



PVS 420 thermal vision 50Hz low budget 18650 monocular (256X192, 384X288, 640X512)



LWC

[VIEW IN BROWSER](#)

updated 31. 8. 2025 | published 31. 8. 2025

Summary

I always wanted a tactical thermal sight/ scope but prices are just not within my budget so I made my own.

[Hobby & Makers](#) > [Electronics](#)

Tags: [camera](#) [military](#) [tactical](#) [thermal](#) [nightvision](#) [thermalcamera](#) [prepper](#) [pvs14](#) [pvs](#) [thermalvision](#) [thermalsight](#)

UPFRONT:

I just created an Discord server for the PVS420 so its easier to talk about and share thoughts, ideas, improvements, etc.:

<https://discord.gg/Ce9BJ2DK3j>

PLEASE READ EVERYTHING BELOW BEFORE YOU ASK QUESTIONS in PM! Thanks!

Wiring schematics are done, check the very last pictures.

Because people keep frequently asking: costs run between **350-400€** for the **minimal** setup (256x192 thermal sensor resolution). Depending on, if you have some usable stuff at home or have to order the whole parts list from aliexpress.

CHECK demonstration video on the bottom of the Details!!

BEFORE YOU PRINT! make sure the objects are flat on the print bed before you slice!!!! (**Main body thermal cam, eye piece, nav switch**)

It is necessary to “re drill” some printed holes to make things fit properly (battery driven drill and drill bits are mandatory, same as a set of screwdrivers, superglue, solder iron, common tinker stuff you have to own anyways if you do projects like this.

If you break any of your stuff in the process or get hurt it is not my fault and your own risk!

The components used in this build are far from cheap even so it says “on a budget” so you have to know what you are doing!

!!!!!!!!WARNING!!!!!!!!!!!!!! AT ALL TIMES when you connect the ATTINY85 to USB, under no circumstances can the Serial out line from the ATTINY board (PB02) be connected to the thermal cameras RX /TX or you will KILL your cameras UART controller!! NEVER (even so the ATTINY85 board says 5Volt, connect it to 5VOLT, it HAS TO BE 3.3 VOLT!!!! Never connect the ATTINY85 over USB with the serial out (PB02) connected!! YOU HAVE TO DISCONNECT IT BEFORE!!

Upcoming Updates/ in the works:

Update History:

UPDATE: 23.01.2025

Improving the lens cap to be more sturdy and easier to take off adding two “ears” on the side.

Adding a Screw plug + TPU friction ring to plug up the camera screw insert.

Added the numbers “420” to the dummy lens retainer clip

UPDATE: 25.01.2025

Added a USB charging option to the device, you now have the choice to go 18650 only or go with the additional USB charging option which needs you to replace the stock BMS with the USB charging board with included BMS. (unsolder the USB connector from the PCB to make it fit properly)

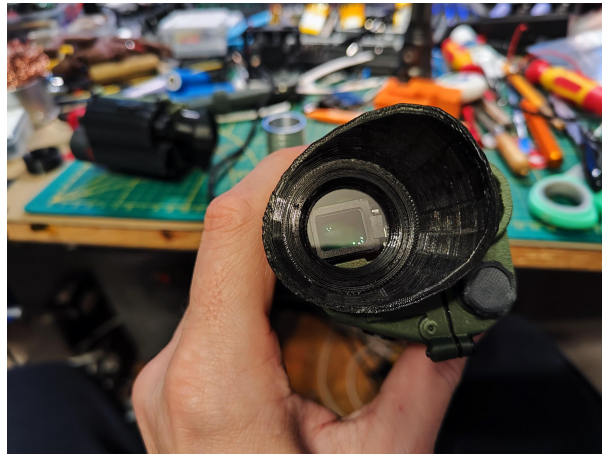


UPDATE 28.01.2025:

Added an abomination of a wiring schematic but it should do the job. (check in pictures)

UPDATE 30.01.2025:

Added some protection to the eye cup piece as it is pretty exposed to the outside elements, a prototype acrylic glass sheet was added that will be replace soon with a proper H9 hardened glass you would normally use for the display of a watch. That way it is easy to clean, its scratch resistant an closed off from the outside, like rain, dust, hair, skin scales, etc.



UPDATE 02.02.2025:

Found a perfect sized storage box with foam insert for the PV420 and added the Link to the Parts list as optional accessory.



UPDATE03.02.2025:

Added a short and long focus adjuster ring for easy manipulation of the focus.



This upgrade needs 3x M2-2.5 x4mm grub screws or normal screws to hold the adjuster ring in place, a bit of silicone lube or similar makes the ring turn smoothly. It is now easy to adjust the focus on the go which can make a big difference (as I had to find out myself the hard way)

3 Parts were updated/added (TPU lanyards for caps and covers, Thermal modul lens dummy, Focus Ring manipulator short and long.

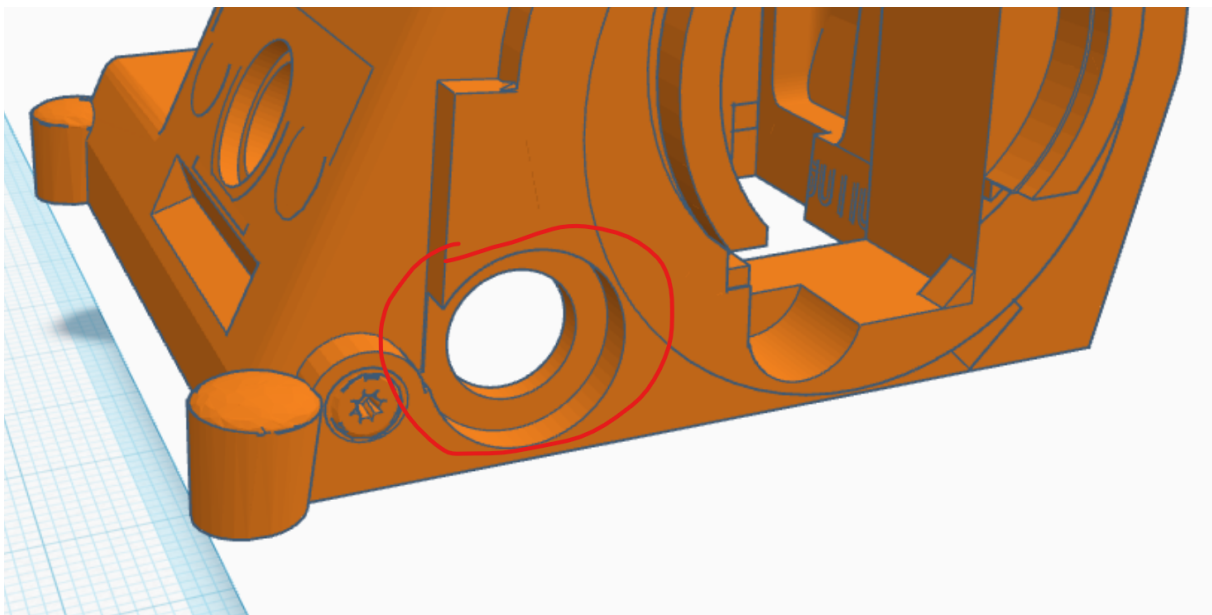
The focus ring needs to wear in, therefor dont bottom out the screws all the way first but go in a bit until you feel that the ring turns harder and give it a few twists, tighten screws, repeat until the ring turns smoothly and does not move up and down anymore! dont forget the silicone lube!

UPDATE07.02.2025

NUCing works now automatic, once the correct strings are sent over UART to the device it can be saved and stored, works like a charm, also Outline Mode, Black hot , digital zoom and a lot of other stuff works! Join the discord to follow all recent discoveries and updates!

UPDATE 08.02.2025

After adding an ATTiny85 to make use of all the recently enabled features of the thermal camera, a second button was needed as the time based button pressing did not work as intended, therefor a additional spot for a button next to the Eye cup was created. This part is not mandatory, only if you want to add the ATTiny85 microcontroller!



UPDATE 10.02.2025

Just realized that I forgot to include the TPU sealant that goes between the main case and the Dummy lens camera holder and added it to the files.



UPDATE13.02.2025

Ordering an alternative glass lens cover for the eye cup instead of the H9 Display protector. it is normally meant to replace the glass on a watch so it has the shape of a dome, I adapted the retainer ring to make it fit and added it, so no matter if you are going to use a flat glass disk or one with a lens like dome shape (no magnification) you can make it fit.

The new Retainer ring is named: Eyecup Lens retainer Dome lens



UPDATE13.02.2025:

Sorry my fault, I completely forgot to add JST connectors to the list, the camera will come with a 5 pin JST connector but only 3 pins are populated (Video Signal , Plus, Minus) But we need Pin1 populated so we can send data to the camera, this is easy but needs a JST 1,25 pin shoved in the JST plug.

fitting assortments can be found here: **5PIN 1.25mm**

<https://www.amazon.de/vuniversum-1-25mm-Female-Stecker-Kupplung/dp/B0BNF6J1RJ>

and here: <https://de.aliexpress.com/item/1005002332868366.html> **10 pairs 5P**

UPDATE23.08.2025

Adding an ESP32 that will replace the Step down converter as well the ATTINY85 for easier programming, stability and convenience!

SOFTWARE AND DEVELOPMENT:

I also got all the bits and bytes of the camera used in a spreadsheet provided by the seller.

<https://docs.google.com/spreadsheets/d/1Xu003dfcgPQcZiMTmYu-F92B396C5p3i/edit?usp=sharing&ouid=107147306011272911004&rtpof=true&sd=true>

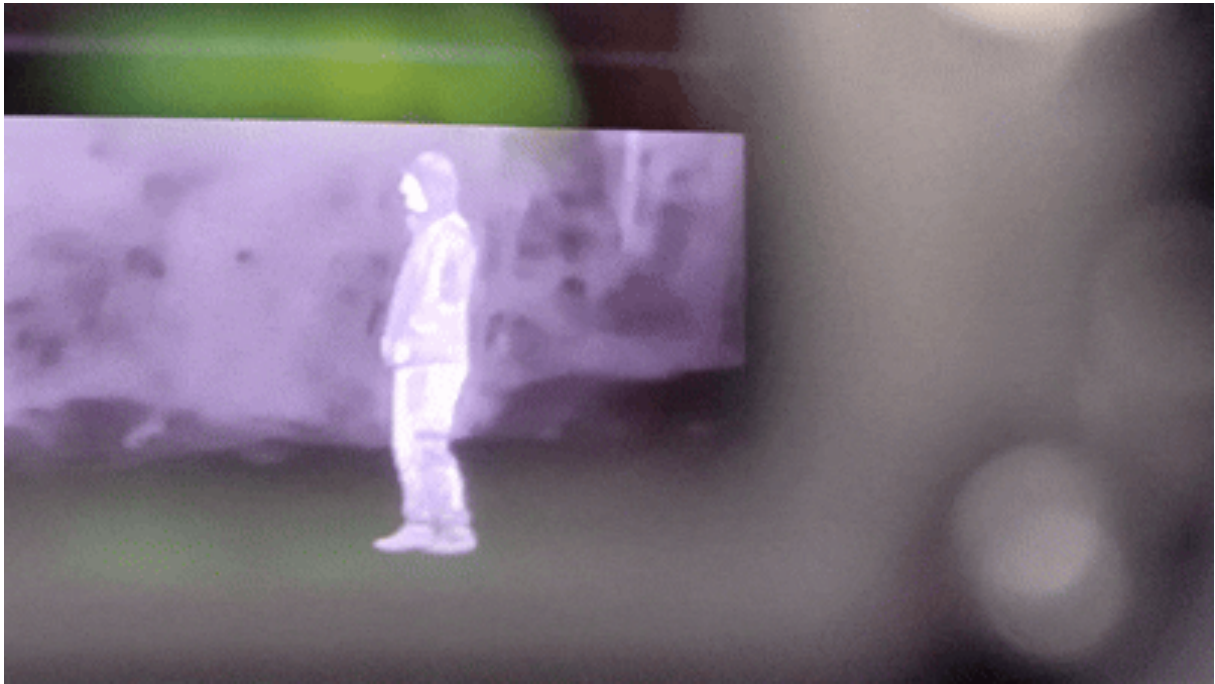
I was also able to get the SDK you can snatch here:

<https://drive.google.com/file/d/19RtgliBe51d1UKy4eEqAAVFnS9z5f9P3/view?usp=sharing>

CV connection interface development English version:

<https://drive.google.com/file/d/1-HopRuwLh8b2B0GDMIMPW4e0x4xGvWg-/view?usp=sharing>

Footage filmed through the eye piece of the finished unit (256X192 x9) recorded with a xiaomi12 smartphone: (flickering only visible in video and not noticeable in actual use)



Night vision, thermal..... while digital night vision became quite affordable by now offering some more or less usable devices even without IR illumination, the thermal sector so far can only really offer small thermal cameras you plug in your phones USB C port, nothing wrong with that! but then you probably only have 25Hz and quite the lag, also it does not really look all to tactical does it?

There are some thermal monocular of course but they are bulky, big, flashy colors and not at all "TACTICool" those who are, are most likely impossible to afford for "normal" people like me.

So I wanted to make my own, with high refresh rate (50Hz) and tacticool looks.

Luckily I found a PVS 14 dummy from Goticwar I was able to use and adapt for all the needed electronics.

After a few prototypes the PVS 420 (Thanks to **Emotional-Orange7758** from Reddit for the name suggestion xD) was born and so far works nicely!

I went for the cheapest option when it comes to the thermal camera, but you can spend a lot more to go all the way to the glorious 640x512 if you can afford it which makes the PVS 420 almost "high definition" speaking in thermal terms ;)

As all the camera modules have the same footprint, its also easy to swap it to a higher resolution once out of a sudden they become super affordable.

The little navigation switch is used to adjust contrast on the micro display, makes all the difference to dial in on a heat source. The button Press on the navi switch cycles through zoom stages. the button on the back cycles through 2 color pallets and 5 scene modes.(needs attiny micro controller)

Runtime on the unit was tested with a 7 year old LGABF1L1865 18650 3350mAh battery, charged to 100%, the PVS420 died after 6hours 20 minutes!

Attention!! The listed buck booster only provides 1Amp @5 volts max, with the lowest resolution option the camera is listed with 600mA max the micro display uses 200mA so we have quite a bit in reserve, not so much with the higher resolution thermal cameras, they take up to 1000mA so you probably wanna use a buck booster with more output there to be on the save side!!

Check pictures for Thermal camera specs / power draw

Important:

There is a part called “ cushion foam Replica” Dont print this, it is supposed to be a part cut out of foam (not the super soft type one but rather “stiff” like that rubber sponge foam kind of thing kids use to tinker with) It goes on the back of the camera with its exposed PCB board above the JST socket. Its purpose is in case of an accidental drop so the camera module has some sort of cushioned backward travel against a hard front impact that could damage the unit. The foam must be tough enough to not get compressed when putting on the protective TPU lens cover.

18650 cells need a little bit of a modification, therefore I added a 18650 stencil.

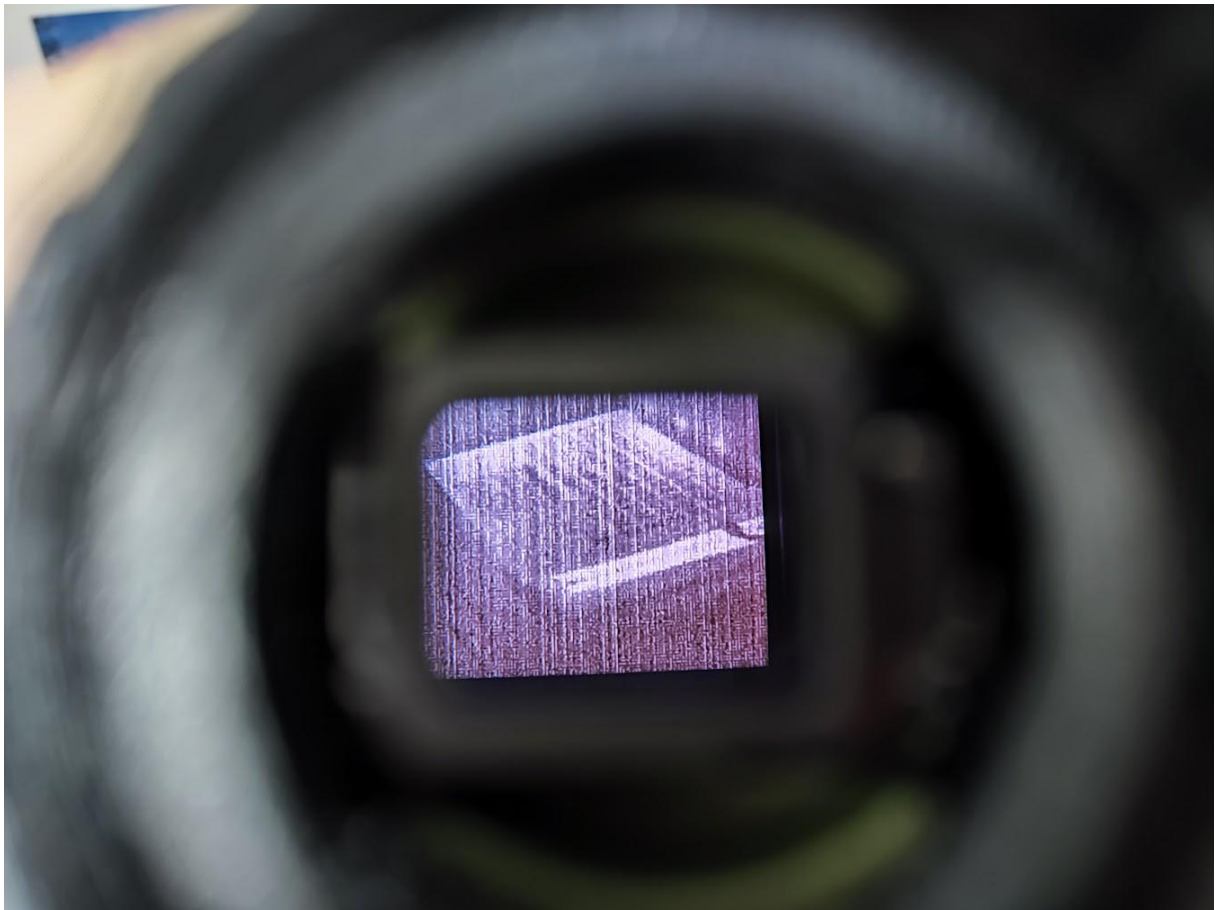
Insert the 18650 cell into the stencil and use a marker to fully color the exposed areas, Take it out of the stencil and remove the foil on the contact area with a scalpel, dont worry it does not compromise your 18650 more then the actual negative side on the back, as long you dont carry your 18650 in a bag of chains and nails xD You can see how it is supposed to look like in the pictures!

Getting the "camera screw insert" into the case can be a bit tricky, use a drill bit to make the cutout bigger so it is easier to screw it in nicely, otherwise its hard to get the screw in parallel to the case wall. PRO Tip: heat the metal screw insert up a bit so the material around it gets slightly soft, makes it super easy to get it in. Don't overdo it with the heat!

Known Problems:

"ARTEFACTS on Display screen"

When your device is "cold" and you turn it on it works right away and normally but after a few minutes your picture will start to form weird visible artifacts on your micro display looking something like this:



DONT worry! your device is not broken, when you switch your 420 off and on again this is gone and picture is clear and works perfectly again.

This "issue" is expected with thermal cameras, the clicking noise you hear when you turn the unit on is the shutter closing and the thermal sensor calibrating, normally this should be automatically executed by the unit itself several times after the unit is turned on (until it reaches operating temperature).

Why is this happening?

As it is a thermal camera seeing thermal radiation (Infrared light) the camera starts to “see” itself when it starts to warm up, to compensate for that it needs to recalibrate the sensor within the time the temperature of the unit still rises/ changes. Once it reaches its max temperature and doing the last manual off/on calibration as the temperature doe snot change a lot anymore the camera wont have those artefact issues anymore.

Solution:

Problem is solved, needs a USB to serial adapter (FTDI chip) and you need to send a few strings over UART that will activate automatic time and temperature based NUCing, this only needs to be done once and works flawless after that. Join the discord for more information!

Parts List:

FPV thermal drone Camera: (choose whatever you like and can afford, they have all the same footprint so they all fit)

The following two camera links are affiliate links. They won't cost you anything extra, but they help support the project and its ongoing development. This allows me to recover a small portion of the costs while continuing to offer everything for free.

https://s.click.aliexpress.com/e/_ooy6s0V

or here

https://s.click.aliexpress.com/e/_ontNcM5

Micro display: Type 1 (or Type2 if you want to have 2 additional color modes like phosphorus white and green)

[DIY Sucher AR 0,39-zoll OLED Miniatur Display PVS31 Nachtsicht Elektronen Mikroskop - AliExpress 1420](#)

JST connector for camera control with micro controller:

Amazon: **5PIN 1.25mm**

<https://www.amazon.de/vuniversum-1-25mm-Female-Stecker-Kupplung/dp/B0BNF6J1RJ>

or on aliexpress: <https://de.aliexpress.com/item/1005002332868366.html>
10 pairs 5P

Spring for turn able Power switch/ knob: wire diameter:0.2, length: 5mm, spring diameter:2mm

10 stücke/Los 0,2 Edelstahl Druck feder Stahl Seide Durchmesser mm
Schrauben feder od 2mm-4mm Länge 5mm bis 50mm Federn - AliExpress
13

Navigation switch for micro display contrast:

Großen Kopf SMD 3-Pin Stativ Daumenrad Kippschalter für MP3 MP4
Telefon - AliExpress 13

2mm Metal ball for turnable switch mechanism: 2mm diameter

Aisi52100 Chromstahl-Lager kugeln 1,2mm-3,5mm 1,5mm 1,588mm 2mm
2,381mm (3/32 ") 2,5mm 2,778mm 3mm 3,175mm gcr15 cr6 - AliExpress
13

Micro switch for the turn able Power switch: **13.5mm Lever**

10Pcs Micro Endschalter Momentary Push Button Schalter 1A 125V AC
Maus Schalter 3Pins Lange Griff Roller hebel Arm SPDT 12X6X6MM -
AliExpress 13

Spring for springloaded mass contact on the 18650 cell:

I used a spring from a ball point pen cut in length (something between
6-10mm in length) , but you can also buy some 3.5-4mm spring in
diameter.

10-20 Stück/Lot 0,4 mm Edelstahl Micro kleine Druckfeder
Außendurchmesser 3 mm/4 mm/5 mm/6 mm Länge 5 mm bis 50 mm -
AliExpress 13

self cutting plastic screws: **M3 (50pcs) 8mm**

M2 m2, 5 m3, 5 m3 m4 m5 pt Pfanne runder Kopf selbst schneidende Holz
schraube schwanz geschnittene Phillips Kreuz vertiefter schwarzer
verzinkter Stahl - AliExpress 13

Camera screw inserts:

ZoeTekway 12 Stück Gewintheadapter, adapter 1/4 auf 3/8 zoll, adapter 3/8
auf 1/4, Zollschrauben Gewinde Mutter, Stative Gewintheadapter für
Mikrofon Kamera Stativ Kugelkopf : Amazon.de: Elektronik & Foto

Front lens connector retainer clip screws: M2x5x3mm

50 stücke M 1,6 M2 M 2,5 M3 M4 304 A2 Edelstahl Nonstandard Kleine
Kopf Kreuz Einbau Phillips senkkopf Bolzen Schraube - AliExpress 13

18650 BMS (battery protection/ management):

10 TEILE/LOS 1S 3,7 V 3A li-ion BMS PCM batterie schutz bord pcm für 18650 lithium-ionen li batterie - AliExpress 502

18650 unprotected Battery: source locally

Battery voltage booster to turn the 3.7 volt from the Battery into 5 volts:

2Pcs DC Boost Netzteil Module Converter Booster Step Up Circuit Board 3V zu 5V 1A Höchste effizienz 96% RT9266 Ultra Kleine - AliExpress 502

Battery contact:

100 stücke Batterie Batterie schrapnell AA oder AAA batterie frühling 5 Keine. positive und negative kontaktieren stücke 50pairs Drop Schiff - AliExpress 13

Metal steel band for mass contact slider: **0.15 X 8 mm 3M**

2/3/5M/Roll 18650 Li ionen Batterie Nickel Überzogene Stahl Gürtel Streifen Stecker Spot Schweißen maschine 10x0.15/5x 0.1/8x0.15/8x 0,1mm - AliExpress 1420

Rocker screw for spring loaded mass contact slider: M2 x 16

M2 x 4 5 6 8 10 12 14 16 18mm Schwarz Vernickelt 12,9 Grade Legierung Stahl Allen hex Buchse Taste Kopf Schraube Bolzen ISO7380 - AliExpress 13

Sponge foam for micro display stabilization and thermal camera impact cushion:

BIBODU Moosgummi 5mm - EVA schaumstoff, Schwarze Farbe, Pack 5 Blätter, Größe A4 210x297 mm, Dichte 80 kg/m3 | EVA foam Cosplay Bastelarbeiten, Bastel | Geeignet Jungen und Mädchen (5MM, Schwarz): Amazon.de: Spielzeug

Protective 30mm glass lens for Eye cup:

sourcing map 3Stück Uhr Glas Kristall Linse, 30mm Durchmesser 1,1mm Kantenstärke Doppelkuppel Runde Klarsichtglas Ersatzteile für Uhrmacher Uhr Glas Linse Ersatzteil : Amazon.de: Fashion

USB C CHARGING UPDATE ONLY:

USB C passthrough adapter: **JQ-118I 2Pin**

1pcs USB-C Type 6Pin Waterproof USB Connector Direct compression female base Female Socket Charging Interface With Welding Wire - AliExpress 13

USB C charging board with included BMS: (replaces the stock BMS!!)

2IN1 Lithium Charger Charging Protection / Protection Board Combo Type-C PD USB TP4056 1A 1S 5V 3.7V 18650 Li-ion Lipo CELL - AliExpress 1420

Nice water resistant metal button:

<https://de.aliexpress.com/item/1005004053646835.html>

OUTDATED!!

ATTiny85: (OPTIONAL/ OUT DATED and NOT needed if you go for the ESP32 alternative which is now recommended!)

Digispark ATTiny85 dev board, easy to work with as with the chip alone:

<https://de.aliexpress.com/item/1005006232777912.html>

dc-dc step down: to bring the 5 volt down so you can use the cameras RX/TX line: **(NOT needed if you go with the ESP32 alternative!!)**

<https://de.aliexpress.com/item/1005007038244411.html> 3.3Volt

**ESP32 (instead of ATTINY85 and Step down converter):
RECOMMENDED**

<https://de.aliexpress.com/item/1005008212278653.html>

Nice to have accessories:

Sturdy foam filled military case for storage and transportation:

Kunststoff-Werkzeugkasten, versiegelt, wasserdicht, Ausrüstungskasten, stoßfest, Instrumentenkasten, Sicherheitsschutz-Werkzeugkoffer, tragbare Box für den Außenbereich - AliExpress 1420

This remix is based on



NVG PVS-14 (Dummy) By Goticwar

by GoticWar

Model files



main-body-thermal-cam-eye-piece-nav-switch.stl



main-body-thermal-cam-eye-piece-nav-switch-attiny85... .stl



main-body-18650-power-switch.stl



main-body-18650-power-switch-usb-charge.stl



18650-battery-cap.stl



thermal-camera-module-lens-dummy.stl



focus-ring-manipulator-short.stl



focus-ring-manipulator-long.stl



tpu-eye-cup-protection-glass-retainer-ring.stl



tpu-sealing-main-body.stl



tpu-lanyard-battery-cap-and-lens-coverss.stl



tpu-sealing-lens-dummy.stl



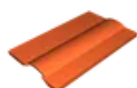
eyecup-lens-retainer-dome-lens.stl



tpu-camera-screw-insert-friction-sealing.stl



main-power-switch-knob.stl



18650-split-wall.stl



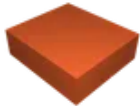
lens-dummy-retainer.stl



springloaded-swivel-battery-contact.stl



camera-screw-plug.stl



dont-print-cushion-foam-replica.stl

☐ Prevents cammera to be pushed inwards



18650-mark-and-cut-stencil.stl



eyecup_glasses.stl

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- ✗ | Free Cultural Works
- ✗ | Meets Open Definition