HDZero Goggle User Manual

Rev 1.1

11/24/2022

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Introduction

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

Diagram
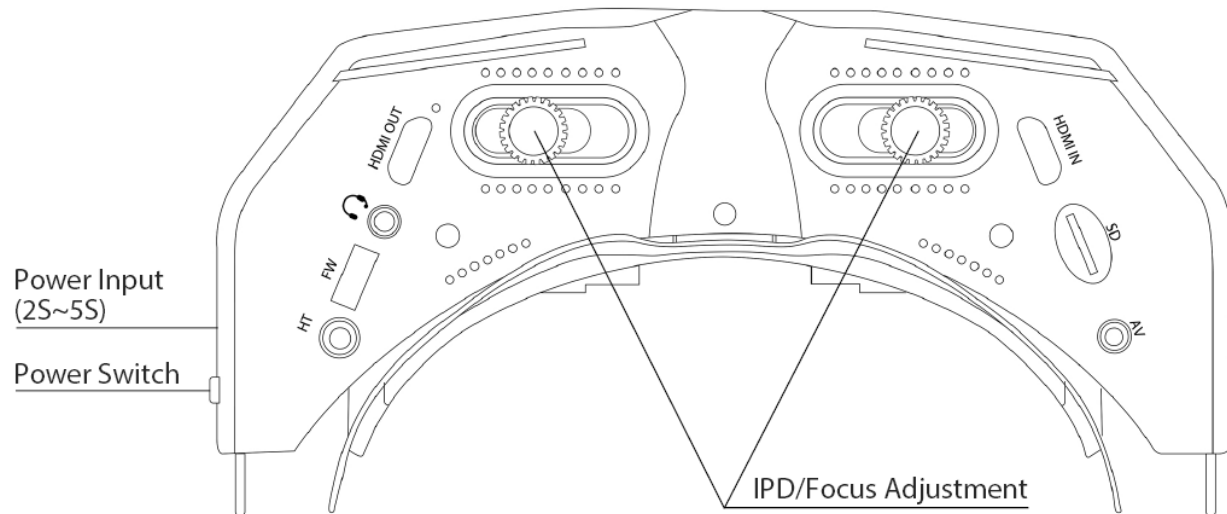
Features

- 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 new goggle runs Linux. All code for the user interface is new and open source
- Support diopter lens inserts
- 90Hz 1080p OLED screens with sliding IPD adjustment and dials for focus adjustment
- By integrating the entire goggle display pipeline with HDZero's fixed-latency video transmission, these goggles achieve 3ms glass-to-glass sub-frame latency with no jitter or dropped frames
- Mounting rails for patch antennas or whatever else you might want to mount
- Recessed front SMA jacks so no need to remove antennas when packing the goggle away
- Three independently addressable fans work in combination to cool the internals and prevent fogging. They are soft mounted to prevent screen vibration and noise
- HDMI input and 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
- Integrated 2D deinterlacer that adds no delay for analog input
- Built-in ESP32
- Built-in H.265 DVR
- 6-axis smart inertial measurement for head tracking pan+tilt support
- Add-on side-mounted analog module bay that accepts most of today's analog modules
- Add-on 2.4Ghz WiFi video streaming module for live streaming

Specification

- HDZero Camera glass-to-goggle glass latency: <3ms
- Adjust IPD range: 57-70mm
- Adjustable focus range: +6 to -6 diopter
- Full HD 1920x1080p 90fps OLED micro display
- FOV: 46deg
- Input voltage: 7V-25.2V
- Power consumption: 14.5W (with HDZero RF on), or 8.4W (with AV In)
- Weight: 294g
- Dimension: 185x81x66mm

Included Accessories
- 1x HDZero goggle
- 1x wide face plate
- 1x narrow face plate
- 1x foam padding
- 1x goggle strap
- 1x 1200mm XT60 cable
- 1x 150mm HDZero VTX programing cable
- 1x Thick Canvas Goggle Bag
- 1x Lens cloth

Setup

The HDZero goggle 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.

Power Input/Consumption

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

TABLE 1. Power Consumption

	Mode	Power Consumption
1	HDZero Digital	1.2A@12V
2	Expansion module+ IRC RapidFire[3]	0.9A@12V
3	AV In	0.7A@12V
4	HDMI in	0.7A@12V

Note:
1. DO NOT use a 6S or above HV lipo to power on the goggle, it will permanently damage the goggle.
2. 18650 battery cases can kill your goggle (blow the fuse). 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 blow to protect the goggle. This can be repaired by replacing the fuse inside the goggles, but at owner's own cost.
3. RapidFire is a product of ImmersionRC limited. It is not included.

XT60 Cable

The goggle includes a 1200mm XT60 cable for connecting a battery in your pocket. You may also purchase a shorter 90mm cable on HDZero shop if you wish to locate your battery on the goggle head strap.
The XT60 cable (either 1200mm or 90mm) has no voltage regulator. The cable passes voltage directly through the goggle.

Note: Do not connect an over 6S battery to the goggle, as the maximum voltage rating of the goggle is 6S (4.2V/cell).

Face Plate/Padding Foam

The goggle includes both a wide face plate and a narrow one. You may choose the appropriate one to fit your face, and use the included 7mm thick foam padding for both comfort and preventing light leakage.

Optical Adjustment

After goggle is powered on, you will see an image on the OLED displays. Complete the following steps to adjust the optics:

1. Focus adjustment: Close one eye and slowly twist the focus knob on that side of the goggle until the image comes into focus. Once it works well with one eye, repeat the process with the other eye.
2. IPD adjustment: Close one eye and slide the knob to center the image. Once the image is centered, repeat the process with the other eye.
3. Fine adjustment: Open both eyes and look at the merged image. Make small adjustments to the focus and IPD for each eye until it feels visually comfortable and merges into a single clear picture.

Note: Do not expose the lens directly to sunlight. Otherwise, the OLED displays might be damaged.

Head Strap

The goggle includes a 50mm (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 goggle includes a single port HDMI 1.4b receiver though a mini HDMI port. The incoming HDMI video is routed to the OLED display without adding any frame buffer 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.

HDMI Output

The HDZero goggle 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	Same as HDMI in

AV input

The HDZero goggle 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.
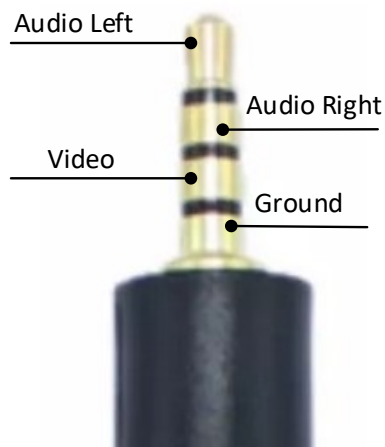

FIG 1. AV input Jack   FIG 2. HT output Jack   FIG 3. Line In/Out Jack

HT Output

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

Mounting Rails

The HDZero goggle has a unique mounting rail for patch antennas or whatever else you might want to mount.
Here is mount adapter for TrueRC patch antennas by Ryan Quellet, and ball joint rail mount by userzero1.

FW Port

The FW port is used for flashing firmware to HDZero VTXes. A 150mm programming cable is included.
The instruction for flashing VTX firmware is described on HDZero Firmware Update section.

Open Source
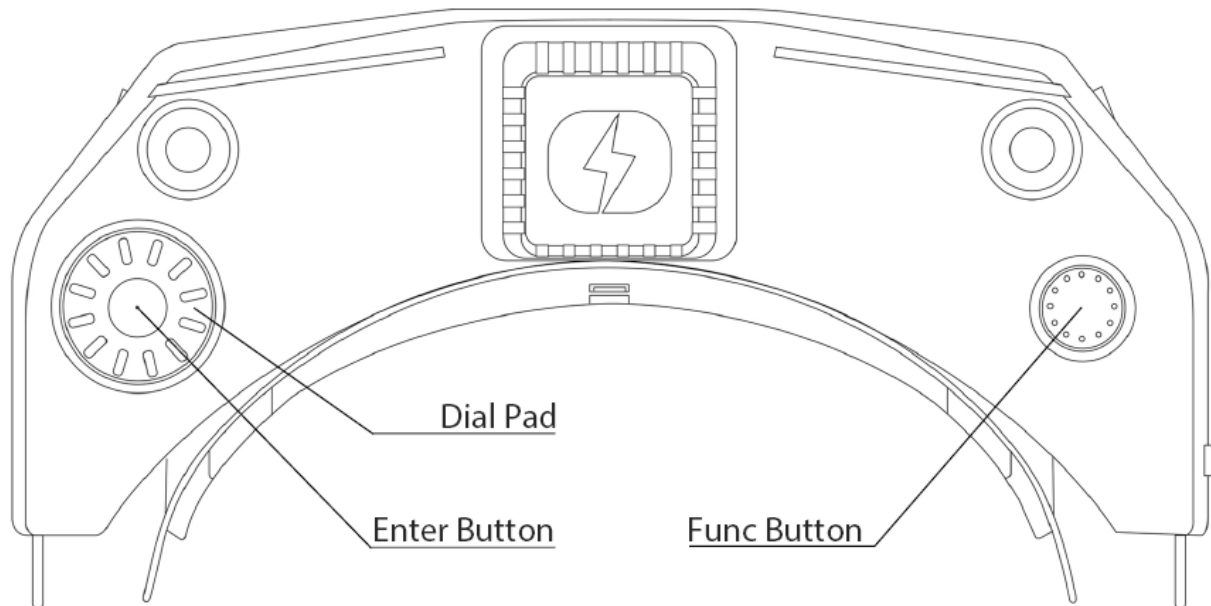
The HDZero Goggle is open source. You can find the SoC Firmware and Goggle CAD files at Github.
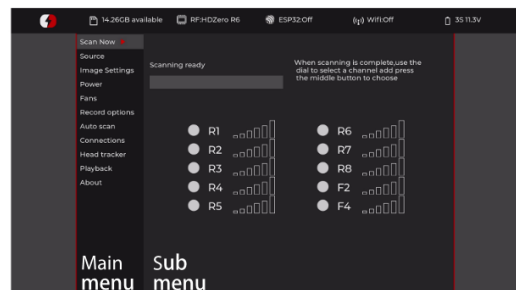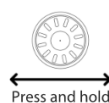
HDZero Goggle Operation

This section describes the general operation of the HDZero goggle.

Controls

- Dial Pad
- Enter Button
- Func Button

Dial Pad

Enter Button   Func Button

Video view and Menu view

Press and hold

- Single click: Show/hide goggle OSD
- Dial up/down: Change to desired channel, click to confirm
- Press and hold: Switch between menu view and video view

- Single click: Start/stop DVR
- Press and hold: Change top fan speed

- Single click: Switch to sub menu
- Press and hold: Switch to main menu
- Dial up/down: Navigation

Goggle OSD:

1: Goggle power low voltage alarm	4: VTX temperature indicator	7: Left Top antenna signal strength
2: Top fan speed	5: Recording state	8: Left Side antenna signal strength
3: Goggle temperature indicator	6: Video Link Quality indicator	9: Right Side antenna signal strength
		10: Right Top antenna signal strength

Video Source

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

- Built-in HDZero digital receiver
- AV in
- Expansion Module in (such as with an analog video receiver)
- HDMI in

HDZero Digital Receiver

The "Scan Now" option on the main menu will scan channels R1-R8, F2, and F4 for an HDZero video signal. It will:

- 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

The HDZero goggle provides the lowest and fixed latency when used with the HDZero Nano 90 camera.

Analog Input

The HDZero goggle takes analog video input from either the AV input jack or the external Expansion Module (not included, available on the HDZero Shop). The goggle processes analog video from either of these inputs in the same way, but the Expansion Module provides an easy plug-and-play experience if you are using a standard FPV analog module.

The HDZero goggle 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;
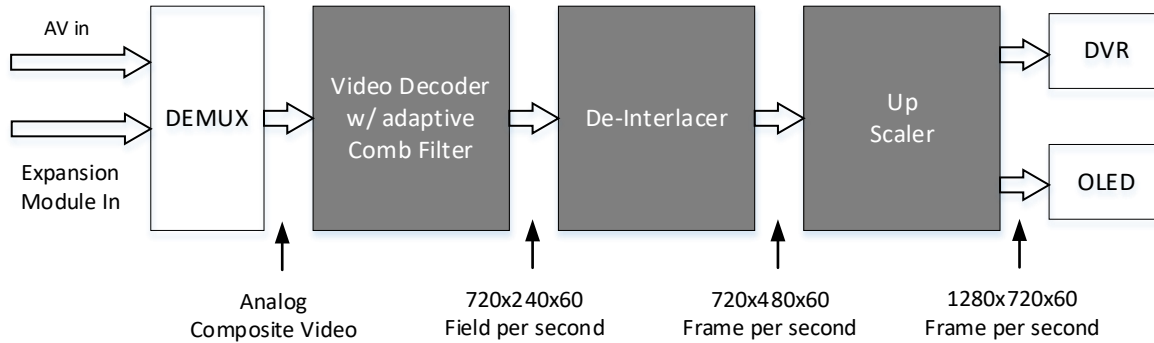- It uses an upscaler to record and display the video;

FIG 4. Signal Processing Path for Analog Input

Fan Management

There is one fan on the top of the goggle and one fan on each side of the goggle. All fans are soft mounted to reduce vibration and noise. There are three temperature sensors on top and sides of the goggle.

These fans are critical to goggle performance:

- The top fan provides cooling for the OLED displays and defogging for the optical lens;
- The side fans provide cooling for the IO and RF boards inside the goggle

They will prevent goggle from being too hot, improving OLED life span and ensuring maximum HDZero RF performance.

Each fan can be set to a 0-5 level, corresponding from off state to max speed.

There are two fan control modes:

- Automatic mode: Goggle firmware will automatically speed up/down the fan on each side;
- Manual mode: You can manually set the speed for each fan. (0=off, 5=max);
- Regardless of the current mode, the goggle firmware will enter into **rescue** mode under these situations:
    - o temperature sensor on top reports hot: top fan goes to max speed;
    - o temperature sensor on left/right reports hot: left/right fan goes to max speed;

Please note that only the side fans have automatic mode. The top fan is always in manual mode unless it is in rescue mode.

You can change the top fan speed by pressing and holding the Func Button while in the Video view. 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.

Note: It is recommended to use automatic mode for side fans, and set top fan speed as desired.

Image Settings

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

- Brightness
- Saturation
- Contrast

OLED Control
For OLED display, you may set OLED brightness to the desired level. Note that the OLED brightness setting applies to the OLED display only.

If the HDZero goggle detects no movement or no key input for programmed time (3/5/7 minutes), it will dim the OLED 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 OLED 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".

DVR

The HDZero goggles integrates a DVR for both the HDZero digital receiver and analog 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. Note that automatic recording is not available for the analog input, you will need to click Func button to start/stop recording.
- 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)
    - AV in (From AV in Jack)

	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	No recording	No recording

Playback

The HDZero goggle 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 are fixed on current firmware.

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.

HDZero Firmware Update

Download the latest firmware from HDZero download site. The firmware package Rev_ddmmyyyy.zip contains firmware for all of the HDZero products.

TABLE 4. Products and their Firmware

Product Name	Firmware Zip file	Firmware Name
Freestyle VTX	FreestyleVTX.Revddmmyyyy.zip	HDZERO_TX.bin
Whoop Lite VTX	WhoopLiteVTX.Revddmmyyyy.zip	HDZERO_TX.bin
Whoop VTX	WhoopVTX.Revddmmyyyy.zip	HDZERO_TX.bin
Race V1	RaceV1VTX.Revddmmyyyy.zip	HDZERO_TX.bin

Race V2	RaceV2VTX.Revddmmyyyy.zip	HDZERO_TX.bin
Goggle	HDZGOGGLE_Revddmmyyyy.zip	HDZERO_GOGGLE_xx.yy.zzz.bin
	HDZGOGGLE_EMG_Revddmmyyyy.zip	HDZGOGGLE.img HDZGOGGLE_RX.BIN HDZGOGGLE_VA.BIN

Flashing Firmware to a HDZero VTX

The HDZero goggle can flash firmware to a HDZero video transmitter via its FW port. Here are the steps:

To flash a single VTX:

1. Copy HDZERO_TX.bin to root directory of a SD card that is formatted as FAT32
2. Power on the goggle
3. Connect the VTX and HDZero goggle with the included programming cable
4. Go to Main menu | About | Flash VTX, the display will show the status of the flashing process
5. Disconnect the VTX
6. This VTX is now flashed with the latest firmware

To flash multiple VTXes of the same type:

1. Copy HDZERO_TX.bin to root directory of a SD card that is formatted as FAT32
2. Power on the goggle
3. Connect one VTX to the HDZero goggle with the included programming cable
4. Go to Main menu | About | Flash VTX, the display will show the status,
5. Disconnect the VTX, this VTX is flashed
6. Repeat 3-5 for the other VTXes

Note: HDZERO_TX.bin will *not* be removed from SD card after programming so that you can flash multiple quads without copying file to SD card.

Flashing Firmware to the Goggle

The HDZero runs on Linux. Its firmware contains the customized Linux distribution and its application software. We only need to update the application instead of updating the whole OS and application in most cases. However, there are some rare cases where the OS could become corrupted, such as losing power during update process. It is also possible that changes may have to be made to the OS in the future to add new functionality.

The HDZero goggle firmware consists of:

- HDZGOGGLE_xx_yy_zzz.zip. This is the application firmware. You should only need this in most cases.

- GoggleEmergency_Revddmmyyyy.zip. This is the complete package including OS and application software for emergency recovery only.

Normal Goggle Firmware Update Process

1. Disconnect all cables from the goggle. Keep the power cable only;
2. Copy HDZGOGGLE_xx.yy.zzz.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 | About | Flash Goggle, the display will show the status;
5. Wait for the completion (about 3 minutes);
6. Power the goggle off and then on again

Goggle Emergency Firmware Update Process

You need to download PhoenixCard.zip from the HDZero Download site, and extract it to a location on a Windows machine, for example, C:\PhoenixCard. This is a one-time process. There is no Mac or Linux version for now.

You need to download GoggleEmergency_Revddmmyyyy.zip zip from the HDZero Download site, and extract to your local drive, i.e. C:\Tmp.

1. Launch C:\PhoenixCard\PhoenixCard.exe;
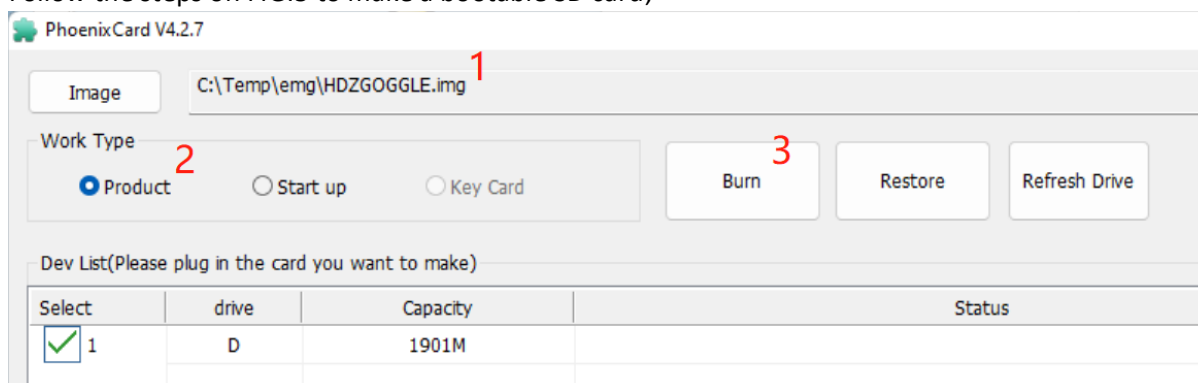2. Follow the steps on FIG.5 to make a bootable SD card;

FIG 5. Make a bootable SD Card

3. Eject the SD card from Windows, and insert the SD card into the SD card slot of the goggle;

4. Unplug all of the cables, i.e., HDMI in/out, Line in/out, AV in. Keep the power cable only. Power on the goggle, you will hear a long beep immediately. Wait for 3 minutes and you will hear another long beep;
5. Power off the goggle, and pull out the SD card from the goggle. (Do not power on goggle now);
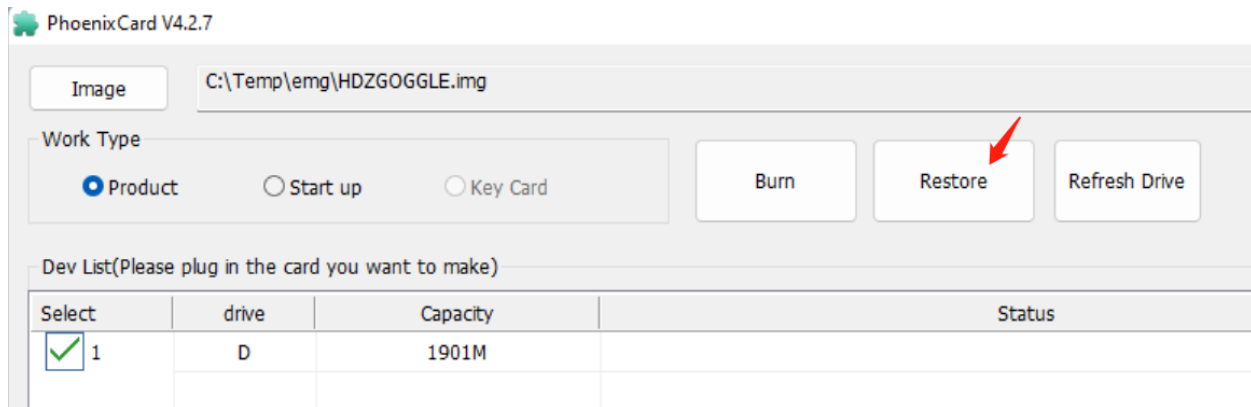6. Follow the FIG.6 to restore the SD Card from BOOT mode, and format it as FAT32 on Windows;

FIG 6. Restore a SD Card

7. Copy HDZGOGGLE_RX.bin and HDZGOGGLE_VA.bin to the SD card;
8. Insert SD card into goggle, power on the goggle, wait for 2 minutes, and there will be a long beep;
9. (Optional) Pull out the SD card, and check SD card contents on the PC. The 2 files should be removed if flash process is successful;
10. Power the goggle off and then on again.

Note. A bootable SD card has a hidden partition that Windows Explorer will not show. And it can't be removed even SD card is formatted with Windows Explorer. It means the goggle will flash itself from the bootable SD card unexpectedly and mess up goggle firmware if a bootable SD card is inserted when the goggle is powered on.

Step (6) must be followed strictly to get rid of the hidden bootable partition. Otherwise, it will brick the goggle when goggle is powered with this SD card inserted. If this happens, you will need to repeat the emergency firmware update process described in this section.

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 Goggle 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 6 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.