

# Configurable Odroid XU4 Case User Guide

19 Nov 2017

This document serves as a user guide for the Configurable\_Odroid\_XU4\_Case.scad openSCAD file. The scad file can be used to create a tailored open-frame shell for the Hardkernel/Odroid XU4 processor board.

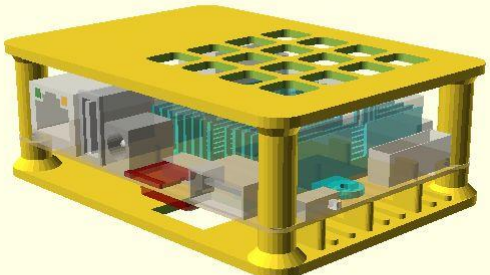
Significant aspects of the results obtained from the script are driven by labeled parameter constants. Once a basic understanding of the parameters has been obtained, tailored versions of the case can be quickly defined.

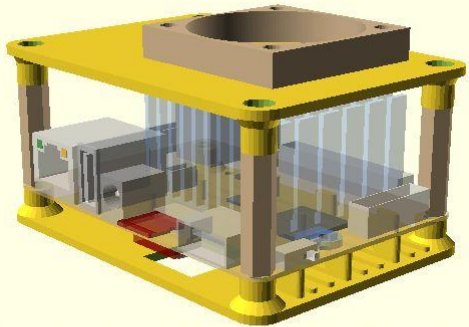
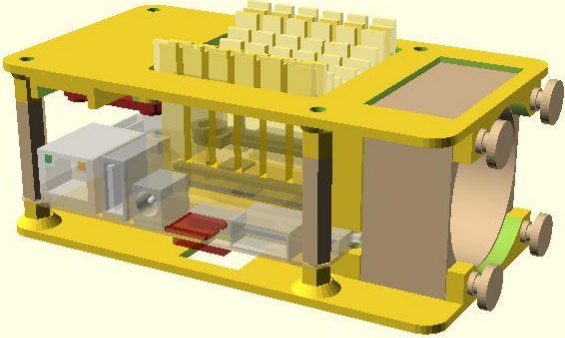
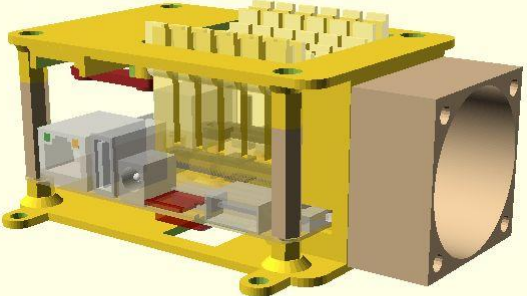
The design leverages the groundwork for a split-airflow case with a fan mounted in a cutout on the case end by user hominoid on the Hardkernel/Odroid support forum at [www.forum.odroid.com](http://www.forum.odroid.com). Information on the original design, including thermal performance testing for that configuration and shim/perch plates installed under the XU4 heatsinks can be found in the Split Air Flow Vertical or Horizontal Case thread at URL <https://forum.odroid.com/viewtopic.php?f=97&t=26373>.

A model of the XU4 can be shown with the case components. This leverages the Hardkernel Odroid XU4 Model v2.scad file and Odroid\_XU4\_Parameters.txt files from <https://www.thingiverse.com/thing:2655812>. Both files need to be downloaded and placed in the same directory as the case-level scad file.

## Case Styles

Support is provided for four distinct case styles, depending on the type of case fan mount involved.

 <p><b>OEM heatsink w/fan, no case fan, threaded top standoffs, 30mm overall height</b></p>	<p><b>No Fan Mount</b></p> <p>The no fan mount option could be used to form a low profile case for an XU4 equipped with the stock low profile heatsink and fan.</p> <p>Note: parameters used to generate this view are captured in file sampleA_parameters.txt. See Appendix A for the parameter values.</p>
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 <p><b>Passive heatsink, top side 7mm fan, 24mm user standoffs, 42mm case height</b></p>	<p><b>Top Side Fan Mount</b></p> <p>The top side fan mount would typically be used with the 25mm high passive heatsink available from Odroid for the XU4.</p> <p>Note: parameters used to generate this view are captured in file sampleB_parameters.txt. See Appendix A for the parameter values.</p>
 <p><b>XU4 w/gold heatsink and 3.18mm perch, outside mount 20mm fan w/iso pins, UART holder, RTC battery holder</b></p>	<p><b>Outside fan mount</b></p> <p>This is essentially the case style from the hominoid source, except it is shown here with a 20mm thick fan. The fan mount is outside the fan, shown with isolation pins used to mount the fan. Length of the case and size of the fan cutout is driven by the fan thickness parameter.</p> <p>Note: parameters used to generate this view are captured in file sampleC_parameters.txt. See Appendix A for the parameter values.</p>
 <p><b>XU4 w/gold heatsink &amp; 3.18mm perch, inside mount 20mm fan, mounting tabs</b></p>	<p><b>Inside fan mount</b></p> <p>Here the fan mount is inside from the fan, with the fan typically mounted to the frame with threaded screws. Mounting tabs have been enabled for this view.</p> <p>This could be used for fans without isolation mounting pins, or for attaching other standard fan adapters to the 40mm fan mount here. An example source of a fan adapter is the configurable one by sheriftaher at <a href="https://www.thingiverse.com/thing/735038">Thingiverse item 735038</a>.</p> <p>Note: parameters used to generate this view are</p>

	captured in file sampleD_parameters.txt. See Appendix A for the parameter values.
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## Top Level Geometry Options

The top level geometry section of the file is where the desired openSCAD result is defined. “show” options are non-printable openSCAD previews that provide a representation of the XU4 board with one or more components of the case design. “make” options apply the necessary rotations and translations to prepare components of the case for STL generation and subsequent printing.

Top level geometry selections are made by uncommenting the row for the desired result. Only one entry in the top level geometry should be uncommented at any given time or openSCAD will superimpose results on top of each other.

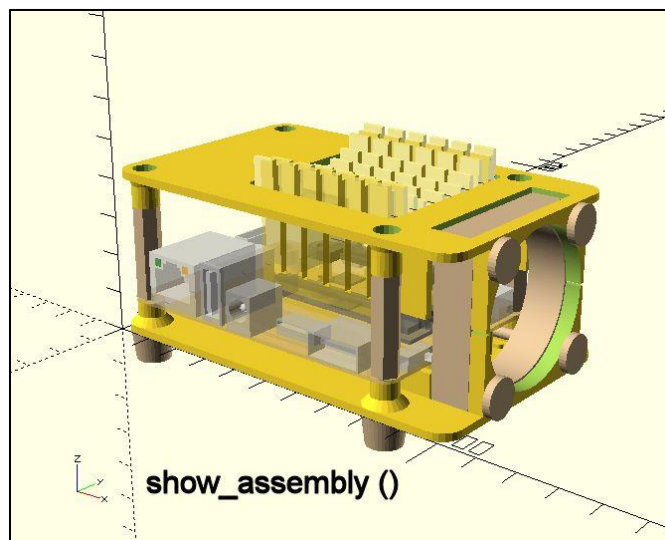
The XU4 model is obtained from file `Odroid_XU4_Model_v2.scad`, available from **\*\*\*TBD\*\*\***. That file, along with `Odroid_XU4_Parameters.scad`, should be located in the same directory as the `Configurable_Odroid_XU4_Case.scad` file you are working with.

### **show\_assembly ()**

The `show_assembly` top level geometry option will provide an openSCAD preview of the XU4 sandwiched between the case top and case bottom. Options that are enabled in the configuration parameters will be included in the preview.

Usage: `show_assembly ( xu4_opacity )`, where

`xu4_opacity`: degree of transparency to be applied to the xu4, ranging from 0 (can't see the XU4 at all) to 1 (full opacity – not transparent at all)

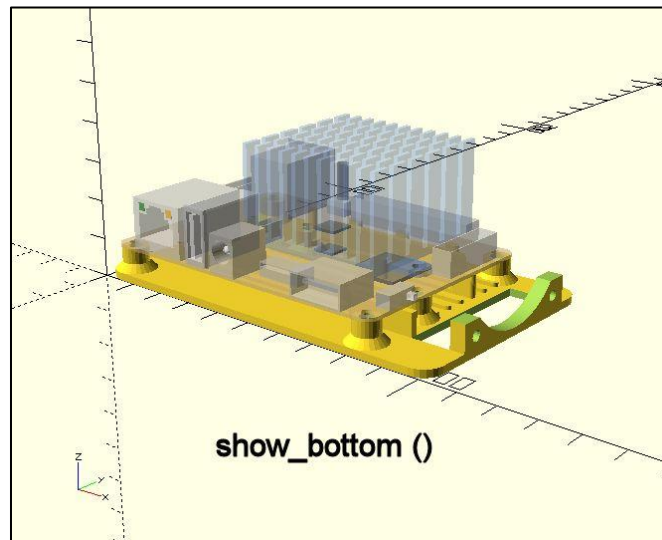


## show\_bottom()

The show\_bottom top level geometry option will provide an openSCAD preview of the XU4 resting on the case bottom. Options applicable to the case bottom that are enabled in the configuration parameters will be included in the preview.

Usage: `show_bottom ( xu4_opacity )`, where

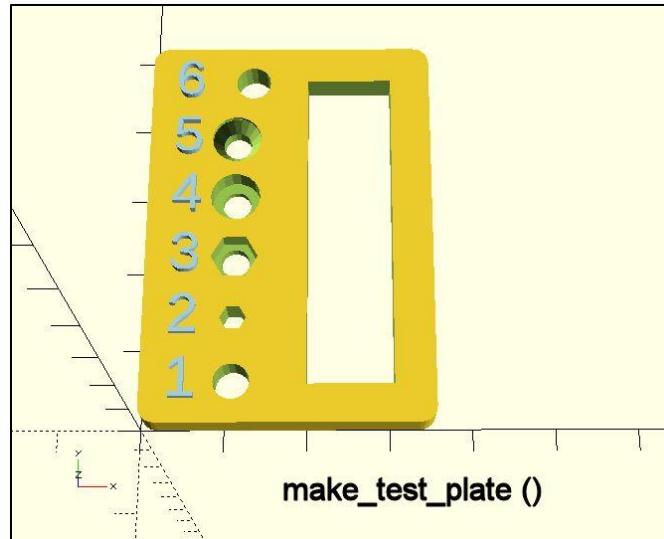
`xu4_opacity`: degree of transparency to be applied to the xu4, ranging from 0 (can't see the XU4 at all) to 1 (full opacity – not transparent at all)



## make\_test\_plate()

The make\_test\_plate top level geometry option creates a printable flat plate that contains all hole types possible in the case options. Slicing and printer calibration can affect printed results; make\_test\_plate can be used to check hardware hole sizing before committing to a full-up print of the case components.

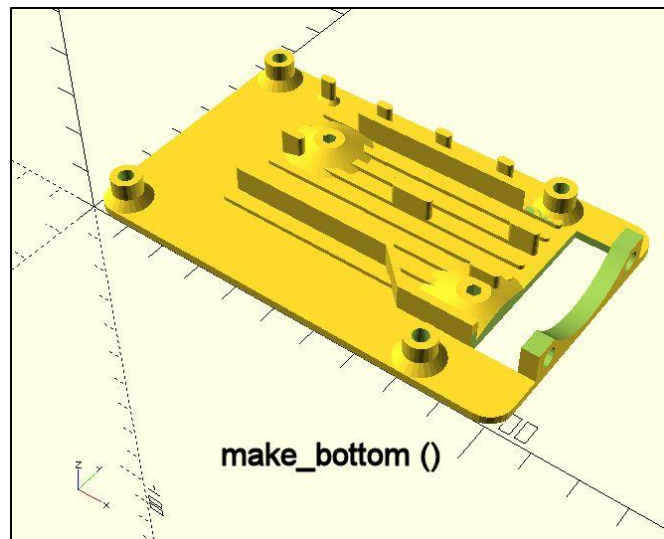
Holes in the test plate are numbered. The large, rectangular hole is for test fitting a fan in the case fan cutout provided in the outside fan mount configuration. Comments in the make\_test\_plate module within the openSCAD file describe how to test each hole, and list the configuration parameters to be tweaked when necessary.



Note: the image shows recesses for flat head, cap head, and nut traps on the top, numbered side of the test plate for visualization purposes. For test realism and for testing any support structure added in slicing, the published scad file actually places those recesses on the bottom side of the test plate.

## make\_bottom()

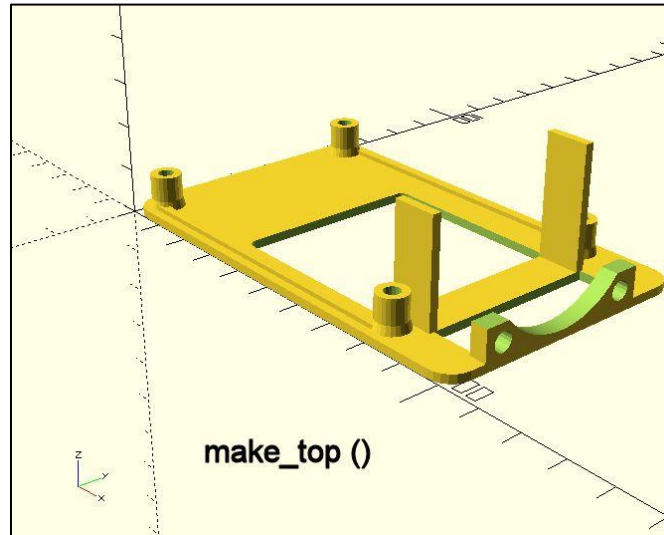
The make\_bottom top level geometry option prepares just the case bottom for creation of STL output from openSCAD.



Note: image shown does not represent all available options

## **make\_top()**

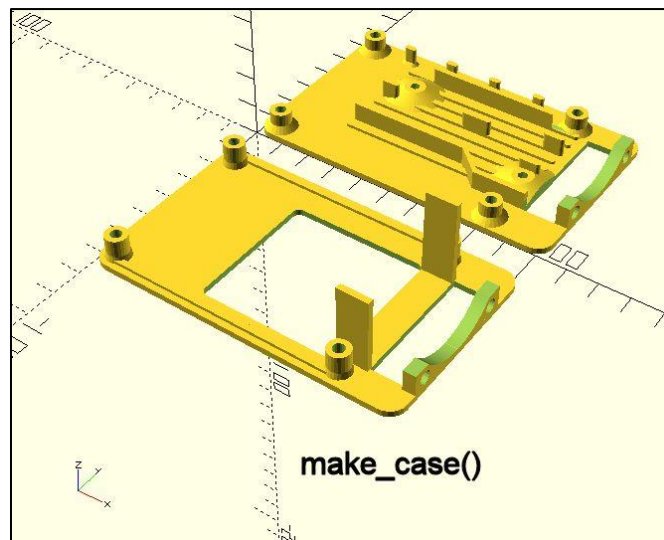
The make\_top top level geometry option prepares just the case top for creation of STL output from openSCAD



Note: image shown does not represent all available options

## **make\_case()**

The make\_case top level geometry option will prepare both the case top and the case bottom for creation of STL output from openSCAD.

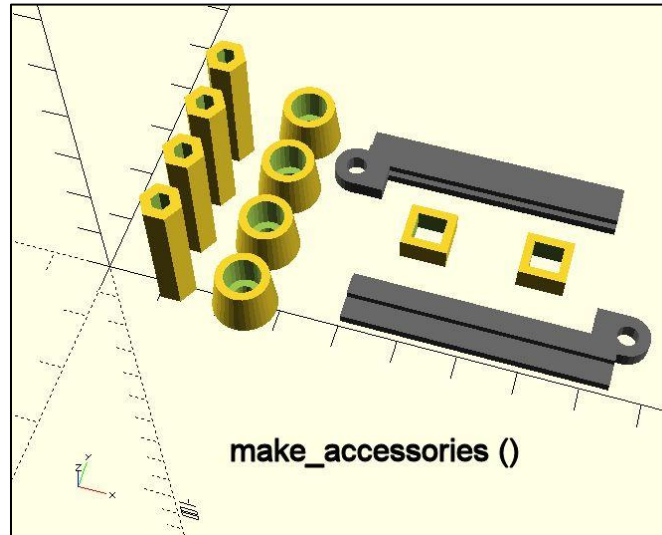


Note: image shown does not represent all available options



## **make\_accessories()**

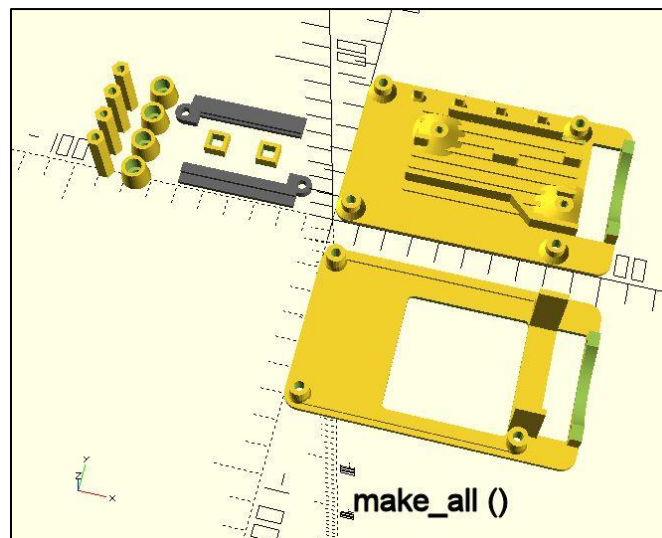
The make\_accessories top level geometry option will prepare the enabled pieces for the case that are not integrated into the case top and case bottom.



Note: The image shown does not represent all available accessories

## **make\_all()**

The make\_all top level geometry option will create the case top, the case bottom, and all enabled accessories for creating of an STL output file from openSCAD.



Note: The image shown is not representative of all available options

## Tailoring

Tailoring consists of modifying configuration parameters in the scad file, previewing the design result in openSCAD, and then generating the STL output for use in slicing/printing. As a guide, tailoring will typically involve the following steps:

1. Change the top level geometry to “show assembly” so that the assembled case can be previewed with an XU4 installed.
2. Modify configuration parameters as desired, using openSCAD preview frequently to observe the design result.
3. When the design is satisfactory, modify the top level geometry to “make test plate” and preview, render, and generate an STL file for the test plate. Print the test plate and check hardware fit, adjusting parameters as required.
4. Once hardware fit is acceptable, modify the top level geometry to “make case” or “make all” and preview, render, and generate an STL for the desired case components.

## XU4 Model Configuration Parameters

The configuration of the Odroid XU4 model displayed in the show\_assembly and show\_bottom top level geometry options is defined by the following component parameters in the scad file.

<b>XU4_HS_TYPE</b>	<b>Defines the Heatsink Type shown on the XU4 model</b> 0=no heatsink 1=stock low profile heatsink with fan removed 2=stock low profile heatsink with OEM fan 3=passive 40x40x25mm as on XU4Q 4=gdstime gold oriented for mounting with gds hardware (hardware not shown) 5=gdstime gold w/custom adapters that allow heatsink rotation 6=flat 40mm plate
<b>XU4_EMMC_TYPE</b>	<b>Defines whether an emmc module is shown on the XU4 model</b> 0=no emmc module 1=show the emmc module installed on XU4 underside
<b>XU4_USD_TYPE</b>	<b>Defines whether a microSD card is shown on the XU4 model</b> 0=no microSD card 1=show a microSD card inserted in the micro-SD connector This requires the Micro_SD.STL file by Thingiverse user Ubergeekking at <a href="https://www.thingiverse.com/thing:710938">https://www.thingiverse.com/thing:710938</a> . Download it and place it in the same directory as the Odroid_XU4_Model_v2.scad file.
<b>XU4_PERCH_T</b>	<b>Defines whether z-axis placement of heatsink is affected by shim or perch installed between the SOC and the heatsink</b> 0=no perch; heatsink shown flush on SOC >0 value=raise the heatsink up that amount in XU4 model As-published default: 3.18mm to reflect perch from 1/8-inch copper plate
<b>XU4_HS_ADAPT_TYPE</b>	<b>Heatsink Adapter Type</b>



	<p>This defines the type of heatsink mounting adapter to be provided as printable accessories if XU4_HS_TYPE defines use of the gdstime gold heatsink</p> <p>0=adapters with clearance hole</p> <p>1=adapters with integral nut trap</p>
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## Case Fan Component Parameters

The physical characteristics of an optional case fan is defined by the following component parameters in the Configurable\_Odroid\_XU4\_Case.scad file.

<b>EXT_FAN_SIZE</b>	<p><b>Fan size</b></p> <p>When the case is defined to include a case mounted fan, the case design expects this value to be 40mm. No other fan size is supported. This is intended to reflect the actual fan component. How a 40mm fan fits in an inside-mount fan cutout is adjusted through the CASE_FAN_FIT design parameter.</p> <p>As-published default: 40mm</p>
<b>EXT_FAN_HID</b>	<p><b>Mounting hole inside diameter</b></p> <p>As-published default: 4mm for a typical 40mm fan</p>
<b>EXT_FAN_MHO</b>	<p><b>Mounting hole offset from edges of fan body</b></p> <p>As-published default: 4mm for a typical 40mm fan</p>
<b>EXT_FAN_WALL</b>	<p><b>The amount of thin frame wall at sides of the fan</b></p> <p>As published default: 1mm for a typical 40mm fan</p>
<b>EXT_FAN_T</b>	<p><b>Fan thickness</b></p> <p>Nominal values for typical fans are 7mm, 10mm, or 20mm</p> <p>For inside-mount fans where the fan sits in a case cutout, EXT_FAN_T should include the additional thickness of any isolation shim or finger guard installed with the fan. How a fan fits in an inside-mount fan cutout is adjusted through the CASE_FAN_FIT design parameter.</p> <p>As-published default: 10mm</p>
<b>EXT_FAN_CASE_CSCREW_OD</b>	<p><b>Case Screw Outside Diameter</b></p> <p>Should computer style case screws be used for mounting a fan to the outside style of fan mount, this is used to capture the thread diameter of the case screws that will be used. When selected by parameter CASE_FMOUNT_HOLE_TYPE, the clearance hole provided in the fan mount will be sized off this dimension.</p> <p>As-published default: 5mm. Case screws can vary. If you are using them, be sure to measure the screws you have and adjust the parameter as required.</p>

## Case Configuration Option Parameters

The following parameters define the key case configuration options. These define which options are included in the case design, how the case is presented in the show\_assembly and show\_bottom top level geometries, and defines what accessories are printed for use with the case.

<b>CASE_FMOUNT_TYPE</b>	<p><b>Fan Mount Type</b></p> <p>0=no case fan. With no fan on the case end, the CASE_NOFAN_HEIGHT parameter will determine the overall case height.</p> <p>1=case fan mounted on top side. With no fan on the case end, the CASE_NOFAN_HEIGHT parameter will determine the overall case height.</p> <p>2=case fan outside mount at end of case. This is the original hominoid configuration. Typically requires mounting the fan with flexible isolation pins. Provision of cutouts for the fan are dependent on case top and case bottom fan recess parameters below. Overall case height will be driven by the EXT_FAN_SIZE parameter.</p> <p>3=fan mounted on case end. Typically requires mounting the fan with screws inserted through the fan mounting holes and threaded into the fan mount. This option can also be used with a typical user-provided fan adapter that interfaces a larger fan to the XU4 case. Overall case height will be driven by the EXT_FAN_SIZE parameter.</p>
<b>CASE_FMOUNT_HOLE_TYPE</b>	<p><b>Case Fan Mount Hole Type</b></p> <p>This governs the type of holes to be provided at the fan mounting hole locations in the case top and case bottom.</p> <p>0=clearance thru-holes for isolation pins. Typically used with the outside fan mount option. Leverages the CASE_FMOUNT_ISO_HID_CLEAR parameter described later for the hole size.</p> <p>1=clearance thru-holes for case fan screws. Typically used with the outside fan mount option. Leverages the EXT_FAN_CASE_CSCREW_OD parameter described above.</p> <p>2=clearance thru-holes for use with M3 hardware. This option is included for completeness, but has little utility in the XU4 case design due to lack of access inside the fan or fan mount.</p> <p>3=thru-hole sized for threading an M3 screw without tapping, primarily with the inside fan mount option. Screws will pass through the fan and engage with the mount at the case top and case bottom</p>
<b>CASE_FAN_HW_SHOW</b>	<p><b>Case Fan Hardware Type</b></p> <p>0=show no hardware on the case model</p> <p>1=show the fan installed with flexible isolation mounting pins</p> <p>2=show Keystone model 720 bumpers on fan</p> <p>3=show printed feet on fan</p> <p>This parameter only applies to the end mounted fan configurations. No hardware will be shown for a fan placed on the top side.</p>
<b>CASE_DUCT_TYPE</b>	<p><b>Case airflow Duct Type</b></p> <p>0=no airflow ducting included in case top and case bottom</p>

	<p>1=include ducting on case top and bottom</p> <p>When the duct is disabled, short support stubs will be placed at various locations on the duct path to “shore up” support for heatsink area of the XU4 board.</p>
<b>CASE_WCHAN_TYPE</b>	<p><b>Case Wiring Channel Type</b></p> <p>0=no wire channel provisions under XU4 in case bottom</p> <p>1=include struts to form wiring channel under USB3.0 connector side</p> <p>2=include struts to form wiring channel under RJ45 connector side</p>
<b>CASE_BFOOT_TYPE</b>	<p><b>Case Bottom Foot Type</b></p> <p>0=no feet on case bottom</p> <p>1=show Keystone model 720 bumper on case bottom</p> <p>2=show printed feet with clearance hole on case bottom</p> <p>3=show printed feet with integrated nut trap on case bottom</p> <p>Note that CASE_BFOOT_TYPE will govern the type of foot printed even if the feet will be used on the fan mounting hardware instead of the case bottom.</p>
<b>CASE_MTAB_TYPE</b>	<p><b>Case Mounting Tab Type</b></p> <p>0=no case mounting tabs</p> <p>1=include mounting tabs on case bottom</p>
<b>CASE_BSO_TYPE</b>	<p><b>Case Bottom Standoff Type</b></p> <p>0=include no standoffs; necessary hardware will be provided by user</p> <p>1=include necessary standoffs integrated into case bottom</p> <p>2=provide necessary case bottom standoffs as printed accessories</p> <p>As-published default: 1 since bottom standoffs are typically short and including them in the case bottom print makes sense</p>
<b>CASE_EMMC_CUTOUT</b>	<p><b>Case EMMC Cutout</b></p> <p>0=provide no EMMC access cutout in case bottom</p> <p>1=include EMMC finger access cutout in case bottom</p>
<b>CASE_HS_MOUNT_TYPE</b>	<p><b>Case Heatsink Mount Type</b></p> <p>0=include no heatsink mounting provisions in case bottom. This is the option to choose if PCB spring clips will be used</p> <p>1=thru-case mount with stanchions on case bottom. A gap will be left between the XU4 PCB and the top of the stanchions</p> <p>2=thru-case mount with standoffs between case bottom and XU4 PCB. Support provided by the standoffs is intended to minimize PCB stress from the heatsink weight or mounting scheme.</p>
<b>CASE_HS_CUTOUT_TYPE</b>	<p><b>Case Heatsink Cutout Type</b></p> <p>0=no cutout</p> <p>1=cutout sized to the CASE_HS_CUTOUT_SIZE parameter described later</p> <p>2=cutout sized to CASE_HS_CUTOUT_SIZE and filled with a linear grid pattern</p>
<b>CASE_XU4_BHOLE_TYPE</b>	<p><b>XU4 Mounting Case Bottom Hole Type</b></p> <p>This governs the type of holes to be provided for XU4 mounting/case assembly in the case bottom.</p> <p>0=thru-hole sized for M3 clearance without any head recess or nut trap provisions. Screw heads or nuts will sit flush on the hole.</p>

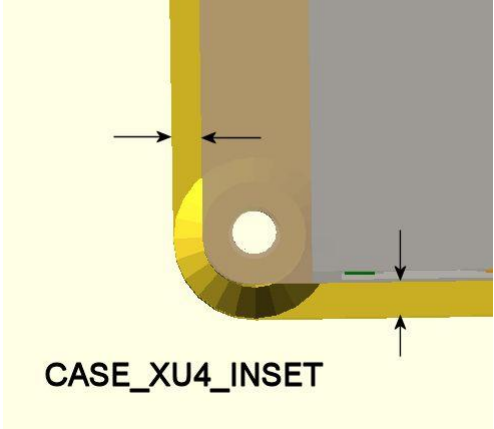
	<p>1=thru-hole sized for M3 clearance and with countersink for flat-head screw.</p> <p>2=thru-hole sized for M3 clearance and with recess for accommodating most screw head styles.</p> <p>3=thru-hole sized for M3 clearance and with recess for serving as a nut trap for a common M3 sized nut.</p> <p>4=thru-hole sized for M3 threading without tapping, without any recess provisions.</p> <p>5=partial depth hole for M3 threading without any recess provisions. The depth of the hole is governed by parameter CASE_XU4_BHOLE_TD. As-published default: 2 for clear hole with head recess so that assembly screws can pass through the case bottom and engage with top side standoffs.</p>
<b>CASE_XU4_THOLE_TYPE</b>	<p><b>XU4 Mounting Case Top Hole Type</b></p> <p>This governs the type of holes to be provided for XU4 mounting/case assembly in the case top. For options, see the listing of hole types in CASE_XU4_BHOLE_TYPE above.</p> <p>As-published default: 2 to allow assembly screws to pass through case top and engage with user-provided threaded standoff segments</p>
<b>CASE_HS_HOLE_TYPE</b>	<p><b>Heatsink Mounting Case Bottom Hole Type</b></p> <p>This governs the type of holes to be provided in the case bottom for heatsink mounting. This parameter only applies for non-zero values of CASE_HS_MOUNT_TYPE. For options, see the listing of hole types in CASE_XU4_BHOLE_TYPE above.</p> <p>As-published default: 5 so that screws can pass through the heatsink or gold heatsink adapter and engage with standoffs on the case bottom without the holes protruding on the case bottom.</p>
<b>CASE_UHOLDER_TYPE</b>	<p><b>Case UART Holder Type</b></p> <p>0=no UART holder</p> <p>1=UART holder integrated into RJ45 side of case top</p> <p>2=UART holder integrated into USB3 side of case top</p> <p>3=provide UART holder with mounting tabs as printed accessory</p>
<b>CASE_BHOLDER_TYPE</b>	<p><b>Case RTC Battery Holder Type</b></p> <p>0=no RTC battery holder</p> <p>1=RTC battery holder integrated into RJ45 side of case top</p> <p>2=RTC battery holder integrated into USB3 side of case top</p> <p>3=provide battery holder with mounting tabs as printed accessory</p>
<b>CASE_TSO_TYPE</b>	<p><b>Case Top Standoff Type</b></p> <p>0=include no standoffs; necessary hardware to be provided by user</p> <p>1=include necessary standoffs integrated into case top</p> <p>2=provide necessary case top standoffs as printed accessories</p> <p>As-published default: 1 so that (some) standoff is integrated into case top</p>
<b>CASE_TSO_USER_H</b>	<p><b>Case Top Standoff User-installed Segment Height</b></p> <p>This provides a means to break the case top standoffs into two segments, specifically with one segment integrated into the case top and a second segment either printed as an accessory or provided by the user.</p>

	<p>0=no second standoff segment, otherwise assume a second segment of this height will be used.</p> <p>As-published default: 24 to enable use of a 24mm loose standoff</p>
<b>CASE_TSO_USER_TYPE</b>	<p><b>Case Top Standoff User-installed Segment Type</b></p> <p>0=second standoff segments to be provided by user</p> <p>1=second standoff segments to be printed as accessories</p> <p>As-published default: 0 so that on-hand standoff can be used</p>

## Tailorable Design Parameters

These are parameters with a more subtle effect on the case results. They affect dimensional refinement of the case.

### Case sizing

<b>CASE_XU4_INSET</b>	<p>This defines a minimum amount the case top and case bottom edges extend beyond the XU4 PCB. The extension helps accommodate recessed XU4 mounting holes in the case top and bottom, and helps to provide some protection for XU4 connectors and SD card that are exposed at the XU4 edges.</p>  <p>As-published default: 2mm</p>
<b>CASE_FAN_ADJ</b>	<p><b>Case Fan Adjust</b></p> <p>Defines the amount of additional clearance to be provided between the extended arm on the XU4 boot select switch and a case mounted fan or fan mount, depending on the fan mount configuration.</p> <p>As-published default: 1mm</p>
<b>CASE_BH</b>	<p><b>Case Bottom Height</b></p> <p>This defines the portion of calculated overall case height that is allocated to the case bottom. It indirectly governs the ratio of fan airflow passing beneath the XU4 vs. passing above the XU4.</p> <p>As-published default: 8mm</p>
<b>CASE_NOFAN_HEIGHT</b>	<p><b>Case No End Fan Height</b></p> <p>When <code>CASE_FMOUNT_TYPE</code> specifies a fan mount on the case end, the case height will be determined by the <code>EXT_FAN_SIZE</code> parameter above and</p>

	the <code>CASE_FAN_BRECESS</code> and <code>CASE_FAN_TRECESS</code> parameters listed below. When <code>CASE_FMOUNT_TYPE</code> specifies either no fan mount or a fan mount on the top side, <code>CASE_NOFAN_HEIGHT</code> sets the overall case height.
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## Parameters Common to Both Case Top and Case Bottom

<b>CASE_FMOUNT_THICK</b>	<b>Case Fan Mount Thickness</b> Defines the thickness of the fan mount on the case top and case bottom. This can be adjusted to accommodate different styles of fan isolation mount pins or adjusted to vary the material depth available for threading fan mounting hardware. As-published default: 4mm
<b>CASE_FAN_FIT</b>	<b>Case Fan Fit Tolerance</b> This governs how tightly the case fan defined by <code>EXT_FAN_SIZE</code> and <code>EXT_FAN_T</code> will fit in the fan cutouts for the outside type fan mount. It is a clearance factor applied to all six faces of the fan body. As-published default: 0.3mm has proven adequate without excessive slop
<b>CASE_XU4_HFN</b>	<b>Case assembly &amp; XU4 Mounting Hole \$FN</b> This is the \$fn parameter to be applied to clearance holes in the fan mount and clearance holes in the case top and case bottom for XU4 mounting and case assembly. When holes are set to be for threading, the openSCAD MCAD library polyhole module will automatically set the \$fn for the desired hole size. As-published default: 18 to ensure a reasonably round clearance hole

## Other Case Bottom Parameters

<b>CASE_FAN_BRECESS</b>	<b>Case Bottom Fan Recess</b> The thickness of the flat plates forming the case top and case bottom is fixed at 2mm. The <code>CASE_FAN_BRECESS</code> parameter governs how the fan body aligns with the flat plate on the case bottom. A zero value will place the fan body flush with the inside of the case flat plate, and no cutout for the fan will be provided in the case bottom. A value between 0 and +2 will recess the fan body into a cutout provided for it in the case bottom. As-published default: set to <code>EXT_FAN_WALL</code> so that inside of fan wall will align with inside edge of the flat plate for the case bottom. This will force a fan cutout for <code>CASE_FMOUNT_TYPE</code> set to outside mount.
<b>CASE_BSO_RISER_HEIGHT</b>	<b>Case Bottom Standoff Riser Height</b> The shoulder risers at the base of the case bottom standoffs provide appearance, support to the standoffs, and additional case thickness for use with recessed heads and nut traps. <code>CASE_BSO_RISER_HEIGHT</code> is the height of these risers. The value can also be adjusted in order to

	<p>use an existing standoff instead of a printed one or one integrated into the case bottom.</p> <p>As-published default: 2mm</p>
<b>CASE_BSO_OD</b>	<p><b>Case Bottom Standoff Outside Diameter</b></p> <p>As-published default: 7mm</p>
<b>CASE_BSO_FN</b>	<p><b>Case Bottom Standoff \$FN</b></p> <p>This is the \$fn parameter to be applied to form the case bottom standoffs. A value of 6 will lead to a hexagon standoff. A value of 24 or more will provide a round standoff.</p> <p>As-published default: 24 to force a round standoff</p>
<b>CASE_XU4_BHOLE_TD</b>	<p><b>Case Bottom XU4 Mounting Hole Threading Depth</b></p> <p>This is the hole depth to be provided for case bottom XU4 mounting holes with CASE_XU4_BHOLE_TYPE set to 5 for limited depth holes.</p> <p>As-published default: 6mm for a reasonable screw threading depth</p>
<b>CASE_HS_HFN</b>	<p><b>Case Bottom Heatsink Mounting Hole \$FN</b></p> <p>This is the \$fn parameter to be applied to form the clearance holes in for heatsink mounting in the case bottom. When holes are set to be for threading, the openSCAD MCAD library polyhole module will automatically set the \$fn for the desired hole size.</p> <p>As-published default: 18 to ensure a reasonably round clearance hole</p>
<b>CASE_HS_STANCHION_H</b>	<p><b>Case Bottom Heatsink Stanchion Height</b></p> <p>Governs the height of the stanchion reinforcements added to the case bottom heatsink mounting holes when the CASE_HS_MOUNT_TYPE parameter is set to select the stanchion mount.</p> <p>As-published default: 3mm as with the hominoid case</p>
<b>CASE_HS_HOLE_TD</b>	<p><b>Case Bottom Heatsink Mounting Hole Threading Depth</b></p> <p>This is the hole depth to be provided for case bottom heatsink mounting holes with CASE_HS_HOLE_TYPE set to 5 for limited depth holes.</p> <p>As-published default: 6mm for a reasonable screw threading depth</p>
<b>CASE_MTAB_HID</b>	<p><b>Case Mounting Tab Hole Inside Diameter</b></p> <p>As-published default: 4.4mm to accommodate a #4 wood screw or equivalent</p>
<b>CASE_MTAB_WIDTH</b>	<p><b>Case Bottom Mounting Tab Width</b></p> <p>As published default: 8mm to ensure head of a #4 wood screw or equivalent rests completely on the mounting tab</p>

## Other Case Top Parameters

<b>CASE_FAN_TRECESS</b>	<p><b>Case Top Fan Recess</b></p> <p>The thickness of the flat plates forming the case top and case bottom is fixed at 2mm. The CASE_FAN_TRECESS parameter governs how the fan body aligns with the flat plate on the case top. A zero value will place the fan body flush with the inside of the case flat plate, and no cutout for the fan will be provided in the case top. A value between 0 and +2 will recess the fan body into a cutout provided for it in the case top. Negative values for CASE_FAN_TRECESS can be used to force</p>
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	<p>an increase in case height. This could be done to increase clearance over a passive or even gold heatsink if desired to eliminate the need for the heatsink cutout in the case top.</p> <p>As-published default: set to <code>EXT_FAN_WALL</code> so that inside of fan wall will align with inside edge of the flat plate for the case top. This will force a fan cutout in the case top if <code>CASE_FMOUNT_TYPE</code> is set to outside mount.</p>
<b>CASE_HS_CUTOUT_SIZE</b>	<p><b>Case Top Heatsink Cutout Size</b></p> <p>This governs the size of the cutout in the case top above the heatsink location on the XU4, if enabled by <code>CASE_HS_CUTOUT_TYPE</code>. The parameter value is used as xy size of case top cutout above XU4 heatsink. 44mm is about the limit before bases of the case top standoffs may start to protrude into the cutout.</p> <p>Note that if <code>CASE_HS_CUTOUT_TYPE</code> is set to not include a cutout, the <code>CASE_HS_CUTOUT_SIZE</code> parameter is still used to govern the length of provided ducting between the fan or fan mount and where the cutout would normally be.</p> <p>As-published default: 44mm. This already forces a reduction in the outer diameter of the case top risers due to the close proximity of one mounting hole to the case cutout.</p>
<b>CASE_TSO_RISER_HEIGHT</b>	<p><b>Case Top Standoff Riser Height</b></p> <p>The shoulder risers at the base of the case top standoffs provide appearance, support to the standoffs, and additional case thickness for use with recessed heads and nut traps. <code>CASE_TSO_RISER_HEIGHT</code> is the height of these risers.</p> <p>As-published default: 2mm</p>
<b>CASE_TSO_OD</b>	<p><b>Case Top Standoff Outside Diameter</b></p> <p>As-published default: 7mm</p>
<b>CASE_TSO_FN</b>	<p><b>Case Top Standoff \$FN</b></p> <p>This is the \$fn parameter to be applied to the case top standoffs. A value of 6 will lead to a hexagon standoff. A value of 24 or more will provide a round standoff.</p> <p>As-published default: 24 to force a round standoff</p>
<b>CASE_XU4_THOLE_TD</b>	<p><b>Case Top XU4 Mounting Hole Threading Depth</b></p> <p>This is the hole depth to be provided for case top XU4 mounting holes with <code>CASE_XU4_THOLE_TYPE</code> set to 5 for limited depth holes.</p> <p>As-published default: 6mm for a reasonable screw threading depth</p>

## User-Installed Top Standoffs

Parameters `CASE_TSO_USER_H` and `CASE_TSO_USER_TYPE` described above determine whether or not a segment of the required case top standoff length is printed as separate accessories for the use to install. The following parameters govern those printed accessories.

<b>TSO_USER_OD</b>	<p><b>Top Standoff User-Installed Outside Diameter</b></p> <p>As-published default: set to <code>CASE_TSO_OD</code> to match standoffs integrated</p>
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	into the case top.
<b>TSO_USER_FN</b>	<b>Top Standoff User-Installed Facet Number</b> A value of six will result in a hexagon standoff. A value of 24 or more will provide a round standoff. As-published default: 6 so that any printed standoff accessories would be hex
<b>TSO_USER_HOLE_TYPE</b>	<b>Top Standoff User-Installed Hole Type</b> This governs the type of hole(s) to be provided in the user-installed top standoff printed accessories. 0=thru-hole sized for M3 clearance. Use this if screws will pass through the top and engage with the case bottom 1=thru-hole sized for M3 threading without tapping. Use this if screws will pass through clearance holes in both the case bottom and case top, and engage in this standoff 2=partial-depth hole for M3 threading on each end. The depth of the holes for threading is governed by TSO_USER_HOLE_TD.
<b>TSO_USER_HOLE_TD</b>	<b>Case Top XU4 Mounting Hole Threading Depth</b> This is the hole depth to be provided in the user-installed top standoff printed accessories when TSO_USER_HOLE_TYPE set to 2 for partial depth holes. As-published default: 6mm for a reasonable screw threading depth

## User-Installed Heatsink Spacers

These parameters govern the optional spacers that might be used to help with heatsink installation on the XU4.

<b>HS_SPACER_TYPE</b>	<b>Heatsink Spacer Type</b> 0=none 1=include (qty 2) as printed accessories
<b>HS_SPACER_SIZE</b>	<b>Heatsink Spacer Size</b> The width and depth of the square spacer As-published default: 8mm as on the hominoid source
<b>HS_SPACER_HEIGHT</b>	<b>Heatsink Spacer Height</b> As-published default: set to XU4_PERCH_T+IC_SOC_H so that the spacer is nominally the same as the gap under the heatsink. Will likely want to sand/file a bit before use.
<b>HS_SPACER_WT</b>	<b>Heatsink Spacer Wall Thickness</b> The heatsink spacers are printed as hollow squares. HS_SPACER_WT governs the thickness of the walls on each side. As-published default: 1.5mm as on the hominoid source design

## Screw Hole and Head Recess Dimensioning

Parameters already listed above define whether a hole is to be clearance type or for threading into. A two-tier approach is used to define the hole and recess dimensioning for most fasteners used with the case. First a standardized dimension is defined, and if desired, refined using the `make_test_plate` top geometry option. These standardized dimension parameters are then applied to specific holes and head recesses throughout the case. This approach makes it easy to adjust all similar holes when a tweak is necessary, while still allowing each hole or recess type to be independently set.

This multi-layer approach to defining hole sizes makes it easy to switch holes from clearance to threaded while still retaining the dimensional details for both. It also enables using a different approach for forming clearance holes vs. holes for threading. The `polyhole` method from the `openSCAD MCAD` library is used instead of the `cylinder` method to form holes for threading. `Polyhole` provides an improved hole size control by manipulating the `$fn` parameter on very small holes such as those used with M3 hardware. The typical `cylinder` method will be used to form clearance holes.

Hardware used with the case is assumed to be metric 3mm size. Note that the finer thread pitch on metric hardware is typically easier to thread into an un-tapped 3D printed hole than a similarly sized imperial screw.

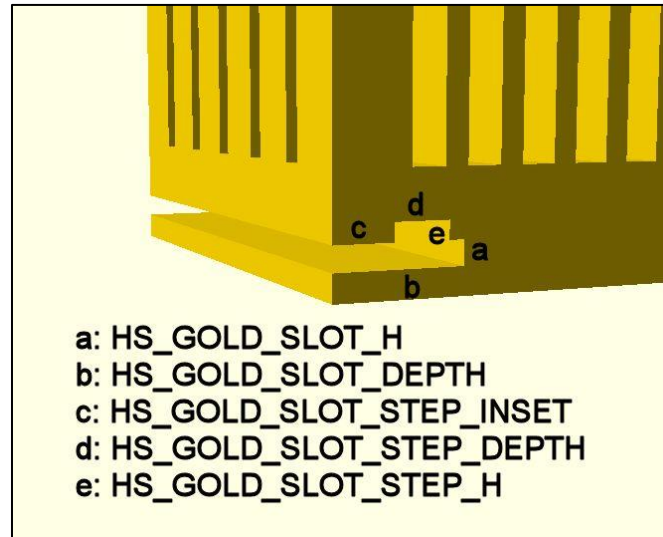
## Standardized Fastener Dimensioning

The parameter section of the `scad` file includes a table of reference data for common metric and imperial hardware. This reference data can serve as a starting point in defining printed hole size, but refinement is typically required to adjust for printer extruder calibration, slicing details such as printing inside vs. outside perimeters first, etc. The `make_test_plate` top level geometry option provides a test plate specifically for this testing.

<b>M3_HID_THREADED</b>	This is the hole inside diameter to be applied when the screw is to be direct-threaded into the hole, without tapping. Assume the <code>polyhole</code> method will be used. As-published default: 2.7 from reference table+0.2, or 2.9mm
<b>M3_HID_CLEAR</b>	This is the hole inside diameter to be applied when the screw is to pass through a clearance hole. Assume the <code>cylinder</code> method will be used. As-published default: 3.3 from reference table+0.3, or 3.6mm
<b>M3_HEAD_OD_CLEAR</b>	This is the hole diameter to be used for recessing an M3 screw head. As-published default: 6.0 from reference table+0.2, or 6.2mm
<b>M3_HEAD_RD</b>	This is the recess depth to be used where a screw head is being recessed. As-published default: 3.0 from reference table
<b>M3_NUT_AFD_CLEAR</b>	This is used to define the Across-Flats-Diameter (AFD) of a M3 nut that will recess into a nut trap. As-published default: 5.5 from reference table+0.3, or 5.8mm
<b>M3_NUT_RD</b>	This is the recess depth for a M3 nut trap. As-published default: 2.4 from reference table+0.2, or 2.6mm

## Gdstime Gold Heatsink Adapters

The adapters used to mount a gdstime gold heatsink to the XU4 so that the heatsink is rotated for improved airflow performance are created by the `heatsink_adapter_gold()` module in the `Odroid_XU4_Model_v2.scad` file. See the `XU4_Model_v2_UG` user guide for dimensioning and options information.



## Other Notes

### XU4 Fan Connector

To connect a case fan to the XU4 fan connector, one option is to cut the connector & wires off of an Odroid OEM fan and splice them onto your new case fan.

The small connector is often referred to as a “micro JST 1.25” connector. Various sources offer the mating connector with pigtail wires already attached. Just search on “micro JST 1.25 2-pin”.

### Spring Heatsink Mounting

You don’t have to give up the concept of using springs to apply attachment pressure to heatsinks if you’re adding a thick shim or perch under the heatsink. If you have spare spring clips, take them apart so you can reuse the spring. Slip it on an M3 screw that passes through the heatsink (or heatsink adapter for the gdstime heatsink) and into either a threaded case bottom or nut underneath. Adjust the screw threading to obtain the desired spring pressure. Use at your own discretion – at some point a heatsink may be too heavy or too bulky to trust to spring pressure.

## Appendix A - Parameter Summaries

This shows the parameter values for the provided openSCAD source and the parameters that were used to generate each of the sample case types shown above. Not all case type actually use each parameter, but most are still involved in initial parameter calculations and parameter limit checking.

Parameter	Provided Source	Sample A	Sample B	Sample C	Sample D
Case Type	Outside mount	No Fan	Top Side Fan	Outside Mount	Inside Mount
XU4_HS_TYPE	5	2	3	5	5
XU4_EMMC_TYPE	1	1	1	1	1
XU4_USD_TYPE	1	1	1	1	1
XU4_PERCH_T	3.18	0	0	3.18	3.18
XU4_HS_ADAPT_TYPE	1	0	0	1	0
EXT_FAN_SIZE	40	40	40	40	40
EXT_FAN_HID	4.0	4.0	4.0	4.0	4.0
EXT_FAN_MHO	4.0	4.0	4.0	4.0	4.0
EXT_FAN_WALL	1.0	1.0	1.0	1.0	1.0
EXT_FAN_T	10	10	7	20	20
EXT_FAN_CASE_CSCREW_OD	5	5	5	5	5
CASE_FMOUNT_TYPE	2	0	1	2	3
CASE_FMOUNT_HOLE_TYPE	0	3	3	0	3
CASE_FAN_HW_SHOW	1	0	0	1	0
CASE_DUCT_TYPE	1	0	0	1	1
CASE_WCHAN_TYPE	1	0	0	1	1
CASE_BFOOT_TYPE	0	0	0	0	0
CASE_MTAB_TYPE	0	0	0	0	1
CASE_BSO_TYPE	1	1	1	1	1
CASE_EMMC_CUTOUT	1	1	1	1	1
CASE_HS_MOUNT_TYPE	1	0	0	1	2
CASE_HS_CUTOUT_TYPE	1	2	2	1	1
CASE_XU4_BHOLE_TYPE	0	2	2	0	2
CASE_XU4_THOLE_TYPE	0	5	2	0	2
CASE_HS_HOLE_TYPE	0	5	5	0	5
CASE_UHOLDER_TYPE	1	0	0	1	1
CASE_BHOLDER_TYPE	2	0	0	2	2
CASE_TSO_TYPE	1	1	1	1	1
CASE_TSO_USER_H	24	0	24	24	24
CASE_TSO_USER_TYPE	1	0	1	1	1
CASE_XU4_INSET	2	2	2	2	2
CASE_FAN_ADJ	1	1	1	1	1
CASE_BH	8	8	8	8	8
CASE_NOFAN_HEIGHT	42	30	42	42	42
CASE_FMOUNT_THICK	4	4	4	4	4
CASE_FAN_FIT	0.3	0.3	0.3	0.3	0.3
CASE_XU4_HFN	18	18	18	18	18
CASE_FAN_BRECESS	EXT_FAN_WALL	EXT_FAN_WALL	EXT_FAN_WALL	EXT_FAN_WALL	EXT_FAN_WALL
CASE_BSO_RISER_HEIGHT	2	2	2	2	2

Parameter	Provided Source	Sample A	Sample B	Sample C	Sample D
CASE_BSO_OD	7.0	7.0	7.0	7.0	7.0
CASE_BSO_FN	6	24	24	6	6
CASE_XU4_BHOLE_TD	6	6	6	6	6
CASE_HS_HFN	6	18	18	18	18
CASE_HS_STANCHION_H	3	3	3	3	3
CASE_HS_HOLE_TD	6	6	6	6	6
CASE_MTAB_HID	4.4	4.4	4.4	4.4	4.4
CASE_MTAB_WIDTH	8	8	8	8	8
CASE_FAN_TRECESS	EXT_FAN_WALL	-1	-1	EXT_FAN_WALL	EXT_FAN_WALL
CASE_HS_CUTOUT_SIZE	44	44	44	44	44
CASE_TSO_RISER_HEIGHT	2	2	2	2	2
CASE_TSO_OD	7.0	7.0	7.0	7.0	7.0
CASE_TSO_FN	6	24	24	6	6
CASE_XU4_THOLE_TD	6	6	6	6	6
TSO_USER_OD	CASE_TSO_OD	CASE_TSO_OD	CASE_TSO_OD	CASE_TSO_OD	CASE_TSO_OD
TSO_USER_FN	6	6	6	6	6
TSO_USER_HOLE_TYPE	2	2	2	2	2
TSO_USER_HOLE_TD	6	6	6	6	6
HS_SPACER_TYPE	1	1	1	1	1
HS_SPACER_SIZE	8	8	8	8	8
HS_SPACER_HEIGHT	XU4_PERCH_T + IC_SOC_H	XU4_PERCH_T + IC_SOC_H	XU4_PERCH_T + IC_SOC_H	XU4_PERCH_T + IC_SOC_H	XU4_PERCH_T + IC_SOC_H
HS_SPACER_WT	1.5	1.5	1.5	1.5	1.5
M3_HID_THREADED	2.7+0.2	2.7+0.2	2.7+0.2	2.7+0.2	2.7+0.2
M3_HID_CLEAR	3.3+0.3	3.3+0.3	3.3+0.3	3.3+0.3	3.3+0.3
M3_HEAD_OD_CLEAR	6.0_0.2	6.0_0.2	6.0_0.2	6.0_0.2	6.0_0.2
M3_HEAD_RD	3.0	3.0	3.0	3.0	3.0
M3_NUT_AFD_CLEAR	5.5+0.3	5.5+0.3	5.5+0.3	5.5+0.3	5.5+0.3
M3_NUT_RD	2.4+0.2	2.4+0.2	2.4+0.2	2.4+0.2	2.4+0.2