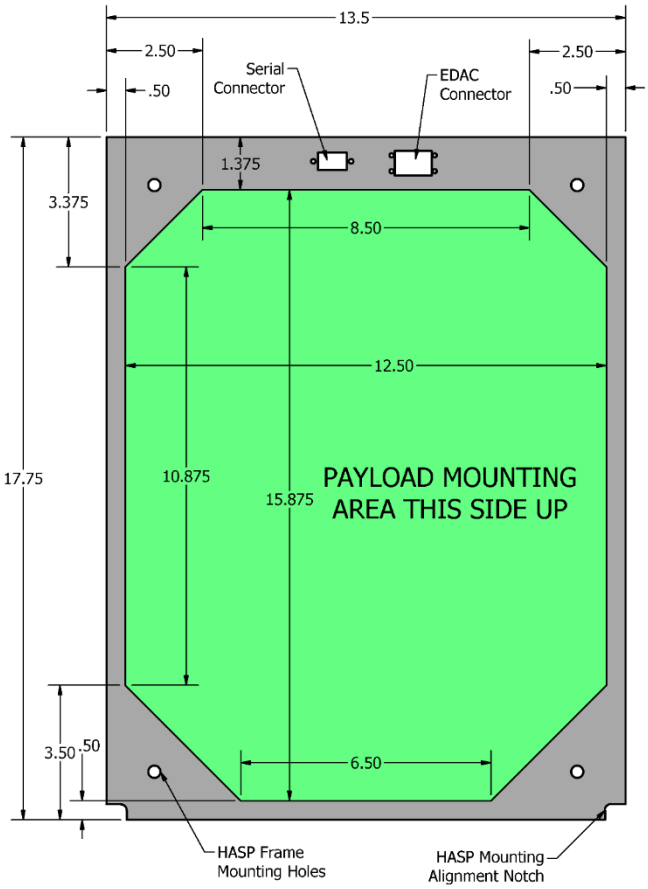


Figure 2: Large student payload mechanical interface plate.

electrical components within the forbidden area should request a waiver, but not assume permission will be granted. 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 surface of the payload plate. All payloads must be less than 30 cm above the top surface of their payload plate.

Large payloads 9, 10, 11, and 12 sit on top of the HASP frame with thermal shields directly below them. So only a limited structure, such as bolt heads, is permitted and must be less than 0.25 in or 0.625 cm from the bottom of the plate.

Large payloads 21, 22, 23, and 24 are mounted on a lower shelf below the main HASP frame (see Figure 4). There is more clearance below these mount points; all components must be within 2 in or 5 cm of the lower plate surface.

Small payloads 1, 2, 3, 4, 5, 6, 7, and 8 are mounted on outrigger booms, with another payload directly below them. Only a limited structure, such as bolt heads, is permitted and must be less than 0.25 in or 0.625 cm from the bottom of the plate.

Small payloads 13, 14, 15, 16, 17, 18, 19, and 20 are mounted on the lower set of outrigger booms. They may have components that extend up to 30 cm below the bottom surface of their plate.

Payloads must weigh less than the maximum weight allowance. 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. For small payloads, the limit is 3 kg, and for large payloads, 20 kg.

The constraints on payload mass, footprint, height, and extension below the payload plate are listed in Table 1. Note that these constraints are maximums. 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

Location	Class	Mass	Height	Extension below plate
Upper	Small	3 kg	30 cm	0.625 cm (mounting structure only)
Upper	Large	20 kg	30 cm	0.625 cm (mounting structure only)
Lower	Small	3 kg	30 cm	30 cm
Lower	Large	20 kg	30 cm	5 cm

Payloads are assigned to a particular position on HASP. The standard HASP positions are shown in During the flight, the gondola will slowly rotate in azimuth, meaning any side of your may be facing north, towards the sun, or in the direction of travel. Only payloads on the upper layer of HASP(1-12) will have unrestricted views of the sky. Only the lower small payloads (13-20) will have unobstructed views of the Earth.

In addition to identifying your physical location on HASP, the Payload Number is also used to tag your downlinked telemetry stream and uplinked commands to your payload.

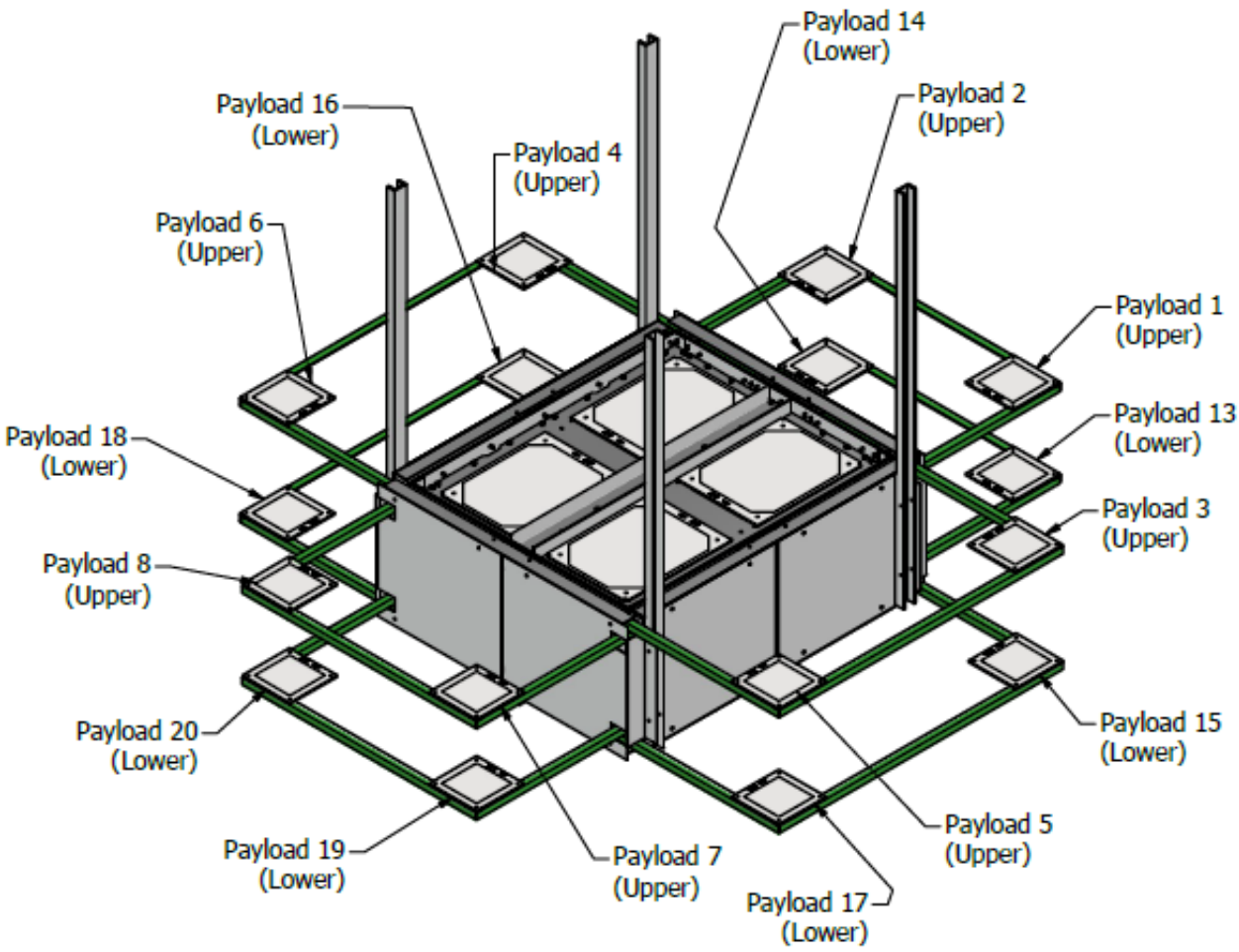


Figure 3: Location of payload seats in relation to the HASP frame. The small payloads' mount positions are the white plates mounted at the end of green fiberglass booms, with 4 large payload seats on top of the HASP

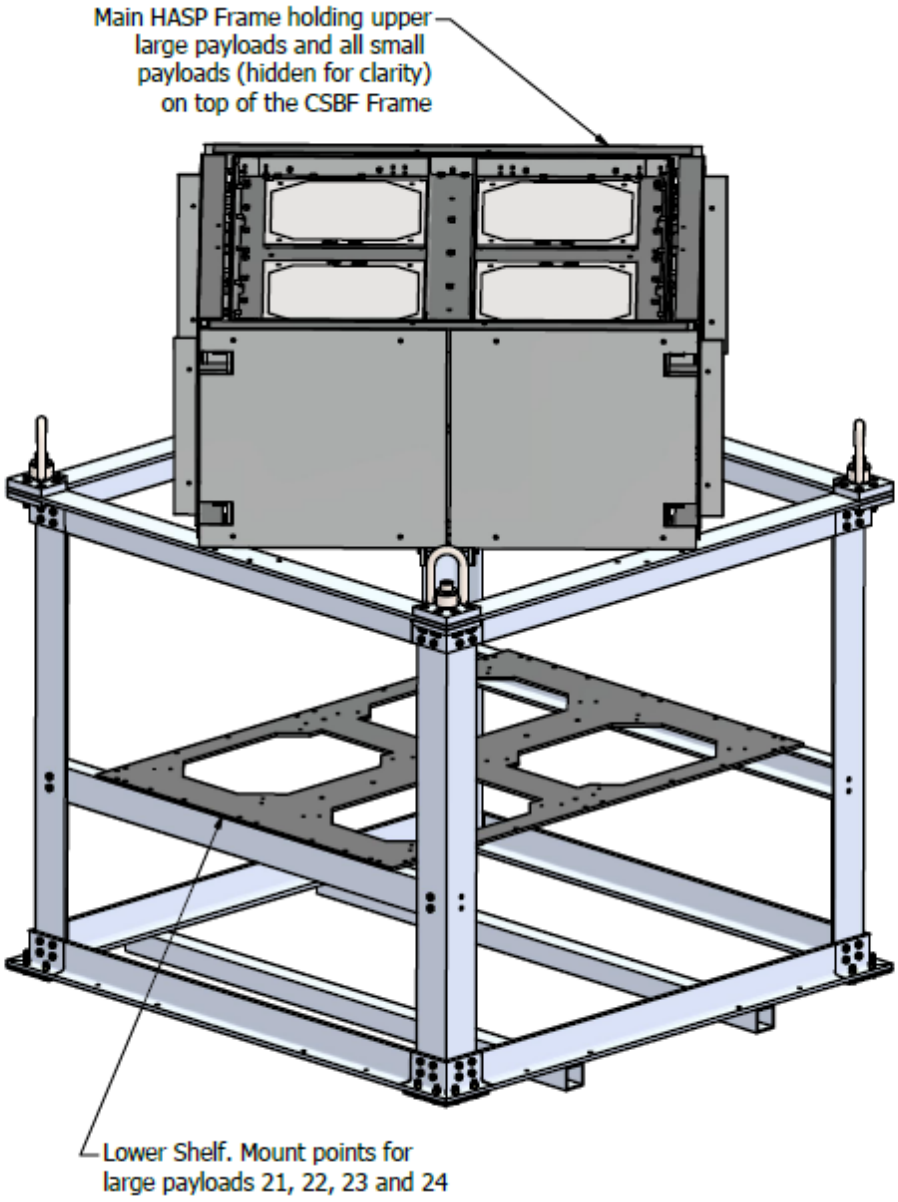


Figure 4: Location of the lower Large Payload mounting shelf relative to the rest of the HASP Gondola.

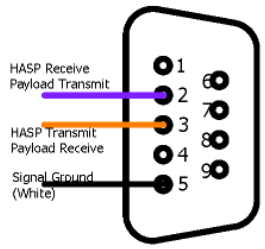
III. HASP – Student Payload Mounting Plate Connectors

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 the connectors from the bottom of the plate. Take care to avoid damaging the pins during construction and testing.

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. Payloads shall use a 9600 baud rate; other baud rates may be available on request. Teams desiring an increased data rate should submit a waiver request.**

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 usually required**. It is recommended that 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.



Payload Plate DB-9 connector as viewed from the back of the connector (top of plate)

Figure 5: DB9 pins used for the HASP serial interface.

The physical interface will consist of a 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.

HASP is configured as a DTE device. This means HASP 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**.

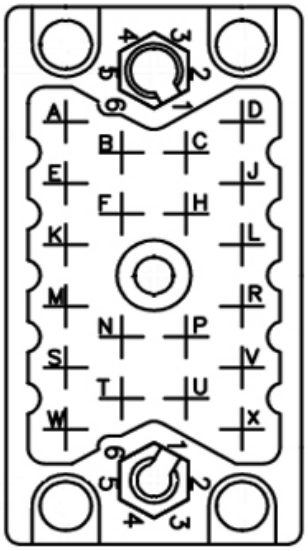


Figure 6: The EDAC 516-020 receptacle pin layout

B. The EDAC 516 Connector

The EDAC connector is a twenty-pin EDAC 516 series connector(manufacturer's 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 the 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 6. Pins are labeled A through X. The functional assignments and corresponding wire colors are listed in Table 2.

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. Fuses are the Littelfuse 0312.500 (0.5 A) and 031202.5 (2.5A).

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 be requested, but may not be approved. For example, a team desiring a small payload position but requires a large current limit.

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.

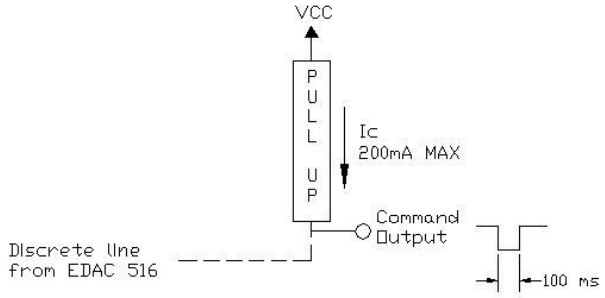


Figure 7: Conditioning circuit for discrete command line interface.

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 a 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, the resulting transient may lead to a blown fuse.

VI. HASP – Student Payload Discrete Command Interface

All payloads can be supplied with a “discrete” digital command on pin F of the EDAC connector. The discrete signals are provided as open-collector 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. The discrete signals can be used as inputs to logic circuitry with an appropriate user-supplied VCC voltage and pull-up resistor. An example implementation circuit is shown in Figure 7. Note: VCC and Pull-up resistor are provided by the payload and not HASP.

Historically, only one or two payloads per flight have requested discrete commanding. Because of this, HASP cannot provide every payload a discrete at the same time. Therefore, it is important that teams desiring to use discrete commands explicitly request that capability in their application or PSIP at the latest.

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 for student payloads. HASP will record the sequence of bytes received at its serial port and downlink that data to the ground station. The baud rate for payloads is 9600. New data will be made available to student teams via the HASP website every 1 minute.

In the event of a loss of Starlink telemetry, data will continue to be logged on the flight computer and downlinked once the connection is restored. During such a loss, HASP monitor telemetry will be able to see if payloads are still sending data.

It is recommended that teams send as much meaningful data as possible due to the chance of local storage (SD card) failure.

In order to ensure your payload is actually operating, a gap of no longer than a minute between data downlinks is recommended.

Teams receive new data approximately every minute from the HASP website. These data files will be available under the Payload Data Sets on the HASP website under the "Flight Information" page for that year(https://laspace.lsu.edu/hasp/hasp-2027-flight-information/).

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 are infrequent but have been observed. Therefore, it is recommended that you implement some type of record format that includes a checksum, timestamp, or record counter, and other housekeeping information.

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. This data will be provided live during flight, with a timestamped log available post flight.

C. Serial Command Uplink

Teams may uplink 2-byte commands to their payload over the serial link. These commands will be embedded in a 7-byte string. Serial commands are manually issued by 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 the two bytes, in hexadecimal format(note that 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. Detailed instructions on the command interface is available from the HASP website at https://laspace.lsu.edu/hasp/payload-commanding-sheet/.

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 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 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.]

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

Byte	Hex Value	Description
1	0x01	Start of Heading (SOH)
2	0x02	Start of Text (STX)
3	command byte 1	First byte of the student command
4	command byte 2	Second byte of the student command
5	0x03	End of Text (ETX)
6	0x0D	Carriage Return (CR)
7	0x0A	Line Feed (LF)

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-served basis, but be aware that there is a potential slowdown if an excessive number of commands are being requested. There could be as many as 24 student groups requesting commands to be sent. 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.

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.

The transmitted string will be the most recent GGA NMEA 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,
   0 = fix not available or invalid.
   1 = GPS SPS Mode, fix valid.
   2 = Differential GPS, SPS Mode, fix valid.
   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.