HDZero BoxPro User Manual

Revision	Date	Description
1.0	Feb 5, 2024	Initial draft

For more product information, please visit:
www.hd-zero.com

Table of Contents

Introduction

The HDZero BoxPro is an all-in-one FPV box style goggle for digital, analog and HDMI video. Please take the time to read through this operating manual thoroughly before using.

Features

- Power on/off sliding switch – be confident that the goggle is on or off at a glance or by feel
- Designed for open source, the goggle runs Linux. All code for the user interface is open source
- 100Hz 1800 nits LCD display
- Supports diopter lens inserts
- By integrating the entire goggle display pipeline with HDZero's fixed-latency video transmission, these goggles achieve 4ms glass-to-glass sub-frame latency with no jitter or dropped frames
- Integrated two 7dBi Patch 5.8GHz antennas
- Included two 2dBi linear 5.8GHz SMA antennas
- Adjustable speed fan cools the internals and prevents screen fogging.
- Integrated HDZero receiver with 4 antennas, supporting all HDZero modes
- Integrated analog receiver that shares an antenna with the HDZero receiver
- HDMI input with 1ms latency, supporting resolutions up to 1080p60 and 720p100
- HDMI output
- Built-in microphone for DVR
- 3.5mm combination headphone / microphone jack for audio and external mic
- 3.5mm analog video/audio input for use with ground station inputs
- 3.5mm head tracker output using 6-axis smart inertial measurement to enable pan+tilt support
- Integrated 2D deinterlacer that adds no delay for analog input
- Built-in H.265 DVR for HDZero, analog and HDMI input
- Built-in ESP32 (Optional)
- Built-in 2.4Ghz WiFi video streaming module for live streaming (Optional)

Specification

- HDMI input to-goggle glass latency: 1ms
- Analog Camera glass-to-goggle glass latency: 3ms
- HDZero Camera glass-to-goggle glass latency: 4ms
- 100Hz 1800 nits LCD display
- FOV: 56deg
- Input voltage: 7V-25.2V (2S-6S)
- Typical Power consumption: 14.5W (with HDZero RF on), or 10W (with Analog RF on)
- Weight: 348g
- Dimension: 166x114x92mm

Included Accessories

- 1x HDZero BoxPro goggle
- 2x linear antennas
- 1x foam face pad
- 1x goggle strap
- 1x 1200mm XT60 cable
- 1x thick canvas goggle bag with sleeve to stow the antennas
- 1x Lens cloth

Setup

The HDZero BoxPro has many features that can be customized to the individual pilot.

Power Switch

There is a sliding power switch on the right side of the goggles. You may use it to turn on/off the goggle, or just leave it on and plug/unplug the DC barrel plug to turn the goggle on and off.

In order to prevent voltage spikes entering the goggle, it is mandatory to plug in a 6S (max 4.2V /cell) battery only if the power switch is off.

Power Input/Consumption

The goggle supports 7-25.2V power input [1]. Please make sure the power polarity is correct [2] (Center pin positive) before powering on the goggle.

TABLE 1. Power Consumption

	Mode	Power Consumption
1	HDZero Digital	1.2A@12V
2	Analog RF	0.8A@12V
3	HDMI in	0.7A@12V

Note:

1. DO NOT use a 6S HV lipo to power on the goggle, it will permanently damage the goggle.
2. The goggle contains a self-resetting fuse to protect against reverse polarity. If fuse is tripped, allow some time for the fuse to reset. Always install batteries in correct polarity, check with case's battery checker beforehand, if the checker lights don't turn on, the batteries are installed backwards and the goggle's fuse will trip to protect the goggle.

XT60 Cable

The goggle includes a 1200mm XT60 cable for connecting a battery in your pocket. The XT60 cable has no voltage regulator. The cable passes voltage directly through the goggle.

Note:

1. Do not connect an over 6S battery to the goggle, as the maximum voltage rating of the goggle is 6S (4.2V/cell).
2. Some types of XT60 cable, i.e., HDZero VRX cable, has integrated DC regulators. Make sure that cable is able to output enough current as indicate at Table 1. The goggle won't boot or keep rebooting if there if that happens.

Optics Lens

The HDZero BoxPro optics include a lens that focus the image and ensure a clear, immersive view for the pilot.

Note: The lens is made of plastic rather than glass. To prevent scratches, only clean it with a soft micro fiber cloth or wipes designed for cleaning glasses.

Diopter Lens Insert

The goggle has no built-in optical adjustment. However, users can customize a diopter lens insert at the HDZero shop according to their prescription.

Note: Diopter lens insert is not included, and needs to purchase separately.

Head Strap

The goggle includes a 30mm (1.2 inch) wide head strap with battery pocket. Once you have configured the face plate and padding foam for your preferred face fit, put on the head strap and adjust the tightness to your preference.

HDMI input

The HDZero BoxPro includes a single port HDMI 1.4b receiver through a mini HDMI port. The incoming HDMI video is routed to the LCD display with less than 1ms latency.

Please note that most HDMI connectivity issues are due to either incorrect monitor settings or a faulty HDMI cable. If you encounter issues using the HDMI input, try connecting with alternative HDMI sources and alternative cables to rule out these common causes.

The current firmware supports resolution up to 1080p60 and 720p100 for HDMI input.

HDMI Output

The HDZero BoxPro includes a high-performance single channel HDMI transmitter that is fully compliant with HDMI 1.3a through a mini HDMI port.
The HDMI output will display exactly the same content as what appears on the OLED displays.

TABLE 2. HDMI Output Format

	Input Source	HDMI Output format
1	HDZero 60fps Camera	1280x720x60fps
2	HDZero 90fps Camera	1280x720x90fps
3	NTSC	1280x720x59.97fps
4	PAL	1280x720x50fps
5	HDMI in	Not supported

AV input

The HDZero BoxPro supports AV input through a 3.5mm AV jack. The pinout is shown in FIG 1.
The AV input cable is not included. It is available on the HDZero shop and other online stores.

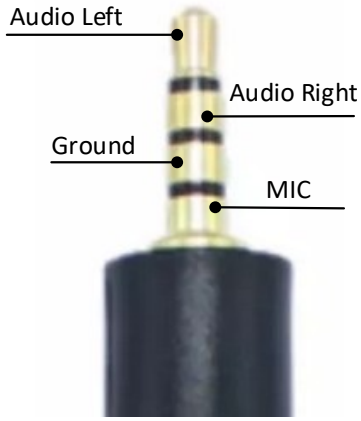


FIG 1. AV input Jack

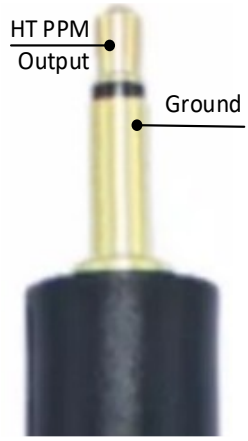


FIG 2. HT output Jack

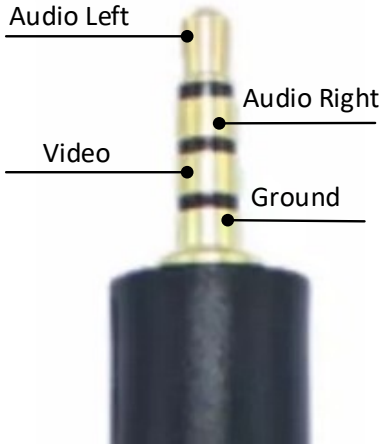


FIG 3. Line In/Out Jack

Head Tracker (HT) Output

The HDZero BoxPro has a 6-axis smart inertial measurement unit for head tracking pan+tilt support. The HT output jack pinout is shown in FIG 2.
The HT cable is not included. It is available on the HDZero shop and other online stores.

Audio Line In/Line Out

The HDZero BoxPro has a CTIA standard 3.5mm Line in/Line out jack for microphone and headphones. The pinout is shown in FIG 3.

Open Source

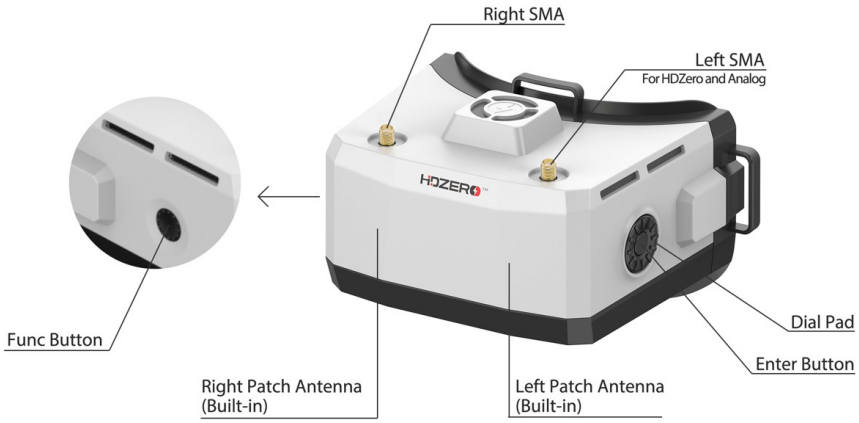
The HDZero BoxPro is open source. You can find the SoC Firmware at Github.

HDZero BoxPro Operation

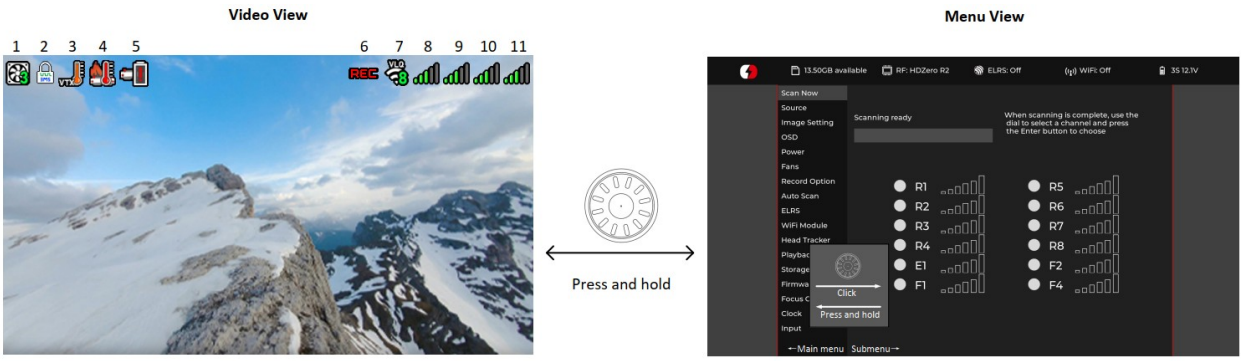
This section describes the general operation of the HDZero BoxPro.

Controls

- Dial Pad
- Enter Button
- Func Button



Video view and Menu view



- Single Click: Show/Hide goggle OSD
- Dial Up/Down: Change to desired channel, Click to confirm
- Press and Hold: Switch to Menu View

- Single Click: Start/Stop DVR
- Press and Hold: Change fan speed

BoxPro OSD:

1: Goggle fan speed
2: Goggle latency lock indicator
3: VTX temperature indicator
4: Goggle overheat alarm
5: Goggle power low voltage alarm
6: Recording state
7: Video link quality indicator
8: Left SMA antenna signal strength
9: Left patch antenna signal strength
10: Right patch antenna signal strength
11: Right SMA antenna signal strength

Video Source

The HDZero BoxPro can display video from any of 4 sources:

- Built-in HDZero digital receiver
- Built-in Analog digital receiver
- AV in
- HDMI in

HDZero Digital Receiver

The “Scan Now” option on the main menu will scan the following channels for an HDZero video signal:

- R1-R8, E1, F1, F2, and F4 channels, or
- L1-L8 if low band is selected

“Scan Now” will perform the following:

- Scan the above channels,
- Lock on to the channel if there is only one valid channel with a signal, or
- Let you choose between the channels if it has found two or more channels, or
- Continue to scan after 5 seconds if no signal is detected, or
- Wait for a long press of the Enter button to exit to the main menu

Note 1: To enable low band, set Source -> HDZero Band to **Lowband**. Here is the center frequencies for L1-L8.

Low Band Channel	L1	L2	L3	L4	L5	L6	L7	L8
Frequency (MHz)	5362	5399	5436	5473	5510	5547	5584	5621

Note 2: The HDZero provides the lowest and fixed latency when used with the HDZero Nano 90 camera. This Nano 90 camera supports 540p60 mode *exclusively*. When it is set to 540p60, the goggle needs to set Source > HDZero BW to **Narrow**.

All other modes need to set Source > HDZero BW to **Wide**.

Analog Receiver

The HDZero BoxPro takes analog video input from either the AV input jack or the built-in analog RF receiver.

The HDZero BoxPro uses a novel approach to process the analog input, resulting in improved analog video quality:

- It uses a video decoder with an adaptive comb filter to separate Y/C from the composite video;
- It uses a deinterlacer to convert fields to frames, instead of doubling the interlaced lines;
- It uses an upscaler to record and display the video;

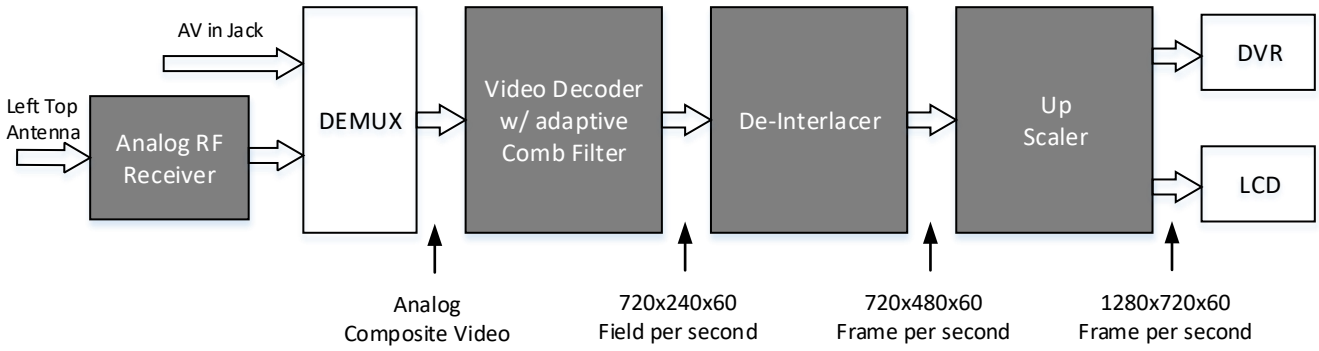


FIG 4. Signal Processing Path for Analog Input

Auto Scan

HDZero BoxPro has options to let goggle boot to desired modes after power on.

HDZero: Main Menu → Auto Scan → Auto Scan = ON | Last
Default = HDZero

Analog: Main Menu → Auto Scan → Default = Analog

Last time: Main Menu → Auto Scan → Default = Last

Fan Management

There is one fan on the top of the goggle. It cools the internals and prevents screen fogging. The fan speed can be set to a 1-5 level, corresponding from minimum to max speed.

There are two control modes for side fans:

- Automatic mode: Goggle firmware will automatically speed up/down;
- Manual mode: You can manually set the speed for each fan;

Regardless of the current mode, top fan will go to max speed if temperature sensor reports a reading that is too hot.

You can change the fan speed by pressing and holding the Func Button. You can monitor the fan speed changes on the goggle OSD to quickly change the amount of air blowing onto your face and the optic lenses while in the Video view.

Image Settings

The HDZero goggle has an image processor to fine tune video before feeding to DVR and display. It includes:

- Brightness
- Saturation
- Contrast
- LCD Brightness

Note: "Brightness" refers to the image brightness processed by the video processor, while "LCD Brightness" pertains to the backlight of the LCD display.

LCD Auto Off

If the HDZero BoxPro detects no movement or no key input for programmed time (1/3/5/7 minutes), it will dim the LCD display as an alarm, and it will wait for another one minute before turning off both the display and HDZero digital receiver with a short beep. The LCD display and HDZero receiver will resume normal operation if the goggle detects movement or any key input. This feature can be disabled by setting the waiting time to “Never”.

It is highly recommended to use the above LCD auto off feature or “Go Sleep” from main menu to turn off LCD while not using the goggle.

DVR

The HDZero BoxPro integrates a DVR for the HDZero digital receiver, analog input (RF or AV in), and HDMI input. These are the DVR options:

- Automatic Record: DVR will start to record when it detects there is valid HDZero RF on the current channel, and stops recording when the signal is no longer detected.
- Manual Record: DVR will start/stop only if Func button is clicked.
- MP4 format or TS format: MP4 format is better supported by many video editing applications. However, MP4 files can be corrupted if the goggle loses power before the file is closed after recording, which can happen if the goggle runs out of battery or the power cord is unplugged unexpectedly. Unlike the MP4 format, the TS format saves the stream instantly to DVR without any risk of corrupted files, even if the goggle suddenly loses power.
- H264/H265. The DVR must use the H264 format when recording 90fps video (it records in 1280x720x90 for better quality). It uses the H265 format in all other cases.
- Audio: You can choose to record audio or not. There are 3 audio sources that can be recorded:
    - Built-in microphone
    - Line in (From Line in/out Jack), aka external microphone
    - AV in (From AV in Jack)

Note:

The file system on SD card can be corrupted by suddenly power off while goggle is writing data to it. The HDZero BoxPro runs on Linux, and it does *not* have a big capacitor that saves power for saving the last emergency bits. The DVR will not work if SD file system is corrupted. Here are tips on how to avoid powering off while recording is ongoing:

- Auto record mode: after quad is landed, do one of the following
  - Long press "Enter" button to switch to menu mode, then power off the goggle, or
  - Power off quad first, and wait for 10 seconds, then power off the goggle
- Manual record mode: Click "Func" button to stop DVR before power off the goggle
- Select "Scan and Fix" if Windows or Mac reports problem when SD card is inserted.

TABLE 3: DVR resolution

	Input Source	Recording resolution	Encoder
1	HDZero 60fps Camera	1280x720x60fps	H.265
2	HDZero 90fps Camera	1280x720x90fps	H.264
3	NTSC	1280x720x59.97fps	H.265
4	PAL	1280x720x50fps	H.265
5	HDMI in	1280x720 (50,60, 90fps) 1920x1080 (50, 60fps)	H.264

DVR for HDMI in

Here is how DVR works when source is set to HDMI in:

- BoxPro will automatically start recording and:
- Restart recording when HDMI in resolution changes.
- Restart recording when recording time reaches 10 minutes.
- Stop recording when HDMI in source is lost.
- Stop recording when SD card storage is less than 100MB or SD card is ejected.

Note: When source is set to HDMI in, there is no Goggle OSD, include recording icon, battery status, etc.

Playback

The HDZero BoxPro can play back DVR recordings.

- The player lists the recent recording first. Use Dial up/down to select a file, and click to play it
- On controller bar, use Dial Up/Down to seek video (5 seconds forward/backward), and click to play/pause
- Long press the Enter button to exit the controller bar, and long press Enter again to exit the player.

Note: The player will ignore files that are less than 5MB.

OSD

The goggle supports OSD from flight controller (FC OSD) and OSD of its own status (Goggle OSD). You may select if both OSD should be recorded with video stream at Record Options sub-menu.

Goggle OSD can be shown/ hidden by clicking the Enter button under Video view. The positions of Goggle OSD items can be changed at OSD | Adjust OSD Elements.

The goggle has built-in OSD fonts for BetaFlight, Arduino and iNav. It will automatically load the corresponding font according to type of flight controller that is connected with HDZero video transmitter. You can also customize FC OSD by putting bitmap files under SD card root directory/resource/OSD/FC.

Note: When source is set to HDMI in, there is no Goggle OSD, include recording icon, battery status, etc.

Tune Channel

By Dialing up/down, video channel number can be tuned on video mode for HDZero receiver input. However, this can be disabled by putting a file named as “no_dial.txt” on SD card root directory when booting up.

WiFi Module (Optional)

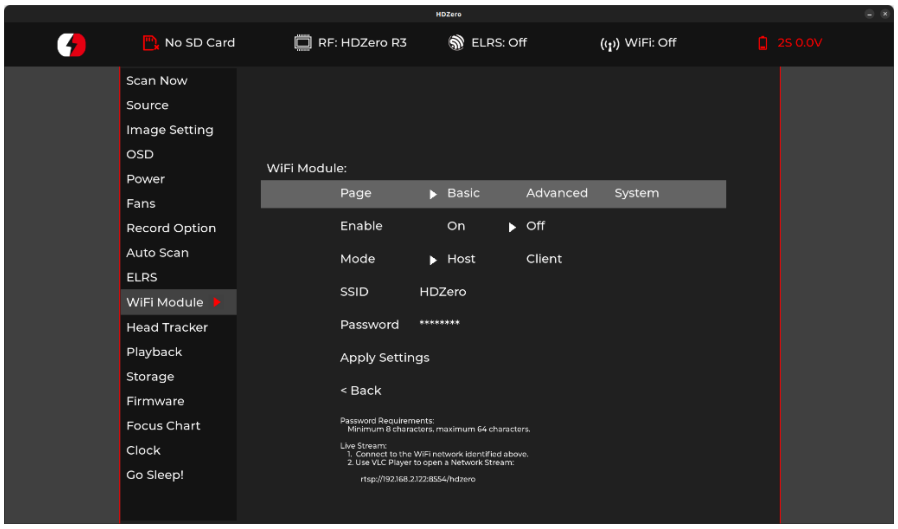
The HDZero BoxPro supports WIFI video streaming to smart phone, desktop or laptop, if it includes WIFI/ESP32 module. Multiple devices can wirelessly connect to the goggle and receive the video simultaneously.

Control over the behavior of the WiFi Module is completely managed from within the WiFi Module page. Users have the ability to configure the goggle as a Host (Access Point) or a Client (Join Network).

WiFi Module page supports both “Basic” and “Advanced” configuration fields.

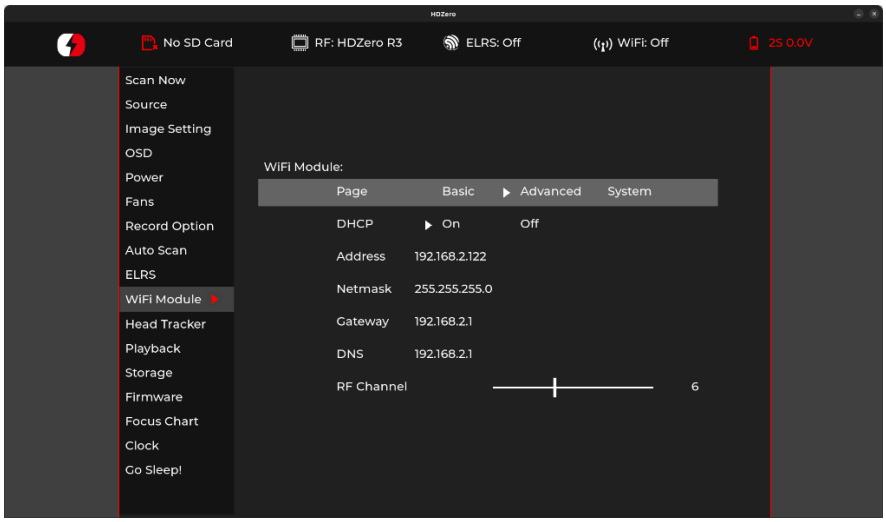
Basic Fields:

- Enable – Powers On or Off the WiFi Module hardware.
- Mode – Host (Access Point) or Client (Join Network).
- SSID – User can specify a Host and Client network names individually based on Mode.
- Password – User can specify a Host and Client network password individually based on Mode.
    - Note that password requires a minimum of 8 characters.
- Apply Settings – Stores and configures the WiFi Module hardware with the settings the user has modified. << change the following pic>>>



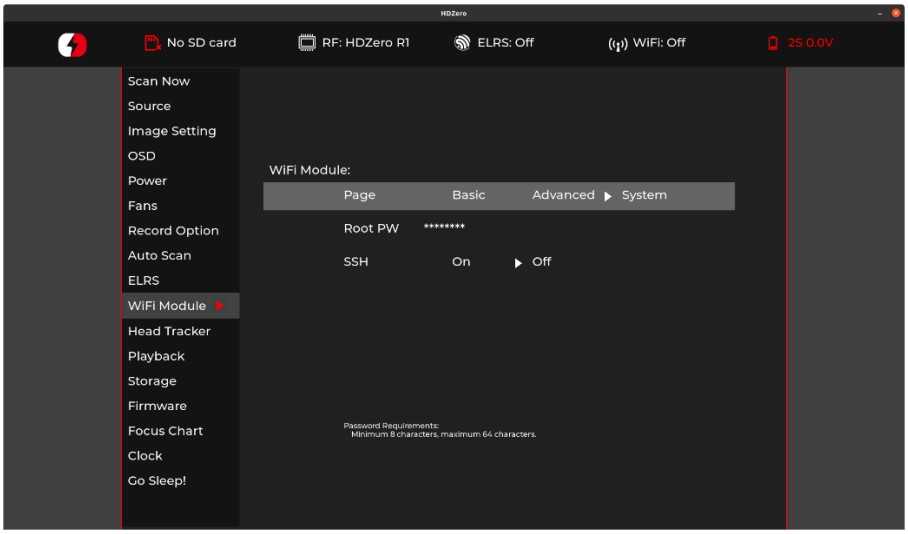
Advanced Fields:

- DHCP – This setting only applies to Client Mode.
  - Note the Address specified will be requested for use by the WiFi. Ultimately it is up to the router to find and available address if the address requested is not in use, then the one specified will be used.
- Address – The network IP address.
  - This setting applies for both Host and Client modes.
- Netmask – The network subnet mask.
  - This setting applies for both Host and Client modes.
- Gateway – The network gateway IP address.
  - This setting applies for both Host and Client modes.
- DNS – the Domain Network Service IP address.
- RF Channel – This setting only applies to Host Mode and a user can specify which radio frequency channel they want to communicate on.



System Fields:

- Root PW – Update the root password for the goggles.
  - This applies to SSH and SCP communications.
- SSH – Enable/Disable Access to the goggles.
  - Defaults to disabled as a security precaution.



Finally, if either page is modified “Basic” or “Advanced”, the user must return back to the “Basic” page and select “Apply Settings” in order to configure the WiFi Module.

In order to establish a wireless video stream with the HDZero BoxPro via a smartphone or computer, the user must follow these steps:

1. The “Basic” page within the WiFi Module page will contain the necessary information in order to establish communications with the HDZero BoxPro:
   a. Host Mode – Refer to the SSID and Password fields in order to join the HDZero BoxPro wireless network.
   b. Client Mode – Refer to your wireless access point user manual.
2. Install VLC app (or other similar app that supports RTSP) on your device.
3. Open the above app, choose “Open Network Stream”, and type the RTSP URL provided by the “Basic” page footnote as it will provided the necessary URL in order to establish a video stream via VLC app, below is the default ip address if the user has not made modifications within the “Advanced” page:

   `rtsp://192.168.2.122:8554/hdzero`

Note: Video latency is expected due to networking protocols, buffering schema of the app, and OS platforms.

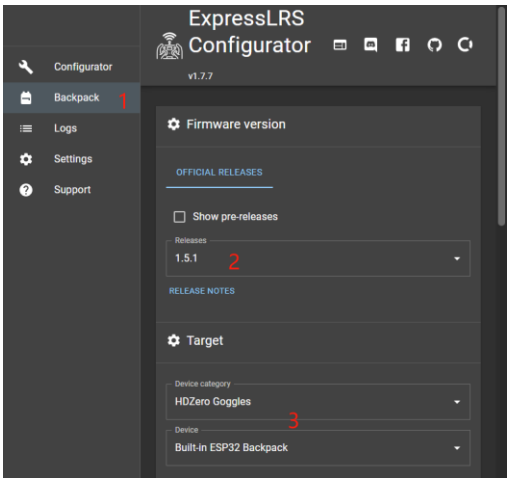
ESP32/Backpack Module (Optional)

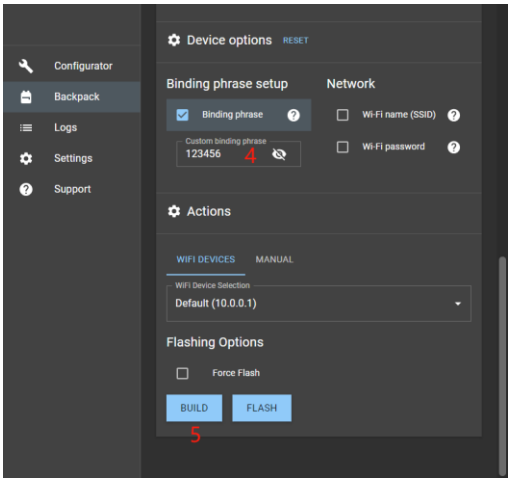
The HDZero BoxPro supports a built-in ESP32 Backpack that achieves:

- Set channel number of built-in HDZero or Analog receiver depending on Source input
- Wireless head tracking
- Start/Stop DVR using a radio switch

Update BoxPro Backpack Firmware

- Create a folder name as ELRS in the root directory of the SD card
- Using **ExpressLRS Configurator** to build firmware for goggle:
  1. Switch to Backpack menu
  2. Select the same release version with the radio backpack
  3. Select target HDZero Goggles -> Built-in ESP32 Backpack
  4. Set the same binding phrase as the radio backpack, otherwise your backpack needs to be bound manually
  5. Build the firmware. A folder will pop up automatically containing the following 4 files when completed. Copy them to the above ELRS folder created on SD card
     - ✓ boot_app0.bin
     - ✓ bootloader.bin
     - ✓ firmware.bin
     - ✓ partitions.bin
- Insert SD card to the goggle
- Flash Backpack firmware at BoxPro: Firmware -> Update ESP32





Bind BoxPro and Radio

Please flash your ELRS TX of Radio to the same version as BoxPro Backpack firmware version. Refer to ELRS official [Tx Backpack Setup] here.

If the binding phrase of goggle is different with Radio, it is needed to bind manually for first use.

1. BoxPro: ELRS -> Backpack = on
2. BoxPro: ELRS -> Bind
3. Radio: ExpressLRS Lua -> Bind

After a few seconds, the goggle will display success if the binding is complete.

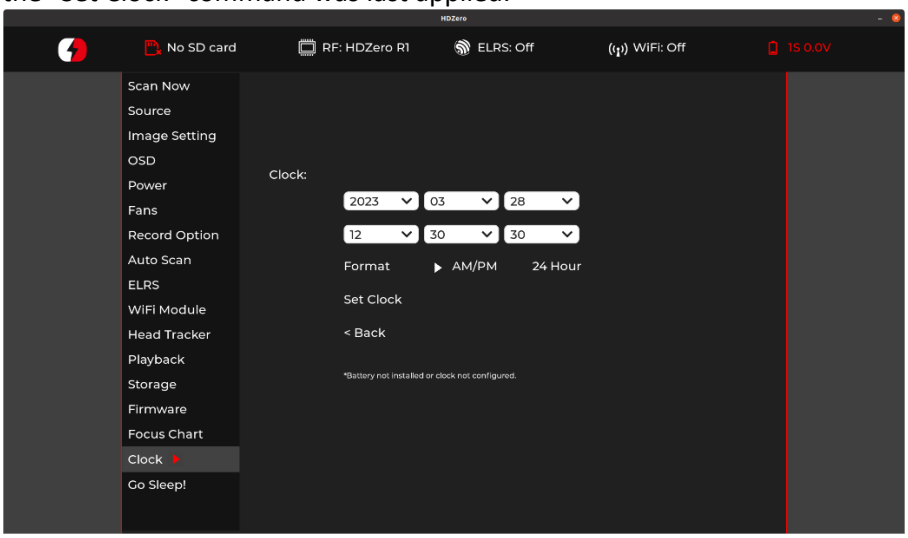
Start/Stop DVR using a radio switch

The HDZero goggle supports start/stop recording using a switch on radio. Here are steps to setup on BoxPro and Radio:

1. BoxPro: Record Option -> Record Mode = Manual
2. Radio: ExpressLRS Lua -> Backpack -> DVR Rec = AUX*n*↑ | AUX*n*↓, where *n* is aux channel number for the switch on radio.

Real Time Clock (RTC)

The HDZero BoxPro is equipped with a Real Time Clock. For initial setup, the RTC can be configured through the Clock Page, which will set both the system clock and hardware clock when you use the "Set Clock" function. Otherwise, when the goggles boot up, they will default to the last date and time set by the user since the "Set Clock" command was last applied.



The pre-installed battery may eventually die and can be replaced with an aftermarket CR1220 battery. After replacing the battery, you'll need to invoke the "Set Clock" function to set the correct time and date.

Please note that the user assumes full responsibility for any damage incurred while opening the goggles to install a replacement battery.

HDZero BoxPro Firmware Update

Download the latest firmware HDZEROBOXPRO_Revyyyymmdd.zip from HDZero download site. Then unzip it.

TABLE 4. Firmware File

Firmware File	Usage
HDZERO_BOXPRO-*.bin	Flash firmware from the menu
Recovery/HDZB_OS.bin	Emergency recovery
Recovery/HDZBOX_RX.bin	
Recovery/HDZBOX_VA.bin	

The goggle can be bricked under some rare cases, please follow Emergency Firmware Update Process to de-brick it. Otherwise, follow Normal Goggle Firmware Update Process.

Normal Goggle Firmware Update Process

1. Disconnect all cables from the goggle. Keep the power cable only;
2. Copy HDZERO_BOXPRO-*.bin to root directory of a SD card that is formatted as FAT32, and make sure there is no previous firmware in the root directory;
3. Power on the goggle;
4. Go to Main menu | Firmware | Update Goggle, the display will show the current version;
5. Wait for the completion (*about 3 minutes*), then power off;
6. Done!

Emergency Firmware Update Process

1. Disconnect all cables from the goggle. Keep the power cable only;
2. Extract Recovery/HDZB_OS.bin, Recovery/HDZBOX_RX.bin Recovery/HDZBOX_VA.BIN, copy them to root directory of a FAT32 formatted SD card, and insert SD card to the goggle;
3. Power on goggle, *wait for 5 min* then power off;
4. Done!

Note: HDZB_OS.bin, HDZBOX_RX.BIN, and HDZBOX_VA.BIN will be removed from SD card if update successfully.

Troubleshooting

Support should be attempted in the following manner.

1. Read this manual first
2. Follow us on Facebook/Discord if possible
    a. Facebook: https://www.facebook.com/groups/hdzero
    b. Discord Server: https://discord.gg/VSkXzkKPHt
3. Email Technical Support: support@divimath.com

Warranty

The HDZero BoxPro can be exchanged for a new unit within 7 days for any manufacturing defects if returned in new condition. The optic module will be warrantied for repair for 12 months, and all other components, for 2 years, if there are no signs of excessive use. Buyer will be responsible for shipping costs. If beyond the warranty period, we will provide repair services for a cost. For assistance with warranty issues, please contact support@divimath.com.