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Makers
Making Change

Laser Cut Keyguard Instructions



This guide describes a workflow to assist a maker to design a custom lasercut keyguard for an Augmentative and Alternate Communication (AAC) device.

An AAC device is used to help someone communicate. AAC devices may be comprised of a variety of different tablets, (tablet cases) and apps. The AAC apps may also provide options to customize the number, size and layout.

A keyguard is a thin plate that sits over top of an AAC device. The keyguard can help a user use the AAC device more easily and more effectively. The openings in the keyguard can help provide focus, tactile feedback, and the ability to rest the user's hand on the device without activating a button, reducing fatigue.

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Overview

The overall process involves measuring the users device, designing the layout of the Keyguard, preparing the vector file for Laser cutting, Laser cutting the Keyguard, and mounting the Keyguard.

Equipment

Creating a custom lasercut keyguard requires the following items:

- Computer with vector graphics software.
 - Inkscape
 - (Optional) CAD Software (Autodesk Fusion 360, SolidWorks)
- Measuring Tools
 - Ruler
 - Measuring Tape
- Keyguard Material
 - Cardstock or cardboard to test fit
 - 1/8 in. or 1/16 in. acrylic
- Mounting
 - Suction tape

These instructions will refer to steps in Inkscape, but alternative vector graphic software such as Adobe Illustrator or Corel Draw may also be used.

1. Gathering Device Information

The first step is to gather information about how the user uses their device and then get the physical size of the device and app to create an appropriate keyguard.

Usage

Does the user want access to the on-screen buttons for editing, menu, iPad home button, etc., or is the keyguard to block access?

What size and shape of openings are required?

Should any additional information be marked on the keyguard?

Device Measurements

If the user's device and AAC application is available, measurements can be made directly. This is the preferred method for a number of reasons:

- You can measure the device directly, and take into considerations such as mounting in the case and size of holes for fingers.
- You can do a test cut on low cost material like card stock and cardboard and see the fit and alignment. You don't have to get it perfect on the first try.
- You meet the person you are helping. It is incredibly rewarding for both the maker and the disability professional/person using the device to see the creation process and to have a solution on hand.

In some cases, the user may submit a photo of the device with some measurements that can be used to scale and determine the measurements. What is below is some notes for that.

Capturing A Reference Image

To accurately measure the position of the various buttons, it can be helpful to capture a reference image. To ensure the final keyguard properly fits the device and the openings match the buttons, it is critical that the AAC used is sent, along with the exact iPad / tablet device, to ensure the keyguard fits for the user's device and app combination.

To capture a reference image for the app, a screen shot of the device running the app is critical for the layout. We have found pictures from phones, with measurements or tape over the device, have issues with scaling and small errors that make the keyguard close, but not good enough.

Take screen shot of the device with the app running and the piece of paper. Try to position the camera so the device is not skewed. This is often done on iPads by

1. Press and hold the Sleep/Wake (on/off) button on the top of your iPad.
2. Quickly click the Home button at the bottom of the screen.
3. Release both buttons.



Some tablets and newer versions of iOS devices have other ways to take screenshots. You may need to google your specific device to see how to best take a screenshot.

Using The Reference Image

In order to use a device photo to design the keyguard layout, the image needs to be rotated and scaled.

Import Reference Image

1. Open Inkscape.
2. Select File > Import
3. Select the reference image. Press Open.
4. Press OK to use the default import options.

Rotation

Rotate the photo so that the tops and sides are aligned with the horizontal and vertical axes.

Tip: Use the measuring tool (ruler icon on toolbar, or 'M' on the keyboard) to measure the angle of part of the image that should be horizontal.

It is also critical to know the exact model of the iPad / tablet being used. This information is important as the screen size varies by device, as well as to make sure there are cut outs for the camera, home button, etc. The information on the make and model can often be found on the back of the device.

A repository of iPad device layouts to start your design can be found and downloaded from Maker Making Change's github library.

<https://github.com/makersmakingchange/Laser-Cut-Keyguard/tree/master/Templates>

Scaling

Scale the image so that the size of the image on the computer matches the size of the device. Often, screenshots come at 1024 pixels wide and 768 pixels high regardless of the actual size of the screen on the device.

Use the measuring tool to measure the known distance in the reference photo. Change the units to match the known measurement. Please refer to the Appendix at the end of this document to convert your picture to the measurement in millimeters (mm) so that your keyguard fits the device.

$$5/25 * 100 = 20\%$$

1. Click Object > Transform
2. Click on the Scale tab.
3. Make sure the 'Scale Proportionally' is checked.
4. Enter the scale factor calculated from the appendix.
5. Click Apply to scale the image.

2. Keyguard Layout

Design Considerations

Message Window Size Settings

Many AAC applications have a message window near the top of the screen. This message window may be adjustable to allow the user to set the number of lines and the text size. Changing the message window size affects the size of the buttons below. Increasing the number of lines or text size of the message window will cause the buttons below to reduce in height.

Camera Access

Don't cover the camera.

Symmetry

In some cases, it can be helpful to make the keyguard symmetric about a vertical axis so that the device can be rotated.

Material Thickness

Thicker keyguards may help reduce the number of accidental touches.

Robustness

Round the corners of the keyguard to remove the sharp edges.

Try to avoid skinny section, especially near the edges, that may cause the keyguard to crack or break.

Mounting

How will the keyguard be mounted to the device?

Keyguard Design

Using the reference image as a reference, add rectangles and circles to match the outline and the openings for the keyguard.

TIP: Use rectangles and circles and set the dimensions using the top bar.

Marking

Adding some laser etched marking can make the keyguard easier to use for the user, caregiver, or therapist, by helping identify for which app, device and/or user the keyguard belongs.

One way to add text that is fast to etch as lines with the laser cutter is to use the Hershey Text plugin in Inkscape:

1. Extensions > Render > Hershey Text
2. In the Hershey Text dialog box:
 - a. Type in desired text
 - b. Select Action: Typeset that text
 - c. Select Font Face: Sans-1 stroke
3. Click Apply.
4. Adjust the size and position of the text as desired.

This will create a single-stroke vector path that can be quickly etched using the laser cutter.

Use these steps to add “makersmakingchange.com” near an edge of the keyguard. In order to be legible, the text should be $\frac{1}{8}$ inch (3 - 4 mm) in height. This will allow the user to locate the plans for a replacement or request a modification to their keyguard and provide an opportunity for other potential keyguard users to request their own keyguard.

Customization / Personalization

Add any additional information requested by the user to the keyguard. This may include, for example:

- Name
- Organization
- Phone number
- App / App setting
- Etc

Try to position the text in a location so that it will not obscure the screen. The space on either side of the camera or Home button is usually a good choice.

Laser Cutter File Preparation

Once the geometry of the keyguard has been finalized, the next step is to prepare the design for laser cutting. These instructions may vary depending on the laser cutter and laser cutter software.

Operation	Stroke	Fill	Width
Cut Line	Red (R:255,G:0,B:0)	None	0.01mm

Engrave Line	Blue (R:0,G:0,B:255)	None	0.01mm
Engrave Area	None	Black (R:0,G:0,B:0)	0

Cut lines are meant to cut through the entire depth of the material. The outside outline and all of the button openings should be set as Cut Lines.

Engrave lines will engrave a line a limited depth. Single-line text markings should be set as Engrave Lines.

Engrave Area will engrave a closed area. This can be useful for adding closed shapes, but takes longer to do on the laser cutter.

Save the design file using the following naming convention:

{FirstName}{LastInitial}{Number}_{Revision}.svg

Save a copy as a PDF for laser cutting using the same naming convention:

{FirstName}{LastInitial}{Number}_{Revision}.pdf

For example, the initial design for John Smith's first keyguard should be saved as:

JohnS01_1.svg

AND

JohnS01_1.pdf

Data Transfer

Transfer both the SVG and PDF file to a USB flash drive.

3. Test-cut

This is a recommended but optional step.

Before cutting the keyguard out of plastic, it is helpful to test the fit to see how well the design matches up on the device and how well the openings match up to the buttons on the application. To quickly and inexpensively test the fit, we can laser cut the keyguard out of cardstock or cardboard.

Laser Test Cut

Bring the USB stick with the PDF design file to the laser cutter.

Assessing Fit

The keyguard should sit flat on the touchscreen. A little wiggle room is better than too tight. The openings should match up with the buttons

Refinements

If necessary, adjust the size and spacing so the keyguard fits the device and matches the buttons properly.

4. Final Cut

Final Design Checks

- If possible, have you cut a design to test the fit?
- Are the corners rounded?
- Is the keyguard marked with makersmakingchange.com ?
- Is the keyguard marked with any requests from the user (name, app, etc)?

Laser Cutting

Bring the USB flash drive with the final design files to the laser cutter so the keyguard can be cut out of acrylic.

5. Finishing

There are a few final steps to make the keyguard ready for use.

Smoothing

Check to make sure there are no sharp edges on the keyguard outline or any of the openings. A sharp knife or small file can be used to smooth over any sharp edges.

Mounting

There are a few different methods for mounting a keyguard on to an AAC device including:

- suction cups

- velcro
- suction tape (such as UGLu - <https://www.amazon.com/MTR100-UGLU-Glue-Strips/dp/B001KFY7EY>)
- magnets
- under the case

Suction tape (or "suction cup tape") bonds to smooth, flat, clean surfaces just like a suction cup. Though not actually suction cups, the surface of this tape has thousands of microscopic craters that work by creating many partial vacuums between the tape and the target surface.

The tape is not pressure sensitive, can re-bond repeatedly, and leaves no residue on the target surface. To remove, you simply pull the tape off or twist it to break the bond.

1. Cut some narrow strips of suction tape.
2. Attach the strips of suction tape to the edges of the keyguard.

Appendix

iPad Screenshot Scaling

To capture a screenshot on an iPad device, load the app and hold the device in the desired orientation. While holding down the On/Off button, press the Home button. The screen will flash to indicate a screenshot has been captured.

The screenshot image will be 1024 pixels wide and 768 pixels high regardless of the actual size of the screen on the device. In order to scale it properly, use the conversion factor in the table below.

iPad Type	Screen Width (mm)	Screen Height (mm)	Conversion (px to mm)
iPad	198.1	149	0.193
iPad2	198.1	149	0.193
iPad 3rd generation	198.1	149	0.193
iPad 4th generation	198.1	149	0.193
iPad 5th generation	196.47	147.39	0.192
iPad Pro 9.7-inch	203.11	153.71	0.198
iPad Pro 10.5-inch	213.5	160.13	0.208
iPad Pro 12.9-inch 1st Generation	262.27	196.61	0.256
iPad Pro 12.9-inch 2nd Generation	262.27	196.61	0.256
iPad mini	161.2	121.3	0.157
iPad mini 2	161.2	121.3	0.157
iPad mini 3	161.2	121.3	0.157
iPad mini 4	161.24	121.31	0.157
iPad Air	198.1	149	0.193
iPad Air 2	203.11	153.71	0.198

Source: <http://volksswitch.org/index.php/volks-devices/fully-customizable-3d-printable-aac-keyguard-for-tablets/using-app-screenshots-to-determine-the-app-layout/>

For templates for the device that take into account the device dimensions, holes for the camera or home button, etc, please see this github repository of iPads.

<https://github.com/makersmakingchange/Laser-Cut-Keyguard/tree/master/Templates>

Fusion 360 Workflow

Autodesk Fusion 360 is a cloud-based, computer-assisted design program with a free license for hobbyists and enthusiasts. Fusion 360 requires a 64 bit system and either Windows or MAC OS. To access the hobbyist license, you'll need to sign up for an account and download the free trial: <https://www.autodesk.com/products/fusion-360/overview>

Fusion 360 has a few features that make it a useful tool for designing custom laser cut keyguards.

Insert Canvas

1. Under the insert menu, select Insert Canvas
2. Choose the top plane
3. Select the image
4. Rotate the image to align the edges with the grid. You may need to manually enter a small value (e.g. 1, 0.1 degrees) into the box.

Scale the Image

1. In the Browser bar, click the triangle beside the Canvasses Folder to show its contents
2. Right click on the canvas image you added in the previous step and select 'Calibrate Image'
3. Use the mouse to select a first and a second point on the image with a known distance between them, and then enter the distance value in to the dialog box. Try to be as accurate as possible when entering the points so the reference image is scaled properly.

Design Keyguard Layout

1. Create a new sketch on the same plane as the canvas.
2. Create the outline of the keyguard using the rectangle tool.
3. Create the keyguard button openings using rectangles or circles according to the users preference.
4. When finished, close the sketch.

Tip #1: Use construction lines to help align the openings.

Tip #2: To make the design symmetric, add a construction line in the middle and use the Sketch>Mirror tool to copy openings to the other side. You can also use Symmetry constraints to enforce symmetry.

Extrude Keyguard Sketch

1. Click Create > Extrude

2. Select the keyguard profile sketch.
3. Set the extrusion distance to 1/16 inch or 1/8 inch

Export sketch

1. Right click on the sketch
2. Click 'Save as DXF'


Import sketch into Inkscape

1. Import the dxf file.
2. In some cases the design may be upside down. You may need to rotate the design 180 degrees.
3. Add any marking or text.
4. Change the line color and stroke according to the laser cut file preparation instructions.

SolidWorks Workflow

Insert Sketch Picture


To insert and resize a picture on a sketch plane:

1. In an open sketch, click Sketch Picture  (Sketch toolbar) or click Tools > Sketch Tools > Sketch Picture.
2. In the dialog box, browse to the picture file and click Open.


When you insert a picture, the scale tool automatically displays.






The scale tool is a construction line with handles at each end. Use the scale tool to resize the picture.

You can also resize the picture in the graphics area by dragging its handles. You can drag the picture without changing its size when the pointer changes to .

3. To use the scale tool:
 - a. Place the left end of the scale tool at one end of the picture. Zoom to position the scale tool and picture as needed.

The pointer changes to .
 - b. Drag the right end of the scale tool to extend the length of the line. You can also drag the right end to rotate the picture.

The pointer changes to .
 - c. In the Modify dialog box for dimensions, enter a value for the desired measurement and click .
 - d. Clear Enable Scale Tool in the Property Manager to remove the construction line from the graphics area.
4. Continue to set properties in the Sketch Picture Property Manager and click .

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Export DXF File

Option 1 File > Save As > DXF is the most general method. The dialog at the right requires several inputs from the user: Be sure to select a view that is normal to the flat part and deselect the others. The output alignment tools specify the X and Y axes and whether the part is flipped on an axis.

Option 2 For an inherently flat part or an unfolded sheet metal part, right click on the face and select Export to DXF/DWG from the context menu. In this case, there's no dialog to select a view because the face determines the view. This workflow is a little faster.

Import sketch into Inkscape

1. Import the dxf file.
2. In some cases the design may be upside down. You may need to rotate the design 180 degrees.
3. Add any marking or text.
4. Change the line color and stroke according to the laser cut file preparation instructions.

Additional Resources

Suction Tape

<http://www.keyguardat.com/suction-tape/>

3D Printed Keyguard Workflow

<http://volksswitch.org/index.php/volks-devices/fully-customizable-3d-printable-aac-keyguard-for-tablets/>