T&M BB8 Part Files: Instructions Guide to 3D Printing, Assembling & Finishing

beta v024 – 28-OCT-2015

— Revision History —
beta v024 – Revised Hamster Hardware BOM
beta v023 – NEW: Updated BMM Parts, BOM & Assembly. Initial Hamster Hardware BOM.
beta v022 – NEW: DMM Caster BOM, Information & Assembly, PSI Rear Cover.
beta v021 – Clarifications to instructions, typo in BOM PN, Deprecated Stud Load Transfer Caster & 5/16” Nut. NOTE: A new DMM part for a custom caster is being worked on. This will increase performance, save weight and cost.
beta v020 – New Sections: Body Stage Files: Hamster Battery Boxes, Orange Rings, Panels, Triangles
beta v019 – Additional Filament notes, Added Simplify3d Skirt/Brim section
beta v018 – Fixed McMaster-Carr Part number TYPO in Dome BOM: 92095A183
beta v017 – Adding detail to Body Stage build, created Body Panel Painting & Orientation section
beta v016 – Minor Changes, started adding detail to Body Stage section
beta v015 – Added Page Numbering
beta v014 – Minor changes
beta v013 – Started Body HW BOM
beta v012 – Updated Dome HW Magnet BOM
beta v011 – Minor changes
beta v010 – Minor clarifications, Minimum Print Area Required, Updated DOME HW BOM
beta v009 – Initial Public Release
beta v008 – Ordering of sections, Updated Finishing, Added additional pictures for clarification
beta v007 – Dome Assembly Instruction, Renamed Document, File URL Locations, CC4 Full Text, Using Helper Disks
beta v006 - Updated Introduction, Printing Parts for Others : The Economic Realities
beta v005 - Body Sections
beta v004 - Creative Commons License 4.0, Scale, Discussion about PIE top magnet mounts & Optional Parts, Painting, Weathering
beta v003 - Hardware Parts List, McMaster Part #s.
beta v002 - Initial beta Release

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— Introduction —

We have worked hard to make these parts as close as we can until we get our hands on more accurate information. We've also spent numerous hours doing various iterations to make sure the parts print well and worked as expected. Our goal is to make a repeatable, printable solution to building this new droid. Please keep in mind, we're currently only releasing the Dome as interpreted by us, and we're working on two versions ("Stage" & "Static") of the body, and we'll release them as we can get them through the process.

Please don't think of this is plastic model kit. While the pieces are wonderful if we do say ourselves, the model files are accurate as they can be until we get actual measurements from the screen used droid.

All part model files are in mm and as such should not need re-scaling. The files are designed to print at 100% scale with every 3D slicer and printer we've tried to date. If you change the scale of a part, it's going to cause you issues with fitment and or look.

All of the printed parts will require some minor level of custom fitment for your build. This is due to the fact that every printer is slightly different, even those that are the same make and model. So be prepared to invest a little time in properly fitting & finishing the parts. We are after all members of a builders club and not a for profit model kit manufacturer.

If you're new to 3D printing, we recommend you start with the smaller parts, like the HP, PSI, Radar Eye. Then followed by the Dome Ring. If you have issues printing those parts, then don't attempt the larger Dome Panels, or Dome Skirt. To us, the hardest part to print is the Radar Eye Internal, and we recommend you print it at 0.1mm, if possible.

We'd also like to take this opportunity to thank all those beta testers and early adopters that spent numerous hours printing test pieces, and testing fitments from various printer manufactures, models, settings & trying different filament manufacture and types. Including several beta testers that bought new 3D printers. (43 at current count) Honestly without their rapid, candid and direct feedback, along with their encouragement for this project, this would have been a much longer & harder project. We thank them for the filament they extruded for part testing. These same experienced builders are located around the globe and are willing to assist new droid builders. What an amazing, talented group of folks. Again we thank them for their efforts!

So now that you have obtained the current files, how do you make the droid parts? For most of them you print them on your 3D printer, ask another builder to print them for you, or have them printed by a commercial printer service provider.

— Printing Parts for Others: The Economic Realities —

We encourage everyone to print your own parts. That way it will ensure that you know exactly how all the parts work together, as well as to be able to make replacement parts when needed.

In all areas of the globe, there are also printer service providers that will manufacture or "print" these parts, and typically they charge based on the volume of material used or the amount of time of the print. Example of these are Shapeways.com & 3DHubs.com. 3DHubs.com list locally available providers around the globe.

Both of which we have used in the past. Using either of those services is going to be a pricy option of printing these parts. An example, most 3Dhubs.com service providers average charges $25 (US) per hour and more, depending on the filament being used. That would mean it would cost a builder about $1500 (US) for just the dome pieces from a basic FDM service operator. We have heard of a new service provider Voodoo at an unbelievable price of $3.00(US) per hour, plus various setup & shipping fees. We do not have any experience with them as of this writing. (12-Oct-15)

One affordable solution is renting a 3D printer. In the San Francisco Bay area, you can rent an Ultimaker2 for $350 per month. Several builders could go in together and make several sets of the parts, rather inexpensively with in a month.

However we also recognize that many don't have access to a 3D Printer nor can they afford that cost, and as such those builders with access, may be asked or offer to print parts for those without access, and that is a reasonable/honorable request, and one we want to encourage the community to do.

That being said, a little financial analysis is in order. Currently, Aug-2015, a modern large format FDM PLA printer cost in a range from $1200 to $2900, and the cost of quality FDM material ranges from $29(US) to $60(US) per kg roll. Once we add in an average number of failed prints, electric (~150 Wh), maintenance, we currently estimate a cost of $4.00 to $5.80 per hour based on 500 hours of printing per year. This figure does not account for operator time, and that becomes a rather large variable.

It is reasonable to us, that an average per hour printing, including the PLA filament, in the setting we used above, is costing the printer owner/operator around $5.00(US) per hour or about .09 per minute. (US rates).

This means that printing all of the parts of the BB8 dome files, using the resolutions and settings outlined in this guide, requires about 65 hours. Excluding any large failed prints. That time of 65 hours equates to a cost around $325 to the printer owner. Our experience confirms that cost as well.

We are not accounting for any post processing of the parts in either scenario, simply the printer operator removes the printed file parts off the printer build plate and moves on to the next file in the queue.

It seems logical us, that if someone asked another builder to print out all the Dome files for them, it is reasonable that the printer operator be reimbursed for his or her time to some modest level. If the printer owner/operator is a FDM service provider, $1500 is currently reasonable to the industry right now.

So what are we saying? Well as of this writing October 2015, we feel that a builder should be able to acquire all of the BB8 Dome pieces for approximately $400, unfinished with no post processing. That works out to about $1.67 per hour for operator labor or $6.67 (US) per print hour all in. (0.11 per minute) If nothing else the little extra will help the printer operator take their significant other out for a dinner to get away from the printer running for 65 hours.

We encourage printer owners/operators to offer to print files for others builders without a 3D printer! We'd like for none printer owner builders to think about the unaccounted for time that a printer owner is spending in dealing with things in printing of the parts.

If a printer owner/operator can print out all of the parts for $100, and the parts are of an acceptable quality to the new builder, great. If the printer/operator is going to do some post processing, i.e. sanding & sub assembly, and asks for a little more than outlined above as a value added service, fantastic.

If a printer owner/operator makes a cast of a finished part, for reproduction via another means, we're ok with that, as long the maker of the part is not charging more than the reasonable cost per hour for the printed part. Not that we could actually enforce it if we wanted too, we're just asking for common courtesy. Golden Rule applies; treat others like you would like to be treated.

If a printer owner/operator offers to get some number of makers on a specific print file, as part of a specific "run" that's also a great idea to lower costs.

However, here are some things we're not OK with and we simply don't support:
1) If you try to sell these files to others.
2) If you list individual parts, complete sets of parts, finished parts on eBay, Craig's List, etc, whether it's an auction or buy-it-now created by the files we made available.
3) If you imply these parts are "official" in anyway.
4) If you commercially "market" parts produced by these files.
5) If a printer owner/operator prints out the parts and lists the parts for sale beyond the reasonable cost factors that could be seen as a commercial use.
6) If a printer owner/operator routinely makes a practice of finishing a the dome, body, or sub assemblies, including stocking all parts in quantities. That's seems to be commercial use in our opinion

These are not rules, its just actions we don't endorse and will not support. The key here is if this looks or smells like a commercial use or false representation, we don't approve of it.

Our goal here is to make sure the builder has reasonable options, and in the meantime, we'll keep an eye on this to see where it goes.

Now on to the good stuff…

-Tiny Panganiban & Michael Erwin

— Parts File URL Location —

To download the current version of this guide, STereo Lithography (STL) files, along with an Instructions Guide and Build checklist. Visit:

http://tiny.cc/BB8Builders

For group discussions on printing and building various droid replicas from the SW universe visit:

BB8Builders.club – Redirects to the FaceBook Group
Astromech.net : Home of the R2 Builders Club – Free membership

— Printing the Part Files —

If you read nothing else about printing these files, please note, in general we recommend you use 5 or 6 or approximately 1.2mm and hexagonal infill of 10% to 15% for all parts and a 0.2mm layer height.

For several parts, the shell become used a load spreading device like a how a fender washer does. If you assemble to Dome & Body Magnet Mounts, as outlined here, there will be 272kg (600 lbs) of magnetic pull pressure on a few parts.

The second reason 5 or 6 shells, is you will be sanding many of the part surfaces to get smooth. You need enough material to sand and not go through shell, into the infill. That would effectively ruin the part. In our testing doing 5 or 6 shells added very little time to the overall print time.

Most of the files will be printed at 0.2mm as outlined in the Part File Checklist. A layer height of 0.2mm is a good balance of speed, detail and strength.

The only one that we think should be printed at 0.1mm is the Radar Eye Internal, even then that can be printed at 0.2mm layer height if you so choose, and will not really be too noticeable.

For finest finish, slowing extruder movement to say 60mm/s (MakerBot default 90mm/s), give a better finish. In beta testing these parts we have seen a few be able to do 0.08mm. If you live on Hoth (Norway) apparently, the testers there were able to print layers at 0.06mm. However that meant a single dome panel took 54 to 57 hours of machine time to print. While it looks amazing, once you sand it, you won't be able to tell, except in the circles or panel lines of the Dome Panels. As mentioned above, using the recommended settings, you should be able to print all the dome parts in approximately 60 hours.

— Choosing Third or Quarter Files —
During our initial beta release, we became aware that a few of the parts were too big for some of the builder's 3D printers. Tiny rose to the challenge and made a special set of the files to print in quarters. If the standard "third" files happen to be too big for your printers build area, look in the quarter files section.

This will not increase the print time, as much as increase labor to fit and finish.

PLEASE NOTE: Not all 3D printers are going to be able to print some of these parts. Our minimum supported print area size is 9in. x 6in. x 6.in (22.5cm x 14.5cm x 14.5 cm) and many of the smaller parts can print on much smaller printers. However we have made the large files, such as the Dome Panel available in quarter cut. We don't recommend slicing the files smaller, due to the fact these are designed as parts, not a simple 3D model.

It also doesn't make sense to keep dividing the parts into smaller printable section beyond what we have provided.

Large single piece files are available as experimentation only.

— Printing Filament Observations & Settings —

In order of our filament preference:

PLA
DeltaMaker PLA 1.75mm: Opaque : Use 1.75mm for Thickness of Filament, TEMP = 230C to 235C : While this is Our Favorite, the packaging leaves a little to be desired.
3DSolutech PLA 1.75mm: Slightly translucent : Use 1.75mm for Thickness of Filament, TEMP = 230C : Best Value, however supply comes and goes, even Amazon runs out of this often. Amazon currently lists White & Black as unavailable, and may not be restocked.
Makerbot PLA 1.75mm : Very Opaque Light Ivory or Egg shell colored : Use 1.77mm for Thickness of Filament, TEMP = 230C
UltiMaker PLA 3.00mm : Nicely Opaque – White : Use 2.85mm for thickness, TEMP = 205C : Most expensive per Kg
JustPLA.com PLA 1.75mm & 3.00mm : Good Color

Gizmo Dorks PLA 1.75mm: Slightly translucent : Use 1.75mm for Thickness of Filament, TEMP = 230C : Close match to color of 3DSolutech, however it seems to clog nozzles much more than the above manufactures
Gizmo Dorks PLA 3.00mm: Slightly translucent : Use 2.85mm for Thickness of Filament, TEMP = 210C : Reports of clogging much more than what is acceptable.
HatchBox PLA 1.75mm: Nicely Opaque & White : NOT RECOMMENDED CURRENTLY – Delaminates on part removal from build plate. Several indications from a few printers that we know also confirmed. We're not sure if it's just a bad batch, or a bad formulation indicative of HatchBox. While the parts were on the build plate, the Hatchbox White PLA was the nicest colors we've printed with. We'll continue to monitor quality.
SainSMART PLA 1.75mm: NOT RECOMMENDED – Has a tendency to be very brittle, we have not used the heated in water solution. Several times, it breaks right as it goes past the extruding feed gear. Which eventually leads to a clog, due to the filament broke. While you might be able to get print for small prints, we would not recommend you leave your printer unattended or overnight.
eSun PLA 1.75mm: Very translucent : NOT RECOMMENDED – reports of trouble with clogging. Odor is somewhat offensive. While researching this, found reports of the PLA sometimes being ABS or having ABS mixed into the PLA filament. Packaging makes this filament look much higher end than it really is.

ABS
Many ask why we don't just recommend ABS? We understand the perceived PROs & CONs of the use of ABS, which we'll not discuss here. We've tried ABS and a few of the BETA testers have successfully used ABS to print the files. We just find that the ABS CONs, currently outweigh the PROs, and a few of the CONs, like part shrinkage, is very hard to overcome when your making parts that need to fit together.

PETG
Experimental. This filament has really started becoming available at a reasonable price. PETG has the PROs of both PLA & ABS, and as such we are currently testing PETG. Feel free to test it and let us know your experiences.

— Using Helper Disks —

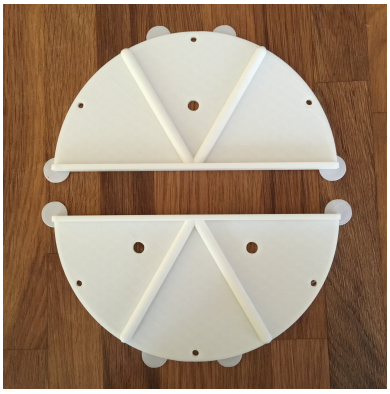
You will see references to "Helper Disks" throughout this guide. If you are new or maybe not to 3D printing, you might not realize what these are and how they are used.

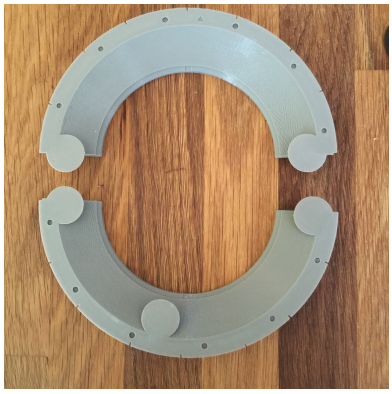
When PLA cools after being extruded, on long straight, sometimes eve n large curved, parts, the PLA wants to contract as part of thermal contraction. When the heated PLA begins contracting as soon as it begins cooling, ever so slightly. This normally isn't a problem for printing small parts, however on long straight run sections, it can cause the part to pull away from the build plate.

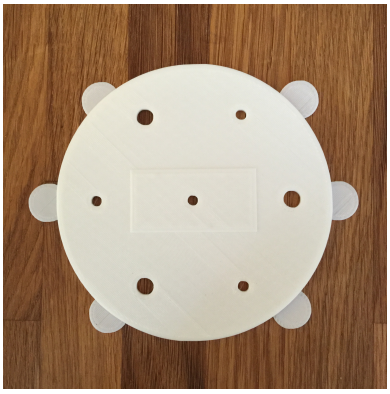
And nothing is more of a time waste, as much as printing overnight, only to wake up and see the part is basically unusable.

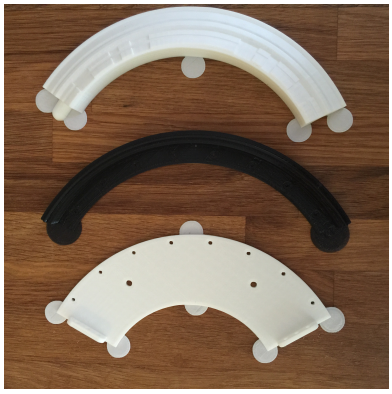
To help alleviate that issue, we place 1mm thick round or oblong disks, onto the slicer software's build platform prior to slicing. Most slicer software has a feature to add these helper disks. If not, just download some basic helper disks from Thingiverse.com, and add them prior to slicing the files for printing. We typically locate the disk where we think there might be a problem. For example, below left shows two Dome Upper Plate sections. The top part, has helper disks on the end, the bottom does not, notice the distortion of the lower part. While the lower part may be fundamentally usable, it's going to require a lot of work to get it presentable.

Here are recommended placement of helper disks for various parts.

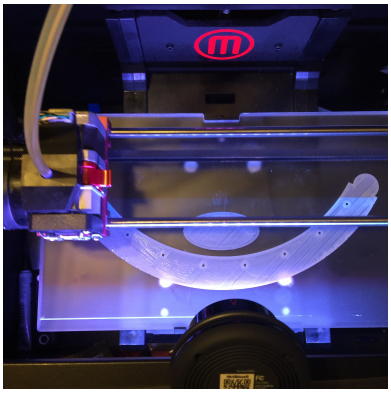








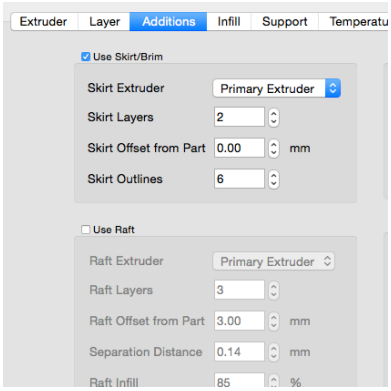
On Dome Panel 1, we typically make an elongated helper disk to place slightly behind the Radar Eye. This gives the support structure a nice PLA base for the printer to print the supports on as shown below.



— Simplify3D Skirt/Brim —

We highly recommend everyone consider Simplify3d.com Printing & Slicing software, regardless of the make and model of the printer used. As of this writing the cost is $149, and they do not offer trial version. Having said that, this is an essential upgrade in our opinion. The quality of the prints, supports, simple and advanced features are well worth the investment. Changing the slicer many times dramatically improves the quality of the print.

Instead of using helper disks, Simplify3D allows you to add a skirt or brim to the part. By default, Simplify3d prints a 2 outline brim around the part offset 4mm as a boundary. However if you adjust the offset to 0mm, and increase the outlines to 6, this will suffice as one huge helper disk around the part. To use, edit the Process your going to use, for this example Process1 (FFF). Move to the Additions section, select Use Skirt/Brim, set Skirt Layers 2, Skirt Offset from Part 0.00mm, Skirt Outlines 6



— Non-Manifold Models —

Repetier software may occasional report that a few of the models may be non-manifold, meaning holes in the model. We have tested all of the model files with various other manifold checkers and we are not finding the issue. We also do not use Repetier software. However we have had no reported model printing issues with the files as of 24-Sep-2015. We'll continue to monitor to determine if there is a real concern or not.

— DROP of Canola Oil Magic —

If you are having missing layers and general issues with your PLA, we recommend using a very small amount or a small drop of Canola oil on the filament.

For all the PLA parts shown on FB & Astromech, we started each print by putting either drop of Canola (ONLY USE CANOLA) on the filament end when changing filament, or using a paper towel soaked in CANOLA, to wipe down the first 2-3 inches of the filament before inserting into the extruder, especially Delta Maker & 3D Solutech PLA filaments. The Canola oil has a very high smoke temp, so it will not smoke under normal temperatures of <280C.

Some of the new printers have smoother (lubricity) extruder filament tube, and this shouldn't be needed, but just remember, it only cost a few dollars for a HUGE bottle that your never going to use all of anyway.

— Surface Smoothing —

After gluing the parts together, you will want to smooth the outside surfaces.

We've tried 3 methods smoothing of the parts.

1. Vapor Smoothing: We **cannot** recommend or endorse the use of either "vapor" smoothing by using Acetone for ABS or THF for PLA. This "Breaking Bad" technique "smooths" by melting the plastic. If you have not heard of "Vapor Smoothing" it is the technique requires you to boil a chemical and then place the part in the "vapors" of the boiling chemical. Simply put, this isn't safe, good for your health, the environment and smells terrible. Since it melts the PLA or ABS, long term; no one really knows for sure what's going to happen to the PLA or ABS. It about killed us; so please don't do this if you care about yourself, your family, your home or the environment.
2. Smooth-On XTC-3D (epoxy coating): This is interesting epoxy based product. However it's use changes the dimensions of the parts WAY too much to compensate. Its good for single stand alone parts that you don't care about exact dimensions
3. Sanding: Our preferred and best results come from using a simple File and Sanding.

First use a mill file to rapidly remove rough edges from parts.

Second, invest in a 5inch Random Orbital Sander. An example is Rigid 5 inch Random Orbital Sander available at Home Depot: https://www.ridgid.com/us/en/five-inch-random-orbit-sander. It really works great. Some of the newer sanders have a fine dust collection filtration system.

Start with100-120 grit pads, (btw I liked Norton vs. Diablo pads. Norton also leaves a very light yellow sand color in the finish (Jakku dust?), Diablo pads give the surface a RED tint). Sand till the surface smooth to the touch and erase all layer lines, ringing effect and any filament zippers.

Finish with a 220 grit paper and this leaves the parts with a great finish for paint adhesion, and in general it makes the part feel cast rather than FDM printed.

Plus this works great to remove the bad Rustoleum White Satin when the "new and improved Nozzle" sputters and ruins your parts.

NOTE: We've tried using as low as 60 grit paper. **DON'T DO IT!** While it is much faster, it is so fast that it will eat right through your parts. I have also tried higher grit, as much as 1500 grit. It seems to be was a waste of time, but its your time and your droid, it won't hurt. Just makes the finish feel like cheaper plastic injection molding.

— Joint Smoothing —

We recommend two methods that work very well for us during prototyping.

Method 1: PLA Welding
To completely make the seams disappear, use 1 inch of PLA insert half way into a your favorite rotary tool around 4000 to 5000 RPM. If you take your time, you can use that rotating piece of filament as a welder, Heat is produced from the spinning friction between the rotating filament and the seam, the PLA will melt and make a perfect weld, just like metal. After letting the weld cool and set, use a fine file to clean up the bead. It's kind a fun doing this method, plus it sounds cool that you welded with PLA.

Method 2: Tamiya Plastic Model Putty in White and Black. apply with X-ACTO blade, makes a smooth seam, with a little practice, this is the fastest, safest and easiest method with very smooth results, less post work.

— BB8 Dome —

The dome is designed to work with both of our “Stage” and the “Static” body designs. (Yet to be released)

We have spent untold hours with our “interpretation” of the designs. We have noticed several things on the stage & static droids that honestly bug us. (We might be a little OCD) However we have duplicated those “features” in our interpretation to the best of our ability. We simply do not have the massive data points that currently exist with R2 or the other droids. We might be off by a mm here or there. We can guarantee it’s not perfect since we are human after all.

— Printing FDM PLA & Parts Print Order —

Based on our experience and those of some of the beta tests, we are providing a recommended printing ORDER to reduce changing the filaments, and broke the part print order into 2 colors of PLA, Black, White & provide an indication of those you might want to print in Gray or Grey as JoyMonkey would say.

We have listed what we feel are the easier to print parts first, to allow those new with 3D printing to gain some experience before getting to the larger, time consuming pieces. Simple put, if you are having a hard time printing the HP, you’ll be really frustrated by starting with the large Dome Panels. Get your printer settings for the HP correct, and the larger pieces will be much easier.

- Black PLA Parts -

BB8 HP - print at .1mm - No Helper Disks are needed, carefully make sure the CROWN details are clean and stand free. However some printers or slicers don’t quite finish the crown details. In those cases, you can use a small jewelers sharp edged file or better yet, use luthierie gauged nut slotting files or Mitchell abrasive cord. These are available from Stewart-MacDonald @ stewmac.com part numbers #0821, #0823 and #6125.

PSI - .2mm - Print with Support. No helper disks are needed.
There are 2 pieces, print the larger housing piece .2mm. There is a inner white ring .1mm OR optionally fill the PSI ring cavity with paint for smoother look. We find that filling the PSI ring cavity is easier and provides superior results. For that reason we consider the printed white inner ring is optional.

BB8 PSI Rear Cover – New part as of v22. print at .2mm - No Helper Disks are needed,

Dome Pie Panels - print at 0.1mm or 0.2mm - Black, White or Gray. Use Helper Disks on the ends and use a 10mm x 10mm x 4.5mm helper disk in the Antenna hole area for additional strength Gray or Black PLA will help look like metal if chipped. You will notice 2 holes in each end, to insert & glue 1.75mm filament to help strengthen. Test fit before gluing and use a drill bit to enlarge the holes slightly. Make sure to sand the outer surface smooth before painting. We recommend Hot Rod Gray primer to paint first followed by rub-n-buff Silver. Simply rub a very small amount on with your finger, and keep rubbing, it will turn metallic. You will also notice small 3.3mm x 1.1mm holes in the bottoms of the pie panel ring. Those are for you to glue insert & glue in magnets to allow you easy access by removing the pie panel & top of the dome to work on electronics or make changes. It will require you to also install magnets into the top of the dome panels.

Antenna 2 (Lower whip antenna) - print .1mm - actually 3 parts, but 4 pieces are needed, the top piece print twice use 1/16 in music wire or aluminum rod) Helper Disk are required on the ends of the bottom halves. Don't remove helper disks from the part until after gluing the half together. You will need to use 1/16 drill bit to ensure a clean opening on the top end of the assembled bottom half, as well as the top wire protector. We recommend 150mm 1/16 or 0.8mm spring steel for the wire section of the antenna. Once inserted into the base and top, it will be the correct height.

BB8 Radar Eye Surround - print at .1mm - (Gray PLA) - No Helper Disks are needed. There are several optional files for this part, some may wish to do the surround in 2 pieces, the outside surround, and the internal base. This allows for ease of painting, if you choose to do the base flat black. The outer surround needs to be Hot Rod Gray Primer, then when dry, lightly buff with a dry paper towel or cloth, which gives it a machined look.

BB8 Radar Eye Internal - print at .2mm - No Helper Disks are needed To clean up little filament whiskers in the internal details use a file card or a small wire brush. Paint Internals with a flat black. Once paint is cured, glue to finished internals. I prefer Hybrid GO2 or a GEL CA glue for this connection. Then install 6 x 3mm LEDs, with or without flanges. Hold LEDs in place by a touch of hot glue into the holes.

OPTIONAL LARGER RADAR Internals, to some, the internals look larger, so we have made an optional larger version that works with the same 75mm Eye surround. follow the same instructions as above.

Dome Ring - print at .2mm, where as .1mm resolution is a waste of time in our opinion - Black PLA will help the two painted silver rings look like metal. Helper Disk may be required on the ends, depending on the adhesion of the PLA to your build plate. Make sure to sand the outer surface smooth before painting or using rub-n-buff Silver (our preferred)

- White PLA -

Antenna 1 (Top Rubber Duck antenna, looks like 2.4Ghz Antenna) print at .1mm - WHITE PLA, - Use helper disk on the very ends. Don't remove helper disk until after gluing the halves together.

Dome Top - print at .1mm - WHITE PLA, - The reason to print this in finer resolution is it will be the dome top, at lower resolutions you will distort the top trying to sand smooth. Use support and place 8 small helper disk around the perimeter, I also like to place a larger 30mm helper disk directly in the center, this help with removal from the build plate as well as being used to hot glue the part on the flat wooden stick to help paint. No need to remove the supports; just cut the helper disks that go beyond the normal edge away. Future version of this part will not need support or the helper disks.

Dome Panels - sectioned into 3 pieces - print at .2mm - White PLA, 6 shells - its a 3 part collection, that will need to be assembled and glued to make the majority of the dome. Print with Support and Bridging. On my MakerBot Replicator 2, I set the slicer to only add support over 80deg angle. This will allow bridging support. I use helper disk on each end and the inside middle. Careful placement will allow for easy removal. Also recommend a 100mm x 30 mm helper oval, placed behind about 2 cm behind the inside ring mounts. This will provide a base for the bridging supports. Print times, range from approximately 10.5 hrs for Panel 1, to 12.75 hrs for Panels 2 & 3.

You will also notice small 3.3mm x 1.1mm holes in the top of the dome panels. Those are for you to glue

insert & glue in magnets to allow you easy access by removing the pie panel & top of the dome to work on electronics or make changes. It will require you to also install magnets into the bottom of the pie ring.

Dome Skirt pieces- print at .2mm, Ditto - White PLA - 3 or 4 large sections, that once assembled makes a rather large part. Larger helper disk may be required on the outside ends

Dome Magnetic Mount (aka DMM) System, including custom Caster parts - .2mm - no helper disks are required. Do not paint. Interestingly if you don't weather the bottom or the large magnetic mount, it seems to disappear under the dome. Weather makes it show up more, just like it does with the dome panels.

- Radar Eye Lens -
Cut 70mm clear "ornament" Sphere (available on Amazon 12 @ $9) at 68mm for Radar Eye lens. It is a tight fit, so make sure the paint on the surround is well cured. Be patient. Install the single 3mm red LED in the Radar Internal before installing the eye from the inside of the eye. Make sure the inside of the lens is TOTALLY clean before mounting. Unlike R2's radar eye, keep the lens clear.

- HP Cobalt Blue/Purple/Black Lens -
Congratulations you actually read this guide! GET A FREE BB-8 HP LENS, once you have the BB8 HP printed, post a image on Facebook BB8 Builders and/or send Tiny or Mike an image of your BB8 HP along with your shipping address via FB messenger or PM on Astromech.net and Mike will send you a set of custom translucent Cobalt Blue resin 20mm lenses for your HP for free. Supplies are limited.

— Hardware Parts Needed: DOME —

We used McMaster-Carr to order here in the US.
You could simplify this somewhat and possibly safe a little money, however I liked the look of the brass and white PLA for the Dome Magnet Mount.

McMaster-Carr
3x 4624K34 Brass Thread Adapter, 1/4"-20 Male X 5/16"-18 Female
1x 92716A519 Uncoated Brass Cap Nut, 1/4"-20 Thread Size, Packs of 25
DEPRECATED in v22: 1x 92716A610 Uncoated Brass Cap Nut, 5/16-18 Thread Size, Packs of 10
DEPRECATED in v22: 6x 6460K43 Stud-Mount Ball Transfer, Standard, 1" Nylon Ball
1x 92480A207 Brass Flat Head Phillips Machine Screw, 8-32 Thread, 2" Length, Packs of 25
1x 98812A603 Brass Fully Threaded Rod, 8-32 Thread, 1 ft Long, Packs of 1
1x 92671A009 Brass Hex Nut, 8-32 Thread Size, 11/32" Wide, 1/8" High, Packs of 100
1x 92671A011 Brass Hex Nut, 10-24 Thread Size, 3/8" Wide, 1/8" High, Packs of 100
1x 92741A120 Round Brass Thumb Nut with Flange, 8-32 Thread Size, Packs of 25
1x 92741A130 Round Brass Thumb Nut with Flange, 10-24 Thread Size, Packs of 10
6x 90308A655 Zinc-Plated Brass Female Threaded Hex Standoff, 1/4" Hex, 1" Length, 10-32 Screw Size (Dome Float Adjustment)
6x 90308A660 Zinc-Plated Brass Female Threaded Hex Standoff, 1/4" Hex, 1-1/4" Length, 10-32 Screw Size (Dome Float Adjustment - Used on Prototype)
6x 90308A665 Zinc-Plated Brass Female Threaded Hex Standoff, 1/4" Hex, 1-1/2" Length, 10-32 Screw Size (Dome Float Adjustment)
2x 97715A215 Brass Button-Head Socket Cap Screw, 10-32 Thread, ½" Length, Packs of 10
OR
1x 98164A178 Stainless Button-Head Socket Cap Screw, 10-32 Thread ½” Length, Packs of 50

1x 92095A183 18-8 Stainless Steel Button-Head Socket Cap Screw, M3 Size, 12 mm Length, .5 mm Pitch, packs of 100
1x 93625A100 18-8 Stainless Steel Nylon Lock Nut M3 Size packs of 100

NEW DMM Caster Parts
1 x 9660K37 Extreme-Temperature Slippery PTFE Ball (Pack of 50)
3 x 9660K33 Extreme-Temperature Slippery PTFE Ball
1 x 98704A800 Plastic Knurled Head Thumb Screw 6/16”-18, 1/2” long (Pack of 5)

PLEASE NOTE: We plan to convert all of the above parts to Metric soon to make this easier for everyone, including us.

Magnet4less.com
6x ND060-TH 1in x 1/2in Disk Counter-Sunk (3 for Dome, 3 for Body)
2x ND073-T 2in x 1/2in Disk Counter-Sunk (1 for Dome, 1 for Body)

For the Dome Panel to Pie Panel Ring magnets we have tried

Magcraft – Available at many U.S. HobbyTown hobby stores
Model NSN0592 Rare Earth (N40) 1/8in. x 1/32in. (3.2mm x 0.8mm) Disc Magnets (150 Pack).

K&J Magnetics
3x D201-N52 1/8in. x 1/32in. (3.2mm x 0.8mm) N52 Disc Magnets (10 Pack) – Stronger than Magcraft!

Regarding the magnets, always attempt to get the strongest N rating you can. The higher the number the better, a N52 is much stronger than a N40.

— Paints Needed —

- White -
For those white parts that are seen, we've come to like Krylon Satin White. While we've tried Rustoleam satin white (most builders use on R2-D2 for his white paint), however it has a new nozzle, and the new nozzle on the Rustoleam can spatters the paint after a few moments of painting. We have tried hot & warm water baths for the can, 10 minutes in a shaker, spray 30 second, shake for 2 minutes. It should not be this hard to use a can of spray paint. That's the point of buying a can of spray paint. Just buy the Krylon Satin White or similar, and you will be in good shape.

- Black -
Used to seal the Dome Ring prior to applying silver rub-n-buff or silver paint. We also like Brian Munger's use of black paint on the inside of the dome panels to prevent any LED illumination from showing through the dome panel.

- Orange -
We've tried all the canned spray oranges available here in the US and none of them look right to our eyes. We've tested various available off the shelf Oranges here in the US as well. It seems we don't have an exact purchased paint, available in the US. If you order custom mixed spay paint cans, Pantone 715C, seems to be a very close match.

Thanks to Francis Assis, what we have come to love is using Tamiya's Acrylic X-6 Orange 10ml bottle & adding ~0.5ml to 1ml of Tamiya's Acrylic XF-49 Khaki or XF-59 Light Khaki. This de-saturates the Orange to be more representative of a desert lighting condition. To be fair, Francis actually recommended MR Hobby Paints H14 with a small amount of H404 for the de-saturate, however we've had an impossible time acquiring these MR Hobby paint colors here in the U.S.

The Orange will still be a little light or bright to the eye, however once you start weathering it looks great.

The Tamiya paint is super easy to airbrush this Orange, just thin about 2:1 with Tamiya thinner. If you needed a reason to get a decent airbrush, well this is one that is great start for it.

- Silver -

We preferred the appearance of Silver Rub-N-Buff. It has Carnuba and Silver paint, and is best applied with very thin film on your finger or hand.

- Acrylic Clear Coat -

While technically not needed, we really like applying a nice acrylic clear coat before applying weathering. It gives it a nice shine under the weathering. Making it look more realistic.

- Weathering -

There are scenes of R2 weathered, even dented, as well as him looking shiny and new. BB-8 just doesn't look right looking pristine. The weathering really brings out a character of him. Until the weather is on, the many of the dome panels, just don't appear. That absence really affects the overall look of BB-8.

Examine and study the images; from SWCA of the stage and static versions. You will notice the weather is

slightly different on each. Also there are a few shots in the trailers, that weathering doesn't match either the stage or static. We expect that is either a puppet droid, like they did with R2, or a CGI version.

We started out with numerous layers of simple washes, followed by slightly heavier weathering including fluid drips and runs. Then the really heavy stuff and wipes in between.

For washes we used very thinned (5+ thinner :1 paint) acrylics Raw Umber, Raw Sienna, Burnt Umber and Burnt Sienna. DO NOT USE BLACK, it's just too much. Do multiple layers of wash, make sure to get into those panel lines, then use a paper towel to wipe off.

Apply Wash
Wipe off runs
Let dry
Repeat

The more and lighter layers you can do, the more realistic it seems to look.

Use thicker amounts of paint, in the corners, think how you would wipe down if there were an oil leak.

If you can find a copy of Cory Pacione's Droid Weathering video from DroidCON 1, or Dan Baker's video from R2-Atl MegaBuild 2015, both of which are a great help.

Don't forget to get do the dome skirt!

Use a Tamiya XF-59 Light Khaki (sandy color) wash to give it some sand blown look, especially on the front, in the crevices.

NOTE from Mike : It seems to me, when I was testing weathering on the magnet mount housing or the bottom dome plate, it made the dome NOT appear to be "magically floating". So on the prototype finished dome, I did NOT weather or paint the Lower Dome Plate or the Dome Magnet Mount, otherwise I did rather heavy weathering everywhere else.

— Dome Assembly —

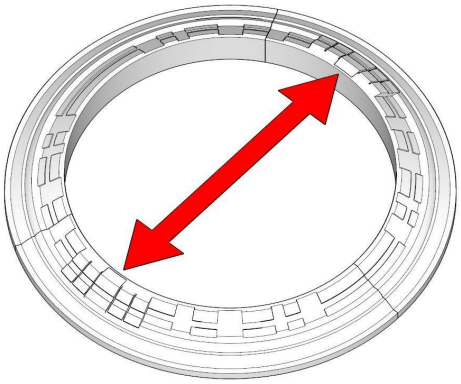
Verify that you have all of the printed parts and hardware needed. Use the above hardware list and the current checklist file on the share.

Estimated build time for the dome is 6 hours, excluding painting and weathering.

We're going to assemble from the outside, bottom up to top, then go inside.

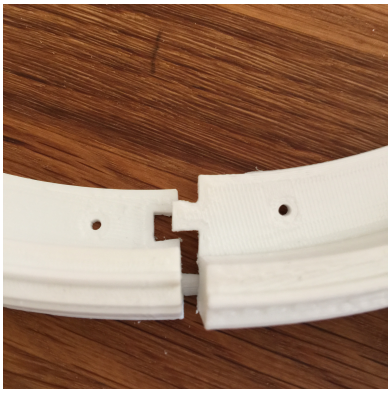
Dome Skirt (3 pieces) - This completed piece will look like its floating above the body sphere, because it is.

There is an order to this, arrange the 3 pieces so it looks like the following. You may have to sand the key & slot areas to get a nice tight fit. You will notice the top & bottom of this picture will be come close to the front & back, and there are extra little raised areas on the front and back. Make sure when you glue this together with thick GEL CA. that you place it on a flat surface covered in wax or parchment paper. Joint should be very clean, and almost disappear if done correctly. Leave this sub-assembly to cure, and you will glue this to the Dome Ring, much later.



— Dome Ring —

The Dome Ring (BLACK PLA) is composed of 3 identical parts. You will notice these are a little trickier to join together due to the key on each end. Flush cutters are a great help in removing helper disks, however just remove a little at a time, or use the flush cutters to score the helper disks first before cutting all the way through the part. Take your time and file the key & slots to get a perfect fit.


Do not glue until all the pieces fit nicely and lay flat. Glue and allow curing on parchment paper. It's critical this piece be as flat as possible, with holes down. You will notice a raised ring that will fit down into the Dome Skirt, and the holes face up and will align with the mounting holes on the bottom of the Dome Panels. If you notice pictures from SWCA, there are slots cut in the dome ring under the Radar Eye or the HP. You can either fill in the joints large seems with black Tamiya model putty, or PLA weld. Sand outside surfaces now if you wish.

Using either a 1/8inch or 3mm drill bit mounted to a drill, ensure all of the outer ring holes are at least 1/8inch or 3mm in diameter.

— Dome Panels —

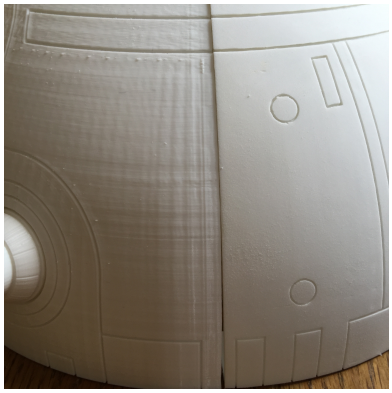
The Dome Panels are composed of 3 different panels or possibly 4 if you have a smaller volume printer. We recommend you sand the outside of the Dome Panels using the orbital sander technique with 120 grit (approximately 10 minutes) followed by 220 grit (approximately 5 minutes). Dome Panel 1 is the one with the Radar Eye, from above going clockwise, joined to Dome Panel 2, joined to Dome Panel 3 (which has the mounting hole Antenna 2 Black whip).
Here in the first photo you see Dome Panel 1 (left), being shown with Dome Panel 3 (right). Dome Panel 3 has been sanded.

Use a small stiff bristle brush or carefully with a hobby knife, remove any filament that clogs the panel lines after sanding. You may wish to use the hobby knife #11 blade to carefully clean up any circles or line imperfections.

In the second picture you will notice there are small holes molded into the edges of the dome panels. These holes, allow you to insert and glue 1.75mm filament into them, strengthening the joint. Prep & clean the hole by using a 2mm drill bit, test fit filament into the holes, leaving about 4mm exposed. Place the Dome Panels on parchment or wax paper. Test fit the dome panels together, WITHOUT gluing. Adjust the

filament length till the panels fit flush as shown in the second picture. Once your satisfied with the all three (3) panels fitment, glue the filament into one panel side only.

Using thick GEL CA, insert glue into the hole of the other panel, and all along the seam edge, including the internal mounting ring. With CA on both panel the edges, press and hold till the CA cures. Continue to work around the dome, using the same process till all panels are glued together.

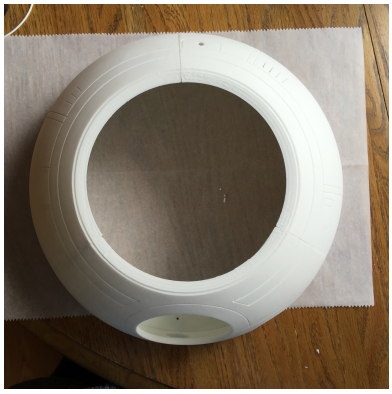



Ensure the glued panels cure on a flat surface.

Fill in the 3 dome panel seams, with either Tamiya White model plastic putty or with a combination of filament welding. Make sure you use the same make and color of filament you used to print the Dome Panels. This technique of spinning PLA or ABS in a rotary tool is quite effective. Both surfaces along with the PLA weld are melted together, forming a very solid bond, reinforcing the CA glue.

Sand the outside seam smooth with the random orbital sander technique introduced earlier. You can use the Tamiya white model putty on the inside seam.





Make sure the top of the dome panels are smooth, however there should be an approximate 1mm raised surface above the top of the Dome Panel top plane. This will be used to put a 1mm gap in between the Dome Panel and the Pie Panel ring. Carefully, hand sand the top of that raised surface smooth, with 320 or 400 grit. This will be the raised surface that the Pie Panel Ring will be affixed via the 1/8in x 1/32in. (3.2mm x 0.8mm) disk magnets.

You may wish to glue in and install the magnets now or after painting.

Remove the bridging support in the LED “logics?” windows, and clean up any rough angles or edges with a small flat hobby file. The picture below shows the support bridging still in the “logic” windows.

Using either a 1/8inch or 3mm drill bit mounted to a drill, ensure all of the bottom outer ring holes are at least 1/8inch or 3mm in diameter.

— Pie Panel Ring —

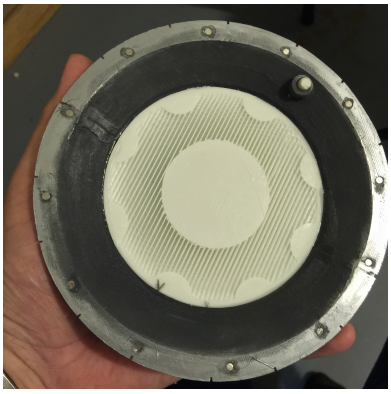
Typically these are either Black or Gray filament. These are two pieces that form a key visual element on the dome. The front ring panel and has a small arrow indicator on the middle bottom. This arrow will also point to the Radar Eye opening. The rear ring panel has the Antenna 1 (White Stubby) mounting hole as well as the parallel circle feature.

Sand, via the Orbital sander method, the panel halves to remove all circular filament printer marks. The better your remove these marks, the more metallic these will look when finished. **Be careful** handling as you sand since the panel lower outside edge tends to get sharper as you sand, the extruded filament holds an edge quite nicely.

Like the dome panels, you will notice that on the joining edges, there are two holes molded into the adjoining edges. These holes, allow you to insert and glue 1.75mm filament into them, strengthening the joint. Prep & clean the hole by using a 2mm drill bit, test fit filament into the holes, leaving about 4mm exposed. Place the Dome Pie Ring panels on parchment or wax paper. Test fit the two pieces together, WITHOUT gluing. Adjust the filament length till the panels fit flush. Once your satisfied with both ring panels fitment, glue the filament into one panel side only. Then using thick GEL CA, insert glue into the hole of the other panel, and all along the seam edge, including the internal mounting ring. With CA on both panel the edges, press and hold till the CA cures. Its critical to keep this piece flat as possible till fully cured.

You may install and glue the 1/8in. x 1/32 (3.2mm x 0.8mm) magnets, into the bottom recesses of the Pie

Panel ring now or wait till finished. Ensure the magnetic poles are aligned the direction to attract the magnets in the Dome Panel.

Set aside to allow the CA to cure.

— Dome Top —

Remove any helper disks on the outside edge.

Since it's only one piece, just sand smooth using the Orbital Sanding technique used before. Clean the panel outline with either a stiff bristle brush or a hobby knife edge.

If you haven't noticed before, the Dome Top has protrusions on the inside front (wide) and rear (thin), and fits SNUGLY into the Pie Ring, in one way. You will now notice there are indentions on the inside top of the Pie Panel ring that aligns the dome top.



You will need to use a half round file to remove material slowly from the inside of the Pie Panel ring, slowly working your way around the inside groove on the Pie Panel ring. You may also need to file the lower outside edge of the Dome Top, be careful not to hit the finished surfaces. Do this till the Dome Top fits firmly and snuggly into the Pie Panel ring.

Do **NOT** glue the Dome Top into the Pie Panel ring.

— Dome General —

If you installed the magnets into the Dome Panel and Pie Panel ring, this is a good time to test fit. Make sure all magnetic poles are oriented as to attract each other.

You should notice an approximate 1mm gap between the bottom outside edge of the Pie Ring and the upper outside edge of the Dome Panel. We want that gap.

With the Dome Panels and Pie Panels, use the orbital sander technique, with 220 grit pad installed, to sand the edges of the Pie Panel to make a smooth transition to the Dome Panel.

Now that upper parts are fitted, time to paint.

—Dome Panel Assembly Painting—

Apply a few light coats of the white of your choice as discussed in the prior section on Paints Needed

Mask the panel lines referring to reference pictures from SWCA.

An easy and accurate way to mask the panel lines is to use the 2 inch blue 3M paint mask over the entire panel. Firmly sealing the tape onto the dome, and use your fingernail to outline the panel through the tape. Carefully using a hobby knife with a new #11 blade, trace the panel to be painted Orange, with the blade. Remove excess blue mask.

Cover all remaining surface area with either paper, or a Press & Seal plastic wrap.

Use your airbrush to paint the orange panels.

Let the paint cure for about 10-15 minutes, remove the wrap & blue masking tape.

Set aside to cure for a few hours.

Then do the same masking technique for the outer ring around the HP opening, using the Hot Rod Gray primer.

Set aside to allow the paint to cure.

— Painting Pie Panel Ring —

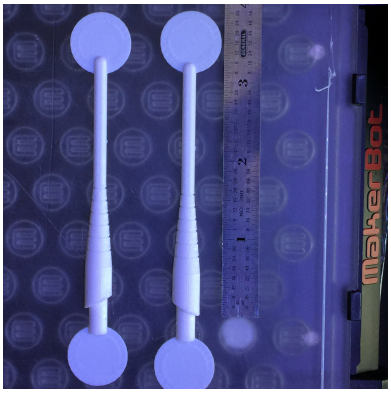
Paint the Pie Panel Ring either flat black or to our eye, the preferred Hot Rod Gray Primer.

To make the Pie Panel Ring look metal, we've found the best results by using Silver Rub-N-Buff. The best application technique we've found is to place a dollop of the Rub-N-Buff on a paper plate. Using your index finger, smear a small section of the Rub-N-Buff dollop, across the plate. This will leave a small film on your index finger tip. Then begin lightly rubbing your finger in the section of the ring.

The Rub-N-Buff, will initially feel like paint, then turning slightly gummy or tacky. Continue rubbing, in the same direction, it will become like a metallic shiny surface. Keep doing this till the entire Pie Ring surface is covered, including the underside edges. By using your finger, it appears to heat from your finger melts the Carnuba wax in the silver and aids in the appearance.

Set aside to allow the paint to cure.

— Antenna 1 —
Antenna 1, the upper white stubby one, is composed of two pieces. While this is most likely a found piece, there are some unique grooves on the antenna, that makes perfect piece alignment easy.



Lightly hand sand with 400 grit, the wide flat side of the two (2) antenna pieces. You may wish to leave the helper disks on the antenna pieces till finished gluing.

Carefully & neatly apply a thin coat of GEL CA to the internal wide areas of the two antenna pieces. As you move the pieces together, align the grooves and edges as closely as you can. Press & hold for 30 seconds along the length of the piece. Remove with a paper towel any CA that has been forced out from the two halves.

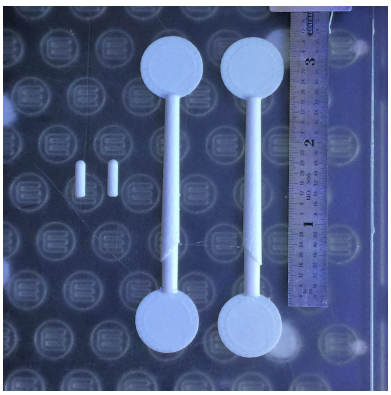
Sand the entire antenna to give the antenna a uniform look and fit.

Test fit Antenna 1 into the hole of the Pie Panel ring. The hole may have a small helper disk at the bottom. That will require you to drill through from the top. Start with a 2mm or 1/8in drill to make the initial hole. Enlarge by increasing the drill bit size until the hole is open to match the inner dimension of the upper hole. Sand the lower mounting section of the antenna till it fits and seats into the Antenna 1 hole in the Pie Panel ring.

Do NOT glue antenna into the mounting hole, until finished painting.

— Antenna 2 —

Antenna 2, the lower multi-piece whip antenna, typically made of black filament, is composed of 4 extruded pieces and a single 150mm x 0.8mm (1/16inch) spring steel or music wire, if this is a static dome that will be collector piece, replace the music wire with aluminum tube for a more accurate look. Shown below in white for clarity



Do not remove the helper disk yet.

You will notice there is a groove on the inside of in the bottom and tip pieces that will be used for the spring steel.

Lightly hand sand with 400 grit, the wide flat side of the two (2) bottom antenna pieces and the two (2) antenna tip pieces.

Carefully & neatly apply a thin coat of GEL CA to the wide areas edge of the two antenna pieces. Avoid getting GEL CA into the wire groove. As you move the pieces together, align the grooves and edges as closely as you can. Press & hold for 30 seconds along the length of the piece. Remove with a paper towel any CA that has been forced out from the two halves.

If you have yet, remove the helper disks from the part.

Repeat for the two antenna tips.

Sand both entire antenna pieces to give the antenna a uniform look and fit.

Using a 2mm or 1/16 in drill bit ensure the hole for the wire whip is clear in both the bottom and tip. If you fail to do this, when you insert the wire whip into the section, the wire may not seat correctly or it may break about the cured CA joint.

Test fit Antenna 2 into the hole of the Dome Panel assembly. Sand the lower mounting section of the antenna till it fits and seats into the lower Antenna 2 hole in the Dome Panel assembly.

If you wish to paint the antenna BLACK, mask off the mounting area of the antenna. Lightly spray a gloss or semi gloss black that is safe for plastics.

TIP: Use some scrap 2mm wire, to hold & turn the pieces when you paints.

Paint the Antenna tip piece the same color as the antenna base.

Once the paint has dried, insert the 150mm X 0.8mm spring steel wire into the pieces. If it’s not fitting correctly, use the 2mm (1/16in) drill bit into the holes to clear any obstruction. Once satisfied that the wire fitting correctly, carefully insert GEL CA into the base hole, and place a thin film of CA on the end of the wire approx 2 cm long (1 inch).

On the tip end of the wire, test fit the antenna tip,

Glue the antenna tip onto the wire. Set the piece aside to cure.

Do NOT glue antenna into the mounting hole, until finished painting.

— Radar Eye —

The Radar Eye assembly is constructed from 2 or 3 printed parts along with purchased 70mm lens. The Radar Eye Lens is a 70mm plastic 2-part ornament. These are available from Hobby Lobby for $1.79 (US) or Amazon in a box of 12, which will give you 24 lenses.

In the simple configuration, shown above, the Radar Eye Surround has an integrated base for Internals mechanism. In the optional 3 piece configuration, it is comprised of separate Surround, internal Base and the Internal mechanism. This allows for an easier way to paint base separate from the Surround and Internals.

For the Internal mechanism, you have the option of either a smaller or larger size. Both sizes will fit either Surround design and currently it's our feeling that larger might be more accurate. However it is your droid.

For either Surround configuration, use the Orbital sander technique to sand the entire outside smooth, with special attention to the visor top. Do not worry about the back of the simple surround or the back of the base; those surfaces will be inside of the dome when finished. The smoother you can get the outside, the better. To get the prongs smooth, use a medium foam-sanding block. Depending on the printer and filament, these may be a little brittle. It typically takes us as much time sanding Radar Eye Surround as it does the entire dome.

For the internal mechanism piece, use a file card or soft wire brush to remove any filament whiskers from the details. This piece will be painted flat black later.

If you are building the 3 piece Radar Eye, sand the inside floor of the base smooth. This will also be painted flat black later.

Make sure the base fits snuggly into the surround. File or sand to ensure a proper fit.

You'll being assembling and gluing the parts later.

You will be required to cut the 70mm lens so that it fits into the 68mm space inside of the prongs. At 67 or 68 mm, the plastic lens will fit into the prongs.

To cut, you can use a compass and draw a 68.5mm circle, and cut a ring with a plastic cutter bit in your rotary tool. The using a flat file, carefully remove excess from the lens, till it has a diameter of 68mm.

You may also print the lens cutting helper tool or print out a helper disk 68mm in diameter, 4mm in height. Insert this into the lens hemisphere and mark the outside of the lens where the disk touches the hemisphere. Once marked, use a plastic cutting blade in your rotary tool to cut away the excess. Take your time, and go slowly and carefully. Let the tool do the work.

File the lens flat, by either using 600 grit sand paper on a flat surface, and sliding the lens cut edge across that, or by using a flat file. The flat file, give better result but takes a little practice.

As you clean and flatten the lens edge, test fit the lens into the Surround.

To insert the lens, start by pushing the lens into the top of the Surround under the visor, the carefully apply pressure the to the lens till it gets past the prongs, and fits inside of the prongs and rests on a ledge on the inside of the prongs.

Test fit a single flanged red 3mm LED, either red or water clear plastic. Insert into into the mechanism from the rear. There is a small lip inside the mechanism that should keep the flange of the LED going to far. We want the LED to just extend into the first left opening, no more than 1mm

Do not glue lens at this time.

Test fit the Surround into the Radar Eye opening of the Dome Panel 1. You might need to remove little material from the opening with a half round file. Go slow, you don't want to remove too much. The Surround should fit very snug, and be flush on the inside of the dome when properly seated.

Do NOT glue the Surround into the opening, till after painting.

— Holo-Projector —

This is most likely the first part you printed, and a great part to start with. We recommend that you sand the raised panel surfaces smooth.

The crown might need a little share edged hobby or jewelers file, to clean up the points. Do not use a hobby knife to cut away the filament, it is too wide and will break off the crown prongs.

We suggest that you paint this with a dark flat gray. We prefer Dupli-color Hot Rod Gray Primer. Like we did on the Radar Eye Surround, once the paint has cured for a few hours, we found that if we take a dry paper towel and rub the primer gently, it gives the HP a nice worn machined patina.

You will need a 20mm hemisphere for the lens. We have made a limited number of the lens, in three shades of cobalt blue. We have a limited number of them and will have them at gatherings or if you check with us, we might be able to send you a set of three, so you can choose which one you want to use.

The outer diameter of the HP lens needs to be ~17.8mm, use a flat file to remove material from the back of the lens, and test fitting into the HP as you go. Be careful not hit the round outward section of the lens, the file will scratch it easily.

Glue the HP Lens in with thick GEL CA.

Test fit the HP into the opening of the Dome Panel 1. You might need to remove little material from the HP opening with a half round file. Go slow, you don't want to remove too much. The HP should fit very snug, and be flush on the inside of the dome when properly seated.

Remove the HP and set to the side

Do NOT glue the HP into dome HP opening.

— PSI —

Whether this is a PSI or not, we don't know, but that's what we're calling it until we figure out what it really is.

This is made of two parts, the black PSI housing, and a optional small white ring, PSI Ring, to inlay into the housing.

The PSI housing actually has an internal ledge, you will notice the opening on the front of the PSI housing is smaller than the rear. This allows you to place a white frosted lens in the PSI housing. If support was used when printing the PSI housing, you will need to remove the support material from inside of the rear of the PSI housing.

Sand the outside of the PSI surface fairly smooth.

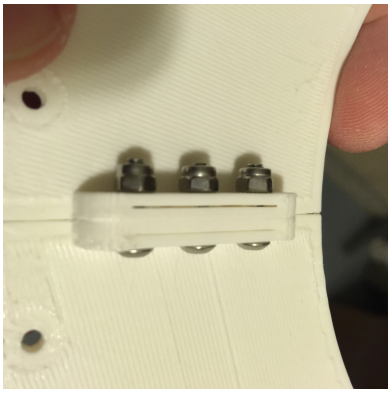
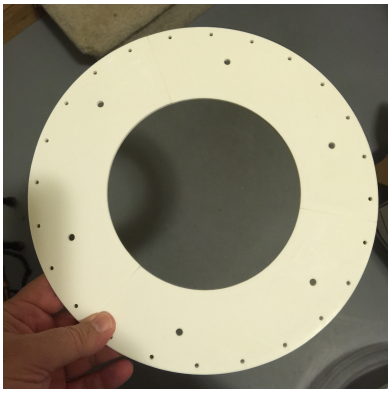
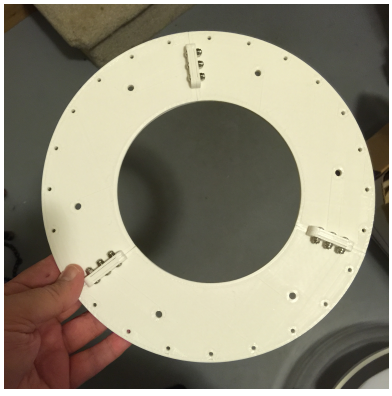
Sand flat & sand edge of PSI Ring to fit into the PSI housing. We did this for completeness, however you may wish to just inlay white paint into the recess in the PSI housing.

Test fit the PSI into the opening of the Dome Panel 1. You might need to remove little material from the PSI opening with a half round file. Go slow, you don't want to remove too much. The PSI should fit very snug, and it will be flush with the outside of the dome. The PSI will extend inside of the dome when properly seated.

To make a PSI frosted lens, we recommend using semi translucent white plastic, such as plastic milk container or similar. Cut the lens to fit into the PSI

— Lower Dome Plate —

This plate is made of 3 pieces. It is bolted together with 9 M3 12mm Button Heads and M3 Nylon Lock Nuts. Recommend that you sand the bottom smooth with the orbital sander. We recommend that you DO NOT paint it. The outside holes will be used to mount the Lower Dome Plate to the Dome Ring and Dome Panels.

The 6 larger holes will be used for standoffs to adjust the height of the Dome Skirt above the body sphere.

Using either a 1/8inch or 3mm drill bit mounted to a drill, ensure all of the outer ring holes are at least 1/8inch or 3mm.

Take Dome Lower Plate and place the Dome Ring that you assembled earlier, on top of the Dome Lower Plate. The Dome Ring should hang down below the Dome Plate.

Align the holes on the bottom of the Dome Lower Plate with the holes in the Dome Ring. Using four 3mm x 12mm stainless button head machine screws, place the screw up from the bottom, through holes on the Dome Lower Plate into the Dome Ring holes, up through the bottom of the Dome Panel assembly.

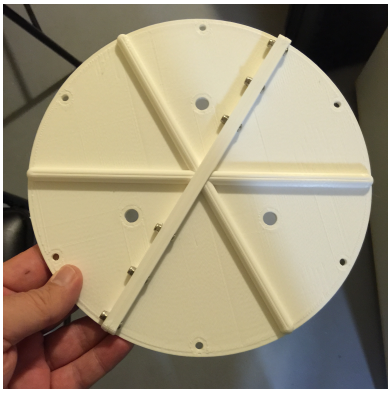
If the holes don't align all the way around, try to get them to align the best you can, then use the 1/8inch or 3mm drill bit, to ensure an open hole. And that the Dome Ring, Dome Panels are as even as possible around the dome.

Take this assembly apart after making sure all the holes align or drilled to align.

— Upper Dome Plate —

This part is composed of 2 parts bolted together with 6 M3 12mm Button Heads and M3 Nylon Lock Nuts.

The Upper Dome Plate will be located above the Dome Magnet Mount (DMM), and will provide the support structure for the DMM to hold the dome.



You will notice the six outside holes align with the six large holes on the Lower Dome Plate. These will be for the standoff of your choice that will adjust the float height of the dome.

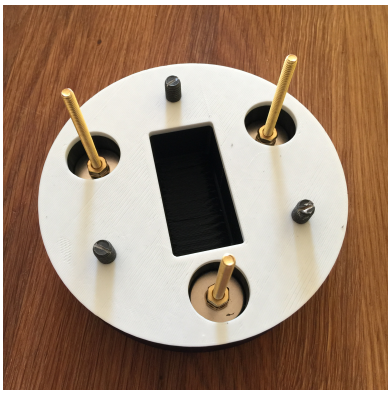
The three larger holes towards the center will be to mount the Dome Magnet Mount.

We recommend that you do not paint the part. It will not be seen from the outside.

— Dome Magnet Mount —

WARNING: The magnets we need to use are very powerful, and as such they will hurt you if you loose control of them. If you ordered the magnets from Magnets4Less.com, it no doubt came with a warning on the shipping box, take that warning seriously. We recommend that you clear at least a 1m (39inch) area away from ALL metal objects and wear leather gloves when handling. If you loose control of the magnets, you will want to have some way to remove them if they begin to crush your hand or fingers. PLEASE DO NOT LET YOUR KIDS PLAY WITH THEM, if you do you're a freaking moron, and we do not want you around others.

The Dome Magnet Mount (DMM) is designed for a few purposes. First to keep the magnets aligned with the casters. Provides the ability change the distance of the magnets from those in the body sphere, which will change the friction of the movement of the dome. Allows you to adjust the float height appearance of the dome above the body sphere, and lastly to hid the "magic" from those viewing your droid.

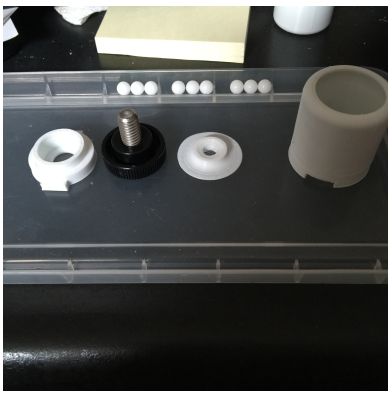


Using the Orbital sander technique, sand the outside & bottom of the DMM smooth.

The use of load transfer casters is now deprecated as v22.

PLEASE READ THIS SECTION CAREFULLY AND FULLY BEFORE ASSEMBLY. Consider yourself warned.

The parts that make up the custom DMM casters are shown in the following photo. The DMM Caster parts from Left to Right are:
Cap, 1 inch/27mm knurled knob with 5/16-18 0.5 Inch length (purchased, see updated BOM above), bearing retainer and far right the housing.

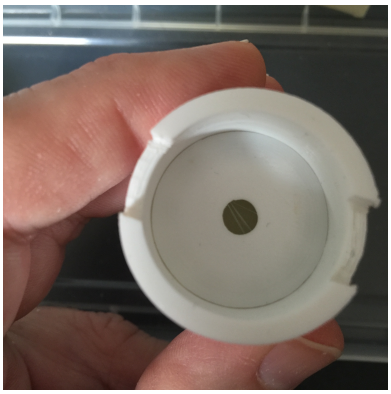


Take the Caster housing, the largest piece on the right of the previous photo. Make sure the cap fits into the notches and flush with the top of the housing. If not, sand or use a small file for correct fitment.

Test fit cap into knob as shown below, making sure it seats fully. If it does not seat fully, sand or lightly file the bottom of the cap extrusions that go into the knob housing. Using thick GEL CA glue, glue the cap onto the knob with the same orientation shown in the following photos. Set aside cap/knob assembly to cure.


It is designed to house 1 x 1 inch (~27mm) PTFE ball.

Place the PTFE ball into the housing and place 9 x .25inch (6.35mm) Delrin Acetal or PTFE ball bearings into the housing.


Place the bearing retainer so that it smooth side up, as shown in the above center image.

Using the GEL CA glue, carefully to ensure no glue gets onto the bearings, glue the surface of the tabs and sides of the cap/knob assembly, and place into the top of the housing.

Additional thick GEL CA can be used to seal the top of the caster around the joint between the cap and housing. A small amount of CA accelerator can applied to the cap/housing joint.

Place completed assembly side ways to ensure CA glue does not run into the bearing area. Set aside, and allow to for the CA to cure for at least 20 minutes.

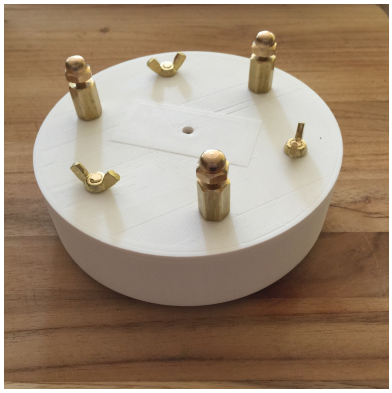
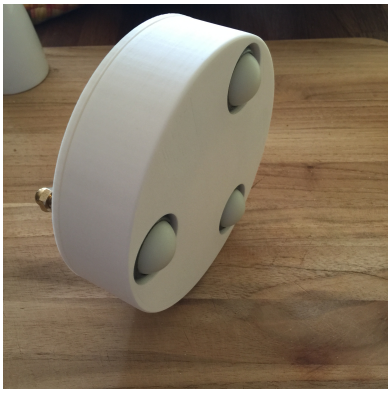
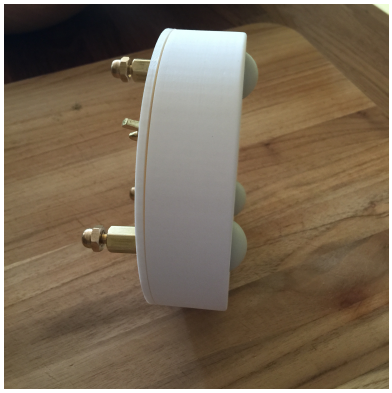
Repeat for the 2 remaining casters.

Install the caster up into the DMM as shown in the photo of the start of the DMM section.

Use brass bolts with multiple nuts or Loc-Tite blue to lock the magnets onto bolts. The bolts will allow you to adjust the magnetic pull with the Body Magnetic Mount.

Recommend you assemble each magnet and bolt away from the others. Document the pole orientation, so as to make sure when you assemble the Body Magnetic Mount, that all magnets pull towards one another. And use a different pole orientation for the large center magnet.

Cautiously place all the magnets into the respective holes and place the DMM Top onto the DMM. Use the three 5/16 brass standoffs to hold the DMM Top onto the DMM, as shown below.

You can then either install brass wing nuts or our preference, brass knurled flange nuts. Press the exposed bolt down into the hole as far as possible, and adjust the flange nut, so it barely touches the surface of the DMM Top. Mark the bolt approximately 1/8inch or 3mm above the top of the flange nut. Use a Rotary tool with a fine metal cutting disc installed, to cut the brass bolt at the indicated mark. Repeat this for the other two outer magnet bolts as well as the center larger magnet.

NOTE: Before we further we'd like to tell you this is our preferred way of installing the parts. However you have another option before going on, the other option is to installed the Dome Lower Plate now, and then coming back here and mounting the DMM to the Dome Upper Plate, "Ship in the Bottle Method", if you don't understand that analogy, just keep working.

Get the Dome Upper Plate that you assembled earlier, and use three brass ¼ inch acorn nuts, to bold the Dome Upper Plate to the ¼ studs on the brass standoffs. At this point the DMM assembly should look like the following.

— Lower Dome Plate —

Locate the 1/4-inch hex standoffs with 10-32 threads. Lengths are 1 inch, 1.25 inch or 1.5 inch. These are the height adjusters for the height of the dome skirt ABOVE the Body Sphere.
1 inch = ~3/16 to 1/4 inch
1.25 inch = ~3/8 inch to 1/2 inch
1.50 inch = ~5/8 inch to 3/4 inch

We like the 1.25 inch on the prototype this gave the Dome Skirt a clearance right at 3/8 inch, and looked the best to our eye. However as always, it's your droid. If you find it low or high later on, you can change out these three hex standoffs to increase or decrease the height.

After selecting matching height 1/4 inch hex stand offs, use the brass 10-32 button head to fasten the hex standoffs to the six holes on Dome Upper Plate.

The using six brass 10-32 button heads, fasten the Dome Lower Plate, smooth bottom down, onto the Dome Plate/DMM assembly.

Take Dome Lower Plate assembly and place the Dome Ring that you assembled earlier, on top of the Dome Lower Plate. The Dome Ring should hang down below the Dome Plate.

Align the holes on the bottom of the Dome Lower Plate with the holes in the Dome Ring. Using four 3mm x 12mm stainless button head machine screws, place the screw up from the bottom, through holes on the Dome Lower Plate into the Dome Ring holes, up through the bottom of the Dome Panel assembly. Repeat this for the other three machine screws approximately spaced ¼ a way around the dome.

Place a 3mm nylon lock onto the 3mm screw on the inside of Dome, in between the Dome Upper Plate and the Dome Panel wall. Be patient with yourself, once you get the hang of this, it is actually faster, than doing the "ship in the bottle" assembly. We've tried several assembly techniques, and this is still our favorite.

— Dome Final Assembly —

— Dome Skirt —

Install and glue with either thick GEL CA or an epoxy the Dome Skirt to the bottom of the Dome Ring.

— HP —

Install and glue with thick GEL CA the HP, making sure the rear of the HP part is flush with the inside dome wall. You may wish to match the panel orientation of the HP with photos from SWCA.

— PSI —

Install and glue with thick GEL CA the PSI, making sure the front of the PSI part is flush with the front surface of the dome panel.

Do not glue the PSI Rear Cover into place.

— Radar Eye —

Install and glue with thick GEL CA the Radar Eye, making sure the rear of the Radar Eye is flush with the inside dome wall. You may wish to match the orientation of the Radar Eye with photos from SWCA.

— Antenna Installation —

We mounted the Antennas before weathering. However you may choose to do this afterwards, just keep in mind where the antennas go, and the weathering around the antennas Use thick GEL CA to install the Antenna 1 (White) into the Pie Panel Ring, and Antenna 2 (Black whip) into the Dome Panel assembly (Dome Panel 3 specifically.

— Weathering —

It would seem that weathering would be impossible to do incorrectly. Try to keep it natural. Make sure you layer the washes, and thinned paints numerous times. Do not use oversaturated colors such as black. Think about what would you wipe off if this was your droid and it was dirty, had a leak, carbon scoring from being blasted or rolled through Bantha poodoo for that matter.

— Electronics —
TBD

— BB8 Body Stage Edition—

This section is under construction. Parts and options are being currently tested, so please check back regularly for updates.

The “Stage” version of the droid body appears to be a few machine panels and cutouts, while the details were mostly painted on to a white painted 506mm sphere. This approach makes finishing the body very quickly. This is what we’ve been calling “Plan B”, which is to spray paint the sphere white, and apply high quality decals and then apply weather effects. This made a smooth surface for the Dome to ride on and looks great on the stage or in photos.

The “Static” edition looks much more detailed, since this version of the droid had deep recess, and most likely was used to build various “puppet” versions of the droid. We know from photos released by the studio, that several panels and arm come out of these panels. This will most likely be what we’ll see in the movie close ups.

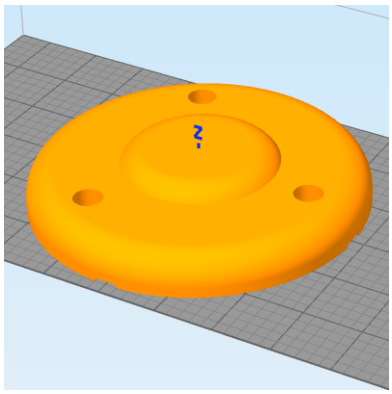
We decided that we’d make our “Stage” version using semi detailed panels, to achieve the look of the “Static” with the functionality of the “Stage”. This should facilitate a nice blend of detail with the ability to operate much like the stage version.

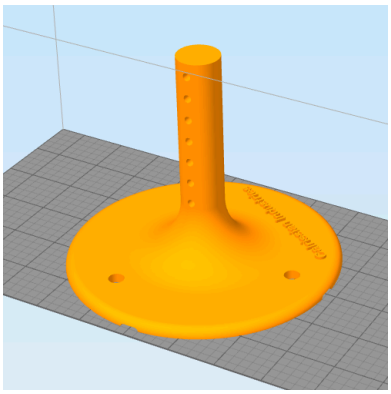
As such, all of our Stage Edition Parts are designed like the static body with the exception that the details are not quite as deep to help facilitate the Dome Magnetic Mount system to roll smoothly over the surface. Please Note that All of the stage body parts are designed to fit a on to a 506mm OD sphere. While we know this makes the overall OD slightly larger than what we saw at SWCA and in the trailers to date, we feel that this compromise to screen accuracy is required to achieve proper function with an acceptable level of detail.

- Printing FDM PLA & Parts Print Order -

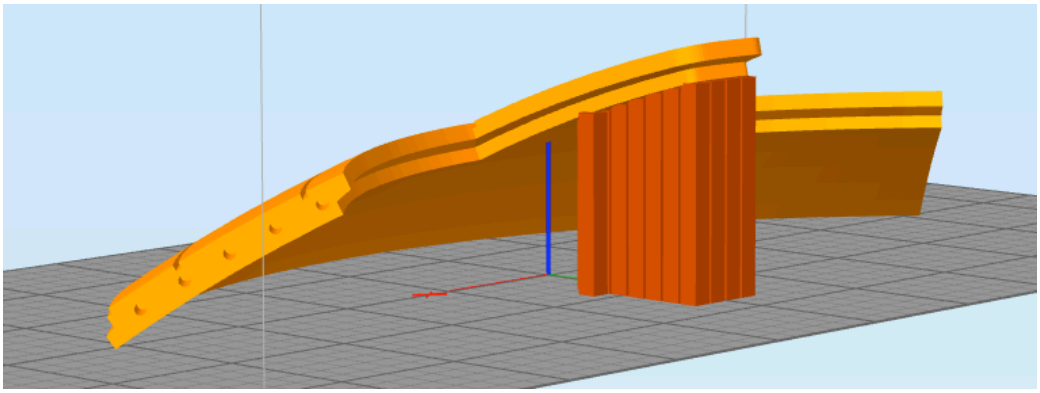
Based on our experience and those of some of the beta testers, we are providing a recommended printing ORDER to reduce changing the filaments, unlike the dome, we recommend all outside body parts be white and a combination of Orange, White or Silver for the internal parts.

Body Magnetic Mount & Arm - 0.2mm - 8 shells or more – 30% Infill, Orange/White/Grey no helper disks are required, however we use support on the BMM. You will notice small what we call James' notches, located around the perimeter to assist those with glass build plates in removing these parts. You should lightly sand the BMM top, however not the BMM Arm. Do not paint these parts. Do not reduce the shells on the Arm, if any thing, increase the shell counts.

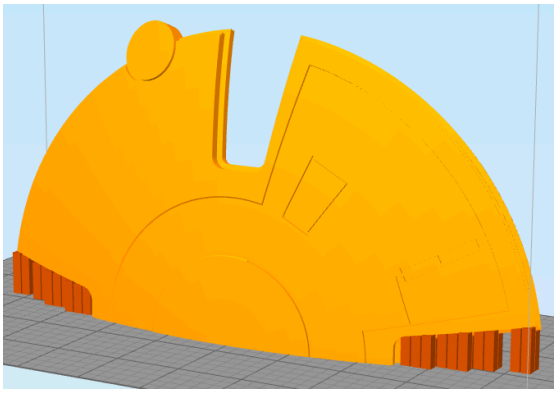




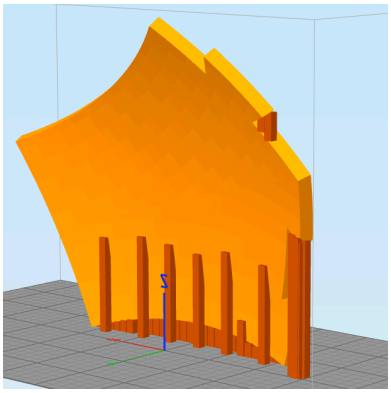
Orange Rings - 0.2mm - 6 shells or more – Orange/Grey no helper disks are required. You will not need to paint or sand these parts. We have tried numerous part printing orientations, and we get repeatable great results by orienting like the following, you will need to use either helper disks or use the brim/skirt feature of Simplify3D.



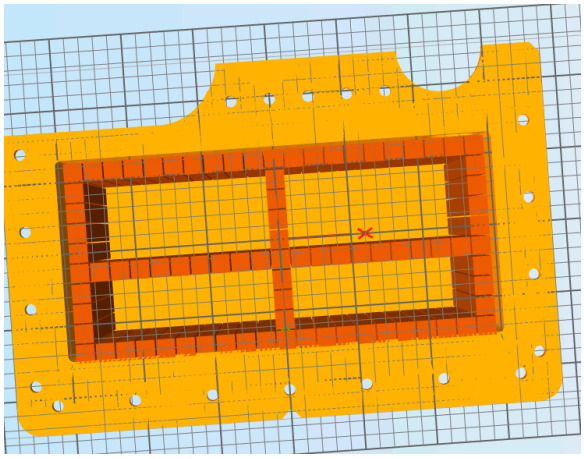
Body Center Panels – 0.2mm – 6 shells – White - Print vertically, this will reduce lines, and reduce print time. You will need to add support under the edges. If using Simplify3D, increase the density of the support 3 layers before part. This will make it easier to smooth later.



Triangle - 0.2mm – 6 shells – White - Print these vertically and make sure to add support. You will need 6 x Triangle 1 and 2 x Triangle 2. You will notice the only difference between Triangle 1 and Triangle 2, is the 3 of 3 pieces on each.



Hamster Battery Box – 0.2 or 0.3mm – 6+ Shells – Infill 20% - White/Grey/Any – Print these with the top flat down on the build plate. Make sure to add just enough support to the inside of the battery box area to support the top, which is actually the bottom of the battery box. We recommend that you start the print of the battery box with a new 2 kg spool of filament. If you print this at 0.2mm layer, it will require 32hours to print each battery box. If you default and add full support, it will require 54 hours. Be judicial on how much support you add. We get good results with the following support configuration:



— Hardware Parts Needed: Body —

We used McMaster-Carr to order here in the US. Many of these parts are available from many world-shipping sources.

TBD

—Body Panel Assembly —

— Body Center Panels —

There are 6 unique round Center Panels, and the center panels are made up of 2 half pieces each. Then surround the center panels with Orange Rings.

We recommend that you use the same technique of gluing small filament pieces into the alignment holes with thick GEL CA glue. When fitting the pieces together, while holding the pieces spray a CA accelerator onto the joint, then wipe the part with a paper towel to remove the excess accelerant.

Once the Center panels are glued, test fit unassembled Orange Ring parts, and sand till a very tight fit is achieved.

— Orange Rings —

The Orange Rings are divided into quarters. You will need to print 3 x Orange Ring 1, 2 x Orange Ring 2, and only 1x Orange Ring 3 parts. Then surround the center panels with Orange Rings.

Like the Center Panels and various Dome parts, we use the same technique of gluing small filament pieces into the alignment holes with thick GEL CA glue. Ensure that the overall ring is in alignment and flat. We recommend you cover a table with parchment paper when assembling. When fitting the pieces together, while holding the pieces in place, spray a CA accelerator onto the glued joint then wipe the part joint with a paper towel to remove the excess accelerant.

Once the Orange Ring is assembled, sand to fit into the Center correct Center Panel & orientation as outlined in the Body Panel Painting & Orientation section of this guide.

Sand smooth the outer surface, and to a lesser degree, the inner sphere facing side.

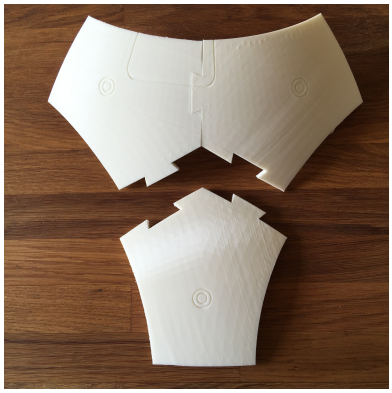
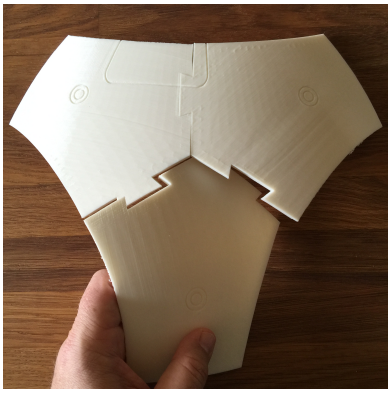
— Triangles —

The Triangles are divided into three pieces. You will need to print 6 x Triangle 1, 2 x Triangle 2. These are designed to fit on to a 506mm OD sphere. You will also notice that pieces 1 of 3 & 2 of 3 on both triangles are the same.

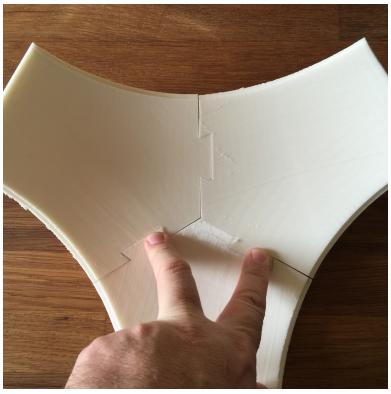
Unlike the Center Panels and various Dome parts, we used a puzzle piece technique to ensure the proper curvature of these parts. You will need to file or sand lightly to assemble. We recommend first assembling the pieces 1of3 to 2of3, which will make 8 triangle.

Inserting the third piece into the triangle assembly is little trickier the first time.

We recommend you file the right inside blank of piece 2of3 at a 45 degree angle, and the left inside blank piece 3of3 at a 45degree angle. This will allow you to twist counter clockwise, the 3of3 piece into position like shown in this sequence of images.


Then you will need to place the triangle assembly, face down on a firm surface. At the joint of piece 3of3 to the rest of the triangle assembly, firmly apply pressure to the two points shown here:



The 3of3 piece will slide into place, do not heavily force. If it does not go together easily, the pieces require more sanding to fit the joint. If you force it, or use hammer, you might fracture one of the pieces.

Then use a THIN CA glue, apply to the combined joint seam, and the CA will be pulled into the inner joint. Quickly, lightly spray CA accelerator to both sides of the joint.

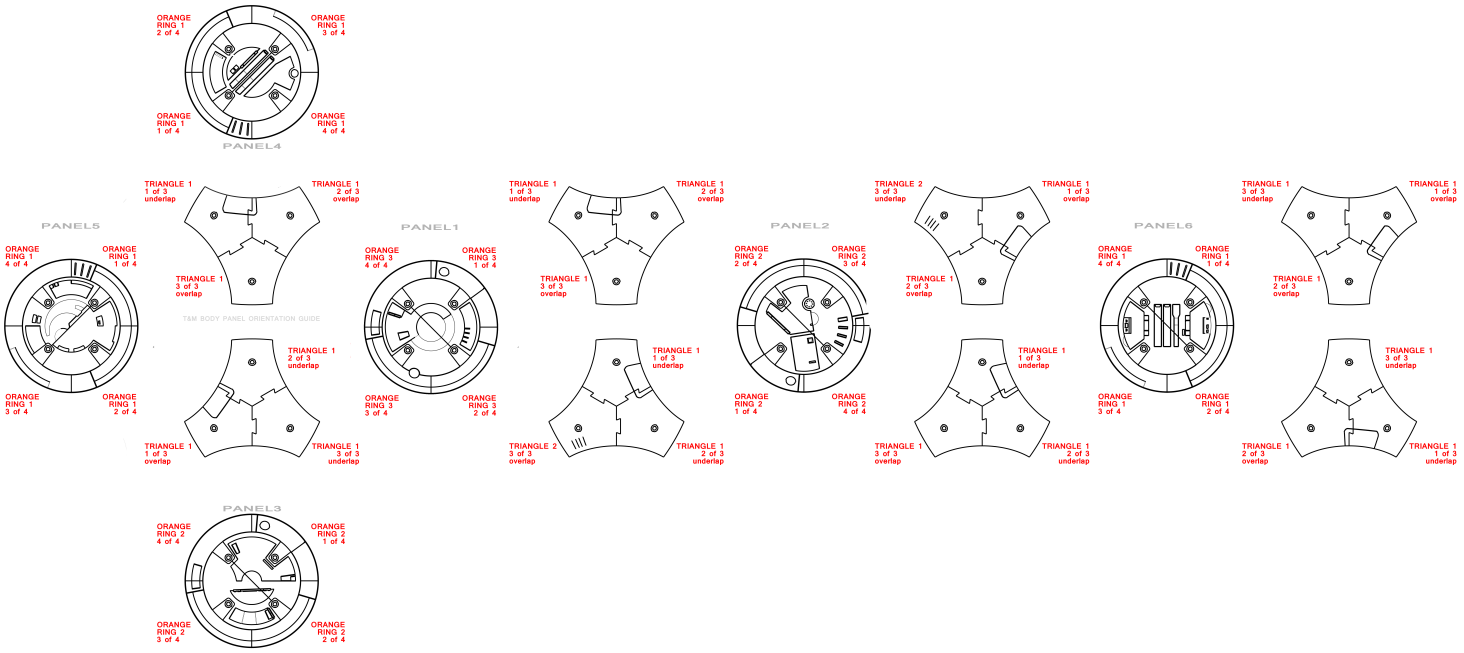
Using the orbital sander technique used on the dome, sand smooth the outer surface and to a lesser

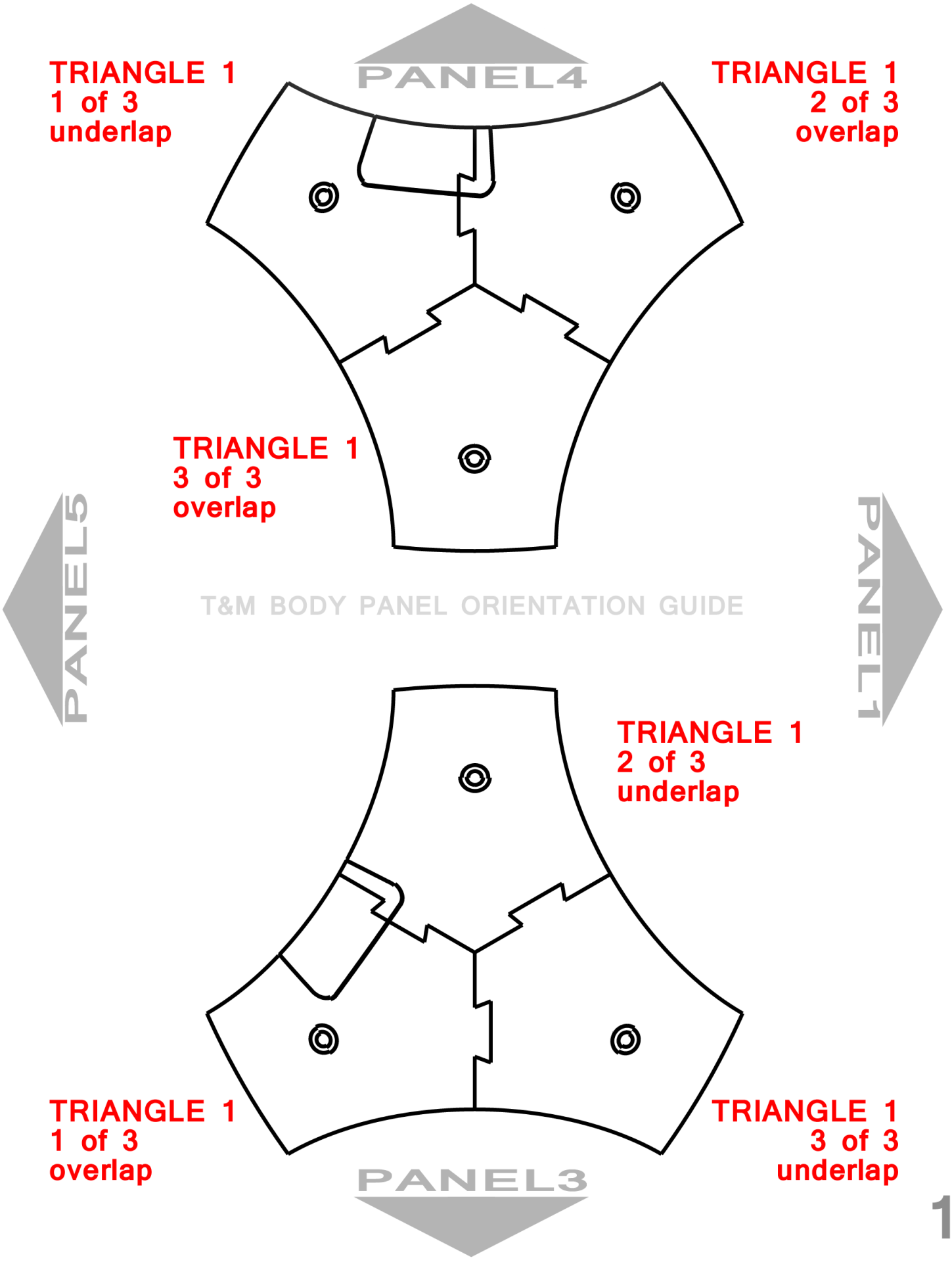
degree, the inner sphere facing side.

You may want to use plastic model putty to fill any gaps and then sand to get the seam totally smooth. Once painted Satin White, you will not be able to tell this is three pieces if done correctly.

— Body Panel Painting & Orientation —

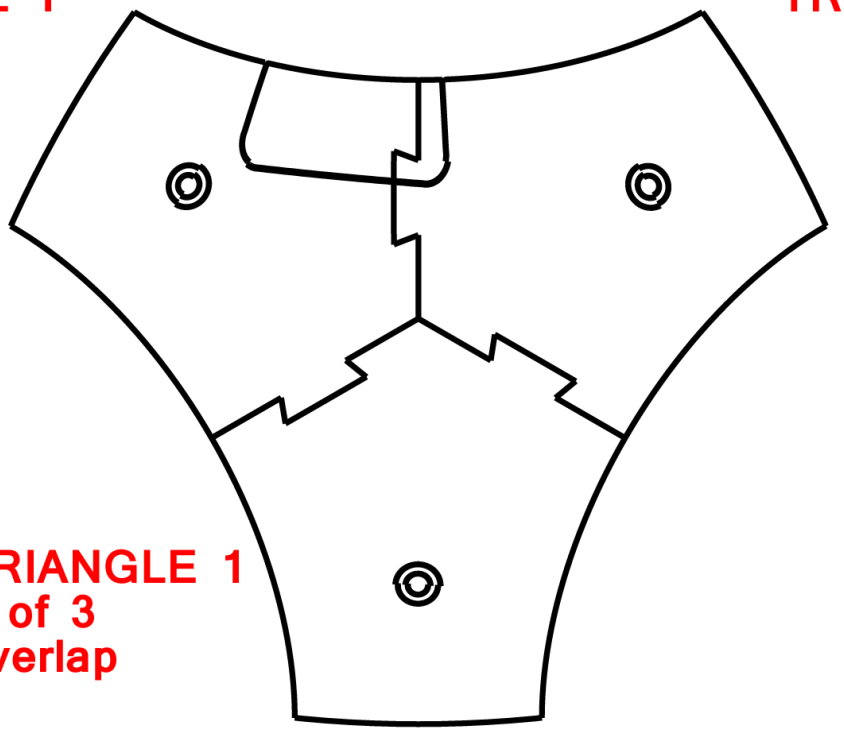
Here a picture is worth a lot more than a thousand words:




PANEL4
TRIANGLE 1
1 of 3
underlap
TRIANGLE 1
2 of 3
overlap
TRIANGLE 1
3 of 3
overlap
PANEL5
T&M BODY PANEL ORIENTATION GUIDE
PANEL1
TRIANGLE 1
2 of 3
underlap
TRIANGLE 1
1 of 3
overlap
TRIANGLE 1
3 of 3
underlap
PANEL3

TRIANGLE 1
1 of 3
underlap

TRIANGLE 1
2 of 3
overlap



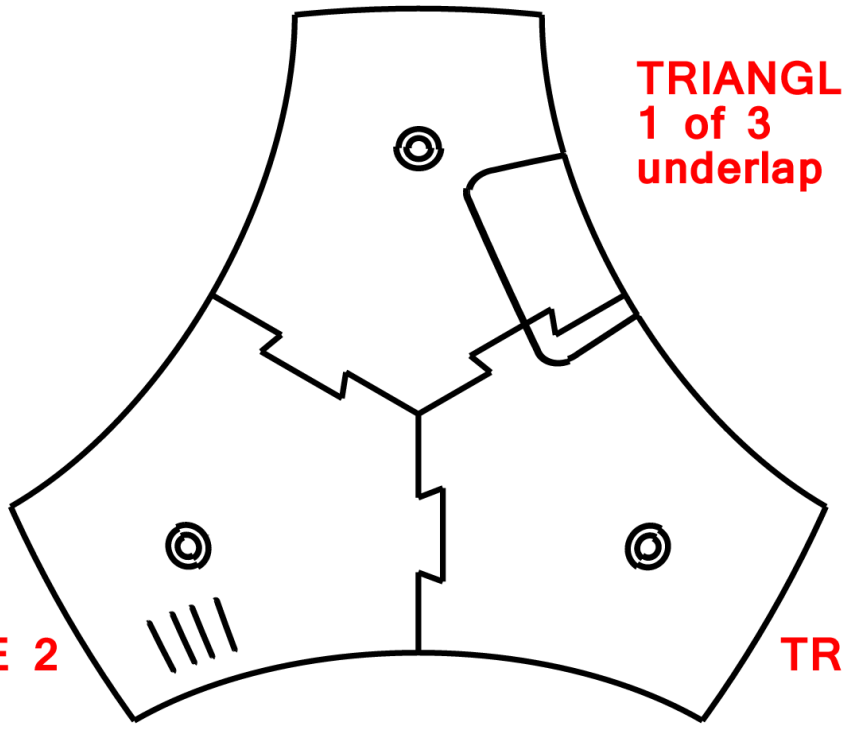
TRIANGLE 1
3 of 3
overlap

PANEL1

PANEL2

T&M BODY PANEL ORIENTATION GUIDE

TRIANGLE 1
1 of 3
underlap

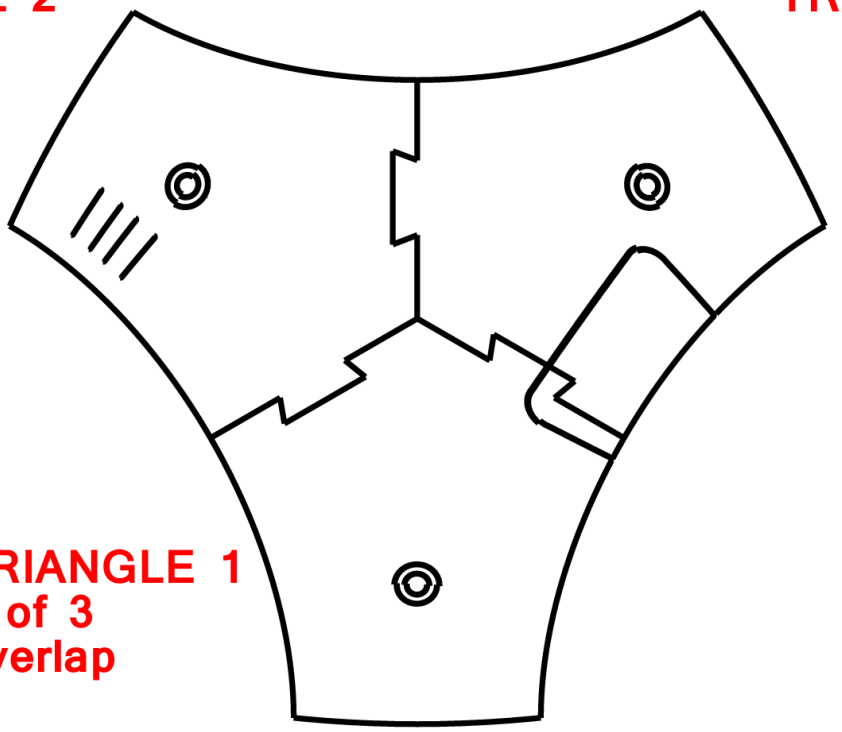


TRIANGLE 2
3 of 3
overlap

TRIANGLE 1
2 of 3
underlap

TRIANGLE 2
3 of 3
underlap

TRIANGLE 1
1 of 3
overlap



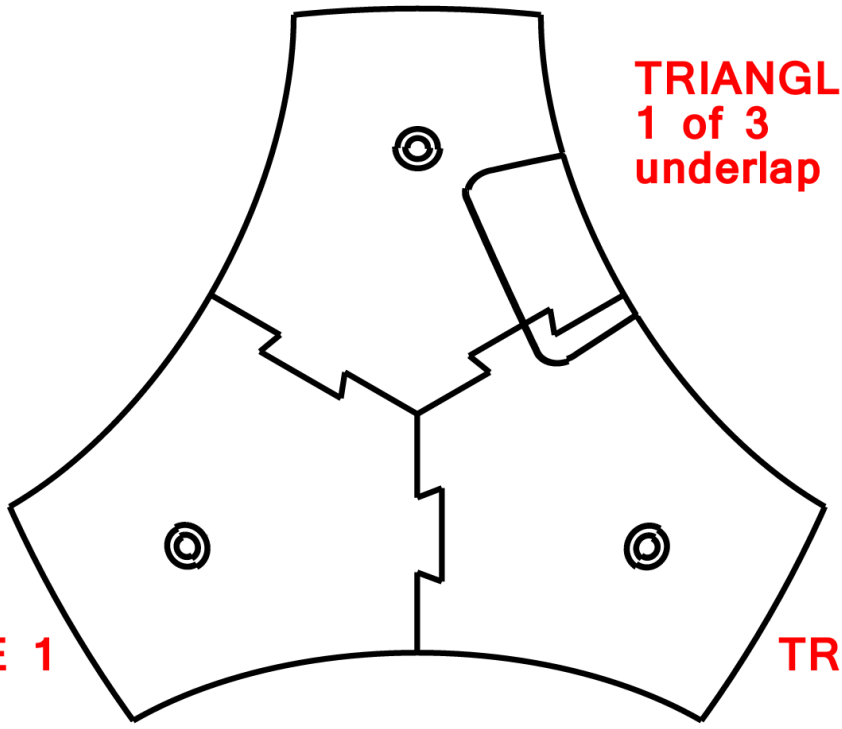
TRIANGLE 1
2 of 3
overlap

PANEL2

PANEL6

T&M BODY PANEL ORIENTATION GUIDE

TRIANGLE 1
1 of 3
underlap

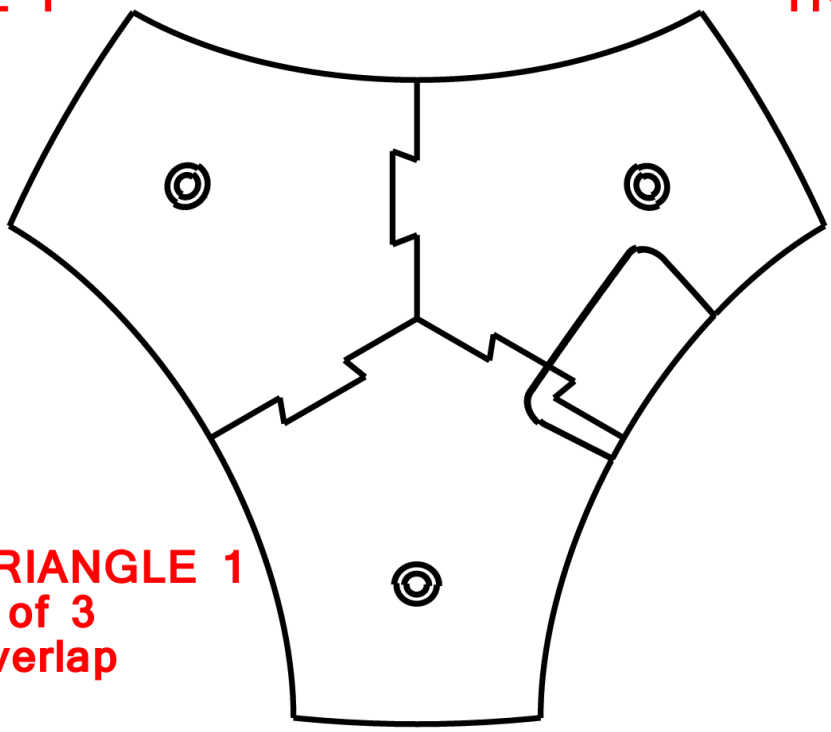


TRIANGLE 1
3 of 3
overlap

TRIANGLE 1
2 of 3
underlap

TRIANGLE 1
3 of 3
underlap

TRIANGLE 1
1 of 3
overlap

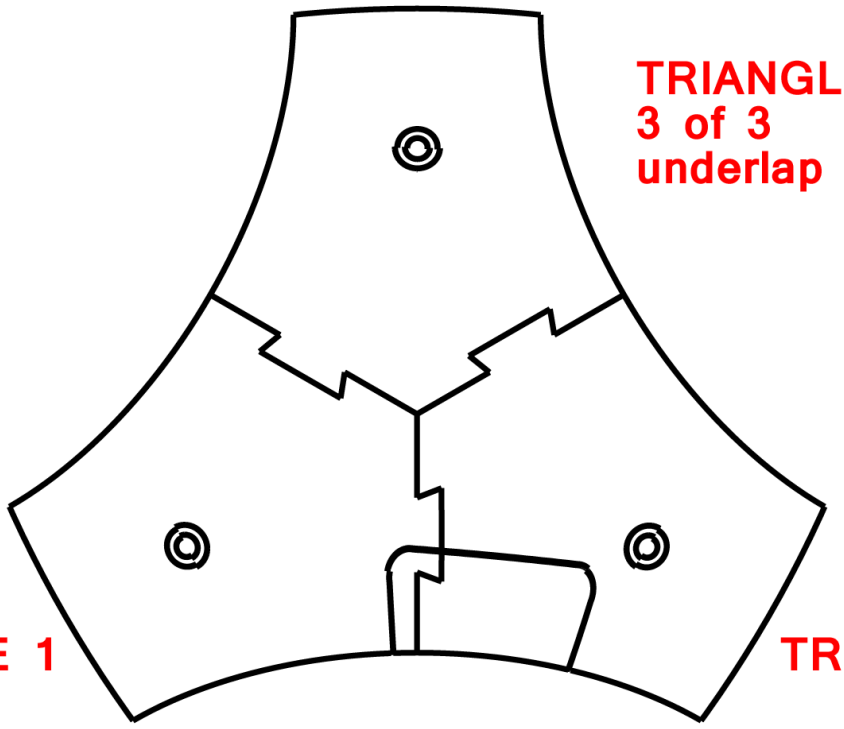


TRIANGLE 1
2 of 3
overlap

PANEL6

T&M BODY PANEL ORIENTATION GUIDE

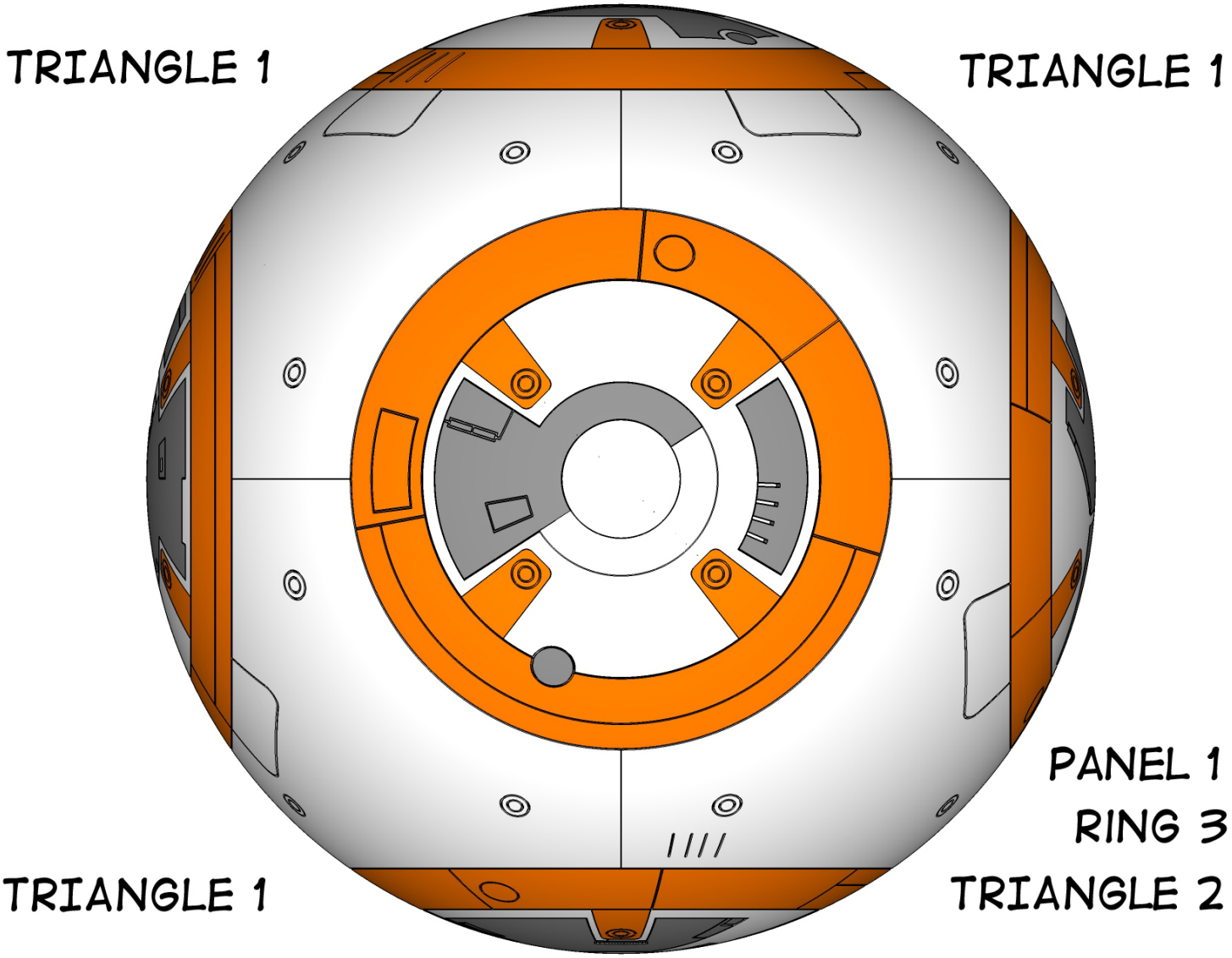
TRIANGLE 1
3 of 3
underlap



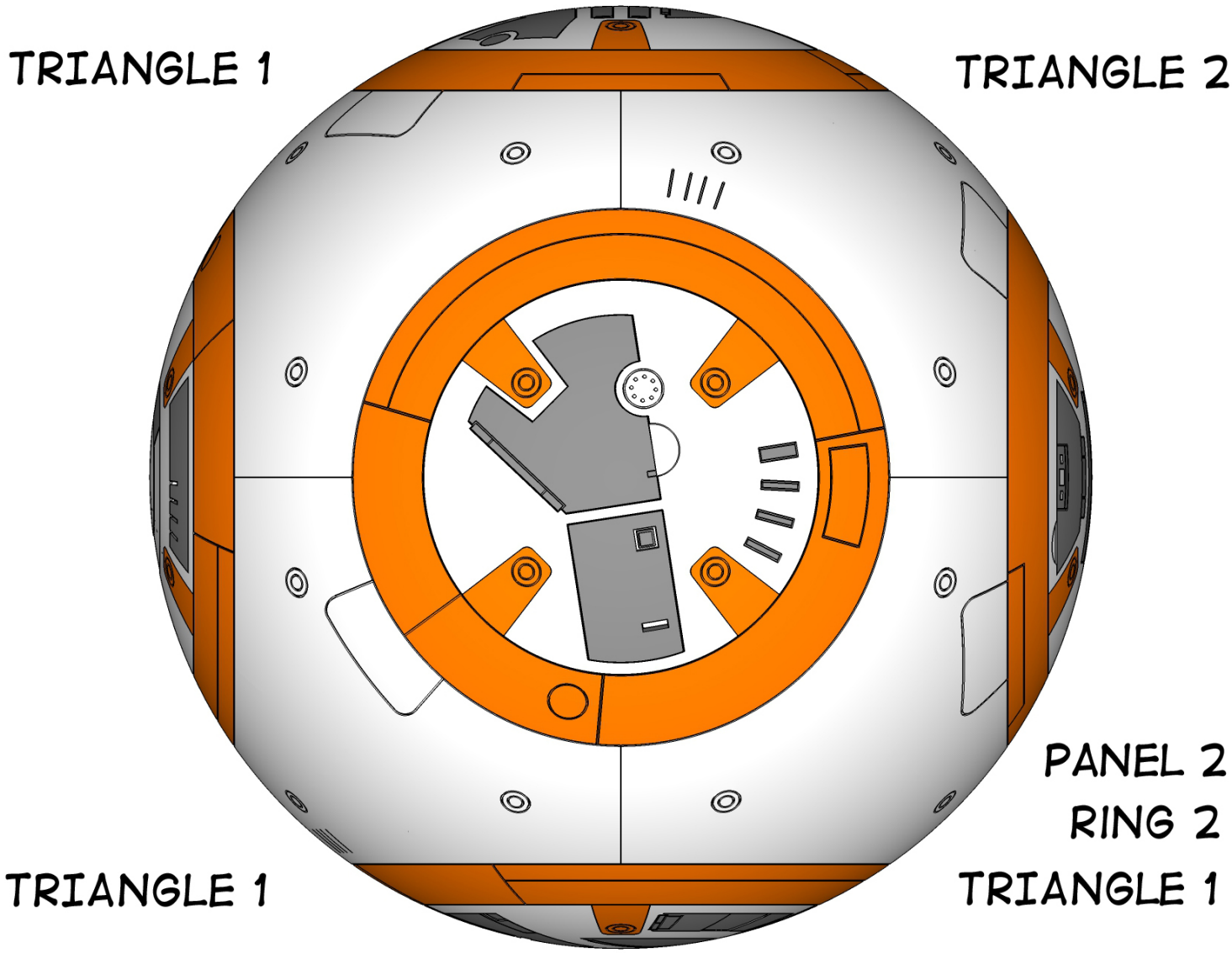
TRIANGLE 1
2 of 3
overlap

TRIANGLE 1
1 of 3
underlap

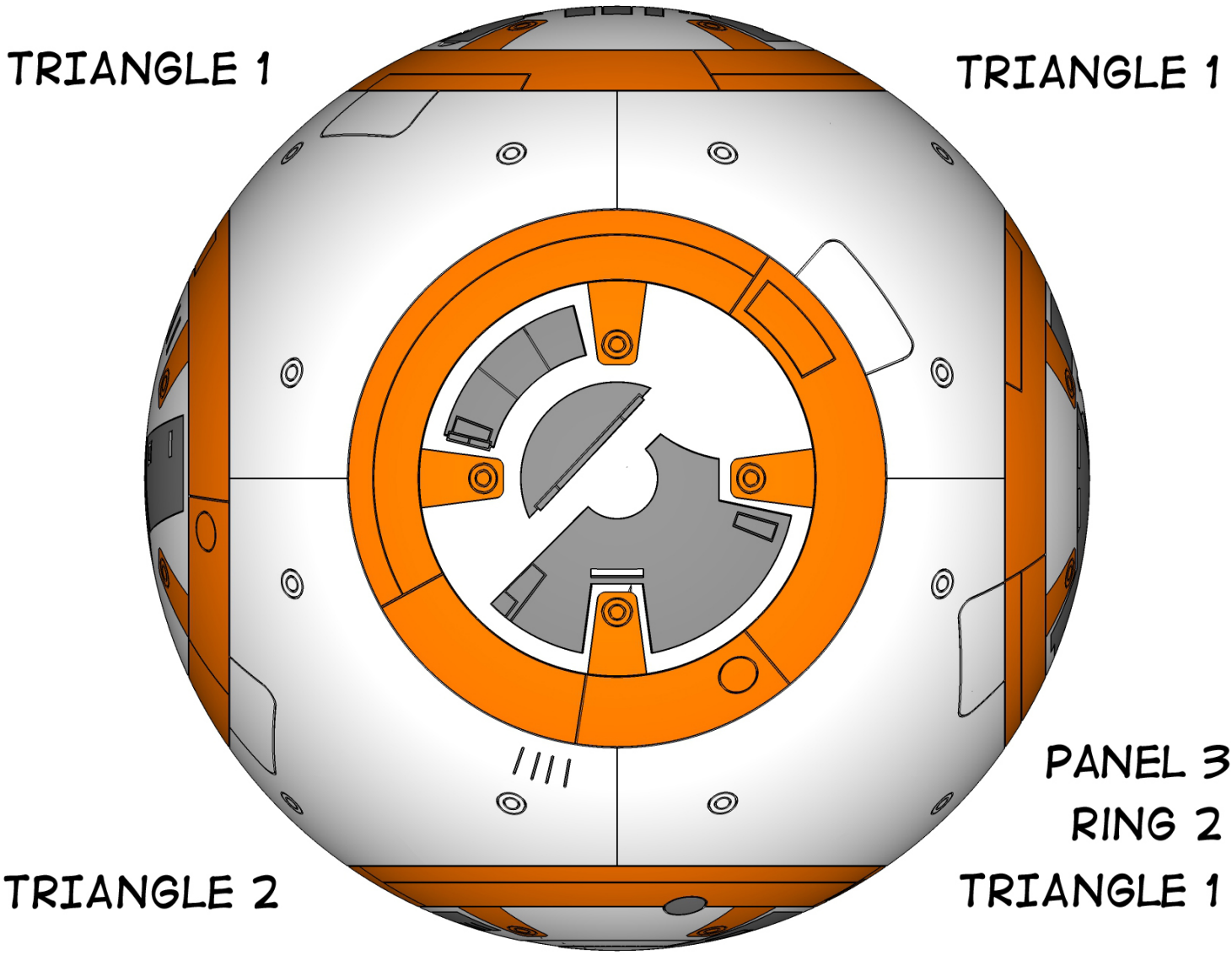
Panel 1 – Front



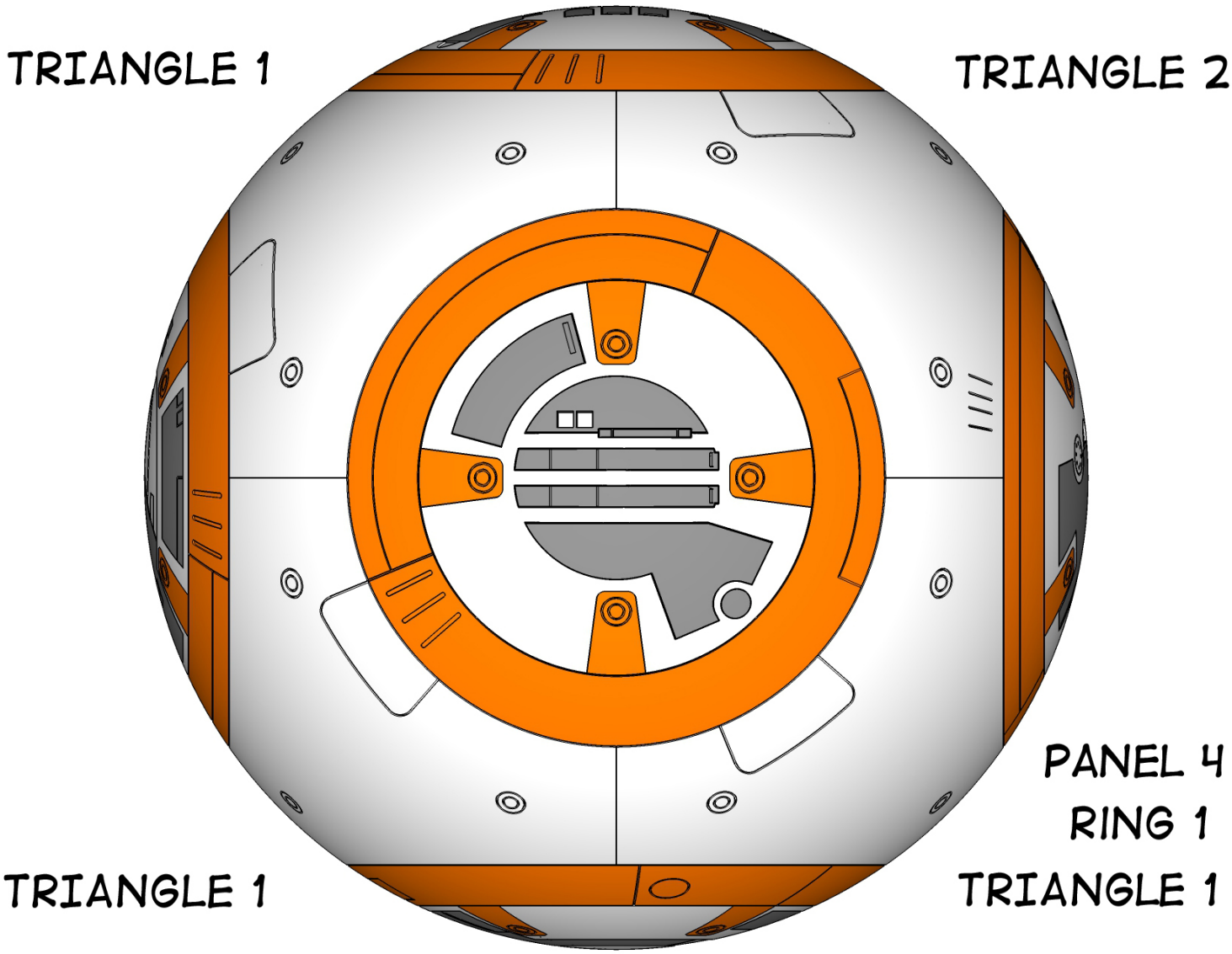
Panel 2 – RIGHT Side



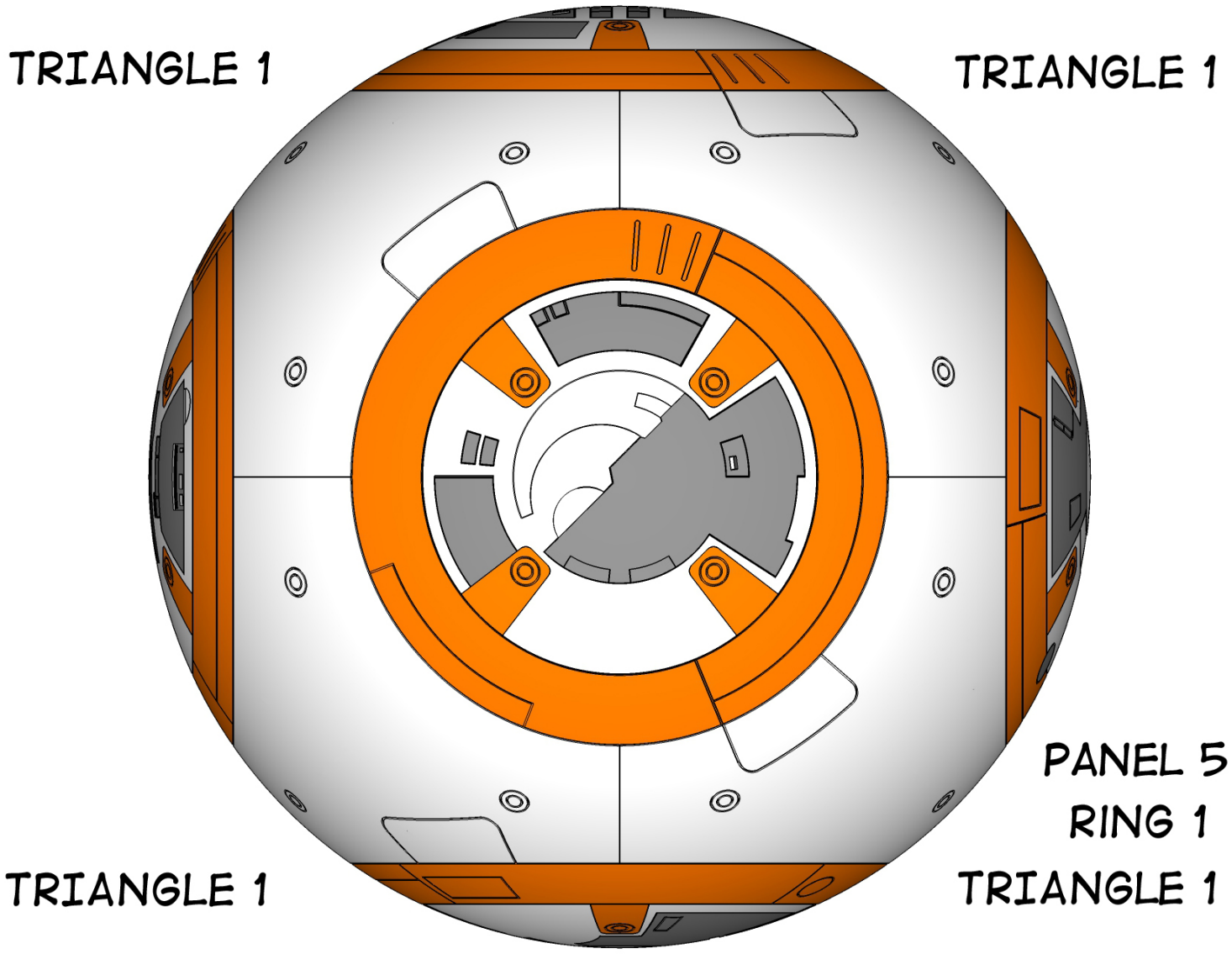
Panel 3 – BOTTOM Side



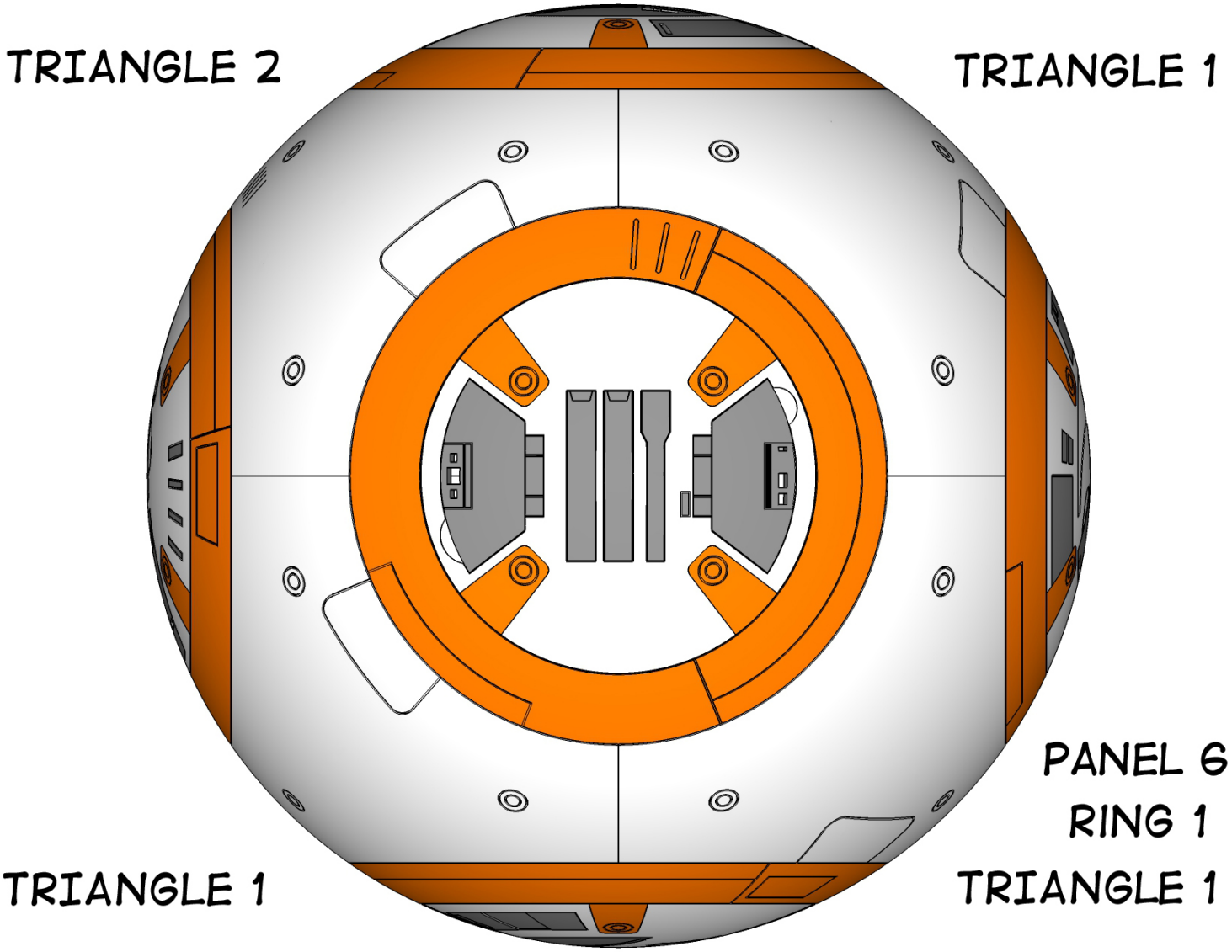
Panel 4 – TOP Side



Panel 5 – LEFT Side



Panel 6 – BACK Side



— Hamster —

— Body Hemispheres —

Since we believe the body sphere is 503mm or so, we are recommending the use of California Quality Plastics molded & matched 20 inch hemispheres for the body either 1/2 (0.5) inch thick or 3/4 (0.75) inch thick. Interestingly of the 20 inch molded hemispheres we have measured, they have all had an outside diameter of 505 to 506mm.

We are using the 1/2 (0.5) inch thick version CQP Stock Number 02-PD500CA-921 (yeah we think its interesting that it has 500CA in the part number as well) Ask for Mario @ extension 126, tell him the BB8 Builders Group sent you, and there is special pricing available for both Acrylic and Polycarbonate versions.

To assist with drilling holes into the edge of the hemispheres and keeping alignment. Steele Smith worked with us on what we call the 506mm Sphere Drill Jig. It is available for download, and designed to be cut out via CNC machine. It uses ratcheting straps to hold the hemispheres in place while drilling.

NOTE: We have indications that for the stage used BB8 were a 3/4 (0.75) inch molded & matched hemisphere from California Quality Plastics.

— Hardware Parts Needed: STAGE —

- California Quality Plastics -

You have options here, however we're using the following from CQP.

02-PD500CA-921 20" outside diameter hemisphere with no flange. Material starting thickness will be 1/2" clear acrylic. Tell them to make hemispheres in mold, they will be used as a matched set.

If you really wanted to replicate the stage droid, order 3/4" thickness.

We used McMaster-Carr to order here in the US. Many of these parts are available from many world-shipping sources.

Hamster Hardware
1x 92196A144 Stainless Steel Socket Head Cap Screw, 6-32 Thread, 1/4" Length (Qty 100)
1x 92196A151 Stainless Steel Socket Head Cap Screw, 6-32 Thread, 3/4" Length (Qty 100)
1x 92196A165 Stainless Steel Socket Head Cap Screw, 6-32 Thread, 1" Long, Fully Threaded (Qty 100)
1x 92196A157 Stainless Steel Socket Head Cap Screw, 6-32 Thread, 1-1/2" Length (Qty 100)
1x 92196A237 Stainless Steel Socket Head Cap Screw, 6-32 Thread, 1-5/8" Long (Qty 25)
1x 91831A007 Stainless Steel Nylon-Insert Locknut, 6-32 Thread Size, 5/16" Wide, 11/64" High (Qty 100)
1x 92196A580 Stainless Steel Socket Head Cap Screw, 5/16"-18 Thread, 5/8" Length (Qty 25)
1x 91855A370 Stainless Steel 5/16-18 Cap Nuts (Pack of 10)
1x 95412A602 Stainless Steel Fully Threaded Stud, 5/16”-18 Thread, 10" Long
1x 91831A030 Stainless Steel Nylon-Insert Locknut, 5/16”-18 Thread Size, 1/2” Wide, 11/32” High (Qty 25)
1x 90313A321 Stainless Steel Oversized Flat Washer, 5/16” Screw Size, 0.344” ID, 2.500” OD (Qty 5)

- ServoCity Dome Control Arm -

PLACE HOLDER NOT COMPLETE YET – DO NOT ORDER PARTS TILL COMPLETE

Qty	Description	Unit	Amount
2	(535178) 1 inch Bore Square Pillow Block * Weight: 0.04 lbs. each	$9.99	$19.98
1	(615222) 76T, 32P, 1 inch Bore Aluminum Gear * Weight: 0.06 lbs. each	$12.99	$12.99
1	(555176) 32mm Aluminum Clamping Motor Mount * Weight: 0.03 lbs. each	$6.99	$6.99
1	(638278) 165 RPM Heavy Duty Precision Planetary Gearmotor * Weight: 0.80 lbs. each	$39.99	$39.99
1	(585446) 6.00 inch Aluminum Channel * Weight: 0.16 lbs. each	$5.99	$5.99
1	(633116) 1 inch Shafting & Tubing Spacers (12 pk) * Weight: 0.01 lbs. each	$1.69	$1.69
2	(545352) 1 inch Bore Clamping Hub A (threaded holes) * Weight: 0.03 lbs. each	$5.99	$11.98
1	(615262) 20 Tooth, 32 Pitch, 6mm Bore Pinion Gear * Weight: 0.04 lbs. each	$12.99	$12.99
2	(585428) Lightweight Actuator Mount * Weight: 0.06 lbs. each	$10.99	$21.98
1	(HDA4-50) 4 inch Stroke, .50 inch/sec., 12V H/D Linear Actuator * Weight: 3.34 lbs. each	$129.99	$129.99
1	(633136) .2497 D x 1.32 L 6-32 Tapped Aluminum Standoff (4 pack) * Weight: 0.01 lbs. each	$3.39	$3.39
2	(535150) 1/4 inch Bore Pillow Block * Weight: 0.03 lbs. each	$5.99	$11.98
2	(632106) .250 in L x 6-32 Zinc-Plated Alloy Steel Socket Head Cap Screw (25 pk) * Weight: 0.05 lbs. each	$1.69	$3.38
2	(632110) .375 in L x 6-32 Zinc-Plated Alloy Steel Socket Head Cap Screw (25 pk) * Weight: 0.07 lbs. each	$1.89	$3.78
1	(57185A44) 7/64 Hex Key	$1.49	$1.49

	* Weight: 0.01 lbs. each		
1	(605061) Simple Motor Controller 18v15	$41.99	$41.99
	* Weight: 0.04 lbs. each		

— BB8 Body Static Edition—

This requires some slight of hand to protect the magic from the guests.

- Printing FDM PLA & Parts Print Order -

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