

# Probando la Orange Pi

Un proyecto de BricoLabs

Luis Llamas [lflamas93@gmail.com](mailto:lflamas93@gmail.com)

Sergio Alvariño [salvari@gmail.com](mailto:salvari@gmail.com)

diciembre-2016

Probando la Orange Pi y aprendiendo a usarla.

TRABAJO EN CURSO NO TERMINADO

## Índice general

<b>1</b>	<b>Empezar rápido desde linux</b>	<b>2</b>
1.1	Crear una SD arrancable . . . . .	2
1.2	Conexión WIFI . . . . .	4
<b>2</b>	<b>Orange Pi Zero, características técnicas</b>	<b>7</b>
2.1	Especificaciones . . . . .	7
2.2	Esquema de pines . . . . .	7
2.3	Esquemas eléctricos . . . . .	7
<b>3</b>	<b>Accediendo al hardware desde linea de comandos</b>	<b>7</b>
3.1	LEDs . . . . .	8
3.2	GPIO . . . . .	9
<b>4</b>	<b>Bibliotecas útiles</b>	<b>10</b>
4.1	Python . . . . .	10
4.1.1	Instalación de virtualenv . . . . .	10
4.2	Referencias . . . . .	10
<b>5</b>	<b>Monitorizar temperatura</b>	<b>10</b>
<b>6</b>	<b>Referencias</b>	<b>12</b>

<b>7 META</b>	<b>12</b>
7.1 Requisitos . . . . .	13
<b>8 Licencia</b>	<b>13</b>

# 1 Empezar rápido desde linux

Para usar la Orange Pi Zero tendremos que crear imágenes arrancables en tarjetas micro SD.

## 1.1 Crear una SD arrancable

Dependiendo de donde conectemos la tarjeta tendremos que usar diferentes rutas. En el procedimiento descrito a continuación `${card}` será la ruta al dispositivo de la tarjeta y `${p}` la partición (si la hay).

Si la tarjeta se conecta via adaptador USB, linux la va a asociar a un dispositivo `/dev/sdx`, por ejemplo en mi portátil el disco duro es `/dev/sda` las distintas particiones serán `/dev/sda1`, `/dev/sda2`, etc.

Si conectamos una memoria con un adaptador USB linux la podría mapear en `/dev/sdb` por ejemplo.

Si la memoria se conecta mediante una ranura SD, linux la asociará a un dispositivo `/dev/mmcblk0` o `/dev/mmcblk1`, etc. etc. Dependerá de la ranura usada. Las particiones en este tipo de dispositivos tienen rutas como por ejemplo `/dev/mmcblk0p1`.

Los datos se pueden almacenar directamente en la memoria SD o en una partición creada en la memoria.

Resumiendo:

- `${card}` será `/dev/sdb` o `/dev/mmcblk0`
- `card{p}` será `/dev/sdb1` o `/dev/mmcblk0p1`

Antes de seguir adelante hay que estar completamente seguro del dispositivo asociado a nuestra memoria SD para no armar ningún estropicio.

Hay varias comprobaciones que se pueden hacer:

`dmesg | tail` nos permitirá echar un ojo a los últimos mensajes en el log del sistema. Si acabamos de insertar la memoria veremos el dispositivo usado.

`sudo fdisk -l` nos permite ver las particiones montadas en nuestro linux, por ejemplo con mi SD en la ranura SD de mi portatil la salida es (entre otras cosas, he obviado las particiones de los discos duros):

```
Disk /dev/mmcblk0: 7.4 GiB, 7948206080 bytes, 15523840 sectors
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0x00000000
```

`cat /proc/partitions` también nos dará una lista de particiones, en mi portátil las que interesan son:

```
179      0      7761920 mmcblk0
179      1      7757824 mmcblk0p1
```

Descargamos la imagen de Jessie adaptada a la *Orange Pi Zero* desde la página <https://www.armbian.com/download/>

Descomprimos la imagen y la grabamos en la tarjeta SD con el comando:

```
sudo dd if=./Armbian_5.24_Orangezero_Debian_jessie_3.4.113.img of=/dev/mmcblk0
```

Insertamos la tarjeta en la *Orange Pi* y le damos alimentación. El primer arranque llevará alrededor de tres minutos, y tras ese tiempo aun hará falta un minuto más para poder hacer login. Este retardo es debido a que el sistema intentará actualizar la lista de paquetes y creará un area de swap de emergencia en la SD, y además cambiará el tamaño de la partición que hemos creado para ocupar todo el espacio libre en la SD.

De momento solo la he arrancado y efectivamente las particiones han cambiado tras el arranque así que tiene buena pinta.

Volvemos a insertar la SD en la *Orange Pi* y la conectamos con un cable ethernet al router de casa. El Armbian viene configurado por defecto para obtener su IP desde un servidor DHCP.

Como mi cutre-router no me da información de las IP asignadas usamos *nmap*:

```
nmap -sP 192.168.0.0 /24
```

Con eso averiguamos la IP asignada a la *Orange Pi Zero* y ya podemos hacer login con el siguiente comando <sup>1</sup>:

```
ssh root@192.168.0.109
```

¡Y ya estamos!

---

<sup>1</sup>La password por defecto de Armbian es **1234**, nos pedirá cambiarla en el primer login.



```
Encryption key:off
Power Management:on
```

```
eth0      no wireless extensions.
```

Todo tiene buena pinta, vamos a ver si detecta WIFIs:

```
root@orangezero:~# iwlist wlan0 scan |grep ESSID
      ESSID:"wificlientesR"
      ESSID:"casa_de_verano"
      ESSID:"MOVISTAR_BEEF"
      ESSID:"wificlientesR"
      ESSID:"R-wlan90"
      ESSID:"MOVISTAR_BAAF"
      ESSID:"ababab"
      ESSID:"WLAN 77"
      ESSID:"castillo"
      ESSID:"unaWifi"
      ESSID:""
      ESSID:"mikasa"
```

Para configurar el wifi echamos un ojo al fichero /etc/network/interfaces pero en ese mismo fichero encontramos el aviso:

```
# Armbian ships with network-manager installed by default. To save you time
# and hassles consider using 'sudo nmtui' instead of configuring Wi-Fi settings
# manually.
```

Así que basta con ejecutar `sudo nmtui` y ya podemos dar de alta nuestra wifi (yo la prefiero con IP estática).

Ejecutamos `ifconfig` y ya vemos nuestro nuevo interface configurado:

```
ifconfig
```

```
wlan0    Link encap:Ethernet  HWaddr a4:7c:f2:9a:97:7c
          inet addr:192.168.0.120  Bcast:192.168.0.255  Mask:255.255.255.0
          inet6 addr: fe80::a67c:f2ff:fe9a:977c/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:2 errors:0 dropped:0 overruns:0 frame:0
          TX packets:8 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:328 (328.0 B)  TX bytes:852 (852.0 B)
```

Edit Connection

Profile name

mikasa

Device

WI-FI

SSID

mikasa

Mode

<Client>

Security

<WPA & WPA2 Personal>

Password

\*\*\*\*\*

☐ Show password

BSSID

Cloned MAC address

MTU

(default)

IPv4 CONFIGURATION

<Manual>

<Hide>

Addresses

192.168.0.120/24

<Remove>

<Add...>

Gateway

192.168.0.1

DNS servers

8.8.8.8

<Remove>

4.4.4.4

<Remove>

<Add...>

Figura 2: Configuración WIFI

## 2 Orange Pi Zero, características técnicas

La tarjeta de desarrollo Orange Pi Zero viene equipada con un procesador Cortex A7 Allwinner H2+ quad core, con 256 o 512MB RAM, Ethernet, y puertos USB. Disponible en Aliexpress (tienda oficial) por 6.99 dolares, mas 3.39 dolares como gastos de envío.

### 2.1 Especificaciones

- SoC – Allwinner H2(+) quad core Cortex A7 processor @ 1.2 GHz with Mali-400MP2 GPU @ 600 MHz
- System Memory – 256 to 512 MB DDR3-1866 SDRAM
- Storage – micro SD card slot
- Connectivity – 10/100M Ethernet + 802.11 b/g/n WiFi (Allwinner XR819 WiFi module) with u.FL antenna connector and external antenna
- USB – 1x USB 2.0 host ports, 1x micro USB OTG port
- Expansion headers – Unpopulated 26-pin “Raspberry Pi B+” header + 13-pin header with headphone, 2x USB 2.0, TV out, microphone and IR receiver signals
- Debugging – Unpopulated 3-pin header for serial console
- Misc – 2x LEDs
- Power Supply – 5V via micro USB port or optional PoE
- Dimensions – 52 x 46 mm
- Weight – 26 grams

### 2.2 Esquema de pines

Un excelente esquema de pines puede conseguirse en [OSHLab](#)

### 2.3 Esquemas eléctricos

Pueden bajarse de [aquí](#)

## 3 Accediendo al hardware desde linea de comandos

La memoria es más que suficiente para correr programas. El Armbian consume únicamente 40Mb en funcionamiento.

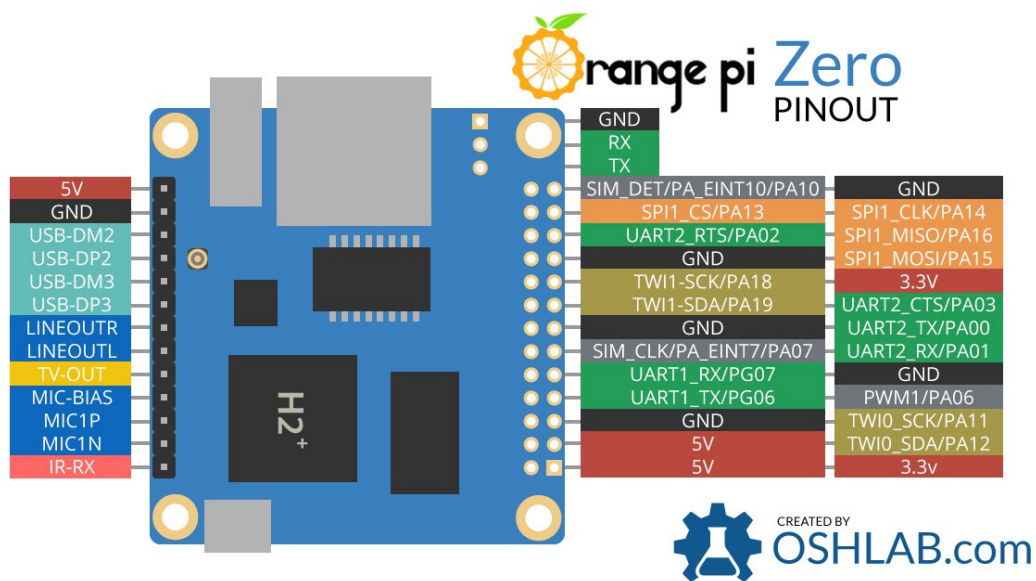


Figura 3: Pineado Orange Pi

```
root@orangepizero:~# free
```

	total	used	free	shared	buffers	cached
Mem:	247068	122300	124768	4620	7908	69548
-/+ buffers/cache:		44844	202224			
Swap:	131068	0	131068			

Vamos a hacer algunas pruebas con el hardware. En Armbian, como todo Unix que se precie, todo es un fichero.

En el directorio `/sys/class` encontraremos cosas interesantes:

```
root@orangepizero:~# ls /sys/class
```

```
backlight  cuse      graphics  i2c-dev  mdio_bus  power_supply  script  spidev      thermal  v
bdi        devfreq  hdmi      ieee80211  mem       ppp           scsi_device  spi_master  tty      vtconsole
block      disp     hidraw    input     misc      rc            scsi_disk   sunxi_cma_test  udc
bsg        dma      hwmon     leds      mmc_host  rfkill        scsi_host   sunxi_dump  usb_device
cedar_dev  gpio     i2c-adapter  lirc      net       rtc           sound       sunxi_info  vc
```

### 3.1 LEDs

Si miramos dentro del directorio `leds` veremos que hay un directorio que representa cada uno de los leds de la placa:



```
root@orangepizero:~# cd /sys/class/leds/  
root@orangepizero:/sys/class/leds# ls  
green_led  red_led
```

Podemos ver, por ejemplo, a que evento está asociado cada led ejecutando `cat green_led/trigger` (tiene el valor `default-on`) o `cat red_led/trigger` (tiene el valor `none`).

```
root@orangepizero:/sys/class/leds# cat green_led/trigger  
none mmc0 mmc1 timer heartbeat backlight [default-on] rfkill0 phy1rx phy1tx phy1assoc phy1radio  
root@orangepizero:/sys/class/leds# cat red_led/trigger  
[none] mmc0 mmc1 timer heartbeat backlight default-on rfkill0 phy1rx phy1tx phy1assoc phy1radio
```

O podemos encender el led rojo ejecutando `echo 1 > red_led/brightness`, y para apagarlo ya os podéis imaginar que es `echo 0 > red_led/brightness`.

## 3.2 GPIO

Podemos ver los GPIO disponibles ejecutando:

```
root@orangepizero:~# cat /sys/kernel/debug/gpio  
GPIOs 0-383, platform/sunxi-pinctrl, sunxi-pinctrl:  
gpio-10 (? ) out hi  
gpio-17 (red_led ) out lo  
gpio-202 (xradio_irq ) in lo  
gpio-354 (? ) out hi  
gpio-362 (green_led ) out hi
```

Podemos activar un nuevo puerto GPIO, digamos el 15:

```
root@orangepizero:~# echo 15 >/sys/class/gpio/export
```

Ahora veremos el puerto activo:

```
root@orangepizero:~# cat /sys/kernel/debug/gpio  
GPIOs 0-383, platform/sunxi-pinctrl, sunxi-pinctrl:  
gpio-10 (? ) out hi  
gpio-15 (sysfs ) in lo  
gpio-17 (red_led ) out lo  
gpio-202 (xradio_irq ) in lo  
gpio-354 (? ) out hi  
gpio-362 (green_led ) out hi
```

En el directorio `/sys/class/gpio/gpio15/` tendremos los interfaces usuales para puertos gpio definidos en el kernel de linux.

## 4 Bibliotecas útiles

### 4.1 Python

#### 4.1.1 Instalación de virtualenv

Para probar bibliotecas de Python instalamos:

```
sudo aptitude install python-pip
sudo aptitude install python-virtualenv
sudo aptitude install python-dev
```

El caso es que el virtualenv no me funciona después de ejecutar estos pasos. Finalmente he tenido que ejecutar, como *root*, los siguientes comandos:

```
pip install --upgrade pip
pip install --upgrade virtualenv
```

Después de eso ya he podido usar *virtualenv* sin problemas.

### 4.2 Referencias

- [Probando la Orange Pi Zero](#)
- [GPIO from commandline](#)
- [mas de lo mismo](#)

## 5 Monitorizar temperatura

Podemos ver estadísticas de nuestra OPI con:

```
sudo armbianmonitor -m
```

Stop monitoring using [ctrl]-[c]

Time	CPU	load	%cpu	%sys	%usr	%nice	%io	%irq	CPU
21:04:18:	1152MHz	0.08	0%	0%	0%	0%	0%	0%	40°C
21:04:23:	240MHz	0.07	0%	0%	0%	0%	0%	0%	39°C
21:04:28:	240MHz	0.15	6%	1%	0%	0%	4%	0%	40°C
21:04:33:	240MHz	0.12	6%	1%	0%	0%	4%	0%	38°C
21:04:38:	240MHz	0.11	2%	1%	0%	0%	0%	0%	39°C
21:04:43:	240MHz	0.11	1%	0%	0%	0%	0%	0%	39°C

21:04:49:	240MHz	0.10	1%	0%	0%	0%	0%	0%	38°C
21:04:54:	240MHz	0.09	1%	0%	0%	0%	0%	0%	39°C
21:04:59:	240MHz	0.08	2%	1%	0%	0%	0%	0%	38°C
21:05:04:	240MHz	0.08	2%	1%	0%	0%	0%	0%	38°C
21:05:10:	240MHz	0.07	2%	1%	0%	0%	0%	0%	40°C
21:05:15:	240MHz	0.06	2%	1%	0%	0%	0%	0%	37°C
21:05:20:	240MHz	0.06	2%	1%	0%	0%	0%	0%	39°C
21:05:25:	240MHz	0.05	2%	1%	0%	0%	0%	0%	37°C
21:05:30:	240MHz	0.05	2%	1%	0%	0%	0%	0%	39°C

También podemos instalar RPi-Monitor con el comando:

```
sudo armbianmonitor -r
```

Una vez instalado podemos visitar desde nuestro navegador la dirección ip de nuestra OPI Zero <http://opi-adress:8888> para ver las estadísticas.



Figura 4: Estadísticas en RPi-Monitor

¡Ojo! Las gráficas no se refrescan automáticamente hay que recargar la página.

Para desinstalar el RPi-Monitor basta con:

```
sudo aptitude uninstall rpimonitor
```

## 6 Referencias

- [Página oficial](#)
- [Recursos oficiales](#) aquí hay imágenes y los esquemáticos
- [Tienda en Aliexpress](#)
- [http://linux-sunxi.org/Bootable\\_SD\\_card](http://linux-sunxi.org/Bootable_SD_card)
- <https://www.armbian.com/orange-pi-zero/>
- [https://docs.armbian.com/User-Guide\\_Getting-Started/](https://docs.armbian.com/User-Guide_Getting-Started/)
- [https://docs.armbian.com/Hardware\\_Allwinner/](https://docs.armbian.com/Hardware_Allwinner/)
- [GPIO](#) Una explicación de como acceder al gpio desde terminal
- [Info variada](#) Aquí tenemos el esquema de pines
- [GPIO desde el espacio de usuario](#)
- [sunxi-gpio](#)
- [orange pi español](#)
- [ArchLinux ARM on Orange Pi](#)
- [Lakka Nightly Builds](#) Lakka is the official Linux distribution of RetroArch and the libretro ecosystem. Each game system is implemented as a libretro core, while the frontend RetroArch takes care of inputs and display. This clear separation ensures modularity and centralized configuration. Also nightly build for H3 is supported

## 7 META

Este documento está escrito en [Markdown-Pandoc](#). Pandoc es un sistema muy sencillo de documentación que permite generar múltiples formatos de salida.

Las fuentes del documento están en el directorio **doc/src** dentro del árbol de directorios del proyecto.

Los formatos de salida son el fichero **README.md** en formato *Markdown-Github* y los documentos que puedes encontrar en el directorio **doc/out** incluyendo un fichero en formato *pdf*.

Los documentos en los distintos formatos de salida se generan automáticamente sin mas que ejecutar:

```
$ cd doc
$ make
```

Otras opciones que soporta el **makefile** serían:

**reset** para regenerar todos los documentos de salida.

**clean** para borrar todos los fichero de salida

**pdf, latex, mediawiki, epub, odt, docx** genera el fichero de salida en el formato especificado: pdf, latex, etc. etc.

Ejemplos:

```
$ make reset
```

```
$ make odt
```

## 7.1 Requisitos

Necesitas tener instalado **Pandoc**, hay [una pequeña introducción](#) en el el github de BricoLabs.

## 8 Licencia

Attribution-ShareAlike 4.0 International

=====

Creative Commons Corporation ("Creative Commons") is not a law firm and does not provide legal services or legal advice. Distribution of Creative Commons public licenses does not create a lawyer-client or other relationship. Creative Commons makes its licenses and related information available on an "as-is" basis. Creative Commons gives no warranties regarding its licenses, any material licensed under their terms and conditions, or any related information. Creative Commons disclaims all liability for damages resulting from their use to the fullest extent possible.

Using Creative Commons Public Licenses

Creative Commons public licenses provide a standard set of terms and conditions that creators and other rights holders may use to share original works of authorship and other material subject to copyright and certain other rights specified in the public license below. The following considerations are for informational purposes only, are not exhaustive, and do not form part of our licenses.

Considerations for licensors: Our public licenses are

intended for use by those authorized to give the public permission to use material in ways otherwise restricted by copyright and certain other rights. Our licenses are irrevocable. Licensors should read and understand the terms and conditions of the license they choose before applying it. Licensors should also secure all rights necessary before applying our licenses so that the public can reuse the material as expected. Licensors should clearly mark any material not subject to the license. This includes other CC-licensed material, or material used under an exception or limitation to copyright. More considerations for licensors: [wiki.creativecommons.org/Considerations\\_for\\_licensors](http://wiki.creativecommons.org/Considerations_for_licensors)

Considerations for the public: By using one of our public licenses, a licensor grants the public permission to use the licensed material under specified terms and conditions. If the licensor's permission is not necessary for any reason--for example, because of any applicable exception or limitation to copyright--then that use is not regulated by the license. Our licenses grant only permissions under copyright and certain other rights that a licensor has authority to grant. Use of the licensed material may still be restricted for other reasons, including because others have copyright or other rights in the material. A licensor may make special requests, such as asking that all changes be marked or described. Although not required by our licenses, you are encouraged to respect those requests where reasonable. More considerations for the public: [wiki.creativecommons.org/Considerations\\_for\\_licensees](http://wiki.creativecommons.org/Considerations_for_licensees)

=====

## Creative Commons Attribution-ShareAlike 4.0 International Public License

By exercising the Licensed Rights (defined below), You accept and agree to be bound by the terms and conditions of this Creative Commons Attribution-ShareAlike 4.0 International Public License ("Public License"). To the extent this Public License may be interpreted as a contract, You are granted the Licensed Rights in consideration of Your

acceptance of these terms and conditions, and the Licensor grants You such rights in consideration of benefits the Licensor receives from making the Licensed Material available under these terms and conditions.

#### Section 1 -- Definitions.

- a. Adapted Material means material subject to Copyright and Similar Rights that is derived from or based upon the Licensed Material and in which the Licensed Material is translated, altered, arranged, transformed, or otherwise modified in a manner requiring permission under the Copyright and Similar Rights held by the Licensor. For purposes of this Public License, where the Licensed Material is a musical work, performance, or sound recording, Adapted Material is always produced where the Licensed Material is synched in timed relation with a moving image.
- b. Adapter's License means the license You apply to Your Copyright and Similar Rights in Your contributions to Adapted Material in accordance with the terms and conditions of this Public License.
- c. BY-SA Compatible License means a license listed at [creativecommons.org/compatiblelicenses](https://creativecommons.org/compatiblelicenses), approved by Creative Commons as essentially the equivalent of this Public License.
- d. Copyright and Similar Rights means copyright and/or similar rights closely related to copyright including, without limitation, performance, broadcast, sound recording, and Sui Generis Database Rights, without regard to how the rights are labeled or categorized. For purposes of this Public License, the rights specified in Section 2(b)(1)-(2) are not Copyright and Similar Rights.
- e. Effective Technological Measures means those measures that, in the absence of proper authority, may not be circumvented under laws fulfilling obligations under Article 11 of the WIPO Copyright Treaty adopted on December 20, 1996, and/or similar international agreements.

- f. Exceptions and Limitations means fair use, fair dealing, and/or any other exception or limitation to Copyright and Similar Rights that applies to Your use of the Licensed Material.
- g. License Elements means the license attributes listed in the name of a Creative Commons Public License. The License Elements of this Public License are Attribution and ShareAlike.
- h. Licensed Material means the artistic or literary work, database, or other material to which the Licensor applied this Public License.
- i. Licensed Rights means the rights granted to You subject to the terms and conditions of this Public License, which are limited to all Copyright and Similar Rights that apply to Your use of the Licensed Material and that the Licensor has authority to license.
- j. Licensor means the individual(s) or entity(ies) granting rights under this Public License.
- k. Share means to provide material to the public by any means or process that requires permission under the Licensed Rights, such as reproduction, public display, public performance, distribution, dissemination, communication, or importation, and to make material available to the public including in ways that members of the public may access the material from a place and at a time individually chosen by them.
- l. Sui Generis Database Rights means rights other than copyright resulting from Directive 96/9/EC of the European Parliament and of the Council of 11 March 1996 on the legal protection of databases, as amended and/or succeeded, as well as other essentially equivalent rights anywhere in the world.
- m. You means the individual or entity exercising the Licensed Rights under this Public License. Your has a corresponding meaning.

## Section 2 -- Scope.



a. License grant.

1. Subject to the terms and conditions of this Public License, the Licensor hereby grants You a worldwide, royalty-free, non-sublicensable, non-exclusive, irrevocable license to exercise the Licensed Rights in the Licensed Material to:
  - a. reproduce and Share the Licensed Material, in whole or in part; and
  - b. produce, reproduce, and Share Adapted Material.
2. Exceptions and Limitations. For the avoidance of doubt, where Exceptions and Limitations apply to Your use, this Public License does not apply, and You do not need to comply with its terms and conditions.
3. Term. The term of this Public License is specified in Section 6(a).
4. Media and formats; technical modifications allowed. The Licensor authorizes You to exercise the Licensed Rights in all media and formats whether now known or hereafter created, and to make technical modifications necessary to do so. The Licensor waives and/or agrees not to assert any right or authority to forbid You from making technical modifications necessary to exercise the Licensed Rights, including technical modifications necessary to circumvent Effective Technological Measures. For purposes of this Public License, simply making modifications authorized by this Section 2(a)(4) never produces Adapted Material.
5. Downstream recipients.
  - a. Offer from the Licensor -- Licensed Material. Every recipient of the Licensed Material automatically receives an offer from the Licensor to exercise the Licensed Rights under the terms and conditions of this Public License.

- b. Additional offer from the Licensor -- Adapted Material.  
Every recipient of Adapted Material from You automatically receives an offer from the Licensor to exercise the Licensed Rights in the Adapted Material under the conditions of the Adapter's License You apply.
- c. No downstream restrictions. You may not offer or impose any additional or different terms or conditions on, or apply any Effective Technological Measures to, the Licensed Material if doing so restricts exercise of the Licensed Rights by any recipient of the Licensed Material.

6. No endorsement. Nothing in this Public License constitutes or may be construed as permission to assert or imply that You are, or that Your use of the Licensed Material is, connected with, or sponsored, endorsed, or granted official status by, the Licensor or others designated to receive attribution as provided in Section 3(a)(1)(A)(i).

b. Other rights.

- 1. Moral rights, such as the right of integrity, are not licensed under this Public License, nor are publicity, privacy, and/or other similar personality rights; however, to the extent possible, the Licensor waives and/or agrees not to assert any such rights held by the Licensor to the limited extent necessary to allow You to exercise the Licensed Rights, but not otherwise.
- 2. Patent and trademark rights are not licensed under this Public License.
- 3. To the extent possible, the Licensor waives any right to collect royalties from You for the exercise of the Licensed Rights, whether directly or through a collecting society under any voluntary or waivable statutory or compulsory licensing scheme. In all other cases the Licensor expressly reserves any right to collect such royalties.

### Section 3 -- License Conditions.

Your exercise of the Licensed Rights is expressly made subject to the following conditions.

#### a. Attribution.

1. If You Share the Licensed Material (including in modified form), You must:
  - a. retain the following if it is supplied by the Licensor with the Licensed Material:
    - i. identification of the creator(s) of the Licensed Material and any others designated to receive attribution, in any reasonable manner requested by the Licensor (including by pseudonym if designated);
    - ii. a copyright notice;
    - iii. a notice that refers to this Public License;
    - iv. a notice that refers to the disclaimer of warranties;
    - v. a URI or hyperlink to the Licensed Material to the extent reasonably practicable;
  - b. indicate if You modified the Licensed Material and retain an indication of any previous modifications; and
  - c. indicate the Licensed Material is licensed under this Public License, and include the text of, or the URI or hyperlink to, this Public License.
2. You may satisfy the conditions in Section 3(a)(1) in any reasonable manner based on the medium, means, and context in which You Share the Licensed Material. For example, it may be

reasonable to satisfy the conditions by providing a URI or hyperlink to a resource that includes the required information.

3. If requested by the Licensor, You must remove any of the information required by Section 3(a)(1)(A) to the extent reasonably practicable.

b. ShareAlike.

In addition to the conditions in Section 3(a), if You Share Adapted Material You produce, the following conditions also apply.

1. The Adapter's License You apply must be a Creative Commons license with the same License Elements, this version or later, or a BY-SA Compatible License.
2. You must include the text of, or the URI or hyperlink to, the Adapter's License You apply. You may satisfy this condition in any reasonable manner based on the medium, means, and context in which You Share Adapted Material.
3. You may not offer or impose any additional or different terms or conditions on, or apply any Effective Technological Measures to, Adapted Material that restrict exercise of the rights granted under the Adapter's License You apply.

#### Section 4 -- Sui Generis Database Rights.

Where the Licensed Rights include Sui Generis Database Rights that apply to Your use of the Licensed Material:

- a. for the avoidance of doubt, Section 2(a)(1) grants You the right to extract, reuse, reproduce, and Share all or a substantial portion of the contents of the database;
- b. if You include all or a substantial portion of the database contents in a database in which You have Sui Generis Database Rights, then the database in which You have Sui Generis Database

Rights (but not its individual contents) is Adapted Material,

including for purposes of Section 3(b); and

- c. You must comply with the conditions in Section 3(a) if You Share all or a substantial portion of the contents of the database.

For the avoidance of doubt, this Section 4 supplements and does not replace Your obligations under this Public License where the Licensed Rights include other Copyright and Similar Rights.

#### Section 5 -- Disclaimer of Warranties and Limitation of Liability.

- a. UNLESS OTHERWISE SEPARATELY UNDERTAKEN BY THE LICENSOR, TO THE EXTENT POSSIBLE, THE LICENSOR OFFERS THE LICENSED MATERIAL AS-IS AND AS-AVAILABLE, AND MAKES NO REPRESENTATIONS OR WARRANTIES OF ANY KIND CONCERNING THE LICENSED MATERIAL, WHETHER EXPRESS, IMPLIED, STATUTORY, OR OTHER. THIS INCLUDES, WITHOUT LIMITATION, WARRANTIES OF TITLE, MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, NON-INFRINGEMENT, ABSENCE OF LATENT OR OTHER DEFECTS, ACCURACY, OR THE PRESENCE OR ABSENCE OF ERRORS, WHETHER OR NOT KNOWN OR DISCOVERABLE. WHERE DISCLAIMERS OF WARRANTIES ARE NOT ALLOWED IN FULL OR IN PART, THIS DISCLAIMER MAY NOT APPLY TO YOU.
- b. TO THE EXTENT POSSIBLE, IN NO EVENT WILL THE LICENSOR BE LIABLE TO YOU ON ANY LEGAL THEORY (INCLUDING, WITHOUT LIMITATION, NEGLIGENCE) OR OTHERWISE FOR ANY DIRECT, SPECIAL, INDIRECT, INCIDENTAL, CONSEQUENTIAL, PUNITIVE, EXEMPLARY, OR OTHER LOSSES, COSTS, EXPENSES, OR DAMAGES ARISING OUT OF THIS PUBLIC LICENSE OR USE OF THE LICENSED MATERIAL, EVEN IF THE LICENSOR HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH LOSSES, COSTS, EXPENSES, OR DAMAGES. WHERE A LIMITATION OF LIABILITY IS NOT ALLOWED IN FULL OR IN PART, THIS LIMITATION MAY NOT APPLY TO YOU.
- c. The disclaimer of warranties and limitation of liability provided above shall be interpreted in a manner that, to the extent possible, most closely approximates an absolute disclaimer and waiver of all liability.

Section 6 -- Term and Termination.

- a. This Public License applies for the term of the Copyright and Similar Rights licensed here. However, if You fail to comply with this Public License, then Your rights under this Public License terminate automatically.
- b. Where Your right to use the Licensed Material has terminated under Section 6(a), it reinstates:
  - 1. automatically as of the date the violation is cured, provided it is cured within 30 days of Your discovery of the violation; or
  - 2. upon express reinstatement by the Licensor.

For the avoidance of doubt, this Section 6(b) does not affect any right the Licensor may have to seek remedies for Your violations of this Public License.

- c. For the avoidance of doubt, the Licensor may also offer the Licensed Material under separate terms or conditions or stop distributing the Licensed Material at any time; however, doing so will not terminate this Public License.
- d. Sections 1, 5, 6, 7, and 8 survive termination of this Public License.

Section 7 -- Other Terms and Conditions.

- a. The Licensor shall not be bound by any additional or different terms or conditions communicated by You unless expressly agreed.
- b. Any arrangements, understandings, or agreements regarding the Licensed Material not stated herein are separate from and independent of the terms and conditions of this Public License.

Section 8 -- Interpretation.

- a. For the avoidance of doubt, this Public License does not, and shall not be interpreted to, reduce, limit, restrict, or impose conditions on any use of the Licensed Material that could lawfully be made without permission under this Public License.
- b. To the extent possible, if any provision of this Public License is deemed unenforceable, it shall be automatically reformed to the minimum extent necessary to make it enforceable. If the provision cannot be reformed, it shall be severed from this Public License without affecting the enforceability of the remaining terms and conditions.
- c. No term or condition of this Public License will be waived and no failure to comply consented to unless expressly agreed to by the Licensor.
- d. Nothing in this Public License constitutes or may be interpreted as a limitation upon, or waiver of, any privileges and immunities that apply to the Licensor or You, including from the legal processes of any jurisdiction or authority.

=====

Creative Commons is not a party to its public licenses. Notwithstanding, Creative Commons may elect to apply one of its public licenses to material it publishes and in those instances will be considered the "Licensor." The text of the Creative Commons public licenses is dedicated to the public domain under the CC0 Public Domain Dedication. Except for the limited purpose of indicating that material is shared under a Creative Commons public license or as otherwise permitted by the Creative Commons policies published at [creativecommons.org/policies](https://creativecommons.org/policies), Creative Commons does not authorize the use of the trademark "Creative Commons" or any other trademark or logo of Creative Commons without its prior written consent including, without limitation, in connection with any unauthorized modifications to any of its public licenses or any other arrangements, understandings, or agreements concerning use of licensed material. For the avoidance of doubt, this paragraph does not form part of the

public licenses.

Creative Commons may be contacted at [creativecommons.org](https://creativecommons.org).