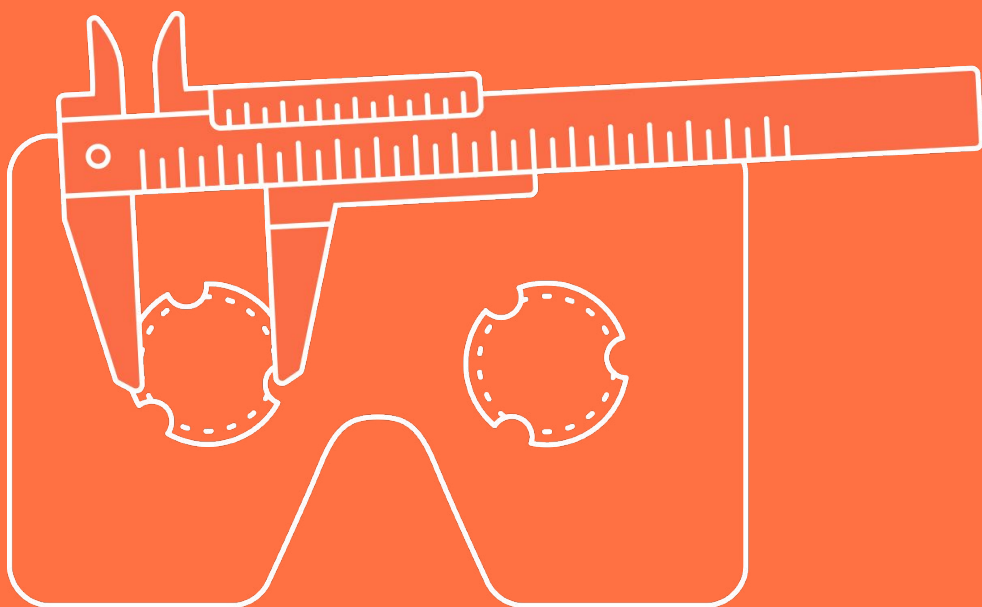




Google Cardboard

For Manufacturers

—

SPECIFICATIONS & TOLERANCES GUIDE

INTRODUCTION

To help unlock virtual reality's potential, the Cardboard viewer's specification is open source and available for manufacturers who want to create their own viewers.

Creating your own Cardboard viewer entails five basic steps:

1. Create your viewer using product specifications
2. Test your viewer
3. Create a viewer profile and generate a QR code
4. Design your QR code and place it on your viewer
5. Get your viewer "Works with Google Cardboard" certified

You can find comprehensive details about each of these steps in Google's online Cardboard for Manufacturers Help Center.



HOW TO USE THIS GUIDE

This guide complements the Cardboard for Manufacturers Help Center by providing downloadable, offline specifications and testing tolerances for creating your Cardboard viewer.

Think about it like this: your Cardboard viewer has 5 main parts:

Lenses, Body, Assembly Components, Sleeve, and Artwork.

First, you'll consider each one of these as individual components within your design, and then you'll test your assembled prototype.

LENSES



COMPONENTS



ARTWORK



BODY



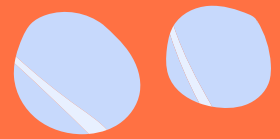
SLEEVE

ENVIRONMENTAL CONDITIONS

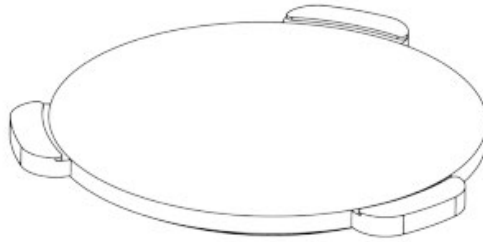
All components in your Google Cardboard viewer must be rated for the following storage conditions that may occur during shipment in cargo planes, sea shipping containers, etc.

Parameters	Minimum	Maximum	Unit
Temperature	-30	50	°C

LENSES



Cardboard lenses enable viewer users to focus their vision on the smartphone screen and allows the smartphone to be placed at short focal distances (2-5 cm). They are critical to providing a great VR experience for users.



SPECIFICATIONS

Parameters	Value	Unit	Notes
Designed FOV	80	°	Circular total field of view
Nyquist frequency	8.7	lp/mm	Based on Nexus 5 screen resolution (1920 x 1080 px), pixel pitch 57.6 μm
Display cover glass thickness	1.4	mm	$n_d = 1.5$, $v = 55$
Design wavelength	550	nm	+/- 25 nm (equal weighting)
Pupil diameter	15	mm	Also known as the "eyebow"
Eye relief	18	mm	From the designed eye pupil to lens surface vertex
Nominal virtual image distance	-667	mm	None
Lens diameter	34	mm	None
Lens edge thickness	1.5	mm	At 34 mm diameter
Lens material	PMMA	n/a	$n_d = 1.492$, $v = 57.4$
Tab to screen distance	39.07	mm	From the tab surface (facing display) to the front surface of display coverglass

Modulation transfer function

Modulation transfer function (MTF) measures a lens' optical performance potential. Use the MTF specifications for nominal operations conditions below when designing your Cardboard lens.

Parameters	Value	Unit
Min on-axis MTF @ Nyquist Frequency, with evaluation pupil centered	80	%
Min MTF @ Nyquist Frequency within +/-25° FOV with 4 mm diameter evaluation pupil	8.7	%

TESTING

Inspect your first article lenses to verify that tolerances are respected. Then, perform visual lens quality checks for any surface distortions, blurry areas, blemishes, etc.

Tolerances

Inspection item	Tolerance	Unit
Center thickness	8.794 +/- 0.1	mm
Lens diameter including tabs	40.0 +/- 0.1	mm
Lens diameter without tabs	34.0 +/- 0.1	mm
Lens tab thickness	1.65 +/- 0.1	mm
R1 surface form (figure error)	< 10	μm
R2 surface form (figure error)	< 10	μm
R1 surface roughness (angstroms RMS)	< 0.05	μm
R2 surface roughness (angstroms RMS)	< 0.05	μm
Lens material	PMMA	n/a

Inspection item	Tolerance	Unit
Surface decenter	< 20	μm
Surface tilt	< 20	arcmin
Surface quality (scratch/dig)	160 / 50	

Visual verification

Common lens surface problems arise from manufacturing process issues like incorrect cooling/cycle times can be detected by “sliding” the lens over a high-contrast straight line and visually inspecting for any distortions. You should see a straight line, not a wavy one. Below are two examples of good and bad lenses.



Good lens (straight image)

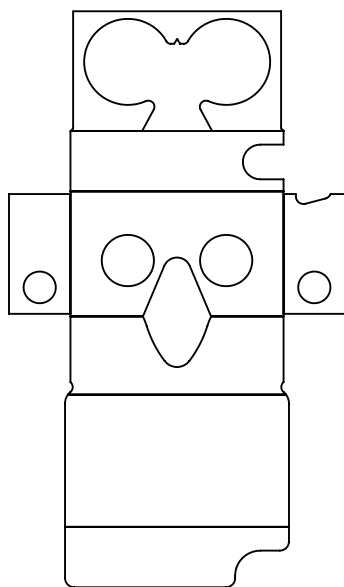


Bad lens (wavy image)

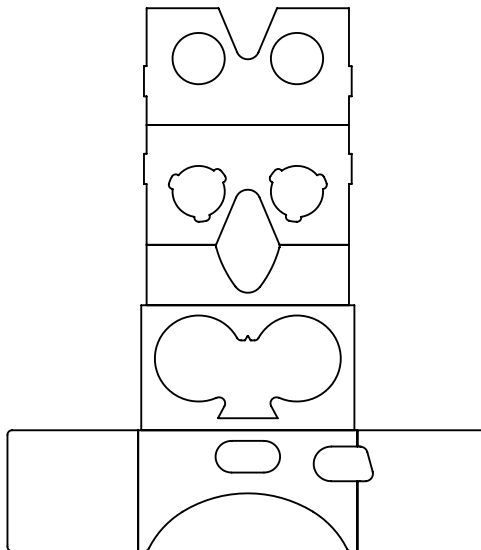
BODY



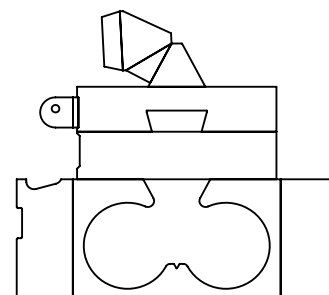
The mechanical body consists of 3 distinct parts: chassis, t-shirt, and button.



Chassis



T-shirt



Button

SPECIFICATIONS

Materials

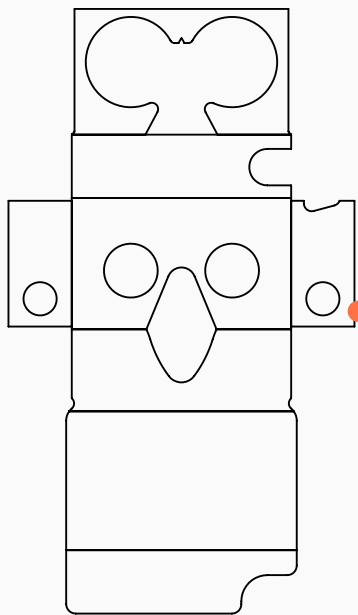
Corrugated

All 3 Cardboard viewer body parts must be made from corrugated cardboard.

Parameters	Value	Tolerance	Unit	Comments
Thickness	1.7	+/-0.1	mm	E-flute

Oleophobic coating

Cardboard coating must provide water and grease resistance, be skin safe, and comply with local food contact regulations. Apply the coating on the user-facing part of viewer's chassis. For optimal performance, apply with a rod coater, not via flexo press.



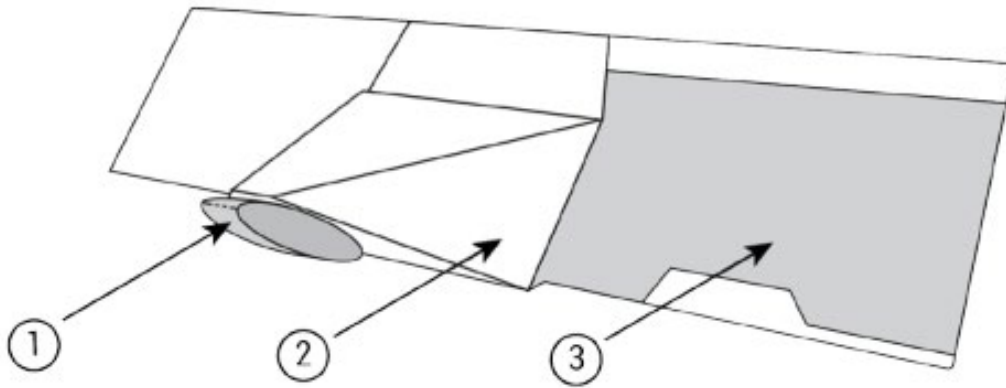
Apply coating to the user-facing side of the viewer's chassis, shown here.

Chassis and t-shirt

We do not provide specifications for these components, as you are free to make them as large or small as you see fit.

Button

The Cardboard viewer button has 2 parts - a "pillow" and a "strip" - that are glued to a cardboard-based "hammer."



Cardboard button parts: pillow (1), hammer (2), and conductive strip (3).

Conductive strip

Parameters	Value	Unit
Material	Metallized fabric (polyester Ni/Cu)	n/a
Surface resistivity	< 0.03	$\Omega/\text{sq.}$
Z-axis resistance	< 0.03	Ω

Conductive pillow

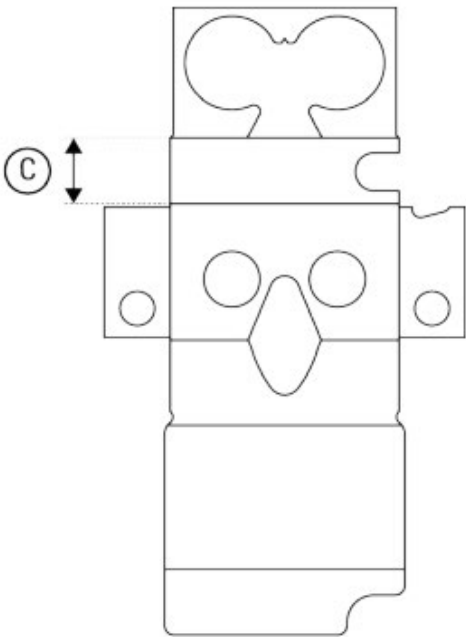
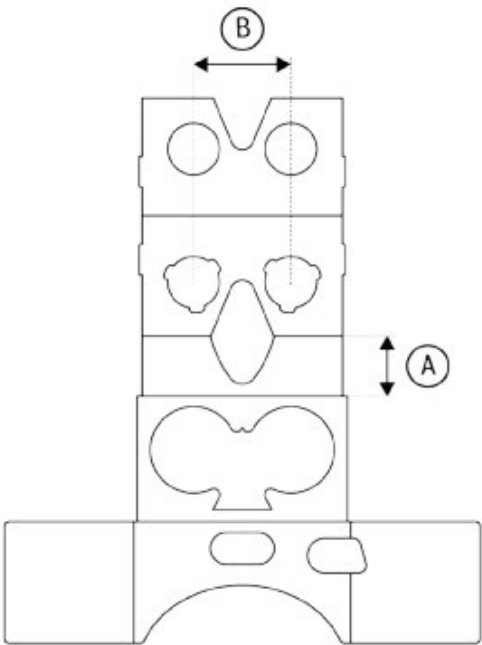
Parameters	Value	Unit
Surface material	Metallized fabric (polyester Ni/Cu)	
Core material	Soft urethane foam	
Core surface resistivity	< 0.07	$\Omega/\text{sq.}$
PSA type	Conductive	
PSA Z-axis resistance	< 0.05	Ω

TESTING

Verify the critical dimensions for the corrugate tooling (e.g. die-cuts) before proceeding to production.

Corrudate tooling

Parameters	Value	Unit	Diagram detail
Distance between two fold lines defining the thickness of Cardboard chassis	40 (+/-0.5)	mm	A, C
Distance between the centers of lens holders (IPD)	64 (+/-0.5)	mm	B



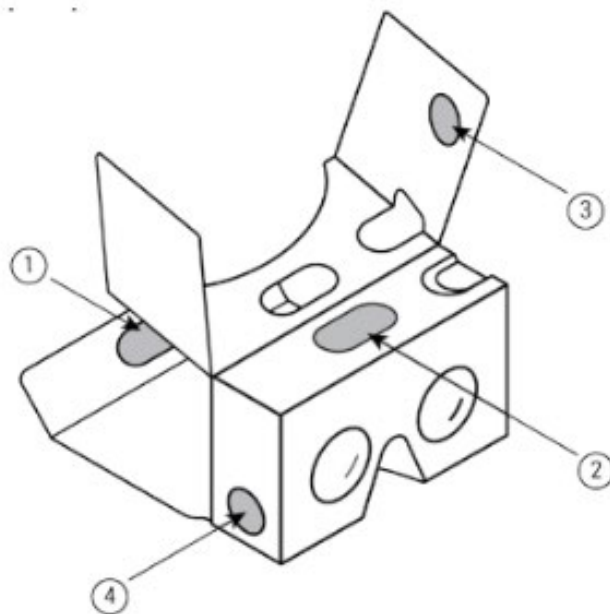
From left to right. Critical "A" and "B" dimensions on the Cardboard "t-shirt" part.
Critical "C" dimension on the Cardboard "chassis" part.



ASSEMBLY COMPONENTS

VELCRO

A Google Cardboard viewer has two round hook-and-loop velcros to assemble the side flaps, and an oval hook and-loop velcro to assemble the top flap.



Hook-and-loop velcros as used in Google Cardboard:
(1) oval "loop" velcro (2) oval "hook" velcro (3) round "loop" velcro (4) round "hook" velcro

Oval velcro

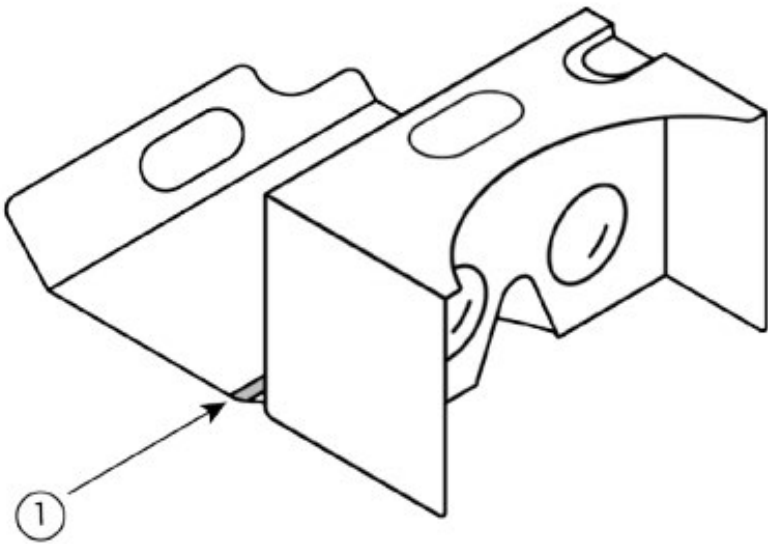
Parameters	Value
Material	Woven nylon
PSA type	Acrylic-based adhesive
Acrylic-based adhesive	Black

Round velcro

Parameters	Value	Tolerance	Unit
Material	Woven nylon		
Diameter	19.25	+/- 0.25	mm
PSA type	Acrylic-based adhesive		
Color	Black		

RUBBER BAND

The back flap of a Google Cardboard viewer contains a rubber band. The rubber band increases the friction between the phone’s bottom surface and the back flap, thereby reducing the chance of slippage.



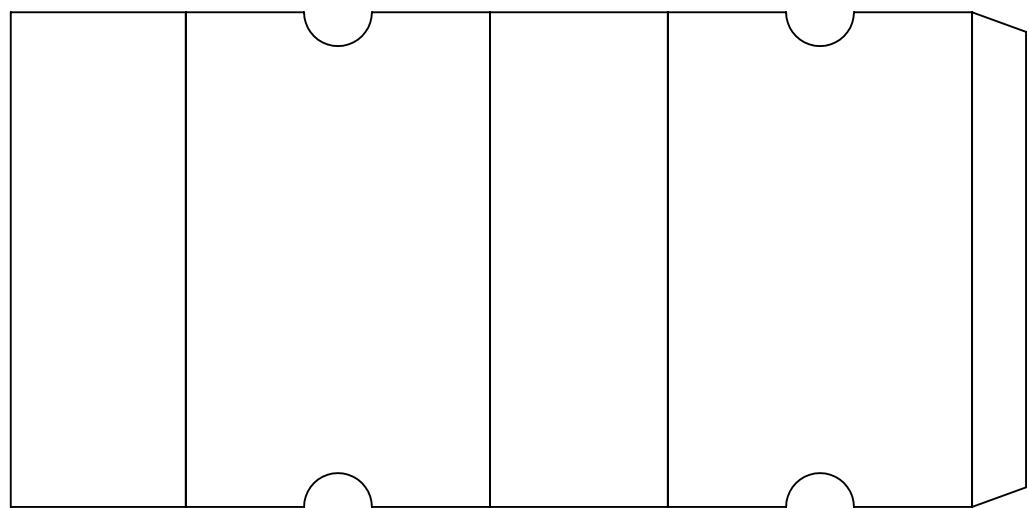
Rubber band (1) on Google Cardboard

Parameters	Value	Unit
Dimensions	76.2 x 6.35 x 1	mm

PACKAGING SLEEVE

Users receive their Cardboard viewer inside a cardboard sleeve. This sleeve must meet the following specifications:

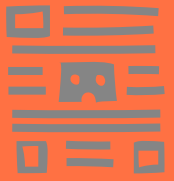
- Kraft bending chip
- 18 mil thickness sleeve
- Side flaps folded over



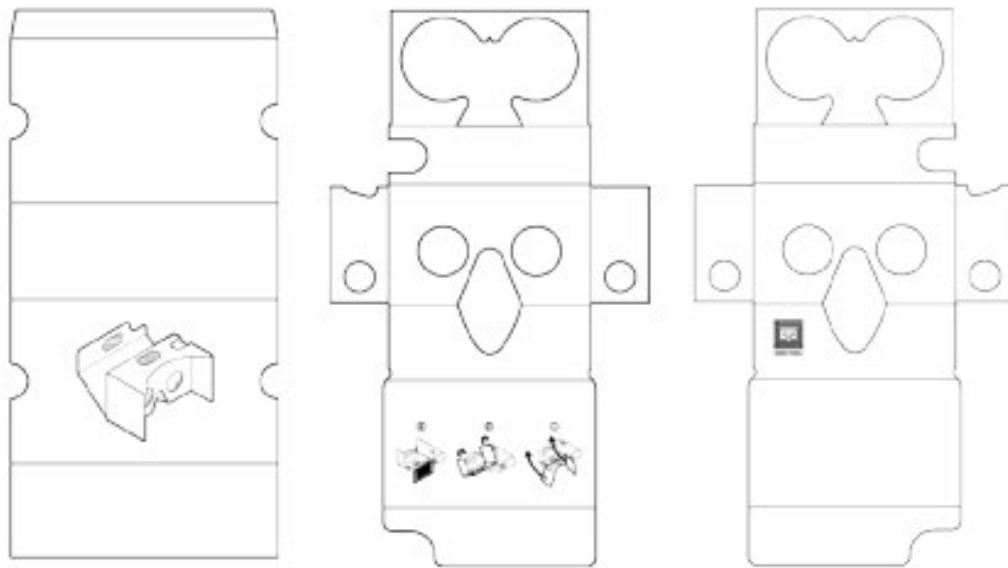
Cardboard delivery sleeve

Parameters	Value	Tolerance	Unit
Gauge thickness	18	+/- 2 mil	(1/1000")
Gauge thickness	0.4572	+/- 0.05	mm

Parameters	Value	Tolerance	Unit
Paper density	337	+/- 10	g/m2
Material	Kraft bending chip		



Your Cardboard viewer must include a QR viewer profile on the chassis bottom. You may also optionally include an isometric viewer diagram and isometric assembly instructions.



An isometric viewer diagram on the sleeve (left); the assembly instructions on the chassis (center); QR viewer profile (right, required).

QR VIEWER PROFILE

Users configure their smartphones for Cardboard by scanning the QR viewer profile on their Cardboard viewer. This profile encodes the viewer parameters and ensures that all apps written using the Cardboard SDKs work well on that viewer. Click to learn more about QR viewer profiles. Also, be sure to:

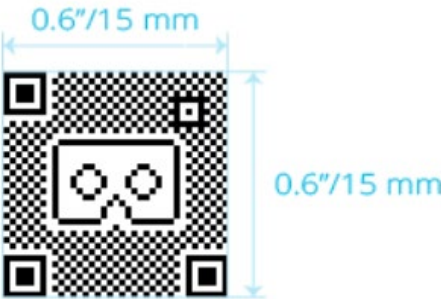
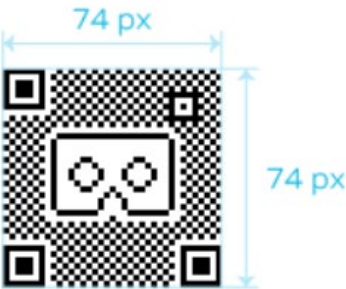
- Include the QR viewer profile on the viewer itself
- Include the QR viewer profile on the viewer's packaging and / or on its website

Parameters	Value	Unit
Primary button type	Indirect touch	
Screen to lens distance	39.3	mm
Inter-lens distance	63.9	mm
Screen vertical alignment	Bottom	
Tray to lens-center distance	35	mm
k1 distortion coefficient	0.33582564	
k2 distortion coefficient	0.55348791	

Viewer profile and badge guidelines

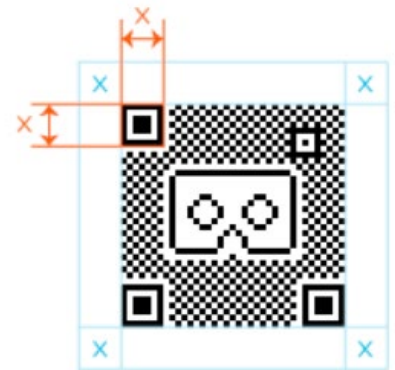
Size

When used in digital media, the QR profile size should never be smaller than 74 x 74 px (in other words, the individual QR modules should never be smaller than 2 x 2 px.) When used in print, the QR profile size should never be smaller than 0.6 x 0.6" / 15 x 15 mm. Do not increase the size of a QR profile to the point where it would become a dominant graphical element in your design.



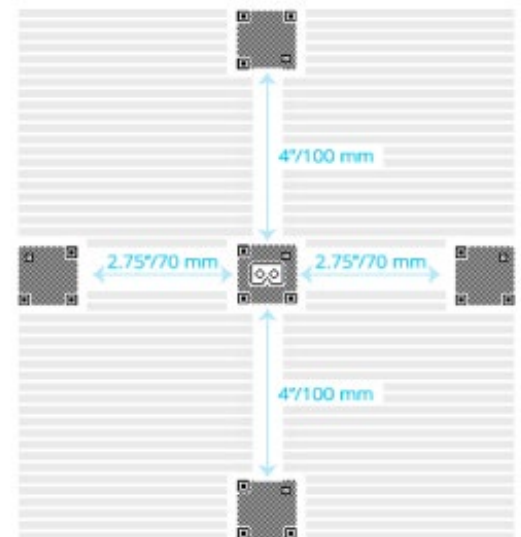
Placement on your viewer

To avoid visual clutter, the clear space around the viewer profile should be equal to or greater than the QR code position patterns (■). Do not place photos, text or any other graphic elements inside the minimum clear space.



Multiple QR codes

QR codes are difficult to scan when multiple codes are placed closely next to each other. If your viewer, packaging, website or other materials include multiple QR codes, ensure that these QR codes are spaced sufficiently far apart. For example, at 7" / 175 mm scanning distance, a typical smartphone QR reader covers about 5.5 x 8" / 140 x 200 mm area. Do not place any other QR codes in this area.



Color options

You can adapt the colors of the QR code to match the design of your viewer. There are a few things to bear in mind when using different color schemes with your QR code.



Do

- Use only two colors (e.g. white and orange, instead of white and black).
- Preserve the color contrast on dark backgrounds by reversing-out the print process. Ultimately, pixels which were black in the original QR code should remain darker than the pixels which were originally white:



Make sure to leave a border around the position patterns (■) as per images above if you are using reversed-out QR profiles. Alternatively, you can include a one-module width border around the whole reversed-out QR profile:



Don't

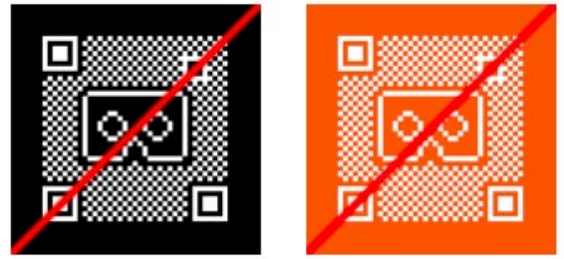
- Use more than two colors:



- Decrease the contrast between the foreground and the background:



- Invert the color contrast such that the pixels which were originally black end up being brighter than the originally white pixels:



- Place the profile on a busy or non-uniform background:



- Use a different color for the border:



Other QR code modifications

Avoid modifying the generated QR viewer profile in any way, apart from scaling/ color changes.

Don't

- Change the shape of QR modules:



- Add or modify the existing visual elements:



- Add shadows:



- Disproportionately stretch or skew the QR profile:



Optional elements

Viewer diagram

Some manufacturer include an isometric diagram of the completely assembled viewer on the packaging sleeve. A diagram of the completed viewer is optional.

Assembly instructions

You may also choose to include an isometric image of the assembly instructions. Typically, manufacturers include these on the back flap of the chassis. Assembly instructions are optional.

'WORKS WITH CARDBOARD' BADGE & TERM

The “Works with Google Cardboard” (WWGC) badge and term are designed to indicate that a particular VR viewer has been certified by the manufacturer to be compatible with a Google Cardboard application ecosystem.

You may use the Google Cardboard assets described below (specifically the “Works with Google Cardboard” badge and the phrase “Works with Google Cardboard”) in plain text, on your viewer, on your viewer’s packaging and on your promotional and advertising materials if and only if you have been accepted to the WWGC Program and received a written approval from Google.

BADGE COLORS

Primary

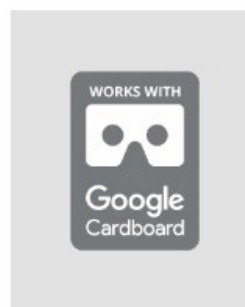
Orange is the primary WWGC badge color. Use it whenever possible.



WWGC Orange
RGB - R255, G110, B64
CMYK - C0, M71, Y79, K0
Web - #FF6E40
Pantone - 1645 C

Secondary

If you cannot use the primary badge because of an existing color scheme, use the secondary badge (gray). If the surrounding background requires a higher contrast, you can also use a reversed-out version of the gray badge. No other color variations are permitted.



WWGC Gray
RGB - R117, G120, B123
CMYK - K60
Web - #75787B
Pantone - Cool Gray 9 C

TRANSPARENCY

You can also make the reversed-out badge transparent to match your viewer's color scheme:



MINIMUM SIZE

The badge width should never be smaller than 64 px when used in digital media, and 0.5" when printed.



CLEAR SPACE

Minimum clear space around the WWGC badge is equal to one sixth of the badge's width. Do not place photos, text or any other graphic elements inside the minimum clear space.



MODIFICATIONS

Avoid modifying the WWGC badge in any way, apart from scaling and using the appropriate color options as described above. Additionally:

- Do not use color badges other than orange or gray:



- Do not use more than two colors:



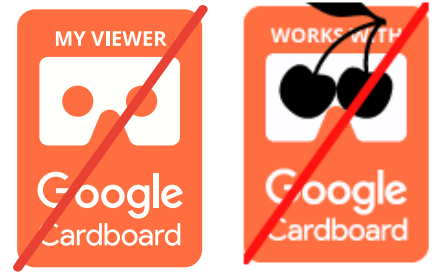
- Do not add reflections or shadows:



- Do not scale the badge disproportionately, or skew it:



- Do not add any visual elements or modify the existing ones:



BADGE PLACEMENT

Do not make the WWGC badge a dominant graphic in a printed or digital layout. In particular, the WWGC badge should occupy less area than your viewer or company signage.

MULTIPLE BADGE USE

If your viewer supports multiple platforms, the WWGC badge should be placed first in the lineup of badges, and should be of equal or greater size.

WEBSITE USE

If you are placing the WWGC badge on your website, make sure that the badge links to <http://g.co/cardboard>.

“WORKS WITH CARDBOARD” TERM USE

If your viewer has been accepted to the WWGC Program and you have received a written approval from Google, you can use any of the following text with your viewer messaging: “This [device] works with Google Cardboard.” Or, “Works with Google Cardboard.” Do not modify these phrases and change the conjugation. For example, do not say “Working with Google Cardboard,” or “[device] works on Google Cardboard”. Use the title case for “Works with Google Cardboard”, unless the phrase is used within a sentence (“we would like to announce that [device] now works with Google Cardboard”). With any of the above text, you must also include the following attribution statement on your website(s) or printed materials: “Google Cardboard is a trademark of Google Inc.”.

TEST YOUR ASSEMBLED VIEWER

Inspect the first articles of the fully assembled viewers to ensure that all critical tolerances are respected.

TOLERANCES

Parameters	Value	Tolerance	Unit	Note
Distance from the back surface to the screen (see image below)	37.3	+2/-0.5	mm	D
Distance between the centers of lens holders	64	+/-0.5	mm	B



Measure the distance between the back surface to the screen of the viewer.

CARDBOARD LAYER ALIGNMENT

1. All layers of cardboard lens cutouts line up and the outlines have $<1 \times$ E-flute thickness of misalignment. Lens tabs are not visible.



2. Button side flaps have $<0.5 \times$ E-flute thickness misalignment (critical for button travel distance). If the units are assembled manually, the button side flaps should be aligned first.



3. The bottom seam of the cardboard (next to the rubber band) does not have a gap of more than $1 \times$ E-flute thickness. This gap is even across the seam and not tilted/wedged.

4. Layers with phone-facing apertures are securely glued together.

BUTTON FUNCTIONALITY

1. Parts of the “hammer” do not come unglued after repeated presses

TIP: Ungluing can occur during assembly when glue dries before components are pressed together, or from not applying sufficient amounts of glue.



2. The button is easily pushed down. Upon release, it springs back.

3. The conductive pillow is centered within the phone-facing apertures, and the bottom edge of the conductive pillow aligns with the corresponding cardboard edge.

VELCRO ALIGNMENT

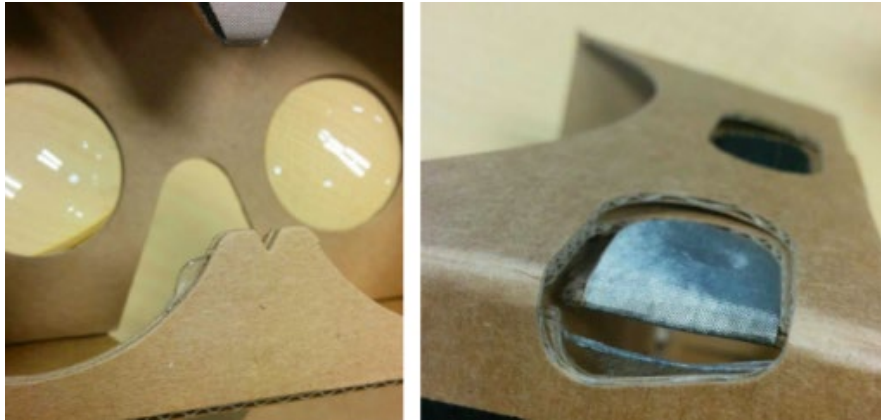
1. Upon closing and re-opening the velcros, the PSA does not peel.

2. All 6 velcro pieces are present and >95% aligned. The following example does not meet alignment criteria.



ADDITIONAL QUALITY CHECKS

1. No glue or tape show around the cardboard edges.



2. The viewer does not have false scores.



3. The lenses are free of contamination, such as glue, velcro loop/hook pieces, cardboard chips or other debris.

THANK YOU!



Have questions? Feel free to contact us at wwgc@google.com.

