

User Guide

HAB VENTER

Integrated Balloon Valve



Balloon
Ascent
Technologies

The sky's not the limit; it's where we start.



Overview

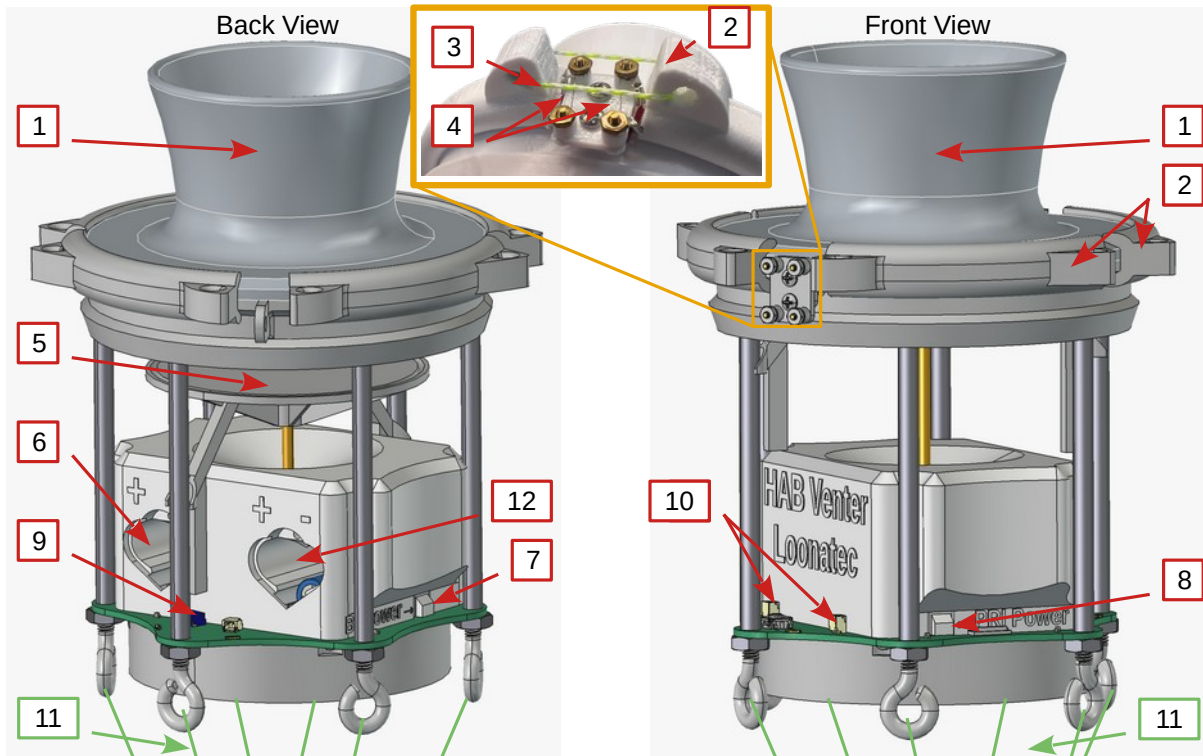
The HAB Venter is a high-flow, multi-use valve with integrated termination system for latex weather balloons.

- High-flow, low-pressure valve
- Interfaces with a wide range of balloon brands and neck sizes
- Redundant termination systems
- Anti-collision strobes
- Switch a low-power device on/off via the AUX port
- Wireless BLE & LoRa Interfaces
- Wired UART Interface

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Hardware Diagram



#	Component	Function
1	Balloon Insert	Fits into balloon neck, stays with balloon after separation
2	V-clamp	Secures balloon insert to HAB Venter until separation
3	Balloon Release Line	Holds v-clamp parts together (the rest are zip-tied)
4	Burn-wires	Cuts balloon release line, separating v-clamp to release balloon
5	Poppet	Moves up and down to open and close venting valve
6	Primary Battery Slots	Holds two primary lithium AAA batteries for the primary system
7	Backup Power Button	Press and hold to turn on backup system
8	Primary Power Button	Press and hold to turn on primary system
9	UART Connector	Wired connector for sending & receiving commands
10	Burn-wire Connectors	Connectors used to attach burn-wires to circuit board
11	Rigging Harness	Attachment point for flight-train, load-bearing
12	Backup Battery Slots	Holds two primary lithium AAA batteries for the backup system

Specifications

Parameter	Min	Typical	Max	Unit
Operating Parameters				
Temperature	-60	-	60	°C
Battery Voltage	1	-	5.1	VDC
Settings				
Internal Heater Set-point	-60	-	60	°C
UART Baud Rate	1,200	115,200	115,200	baud
Termination Timer	-	90	4,000,000	seconds
Sensors				
Battery Voltage	-	2.8 - 3.2	-	VDC
Internal Temperature	-55	-	125	°C
Time since power-on	0	-	-	seconds
Mechanical				
Bottom-mount, no v-clamp, batteries or balloon insert ¹	-	190	-	g
4X L92 Batteries (primary and backup termination)	-	30	-	g
V-clamp	-	20	-	g
3 cm Balloon Insert (Totex small)	-	45	-	g
5 cm Balloon Insert (Totex large)	-	55	-	g
8 cm Balloon Insert (Hwoyee small)	-	60	-	g
11 cm Balloon Insert (Hwoyee large)	-	85	-	g
Top-mount for 3 cm balloon insert, no batteries	-	130	-	g
2x L92 batteries (primary, no backup available)	-	15	-	g
Mechanical: Size, bottom-mount	14 cm diameter, 16 cm height			
Mechanical: Size, top-mount	11 cm diameter, 12 cm height			

1 After termination, with a standard flight-train, the bottom-mount HAB Venter, its batteries, and the v-clamp will remain attached to the parachute’s apex. This will be approximately 240 g of mass as the balloon insert separates and stays with the balloon envelope.

Getting Started

The *HAB Venter* attaches to the neck of a latex balloon and performs two main functions: 1) controlled release of lift gas, and 2) separating the balloon for flight termination. Releasing lift gas decreases the flight's ascent rate. Flight termination can be activated on command to release the *HAB Venter* and flight train from the balloon to end the flight. The *HAB Venter* has built-in redundant systems to ensure successful flight termination and to comply with regulatory requirements.

Bottom Vent Configuration

Our standard configuration where the *HAB Venter* is mounted on the bottom of a latex balloon and is equipped with a v-clamp to release the balloon. After separation, the *HAB Venter* will remain attached to the apex of your parachute, to be recovered with the rest of your flight-train.

Top Vent Configuration

Our light-weight configuration where the *HAB Venter* is mounted on the top neck of special dual-neck balloons to facilitate faster venting. The top vent configuration only performs venting functions and is not equipped with a v-clamp, burn-wires, or redundant backup system.

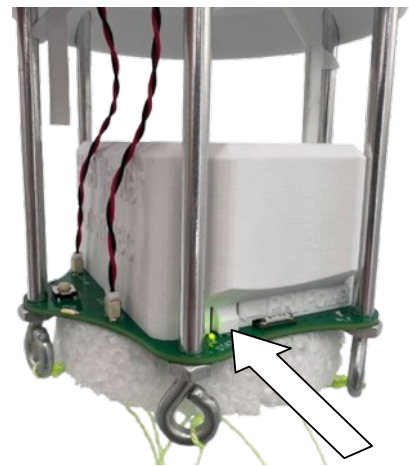
Unboxing

The *HAB Venter* is shipped inside of a clear plastic inflation sleeve. This sleeve is used when inflating the balloon, permitting the *HAB Venter* to be attached to the balloon's neck ahead of time. To remove it, firmly pull the sleeve down, off of a friction connection on the *HAB Venter*.

Powering On

The *HAB Venter* is comprised of two separate systems, the primary and backup systems. Each system requires its own batteries and has its own power-on button. These are located on the either side of the *HAB Venter*. To fully power on the *HAB Venter*:

1. Remove the two battery covers, install four AAA batteries, and then reattach both battery covers.
2. Press and hold the primary power-on button in until the blue BLE LED flashes, about three seconds.
3. Press and hold the backup power-on button down until the orange Backup STATUS LED flashes, about three seconds.



Repeated or constant pressing of either will have no impact on *HAB Venter* operation. To turn off the *HAB Venter* use the shutdown command (!vSD=Y).

The *HAB Venter*'s Backup System can not be shutdown and continues to operate for a considerable time after the batteries removed, 5+ minutes. If the primary side is turned off while the backup is on, it will activate the backup burn-wire. For ground-testing the backup system does not need to be powered on.

Connecting to the HAB Venter

To get started, we'll focus on using the BLE communication link with the HAB Venter. You will likely use this method during launch for inflation and verification.



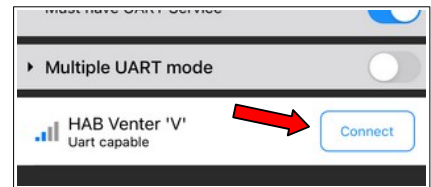
Android



iOS

- 1) Connect via the Bluefruit Connect smartphone app. Use the QR Code links to download this app for Android and iOS smart phones.
- 2) Open the app. A list of one or more HAB Module devices will appear. Connect to the HAB Venter 'V'.

Note: the 'V' in the device name will change to the ID you specify with the **!vSI=___** command.



- 3) Select the UART interface. A blank response window with an input field at the bottom will appear. You can type in the commands in the field at the bottom and the *HAB Venter*'s responses will appear above.
- 4) Below is a command cheat-sheet for the HAB Venter. It contains some of the more commonly used commands.



<p>Command Overview Format: !iSC=VAL ! Commands start with ! i Device ID (default 'V') S Subsystem (V, S, or R) C Command to carry out =VAL Value if applicable</p> <p>ID can be changed with !vSI Ex: !vSI=a sets ID to 'A'. Then !vSC becomes !aSC</p> <p>Subsystems: V – venting subsystem S – state subsystem R – radio subsystem</p> <p>Help Commands !i Recommended commands !iv All vent commands !is All state commands !ir All radio commands</p>	<p>Common Commands !vSC View system charge !vSV Battery voltage !vST Internal temp. !vSS=2 Strobes ON !vSL Display command log</p> <p>!vVI Vent indefinitely !vVQ Close vent !vVV Verify vent seal !vV0=10;50 Vent for 10 sec at 50% opening</p> <p>Irrevocable Commands !vVA=Y Fire burn-wires !vSZ=Y Terminate seq. !vSD=Y Shut down</p> <p><i>Warning:</i> the irrevocable commands will activate the backup burn-wire if backup power is on. For testing, we recommend only powering the primary side.</p>
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Launch Weights

We recommend the use of both an anchor and weigh-off weight during balloon inflation. These two weights need to be attached around the neck of the balloon during the inflation process. Both of these weights should be configured before going to the launch site.

Anchor weight

A heavy object, at least five-times the total flight train mass, to hold the balloon on the ground and keep it from drifting with the wind during inflation. Increase the mass of this weight when expecting faster surface winds during launch.

Weigh-off weight

A weight that is approximately 1.1-times heavier than the mass of all of components that will be below the HAB Venter in the flight train. It serves to indicate when enough lift-gas is in the balloon to provide the necessary buoyancy to both lift the payload and propel it upward. Do not include in the HAB Venter's mass when calculating this. The mass ratio of this weight to the total flight-train mass will determine the initial ascent rate.

The weigh-off weight should be connected with a shorter line than the anchor weight so it is lifted first, indicating that enough lift-gas is in the balloon. A bag of sand or water jug filled to the desired weight works well.

Indicator Lights

Primary Status Indicator – Green

The *HAB Venter* has one green Primary Status Indicator. Possible blink patterns at 1 Hz are:

- **Pulsing** – Primary system is charging
- **Single** – Termination timer is enabled
- **Double** – Venter currently active
- **Triple** – Venter is currently active and moving
- **Quintuple** – Venter error

The green Primary LED will flash briefly once every ~3 seconds to indicate it is powered on and operating correctly.

Communication Indicator – Blue

The *HAB Venter* has one blue communication Indicator. Possible blink patterns are:

- **Brief flashes** at 1-3 Hz – indicates BLE advertising and awaiting first command since power-on
- **Single** brief flash – indicates command received
- **Off** – a command has been received since power-on

Backup Status Indicator – Orange

The *HAB Venter* has one orange Backup Status Indicator. Possible blink patterns are:

- **Pulsing** – Backup system is charging
- **Single** brief flash at 1/2 Hz – Heartbeat signal received
- **Alternating** on/off at 1 Hz – Burn-wire active
- **Rapid flashing** –
 - At power-on: burn-wire continuity failed
 - After power-on: burn-wire is about to activate or just finished activating

Control Interfaces

The *HAB Venter* can be controlled by one or more of the following: Bluetooth Low Energy (BLE) radio, wired Universal Asynchronous Receive Transmit (UART) serial protocol, or LoRa radio. Commands are sent to the desired HAB module by specifying its identifier (ID) character—default is ‘V’ for the HAB Venter. This permits multiple devices to share the same communication method.

Bluetooth Low Energy Interface

HAB Venter uses the Nordic UART Service (NUS) for most Bluetooth communication, which enables the use of Adafruit’s Bluefruit LE Connect App.

Android: <https://play.google.com/store/apps/details?id=com.adafruit.bluefruit.le.connect.v4>

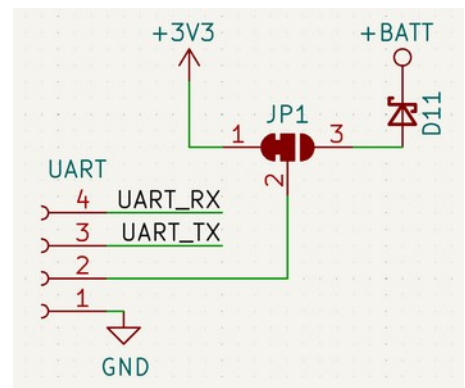
iOS: <https://apps.apple.com/app/adafruit-bluefruit-le-connect/id830125974>

Bluefruit Connect is a smartphone app that it is useful for ground-testing prior to launch.

Wired UART Interface

The *HAB Venter* includes a terminal for a wired UART connection. It uses a 4-pin JST SH (1.0 mm pitch) connector with the following pin-out:

- Pin 1 – GRN/WHT – Ground
- Pin 2 – YELLOW – Power
- Pin 3 – BLACK – Venter Transmits on this pin
- Pin 4 – RED – Venter Receives on this pin

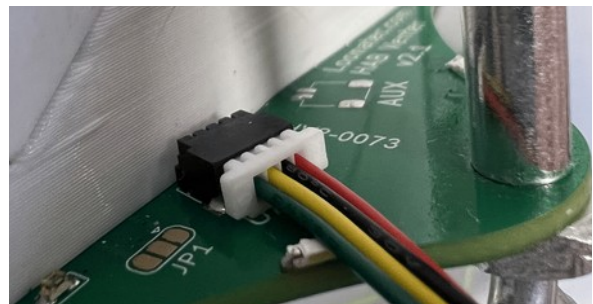


By default, messages are sent at 115,200 baud (user selectable), 8n1, at 3.3 VDC logic levels.

UART Power Pin

By default, pin-2 provides a regulated 3.3 V output. It should not be expected to supply more than 20 mA. Use of it will impact the *HAB Venter*’s expected battery life.

By changing JP1, [a solder blob jumper](#), pin-2 can be reconfigured as power input. This can be used to supplement or replace the internal primary batteries.



LoRa Radio Interface

The *HAB Venter* has an integrated LoRa radio that can be used to send and receive communications to and from other modules on the balloon flight set to the same frequency, such as the flight computer.

The LoRa radio is based on a Semtech SX1262 chip which can be configured to operate in the 862-928 MHz frequency range over a distance of many meters. We recommend using the RadioLib library² on any flight computer that needs to connect with the HAB Venter's LoRa radio.

The radio can be configured in 'gateway' or 'device' mode. As a 'gateway', the radio will echo commands to/from the other communication interfaces, permitting one HAB module to forward commands to other HAB modules acting as 'devices'. With this, the LoRa radio network is self-contained, negating the need to add a custom LoRa radio module to the flight computer.

Refer to the **LoRa Radio** section for more details and a diagram of how to use LoRa 'gateway' functionality on flights with multiple HAB modules.

² The RadioLib library was developed by jgromes. GitHub: <https://github.com/jgromes/RadioLib>

Operation

V-Clamp Separation

The v-clamp is released by activating either of the two burn-wires. Both burn-wires are activated by the separation (**!vVA=Y**) and termination (**!vSZ=Y**) commands. The separation command will only activate the burn-wires, while the termination command will activate the burn-wires and then open the valve. The backup burn-wire will activate when the primary system stops working (ie **!vSD=Y**).

Termination Timer

The termination timer will count down from the initial time specified and terminate the flight when it reaches zero. Resetting, or feeding the timer, will restart the countdown to the initial time specified. This timer can be used to ensure that the flight is terminated if something happens to the flight computer or the LoRa radio link (ex RF jamming).

We recommend programming the flight computer to send the **!vSX** command frequently to both check on the *HAB Venter*'s status and to feed the termination timer. We recommend sending this command at an interval of approximately one-third the termination timer's initial time specified so that a failure to receive the command and feed the timer must happen 3 times in a row before the flight is automatically terminated.

Example: start termination timer, feed once (restarts the timer from the previous value), re-enable once (restarts the timer from a new value), then stop feeding:

- !vSW=120** Start the timer counting down from 120 seconds
... can wait up to 119 seconds ...
- !vSW=F** Feed the timer, restarting the countdown from the prior setting of 120s
... can wait up to 119 seconds ...
- !vSW=30** Reset the timer, starting the countdown from new time of 30 seconds
... wait 30 seconds for time to expire ...

Resulting activation sequence:

1. *HAB Venter* issues the **!vSZ=Y** command to itself
2. Termination message sent out via BLE/LoRa/UART
3. Termination sequence is activated

Termination Sequence

The HAB Venter can terminate a balloon flight. Upon receiving the terminate command (**!vSZ=Y**) it will first activate the primary and backup burn-wires, then open the valve fully.

Resulting activation sequence:

1. Terminate command received
2. *HAB Venter* fires primary burn-wire for 10 seconds
3. Backup burn-wire will activate 2-6 seconds later, for 8 seconds
4. *HAB Venter* pauses until the system recharges (roughly 4 minutes)
5. Valve will open fully and terminate sequence completion message is sent

Burn-wire Checks

The *HAB Venter* continuously checks the burn-wire circuit continuity to ensure they can be activated. If the continuity check fails, then that side's Status LED will display a rapid-flash error pattern. A failed continuity check does not disable the burn-wire. It is only an indication to the operator that the continuity test failed. This can be checked with **!vVC** or the 6th status byte of **!vSX** command.

Non-Volatile Parameters

Most of the *HAB Venter*'s parameters are saved in non-volatile memory. The value is not effected by powering the *HAB Venter* off, so values can be configured in advance of launch. See the **Commands** section for which parameters are saved to non-volatile memory.

During the power-on sequence, the non-volatile memory is verified and then loaded. If the memory is found to be corrupted then it is reformatted and default values are loaded. This is indicated by the green STATUS indicator flashing the rapid, continuous error pattern. This error state will be cleared the next time the unit is powered on.

System Measurements

Every thirty (30) seconds while powered on, the *HAB Venter* will measure the battery voltage, system charge, and internal temperature.

If the temperature measurement is below the set heater threshold the battery heater will be enabled, or disabled if the temperature is above it. The heater threshold is the temperature where the heater will be turned on or off. It is -10 °C by default, and can be changed using **!vSH=___**

Anti-collision Strobes

High-power, white anti-collision LED strobe lights can be placed into one of three states using the command **!vSS=X**, where X is one of the following options:

0. Off, strobes will not activate
1. Strobes will activate when ambient light falls below a pre-set threshold. When activated, they will double-flash every 3 seconds
2. Strobes will always be active, regardless of ambient light levels. Strobes will triple-flash every 3 seconds.

Using the strobes requires a system charge of at least 75%.

Command Logging

HAB Venter has a circular log that saves the last approximately 800 entries in non-volatile memory. Events that are recorded include:

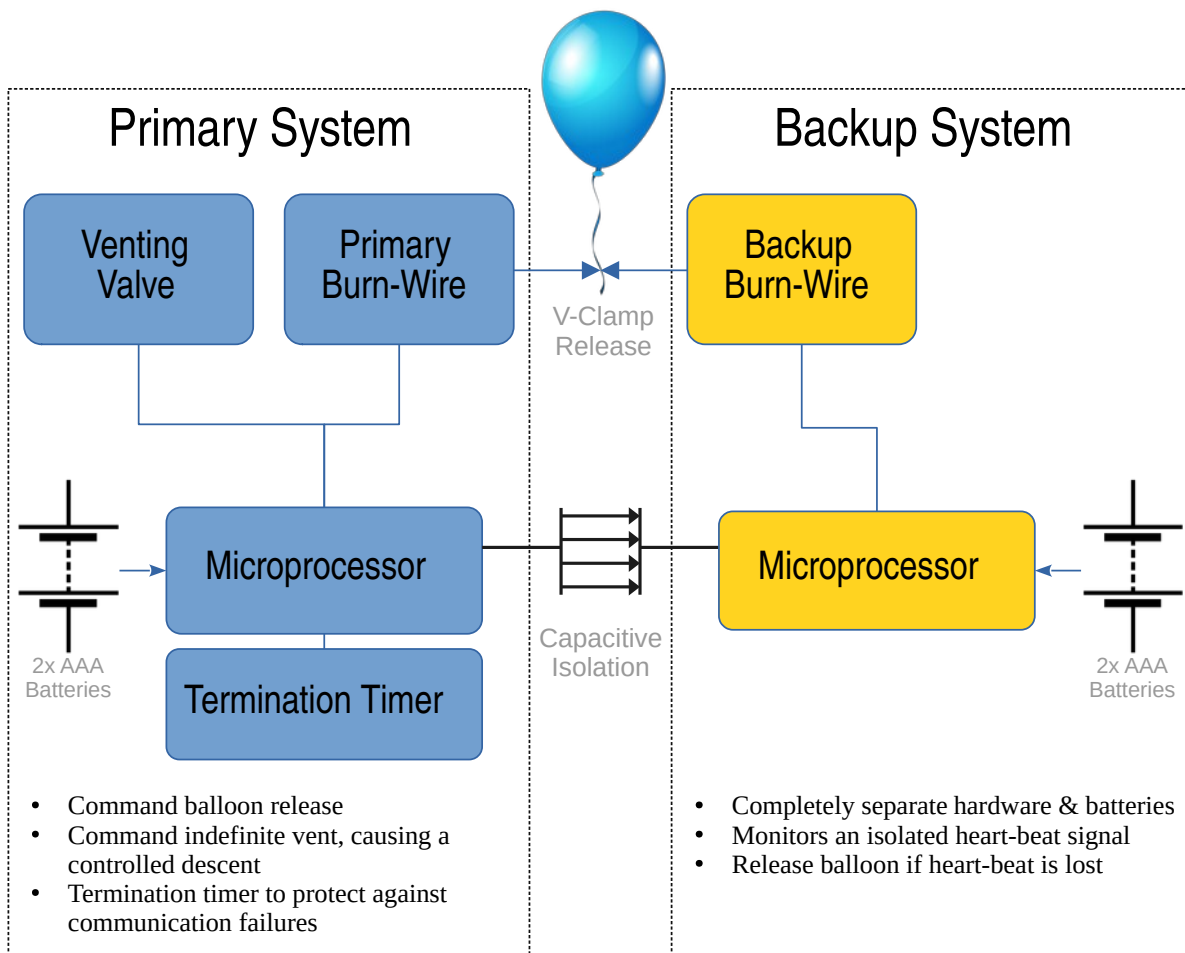
- Incoming commands
- Command responses
- Bluetooth connection events

Termination Redundancy

The *HAB Venter* (bottom-vent configuration) is equipped with completely redundant termination systems. Both systems are completely independent, powered by different batteries, and control independent burn-wires to release the v-clamp. The only connection is a capacitively-isolated heartbeat from the *HAB Venter*'s Primary System to the Backup System.

The *HAB Venter*'s Backup System must see this heartbeat signal from the Primary System once every 4.2 seconds, otherwise it will fire its independent burn-wire and release the balloon. The Primary System automatically sends this heartbeat every 2 seconds when powered on and operating normally. If the terminate command (`!vSZ=Y`) is issued then it stops transmitting this signal to ensure both burn-wires are activated.

The *HAB Venter* also has a termination timer to monitor the health of the primary flight computer and communication link. If a feed command (ex `!vSW=F`) is not received before the timer expires then the termination sequence will be automatically initiated.



Consumables

Batteries

The *HAB Venter* has been designed to use primary lithium batteries of the ‘AAA’ size. The Lithium/Iron Disulfide (Li/FeS₂) chemistry has proven to work well, even at the low temperatures experienced on balloon flights. Possible suppliers of these batteries include:

- Energizer [Ultimate Lithium L92](#) AAA Battery

While the *HAB Venter* will operate on standard alkaline batteries, it is strongly recommended against using them during flight due to their poor performance in cold conditions. They do work great for ground-testing.

Release Line

The *HAB Venter* burn-wires have been designed to cut 50# Dacron kite/fishing line. Below are some of the rigging line options that we have used and liked. The Nano cord holds knots well and comes in a wide variety of colors.

Atwood Rope Nano Cord: <https://atwoodrope.com/collections/nano-cord>

Green-Spot Dacron Fishing Line. Some manufacturers include: [Izorline](#) or [Cortland](#)

Release Line Replacement instructions

- 1) Cut ~150mm length of balloon release line
- 2) Thread line through the disconnected v-clamp sections, leaving a gap of 2cm
- 3) Tie 2 knots to hold the 2cm gap and secure with a drop of superglue
- 4) Wait for glue to dry, then tie 2 more knots and add one more drop of superglue
- 5) Cut off extra line ends sticking out from the knot
- 6) Rotate line so the knot is held within the v-clamp hole

Burn-Wire

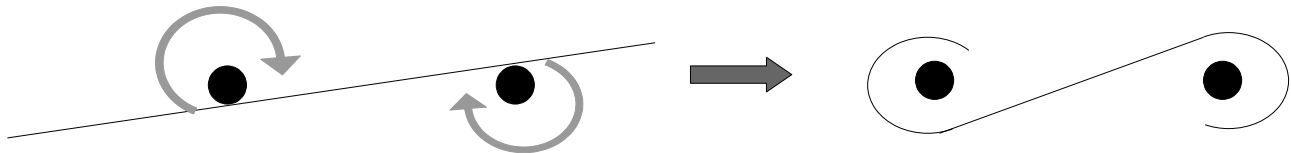
The burn-wire used on the *HAB Venter* can normally be expected to last between ten and thirty activations. After which time, it may need to be replaced. Replacement burn-wire is included with the purchase of a *HAB Venter*. If additional burn-wire is required, please contact us.

Replacement instructions

1. Loosen the two nuts (use a 5/32" or 4 mm socket) holding the wire.
2. Remove the pieces of broken wire.
3. Finger-tighten the nuts down, then loosen 1-turn so that a gap big enough for the wire exists between the nut and washer.
4. Stretch the new wire between the two posts as shown below:



5. Wrap each end of the new wire in a clock-wise direction around each post. The wrap should end at least 180° and no more than 270° from where it started on each post.
 - Limiting to one wrap will prevent the wire from breaking as the nuts are tightened.
 - The direction ensures that the wire will be tightened as the nuts are tightened.



6. Carefully tighten the nuts back down onto the wire. Excessive torque may break the newly installed burn-wire.
7. Trim the excess wire as close to the nuts as possible.

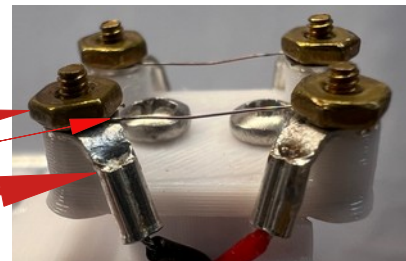
Burn-wire test

1. Insert batteries and wait until the Status LED flashes instead of pulsing (sufficiently charged)
2. Command a separation (!**vVA=A**)
3. Once the replaced burn-wire is glowing, further tighten down on the nuts holding it. This will ensure that the wire is fully stretched tight, even when it heats up.

Mechanical Orientation

The burn-wire should go between the wire ring terminal and the brass nut. Vertically it should be, from top-to-bottom:

1. Brass nut
2. Burn-Wire
3. Ring Terminal



Inflation Sleeve

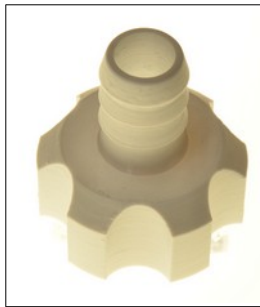
The *HAB Venter's Inflation Sleeve* allows for quick and easy balloon inflation. It allows gas to flow through the HAB Venter after it is already attached to the balloon. This sealed, thin-walled tube surrounds the *HAB Venter* and is fitted with a hose attachment to connect to the lift-gas tank. We recommend the use of an adjustable-pressure regulator on the lift-gas tank so the flow can be controlled.

The inflation sleeve comes with 3 connector fitting options:

½-inch x 14 thread-per-inch
NPS/BSP attachment



½ inch (12 mm) hose barb



¾-inch garden hose attachment.
Screws into the other fittings.



Please contact us for other connection fitting options.

Usage Overview:

1. Install Balloon Insert into balloon neck; connect HAB Venter
2. Attach the anchor and weigh-off weight to the balloon neck
3. Slide the *Inflation Sleeve* up over the *HAB Venter*
 1. Ensure the *HAB Venter's* rigging harness sits completely inside of the *Inflation Sleeve*
 2. Ensure the *Inflation Sleeve* rides up over the sealing ridge
4. Command the valve open
5. Inflate balloon to desired point
6. Command the valve closed
7. Slide the *Inflation Sleeve* off of the *HAB Venter*
8. Connect the flight train to the *HAB Venter* rigging harness
9. Remove the anchor and weigh-off weights



Launch Checklist

Night Before Launch

- 1) Attach Inflation Sleeve to your adjustable regulator
- 2) Slide balloon insert into balloon's neck and secure with zip-ties
- 3) Attach balloon insert to HAB Venter with v-clamp, tighten zip-ties
- 4) Insert four non-flight batteries and power on primary system Green and blue LEDs turn on
- 5) Verify no errors & good burn-wire circuit continuity No rapid status LED flashing
- 6) Connect with BLE, LoRa, or UART Blue LED turns off
- 7) Wait for system to charge, ~10 min **!vSC** → responds 100%
- 8) Shutdown venter to preserve charge **!vSD=Y**
- 9) Remove non-flight batteries, install flight batteries

Pre-Inflation

- 10) Attach anchor and weigh-off weights to balloon neck
- 11) Power on the HAB Venter, then power on the flight computer
- 12) Fit inflation sleeve tightly over venter
- 13) Verify flight computer is communicating with venter **!?** → Comms Check
- 14) Verify payload is turned on and operational
- 15) Open venter valve indefinitely **!vVI**

Inflation

- 16) Start inflating balloon
- 17) Stop inflation when weigh-off weight is close to lifting
- 18) Pause for ~1 min to let balloon's temperature equalize
- 19) Add additional lift-gas, if needed, for neutral buoyancy
- 20) Close venter valve **!vVQ**
- 21) Remove inflation sleeve from venter
- 22) Attach flight train to rigging harness
- 23) Remove anchor and weigh-off weights
- 24) Verify valve operation **!vVW**
- 25) Use checklist command to make sure venter is ready for launch **!?** → All good
- 26) Launch!

Flight Termination

- 27) Send terminate flight command **!vSZ=Y**
- 28) Wait for termination to complete and provide confirmation Takes a few minutes
- 29) Locate and recover flight train once it lands
- 30) Shutdown venter **!vSD=Y**

Commands

The *HAB Venter* uses the same commands for the BLE, UART, and LoRa interfaces. All commands and responses are in easy-to-read ASCII text and follow predefined formats with searchable characters to aid with parsing. The Getting Started section of the User Guide contains a video demonstration that walks through sending commands during testing.

Command Format

Commands follow the following format: **!*i*SC=VAL**

“**!**” (0x21) denotes a new command start. All commands will start with “**!**”

“***i***” is the ID (A-Z) of the device that will receive the command. This can be any letter except “***i***” itself, which is used for special help commands. By default, it is set to “***V***”.

“***S***” is the subsystem that will carry out the command. Valid options are V, S, or R.

“***C***” is the subsystem’s command that will be carried out.

“**=**” (0x3D) is only required when there is a VAL associated with the command.

“**VAL**” is the optional command value.

Notes: no termination character is required, commands are not case-sensitive with a few exceptions

Example command: **!ash=-10** → ID=A, Subsystem=S, Command=H, VAL=-10

Result: tells device with ID = “a” to set its heater threshold to -10 °C

Response Format

Responses use the following format: **[*i*SC, VAL] Description (unit)**

“**[]**” (0x5B & 0x5D) enclose the command and it’s formal response

“***i*SC**” repeats the command that was received, displayed all uppercase

“**,**” (0x2C) separates the command from its value

“**VAL**” is the command response value

“**Description**” and if applicable “**(unit)**” help a human operator understand the response

Help Commands

These help commands do not follow the typical format, and will respond with information for the user rather than performing a task.

<u>CMD</u>	<u>Description</u>	<u>Reply</u>
!i	Command Cheat Sheet	Displays recommended commands for basic HAB Venter functions
!iv	Venting Commands List	Displays all available Venting commands
!is	State Commands List	Displays all available State commands
!ir	Radio Commands List	Displays all available LoRa radio commands
!?	Launch Final Checklist	Displays a launch checklist to complete before releasing balloon

Venting Commands

This is a list of commands to control the *HAB Venter*'s venting functions. These use the subsystem identifier "**V**".

<u>CMD</u>	<u>VAL</u>	<u>Description</u>	<u>Reply</u>	<u>Non-Volatile</u>
!VVA	Y	Activate burn-wire	[VVA,GOOD] Burn-wire Activated [VVA,ERROR] Use "iVA=Y" to activate	
!VVB		Burn-wire Enabled → Query	[VVC,ENABLE or DISABLE] Burn-wire State	X
	0	Burn-wire Enabled → Disable	[VVC,DISABLE] Burn-wire State	
	1	Burn-wire Enabled → Enable	[VVC,ENABLE] Burn-wire State	
!VVC		Burn-wire Continuity → Query	[VVC,GOOD or FAIL] Burn-wire Continuity	
!VVD		Burn-wire Activation Duration → Query	[VVD,10] Burn-wire duration (s)	X
	10	Burn-wire Activation Duration → Set	[VVD,ERROR] Burn-wire duration (s)	
!VVI		Open Valve Indefinitely	[VVI,INDEF] Indefinite venting	
!VVL		Limit Switches → Query	[VVL,0] Limit switch state → Neither [VVL,1] Limit switch state → Valve fully closed [VVL,2] Limit switch state → Valve fully open [VVL,3] Limit switch state → Both	

!VVO		Open Valve → Query	[VVO,INACT] Inactive, closed → Currently closed [VVO,15] Opening, % open → Current percentage open [VVO,10] Venting, sec @ 70% → Time left to remain open [VVO,15] Closing, % open → Current percentage open [VVO,ERR-1] Opening error → Failed to open last attempt [VVO,ERR-2] Closing error → Failed to close last attempt [VVO,ERR-3] Inactive, open → Inactive, but not fully closed [VVO,ERR-4] Already venting → Active, use !vVQ to stop	
	10;50	Open Valve for 10 seconds at 50% position	[VVO,10] Venting initiated [VVO,ERROR] Invalid valve position [VVO,ERROR] Too many arguments	
	10	Open Valve for 10 seconds to pre-set position	[VVO,10] Venting initiated	
!VVP		Valve Pre-Set Position → Query	[VVP,15] Open position (%) [VVP,ERROR] Invalid position, 1-100%	X
	50	Valve Pre-Set Position → Set		
!VVQ		Quit Venting, close valve	[VVQ,GOOD] Venting stopped	
!VVV		Verify Valve Seal	[VVV,GOOD] Verifying valve...	

State Commands

Below is a list of commands to control the HAB Venter’s state functions. These use the subsystem “S”.

<u>CMD</u>	<u>VAL</u>	<u>Description</u>	<u>Reply</u>	<u>Non-Volatile</u>
!VSA		AUX Output → Query	[VSA,n] AUX State	
	0	AUX Output → Set, low output		
	1	AUX Output → Set, high output		
!VSC		System Charge → Query Percentage	[VSC,52] System Charge (%)	
	T	System Charge → Query Time to Charged	[VSC,303] Time to charge (s)	
	V	System Charge → Query Voltage	[VSC,2.23] System Charge (V)	
!VSD	Y	Shutdown	[VSD,SHTDWN] Shutdown [VSD,ERROR] Use “iSD=Y” to shutdown	
!VSE		UART<->BLE Comm Echo → Query	[VSE,ENBL or DSBL] Comm Echo	X
	D	UART<->BLE Comm Echo → Set to OFF		
	1	UART<->BLE Comm Echo → Set to ON		
!VSF		Display Settings	Returns multiple lines of text indicating Serial #, Sensors, and Parameters	
!VSG		Seconds since power-on	[VSG, 45.24] Seconds Powered-On	
!VSH		Heater Set Threshold → Query	[VSH, -10] Heater Threshold (C) → Default is -10 C	
	10	Heater Set Threshold → Set (°C)	[VSH,10] Heater Threshold (C)	
!VSI	B	Device Identification Letter → Set (A-Z)	[BSI,B] Device ID → If ID set to B [VSI,ERROR] ‘I’ Reserved → Cannot set to I	X
!VSL		Displays Log (Cannot transmit over LoRa)	Returns multiple lines of text with past commands [VSL,ERROR] E=enable, D=disable, C=clear	
	C	Clear Log	Log Cleared! [VSL,ERROR] Use “iSL=C” to clear log	
	D	Disable Logging	[VSL,DSBL] System Event Logging	

	E	Enable Logging	[VSL,ENBL] System Event Logging	
!VSS		Strobe State → Query	[VSS,1] Strobe State	X
	0	Strobe State → Set to OFF		
	1	Strobe State → Set to ambient ON		
	2	Strobe State → Set to always ON		
!VST		Internal Temperature → Query	[VST,22.50] Temperature (C)	
!VSU		UART Baud Rate → Query	[VSU,115200] UART Baud Rate → Default is 115200	X
	1200	UART Baud Rate → Set	[VSU,1200] UART Baud Rate [VSU,ERROR] UART Baud range: 1,200 to 115,200	
!VSV		Battery Voltage → Query	[VSV,2.78] Battery (V)	
!VSW		Termination Timer → Query	[VSW,-1] Term. Timer Inactive [VSW,n] Term. Timer Remaining (s)	
	D	Termination Timer → Disable	[VSW,-1] Term. Timer Disabled [VSW,ERROR] Failed to stop Timer	
	F	Termination Timer → Feed	[VSW,n] Term. Time Remaining (s) [VSW,ERROR] Term. Timer not Fed	
	60	Termination Timer → Set	[VSW,n] Term. Timer Enabled/Feed (s) [VSW,ERROR] Term. Timer invalid interval (1-4000000 s)	
!VSX		System Status → Query	[VSX,n,n,n] STV	
!VSZ	Y	Start Termination Sequence	[VSZ,TERM] Termination initiated [VSZ,ERROR] Use "iSZ=Y" to terminate	

System Status Message Details:

Description: This message is intended to be called regularly to check on the *HAB Venter*'s status AND keep the termination timer fed, if it is enabled. It combines together the following commands: **!vST**, **!vSV**, **!vSW=F**, and provides the same information that the green status indicator is currently displaying.

It is recommended to send the **!vSX** command at an interval below one third of the termination timer's interval to ensure the timer is fed even if occasional connection issues occur. The command itself returns the decimal-value of a bit-mapped Status Field as well as the module's internal temperature and battery voltage.

Status Field: A decimal number converted from binary. Convert it back to interpret

7	6	5	4	3	2	1	0
System Charging	ERROR	Valve Active - Moving	Valve Active - Waiting	Termination Timer Active	Valve Fully Open	Valve Fully Closed	Heater ON
1	0	0	0	0	0	1	0

Temperature Field: Board temperature in degrees C, zero decimal places

Voltage Field: Battery voltage in volts, two decimal places

Example: [ASX,130,16,5.03] STV

The returned decimal value of 130 converts to binary 0b10000010. These digits correspond to the characteristics in the bitmap.

System power is charging, valve is fully closed, other characteristics are off

Board temperature is 16 °C

Battery voltage is 5.03 VDC

LoRa Radio Commands

This is a list of commands to control the HAB Venter’s LoRa Radio functions. These use the subsystem “**R**”.

CMD	VAL	Description	Reply	Non-Volatile
!VRA		Preamble Setting → Query	[VRA,n] Preamble length → Default is 8	X
	6 to 65535	Preamble Setting → Set		
!VRB		Bandwidth Setting → Query	[VRB,n] Bandwidth → Default is 125	X
	7.8 to 500	Bandwidth Setting → Set		
!VRC		Coding Rate Setting → Query	[VRC,n] Coding rate → Default is 7	X
	5 to 8	Coding Rate Setting → Set		
!VRE		Echo Setting → Query	[VRE,n] Radio Echo Setting → Default is Device	X
	D	Echo Setting → Set as ‘Device’		
	G	Echo Setting → Set as ‘Gateway’		
	0-255	Echo Setting → Set bit mask manually		
!VRF		Carrier Frequency Setting → Query	[VRF,n] Carrier Frequency → Default is 915 in US → Set to ~865 in EU	X
	862.0 to 928.0	Carrier Frequency Setting → Set		
!VRG		Gain Setting → Query	[VRG,n] Gain	X
	0 = AGC	Gain Setting → Set		
!VRN		Latest Signal to Noise Ratio	[VRN,n] SNR (dB)	
!VRO	0	Turn Radio Module OFF	[VRR,ON] Radio State → Default is ON	*if other setting later set
	1	Turn Radio Module ON	[VRR,OFF] Radio State	
!VRP		Output Power Level Setting → Query	[VRP,n] Output Power → Default is 2	X
	-17 to 22	Output Power Level Setting → Set		
!VRR		Latest RSSI Value	[VRR,n] RSSI (dBm)	

!VRS		Spreading Factor Setting → Query	[VRS,n] Spreading Factor → Default is 9	X
	6 to 12	Spreading Factor Setting → Set		
!VRW³		Sync Word Setting → Query (default = 0x12)	[VRW,n] Sync word (dec) → Default is 18	X
	≤ 8 bytes	Sync Word Setting → Set		

3 The Sync Word is displayed in HEX during the boot sequence but set in DEC by the RW command. It can be up to 8 bytes in length but ≥2 bytes has not been tested yet.

Unprompted Messages

The *HAB Venter* normally only sends information after a command is issued. Below are the five exceptions to that:

Terminate Sequence Completion

The following command is issued when the *HAB Venter* finishes a termination sequence

```
[VSZ,TERM] Termination completed
```

Termination Timer

The following command is issued if the *HAB Venter*'s termination timer expires

```
[VSZ,TERM] Termination initiated  
[VSZ,TERM] Termination completed
```

LoRa Message Information

The *HAB Venter* currently displays a line of information each time it echos a LoRa interface message to/from the BLE and UART interfaces:

```
<LORA> RSSI: val, SNR: val
```

Power-On UART Message

At power-on, the *HAB Venter* will transmit an introductory message over the hardware UART interface that includes basic parameters. This information can also be accessed by sending the **!VSF** command.

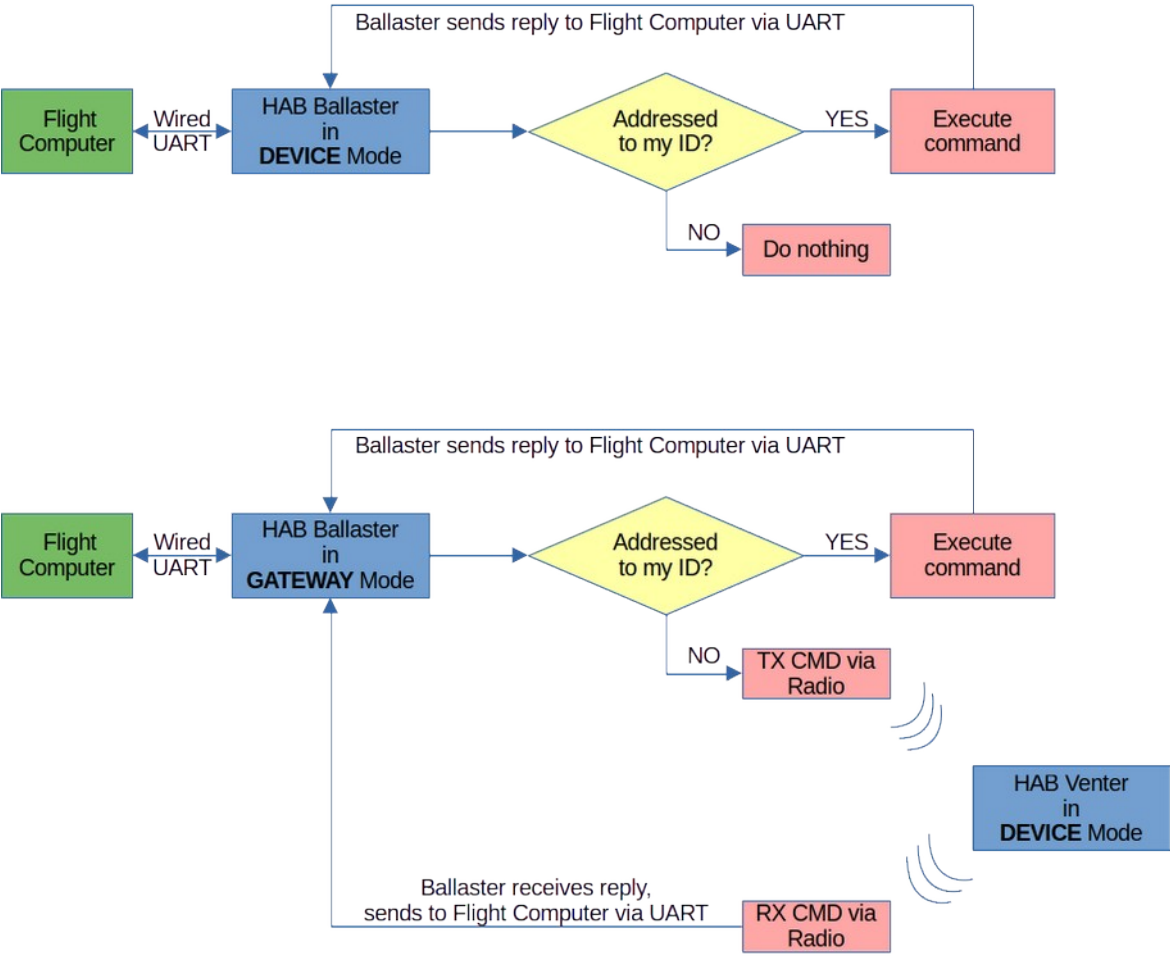
```
----- HAB Venter, rev 2.1 -----  
SERIAL NO   : XXXXXXXXXXXXXXXXXXXX  
FIRMWARE    : Jun  4 2026  
----- Settings -----  
ID CHARACTER: V  
HTR SET PNT : -10 (C)  
COMM ECHO   : ENBL  
...  
...  
...  
----- Loonatec.com -----
```

LoRa Radio

The HAB Venter, and other HAB modules, can be controlled through messages sent over LoRa radio on the same frequency. All HAB modules receive the messages sent at that frequency so it is essential that each device has a different ID.

If the flight computer does not have LoRa radio capabilities, then it can be connected via wired-UART to a HAB module configured to LoRa ‘gateway’ mode. This gateway unit will then bi-directionally echo commands to/from the flight computers UART interface and its LoRa radio. Only one HAB module at a time should be set to ‘gateway’ mode in order to prevent endless command echoing.

Example: A HAB Ballaster is set to ‘gateway’. It will execute commands addressed to **!b** and echo commands addressed to other IDs. Sending a command such as **!vST** will be transmitted by the HAB Ballaster’s LoRa radio to the HAB Venter. The HAB Venter’s reply will be received by the HAB Ballaster and sent on to the Flight Computer via the UART connection.



LoRa Settings & Effects

Below is a simplified overview of the basic LoRa and its chirp spread spectrum modulation settings.

Bandwidth Default = 125

The bandwidth is the frequency range each chirp covers. Decreasing this value increases the data rate, lowers transmit power consumption, but requires better oscillator tolerances between units. Frequency tolerances are typically $\pm 25\%$ of this bandwidth to maintain a packet error rate below 10 %.

Spreading Factor Default = 9

The spreading factor is the number of RF chirps per symbol (encoded 4-bit data packet). Increasing this value makes the data more resistant to noise but lowers the data rate.

Coding Rate Default = 7

The coding rate is the total number of bits in encoded symbol—4-bit data packet plus bits added as a forward error correction. Increasing this value increases reliability while decreasing the data rate.

Sync Word Default = 18 (0x12)

The sync word can be used to isolate groups of LoRa devices. For instance if more HAB modules are installed on a flight train than device IDs (A-Z) permit then two groups, each with their own ‘gateway’ HAB module, could be created by using different sync words. Note that there are some restrictions on valid sync words, for instance 0x34 is reserved for LoRaWAN.

Power Default = 2

This is the transmit power level, in decibel-milliwatts. Its range spans transmit powers of approx 20 μ W (-17 dBm) to 150 mW (22 dBm).

Preamble Default = 8

The preamble is used to detect the start of a data packet. It is the number of symbols that a long constant chirp is transmitted prior to data being sent to alert and allow the receive to achieve lock. Increasing this value increases the time on air.

Gain

A value of 0 will permit the LoRa radio to use automatic gain control. In most circumstances this is best.

State

This is an internal bit-mask value that controls the following:

0. Transmit Enabled → Enable LoRa TX echoing from BLE/UART
1. Receive Enabled → Enable LoRa RX echoing to BLE/UART
2. Send Reply Messages → TX device reply messages over LoRa
3. Forward Other Messages → TX received messages over LoRa
4. Forward My Messages → Also TX messages that match device ID over LoRa
5. Forward Reply Messages → Also TX reply messages that match device ID over LoRa

There are two preset options for State:

- Device → State = 7 → Tx & Rx enabled, send reply messages
- Gateway → State = 15 → Tx & Rx enabled, send reply messages, and forward other messages

Note: some care and experimentation with these settings may be required to avoid creating an echo chamber between multiple modules.

Additional LoRa Resources

See: <https://www.semtech.com/products/wireless-rf/lora-tranceivers/sx1262#download-resources>

LoRa Country Restrictions

Frequencies, transmit power, and duration restrictions vary from country-to-country. Below are the basic restrictions of two common regions.

Region	North America	Europe
ISM Band	902-928 MHz	863-870 MHz
Regulated by	FCC	ETSI
TX Restriction	400ms tx time	Generally 1% tx duty-cycle
Payload sizes	11 – 242 bytes	51 – 242 bytes
Spreading factors	7 – 10	7 – 12
Data rates	1 – 12.5 kbps	0.3 – 5.5 kbps
Max transmit power	21 dBm	Generally 14 dBm

Spreading Factor & Bandwidth	Transmit Data rate	Maximum Payload Size	
		North America	Europe
SF_8 500kHz(AT+SENDH)	12.5 kbps	242 bytes	-
SF_7 125kHz	5.47 kbps	242 bytes	242 bytes
SF_8 125kHz	3.125 kbps	129 bytes	242 bytes
SF_9 125kHz	1.76 kbps	53 bytes	115 bytes
SF_10 125kHz	0.98 kbps	11 bytes	51 bytes
SF_11 125kHz	0.44 kbps	-	51 bytes
SF_12 125kHz	0.25 kbps	-	51 bytes

From [Differences Between North America & Europe](#)

Note: All HAB Module messages are ≤ 50 bytes with the exception of displaying the system log (!vsl) which can only be transmitted over the BLE or UART interfaces.

Safety Precautions and Recommendations

Regulatory

Always adhere to the regulations governing high-altitude ballooning applicable in the country of operation. In the United States, high-altitude balloon flights are governed by “FAA Part 101”.

Touch Hazard

The HAB Venter’s two burn-wires are fragile and produce high temperatures when activated. Never press-down on or touch the burn-wires.

Falling Payload Hazard

Always clear the launch area prior to launch. While unlikely, balloon or line failure after release may result in a falling payload impacting the ground before the parachute fully deploys.

The owner shall be liable for any damages resulting from any use of the *HAB Venter* and other related materials, and shall defend, hold harmless and indemnify Balloon Ascent Technologies LLC, officers, employees and agents, against any and all claims, suits, actions, costs, counsel fees, expenses, damages, judgments and decrees, by reason of any person or property being injured or damaged directly or indirectly by use of the *HAB Venter* or activities arising therefrom.