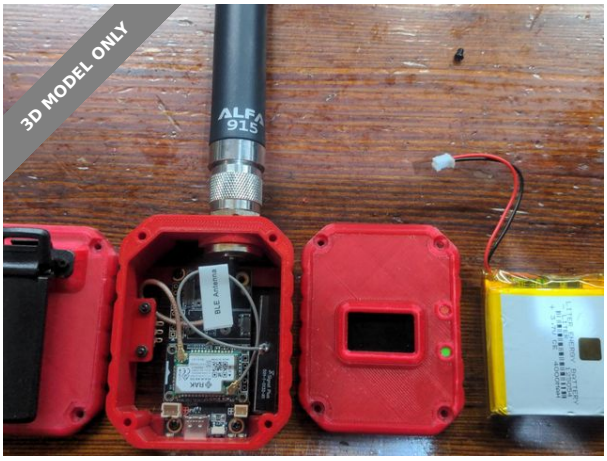

NodeBrix Modular Case System for Heltec LoRa32 v3 and RAK19007 for use with Meshtastic

Open Source Country

VIEW IN BROWSER

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Summary

This is a modular kit to build your own custom portable Meshtastic node devices. RAK19007 support is a work in progress.

Gadgets > Portable Devices

Tags: case clip magnet enclosure magnets tripodmount tripod 18650 esp32 magnetic sma opensource rotary buzzer emergency rotaryencoder beltclip mesh suctioncup node horizontal nrf52840 lora communications bme680 rak meshtastic vibrator heltec rakwireless helteclora offgrid comms meshnetworks heltecv3 suctioncups rak4631 rak19007 heltecesp32lorav3 wizblock heltecv3case helteccase

ntype helteclora32 nconnector opensourcecountry meshnode nodebrix

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Update 5-29-24

Updated 18650 suction cup backs for less supports.

Update 5-22-24

Uploaded large encoder knob STL that I forgot to include.

----------NodeBrix Modular Case System For Heltec LoRa 32 v3 and RAK19007

NOTE: RAK19007 support and this manual are still under development!

What is it?
NodeBrix Modular Case System is a set of models for building portable enclosures for two of the currently most popular LoRa boards commonly used for Meshtastic off-grid communications. The system generally consists of front plates, frames to hold the board and backs to hold one or more batteries. I have included all usable
combinations of these. A case is initially built by bolting one of each of these together in a stack. There are many options for different use cases. Also, I tried to make sure there was enough room and space for things like header pins and addons. These cases are intended to be modified and experimented on. Model source code and the project file has been included as well as some tool models that may help you modify or put your own spin on things.

Why did I make this?
Once upon a time I was a developer of things. I felt there needed to be a system that provided users with swappable options and also was free for users to modify and use in any way they chose. The system should be able to supply some simple builds for new people as well as advanced builds for the hardened veterans. My biggest hope is that users modify and remix parts or all of this system and release it back into the wild.

Licensing?
These files are released as Public Domain to benefit everyone. Yes, this means you can use them or derivatives commercially. No attribution is required but if you wish to do so please attribute to or thank “Open Source Country”. You can also copy/paste a feature to your own project and I left some parts and tools in the files that might help. My pixels are your pixels.

Do I like Country Music?
Not really. Open Source Country is an idea. We are all citizens, the internet is our home, information is our currency and the only borders are firewalls. If you know, you know.

Printing The Models

Orientation:
Most of the models are in the orientation they should be printed in. But feel free to experiment. It's your time and your filament. The back modules with clip mounts need to be rotated 180 degrees so the two holes for the clip are facing up and yes, use supports.

Supports:
Sorry printer enthusiasts, yes you need to use supports. If you want to be that clever troll that prints it at 45 degrees, well, /tiphat. There are probably some Heltec frames and some back modules you could get away with not using supports on. The strap back attachment ezprint version and magnetic back attachment do not require using supports. I also have tried flipping the fronts and sinking the face into the bed for easy printing and had good results.

Support Blockers:
The BME680 front plates will need support blockers on the BME680 vent and the connected chimney. The PCB external frames will need support blockers on the antenna hex tube.
Parts & Materials

Nuts and Bolts:
4 M3 hex head bolts and nuts are used to bolt the front, frame and back together at the corners. I have no idea what back modules, frames and fronts people will mix and use. So the length of these bolts varies. 20mm works well on the Heltec 4ah configuration. To be honest you should have a ruler or a set of cheap calipers to measure the thickness of your configuration and go from there. One of the tricks I use is either a pair of lineman's pliers or side/diagonal cutters and just cut long bolts to fit. M2 button or hex head bolts for internal components like the screen, BME680, RAK19007 power switch, RAK19007 user/reset buttons and also is used to attach the belt clip on certain back modules.

USB-C:
USB-C silicone dust plugs are recommended. Also for putting the device into pouches right angle aka 90 degree cables can be helpful.

- USB-C Silicon Dust Plugs https://a.co/d/1jmwQX4

Heltec Frames:
The carrier plate for the Heltec frames has two screw holes. You will need

to remove two of the screen bolts on your Heltec board and reinstall them through the carrier plate back into the Heltec screen. Be careful not to remove all 4 bolts because the ribbon cable attached to the screen is very fragile.

Screen Fronts:
The screen openings have room for a 1mm or 3mm acrylic window to protect the screen. I have included two jigs for cutting the windows out of 4” x 6” 1mm acrylic sheets. 1mm is easy to cut with a razor knife and offers great protection in my opinion. 3mm acrylic sheets require a laser cutter, CNC or good shop tools, patience and a steady hand. Acrylic will crack and shatter when you try to separate it if your cuts aren’t true and through. If the window is slightly too big to fit use quality 80 grit sandpaper on the edge(s) and try again. I still need to make jigs for the RAK19007 windows. To fasten the window into the opening you will need glue. I prefer silicone or shoe repair glue. A large gauge (14ga) needle bottle makes it easy to apply and letting the bottle sit in a bowl of hot water makes the glue viscous (“runny”) and flows through the needle easier. All that being said, you could also use super glue (and baking soda?) but I noticed super glue left a white haze on parts of the window but it was still very readable.

- 1mm acrylic sheets https://a.co/d/gxVuyVz
- 3mm acrylic sheets https://a.co/d/8GPrwv1
- Needle Bottles https://a.co/d/19WiSp6

Buzzer Fronts:
On these front parts there is a round 12mm slot for a buzzer to fit in. Super glue the buzzer with the hole facing the part and the wire leads facing away. Either passive or active buzzers can be used. I use active buzzers and was able to have them play ringtones. Passive seems to be the popular choice though so do your homework. The buzzer slot has a hole to the outside of the case so you could alternatively glue an LED in the hole instead of a buzzer.

- Passive Buzzers https://a.co/d/hy7j6Ae
- Active Buzzers https://a.co/d/f0lLVJH

More information here:
https://meshtastic.org/docs/configuration/module/external-notification/
https://adrelien.com/blog/how-to-add-buzzer-to-diy-esp32-heltec-lora-meshtastic-node/

Vibrator Fronts:
These fronts have a round 10mm slot for a vibrating module and a small channel for the wires. It’s basically the exact same setup as the buzzer

except if you use a buzzer you would choose a different GPIO pin.

- Mini Vibration Motors https://a.co/d/49uhxek

Rotary Fronts:
These fronts have a hole for an EC11 rotary encoder with a 15mm shaft. There are also two model files for knobs. The rotary encoder is for using the canned message module in Meshtastic. It allows you to choose from predefined messages and send them standalone without having to use a mobile device. I left the tolerance on the hole just tight enough where you will need to screw the encoder into the hole.

- EC11 Rotary Encoders https://a.co/d/9zSADVF

More information here:
https://adrelien.com/blog/how-to-setup-canned-pre-defined-messages-with-rotary-knob-button-for-meshtastic-node/
https://meshtastic.org/docs/configuration/module/canned-message/

BME680 Fronts:
These fronts have a vent chimney for the sensor and the sensor board mounts to the front plate with 2 M2 4mm bolts. The BME680 sensor measures temperature, humidity, barometric pressure and air quality (sort of).

- BME680 https://a.co/d/bKv1FOo

More information here:
https://meshtastic.org/docs/configuration/module/telemetry/

RAK19007 Fronts:
These fronts probably require the most work. The user and reset buttons are 6mm x 6mm tactile switches. 5mm tall for recessed buttons and 6mm for pressable but still protected buttons. They are held in place with 2 M2 6mm hex head bolts or 3 M2 6mm grub screws. The button plate model is required if using a RAK front with buttons. The power switch is held in place with 2 M2 4mm bolts. An SS12F55 slide switch is used for power. The optional screen is a 0.96 OLED board and is held in with 4 M2 4mm bolts (any type is fine) and 2 M2 washers.

- Micro Tactile Buttons 5mm Tall https://a.co/d/2qAhX23
- Micro Tactile Buttons 6mm Tall https://a.co/d/fs39sei
- M2 6mm Grub Screws https://a.co/d/i6nneE8
- 0.96 OLED Screen https://a.co/d/0bhJPGn
- SS12F55 Slide Switches https://a.co/d/0Q8RVnt

More information here:
https://meshtastic.org/docs/hardware/devices/rak/screens/?rakscreens=OLED

SMA Frames:
These frames will probably be the most commonly used. They have a hole with a flat side to fit an SMA connector for an external antenna. This is the same connector as the pigtail (antenna cable) that comes with Heltec boards. The other end of the pigtail is called U.FL or IPEX and connects to the LoRa board. A 3”-5” pigtail should work fine. Be aware RP-SMA is the same size but will require a different antenna.

- SMA to U.FL 5” Pigtail https://a.co/d/1vH79z5

N-Type Frames:
These frames use a large N-Type RF antenna connector. Personal note, this is one of the reasons I started this project. These frames are deeper than the other frames and leave a bunch of extra room unused in the case. Maybe good for adding extra components or you could use the 2ah back module and use the extra space in the frame for the battery. I really hope this frame specifically gets modified by people. For this connector I like to buy quality N-Type pigtails. My favorite antenna for this is the Alfa linked below.

- N-Type Female Bulkhead Pigtail https://www.digikey.com/en/products/detail/gradconn/CABLE-329-RF-100-A/9859837
- Alfa N-Type 5dbi Antenna https://store.rokland.com/collections/all-helium-antennnas/products/alfa-aoa-915-5acm-5-dbi-omni-outdoor-915mhz-802-11ah-mini-antenna-for-lora-halow-application

Magnet Frames:
These frames are only available for the Heltec boards currently. The frame allows 2 30x10x5mm neodymium magnets to be inserted flat on top of each other in the bottom of the frame. They pressure fit into place very tight but you could use glue to help secure them. I have thrown a device using this frame at my old farm truck and it stuck. The magnets are very strong but can be annoying when working on the case. If you can’t find a missing screw or tool, check the magnet area. ;)

- 30x10x5mm neodymium magnets https://a.co/d/98kjIIK

PCB Frames:
These frames have no antenna hole and no specific place to mount one inside or out. I included these so you could cleverly place a pcb antenna inside with double sided tape or glue or drill a hole for a connector of your

choosing. The RAK Wireless Meshtastic Starter Kit comes with a PCB antenna that could be used. They can also be purchased separately.

- PCB U.FL Antenna https://store.rakwireless.com/products/pcb-antenna-for-lora?variant=43045890326726

PCB External Frames:
These frames have an external hex tube to hold the stock antenna that comes with a Heltec. To use the Heltec antenna you will need to gently remove the plastic sleeve covering the antenna coil. Side note, the Heltec antennas aren't very good and should be tuned with a VNA. These frames were included to give a rugged short antenna that wouldn't easily get snapped off. Also PETG is the only filament I found that didn't reduce the antenna's SWR too much. So I recommend PETG filament if you are using these frames.

- 2 dbi SMA antennas https://a.co/d/9BeR1Ni

GPS Module:
In all the frames there is a slot at the top for a 15x15mm GPS module or antenna. The slot can fit either a Mini M100 or a GT-U7 antenna. I prefer the Mini M100. Again, I feel the need to mention that PETG is the most transparent to radio waves but I have installed these units in PLA+ cases and they worked fine.

- Mini M100 GPS module https://a.co/d/6Q380wM
- GT-U7 GPS module and antenna https://a.co/d/e0tYg18

More information here:
https://meshabout.com/how-to-add-gps-module-to-heltec-v3-meshtastic-node/
https://meshtastic.org/docs/configuration/radio/position/

Clip Backs:
These back modules have a raised section and two holes for heat set inserts. A spring belt clip like the kind used on radios and old pagers can be bolted onto these. These back modules need to be rotated 180 degrees in the slicer so they are printed with the two holes facing up. A soldering iron is used to press the heat set inserts into the back. The two holes are 3mm in diameter and in theory you could use M3 bolts and skip the heat set inserts but I worry they would tear right out under everyday or hard use.

- Radio Belt Clips https://a.co/d/7kzoEll
- M2 3x3mm Heat Set Inserts https://a.co/d/3nzpsYY

Tripod Backs:
These back modules use a 1/4-20 heat set insert in the bottom that is

compatible with most tripods and camera mounts. A soldering iron is usedto install them. The ones I used are 7mm long.

- 1/4-20 Heat Set Inserts https://a.co/d/2BHtif1

Suction Cup Backs:
These back modules have four arms that extend from the corners and have holes to insert threaded M5 suction cups. Rather than use the plastic nuts that came with them I recommend using M5 nylon lock nuts. These actually stick really well and work good for a vehicle window or windshield or a window up high in a house or building.

- M5 Threaded Suction Cups https://a.co/d/a2v0Dh9

2ah Backs:
This is the slimmest back module in the set. Finding a battery that fit was pretty much an afterthought. I felt a super slim back module needed to exist for small capacity batteries as well as give a template for people to design their own with. An 804050 2000mah battery can just barely squeeze into this back module.

- 2000mah 804050 3.7v Lipo Battery https://a.co/d/1gaO5BC

3ah Backs:
This is a slim battery back module that I designed for more of an everyday carry device. It was the first one I attached a belt clip to. It holds a 3000mah 105151 3.7v lipo battery.

- 3000mah 105151 3.7 Lipo Battery https://a.co/d/jceRgJm

4ah Backs:
This is the first back module I made and is what I consider “standard”. It holds a 4000mah 125054 3.7v lipo battery.

- 1 piece 4000mah 125054 3.7v Lipo Battery https://a.co/d/4En0eTE
- 10 pieces 4000mah 125054 3.7v Lipo Battery https://www.aliexpress.us/item/2255800988664812.html

18650 Backs:
This back module holds 2 18650 batteries in parallel. At each end of the battery slots are gaps to install spring and plate contacts. There is also room on the sides to install a small BMS (battery management system) if you are not going to use protected cells. Using protected cells is recommended and they will fit. There are two types of spring and plate contacts that will fit in these slots. One type is individual plates that you install into each end and will need to solder the ends together in parallel, + to + and - to -. The other type is strips that can be cut apart that are used in DIY 18650 power banks. You can buy these strips or possibly

reclaim them from a spare power bank. It’s possible AA or other sized spring plates could be salvaged and used as well. With 2 3500mah 18650 batteries you could have 7ah of power.

- 18650 Spring Contacts https://a.co/d/fy8Oi9K
- 3.7v 18650 BMS Board https://a.co/d/b4bkl5w
- 8 Slot DIY Power Bank Contact Strips https://www.aliexpress.us/item/2251832864941882.html

Strap and Magnet Back Attachments:
Both of these attachments are like a fourth layer of the case stack. They are added behind the back module and use the same corner bolts (you will need longer bolts). These will not fit flush on clip back modules.

Window Jigs:
There are two jigs for cutting 1mm acrylic windows for the Heltec screens. One is to cut strips off of the sheet and the other is to cut the strips into windows. I will add another for the RAK19007 when time allows.

Gaskets:
Both front and back gaskets are included and are placed on their respective sides of a frame before assembly. They should be printed in a flexible TPU. TPU is a great material and can withstand harsh temperatures and chemicals but it can be a pain to print on bowden tube printers. I would also like to mention that these could be printed in any material as stencils for using a razor knife to cut gaskets out of silicone. Gaskets aren’t needed to assemble the cases but if you are going to all this effort why not do a little extra to help protect your device?

Heltec Buttons:
The models are inserts for Heltec fronts to allow pressing the onboard buttons. If a button doesn’t seem to have any travel try sanding the bottom of the button insert with some 80 grit sandpaper.

Assembling & Wiring

Batteries:
The Heltec V3 board uses a female 2 pin JST 1.25 battery connector. The RAK19007 board uses a female 2 pin JST 2.0 connector. Depending on your build you may have to splice and swap the battery connector. Most of the batteries I listed come with JST 2.0 female connectors. Also pay close attention to the polarity of the connectors, red to + black to - on the boards. Otherwise you will kill your board and smell and maybe see the dreaded magic smoke.

Antenna Warning:
Never ever ever under any circumstance power on your device without an

antenna connected. It can desensitize your radio and your range can be impaired permanently.

Assorted Mods/Addons:
I tried to include links to most of these in the parts and materials section. This document is really about the cases and not the mods. So you are going to be on your own for those. But the information is out there.

Model files

Gaskets 4 files

gasket_back.stl

gasket_front.stl

gasket_front.step

gasket_back.step

Heltec LoRa 32 v3 114 files

front_heltec_buzzer_bme680.stl

window_jig_2.stl

encoder_knob_large.stl

encoder_knob_small.stl

front_heltec_bme680.step

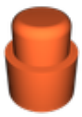
front_heltec.step

front_heltec.stl

front_heltec_bme680.stl

front_heltec_buzzer_encoder_bme680.step

encoder_knob_large.step



heltec_button_recessed.stl

front_heltec_buzzer.step

encoder_knob_small.step

front_heltec_buzzer_vibrator_encoder_bme680.stl

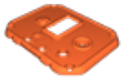
front_heltec_vibrator_encoder.step

front_heltec_buzzer_vibrator_encoder.step

heltec_button.stl

front_heltec_encoder_bme680.stl

front_heltec_encoder.step



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front_heltec_buzzer_vibrator_bme680.stl

front_heltec_buzzer.stl

front_heltec_vibrator.step

heltec_button_recessed.step

front_heltec_buzzer_vibrator.step

window_jig_2.step

front_heltec_buzzer_vibrator_bme680.step

front_heltec_vibrator_encoder_bme680.step

front_heltec_vibrator_encoder_bme680.stl

heltec_button.step

front_heltec_encoder.stl

front_heltec_buzzer_vibrator_encoder.stl

window_jig_1.stl

front_heltec_buzzer_vibrator.stl

front_heltec_vibrator_encoder.stl

front_heltec_buzzer_encoder.step

front_heltec_vibrator.stl

front_heltec_buzzer_vibrator_encoder_bme680.step

front_heltec_buzzer_bme680.step

front_heltec_vibrator_bme680.stl

window_jig_1.step

front_heltec_vibrator_bme680.step

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front_heltec_encoder_bme680.step

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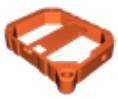

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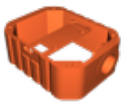

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frame_heltec_pcb_lanyard_right.step

frame_heltec_sma_magnets_lanyard_left.stl

frame_heltec_sma.step

frame_heltec_pcb_external_lanyard_right.step

frame_heltec_pcb_magnets_lanyard_right.step

frame_heltec_pcb_external_lanyard_quad.stl

frame_heltec_pcb_magnets_lanyard_left.stl

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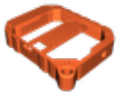

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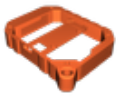

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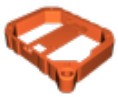

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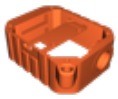

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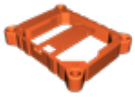

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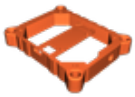

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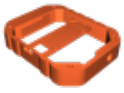

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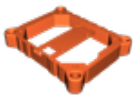


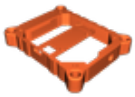
frame_heltec_pcb_lanyard_quad.stl

frame_heltec_sma_magnets_lanyard_right.step

frame_heltec_pcb_lanyard_left.stl

frame_heltec_n-type.step

frame_heltec_n-type_magnets.step

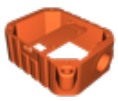


frame_heltec_sma_magnets_lanyard_quad.stl

frame_heltec_sma.stl

frame_heltec_pcb_external_magnets_lanyard_left.step

frame_heltec_pcb_external_lanyard_right.stl



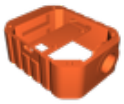
frame_heltec_n-type_lanyard_right.stl

frame_heltec_pcb_external_lanyard_quad.step

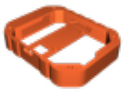
frame_heltec_pcb_lanyard_quad.step

frame_heltec_n-type_magnets_lanyard_right.step

frame_heltec_n-type_lanyard_right.step



frame_heltec_n-type_magnets.stl



frame_heltec_pcb_magnets.stl

frame_heltec_pcb_magnets.step

lanyard_left.step

lanyard_left_bottom.stl

lanyard_right_bottom.stl

lanyard_left_bottom.step

lanyard_right.step

lanyard_right.stl

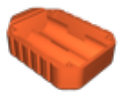
lanyard_left.stl

lanyard_right_bottom.step

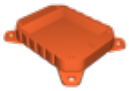
Back Modules

50 files

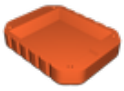
back_18650_tripod.step



back_18650_tripod_clip_fitted.stl



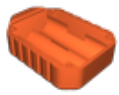
back_4ah_tripod_suctioncup.stl



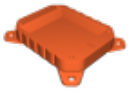
back_4ah_tripod.stl

back_18650_tripod_clip.step

back_18650_tripod_fitted.step



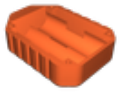
back_18650_tripod_fitted.stl



back_4ah_suctioncup.stl

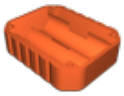
back_18650_clip.step

back_2ah.stl



back_18650_tripod.stl

back_2ah_clip.stl

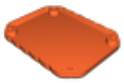


back_18650.stl

back_3ah_clip.step

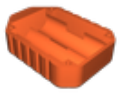
back_4ah.step

back_2ah.step



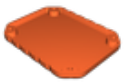
back_3ah.stl

back_4ah_suctioncup.step



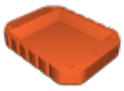
back_18650_tripod_clip.stl

back_4ah_tripod.step



back_3ah_clip.stl

back_18650_tripod_clip_fitted.step



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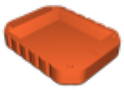


back_4ah_clip.stl

back_2ah_clip.step

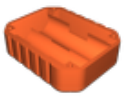
back_4ah_tripod_suctioncup.step

back_3ah.step

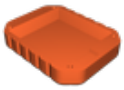
back_18650.step

back_4ah_tripod_clip.step

back_4ah_clip.step



back_18650_clip.stl



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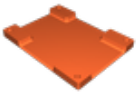


back_strap_attachment_ezprint.stl

back_strap_attachment_ezprint.step

back_18650_tripod_finisher.stl

back_magnet_attachment.step

back_strap_attachment.step

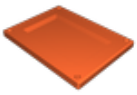
back_suctioncups.stl

back_clip.step

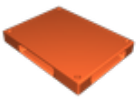
back_suctioncups.step

back_clip.stl

back_18650_tripod_finisher.step



back_magnet_attachment.stl



back_strap_attachment.stl

back_18650_tripod_suctioncups.step

back_18650_suctioncup.step

back_18650_tripod_fitted_suctioncups.step

back_18650_tripod_suctioncups.stl

back_18650_tripod_fitted_suctioncups.stl

back_18650_suctioncup.stl

RAK19007 98 files

front_rak_buzzer.step

front_rak_screen_vibrator.step

front_rak_nobuttons.step

front_rak_vibrator_bme680.step

front_rak_vibrator_bme680.stl

front_rak_screen_encoder_bme680.step

front_rak_bme680.step

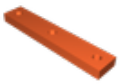
front_rak_screen.step

front_rak_buzzer_vibrator_bme680.step

front_rak_screen_encoder_buzzer_vibrator.stl

front_rak.step

front_rak_screen_buzzer_vibrator_bme680.step



front_rak_buttonplate.stl

front_rak_screen_buzzer.step

front_rak_vibrator.stl

front_rak_buttonplate.step

front_rak_screen_encoder_buzzer_vibrator.step

front_rak_screen_encoder.stl

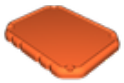
front_rak_buzzer_vibrator_bme680.stl

front_rak_screen_buzzer_vibrator.stl

front_rak_buzzer.stl

front_rak_screen_encoder_buzzer_bme680.step

front_rak_screen_vibrator_bme680.stl



front_rak_nobuttons.stl

front_rak_screen_encoder_vibrator.stl

front_rak_screen_encoder_buzzer.step

front_rak_screen_encoder_vibrator_bme680.stl

front_rak_screen_bme680.step

front_rak_buzzer_vibrator.step

front_rak_screen_buzzer_vibrator.step

front_rak_screen_encoder_vibrator.step

front_rak_buzzer_bme680.step

front_rak_screen_encoder.step

front_rak_screen_buzzer_bme680.stl

front_rak_screen_encoder_vibrator_bme680.step

front_rak_bme680.stl

front_rak_screen_vibrator.stl

front_rak_screen_encoder_buzzer.stl

front_rak_screen_bme680.stl

front_rak_screen_encoder_bme680.stl

front_rak_buzzer_bme680.stl

front_rak_screen_buzzer_vibrator_bme680.stl

front_rak_vibrator.step

front_rak_screen.stl

front_rak_screen_encoder_buzzer_vibrator_bme680.stl

front_rak_screen_encoder_buzzer_vibrator_bme680.step

front_rak_screen_buzzer.stl

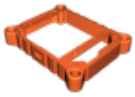
front_rak_buzzer_vibrator.stl

front_rak_screen_buzzer_bme680.step

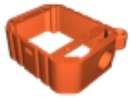
front_rak.stl

front_rak_screen_vibrator_bme680.step

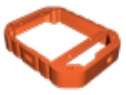
front_rak_screen_encoder_buzzer_bme680.stl



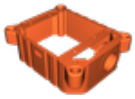
frame_rak_pcb_lanyard_quad.stl



frame_rak_n-type_lanyard_left.stl



frame_rak_sma.stl

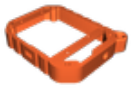


frame_rak_n-type_lanyard_quad.stl

frame_rak_pcb.step

frame_rak_sma_lanyard_quad.stl

frame_rak_sma_lanyard_right.step



frame_rak_sma_lanyard_left.stl

frame_rak_sma_lanyard_quad.step

frame_rak_pcb.stl

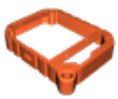
frame_rak_pcb_external_lanyard_right.stl

frame_rak_pcb_lanyard_quad.step

frame_rak_pcb_external_lanyard_quad.step

frame_rak_pcb_lanyard_right.step

frame_rak_pcb_external.step



frame_rak_pcb_lanyard_right.stl

frame_rak_sma.step

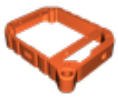
frame_rak_pcb_external_lanyard_left.step

frame_rak_pcb_external_lanyard_left.stl

frame_rak_pcb_external_lanyard_quad.stl

frame_rak_pcb_external_lanyard_right.step

frame_rak_n-type.step



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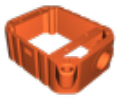

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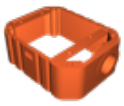
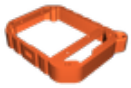


frame_rak_n-type.stl

frame_rak_n-type_lanyard_left.step



frame_rak_pcb_lanyard_left.stl

frame_rak_pcb_lanyard_left.step

frame_rak_n-type_lanyard_right.step

frame_rak_n-type_lanyard_quad.step

frame_rak_sma_lanyard_left.step

frame_rak_pcb_external.stl

frame_rak_switch.step

frame_rak_switch.stl

carrier_rak2.stl

carrier_rak1.step

carrier_rak2.step

carrier_rak1.stl

lanyard_left.step

lanyard_left_bottom.stl

lanyard_right_bottom.stl

lanyard_left_bottom.step

lanyard_right.step

lanyard_right.stl

lanyard_left.stl

lanyard_right_bottom.step

Other files

nodebrix-modular-case-system.pdf

The Manual

readme.txt

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osc_nodebrix_v1plasticity.zip

Plasticity Project Source File

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