Appendix B
Raspberry Pi Camera Module Quick Reference

THE RASPBERRY PI Camera Module comes with software designed to capture still images and videos, each of which has a variety of options that can control the final output. Options for `raspistill` and `raspivid` are included in this appendix. For more information, see Chapter 15, "The Raspberry Pi Camera Module".

Shared Options

The following options, listed in alphabetical order, are shared between `raspistill` and `raspivid`. For application-specific options, see the individual `raspistill` and `raspivid` entries later in this appendix.

- **-? or --help (Help)**—Displays all options and their uses.
- **-a or --annotate**—Allows for text annotations to be applied to videos or images. Any text provided in quotes following this option will be printed on all images or videos captured, or the following bit fields (used in the form of -a N or --annotate N, where N is one of the following numbers or the sum of two or more numbers if multiple fields are desired) can be used to print other information or change how the text is displayed:
  - 1—Prints the text supplied by the user on the command line.
  - 2—Prints the text supplied by an application calling the utility as a module.
  - 4—Prints the current date.
  - 8—Prints the current time.
  - 16—Prints the camera's shutter settings.

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- 32—Prints the camera's CAF settings.
- 64—Prints the camera's gain settings.
- 128—Prints the camera's lens settings.
- 256—Prints the camera's motion settings.
- 512—Prints the current frame number.
- 1024—Uses a black background.

- **-ae or –annotateex**—Controls the appearance of text annotations, in the format: size, text-colour, background-colour, with colours specified in hexadecimal YUV format and sizes from 6 to 160 (default 32) available.
- **-awb or --awb (Automatic White Balance)**—Sets the colour temperature of the captured image or video according to one of a series of preset configurations. If your image or video appears blue or orange, try adjusting this option first. Possible values for this option are `off`, `auto`, `sun`, `cloud`, `shade`, `tungsten`, `fluorescent`, `incandescent`, `flash`, and `horizon`.
- **-awbg or –awbgains**—Sets the blue and red channel gains which should be applied when the automatic white balance is set to off, specified as a floating-point number.
- **-br or --brightness (Brightness)**—Adjusts the brightness of the captured image or video. Possible values for this option are whole numbers ranging from 0 (minimum brightness) to 100 (maximum brightness).
- **-cfx or --colfx (Colour Effects)**—Allows the user to adjust the YUV colour space for fine-grained control of the final image. Values should be given as `U:V`, where `U` controls the chrominance and `V` the luminance. A value of `128:128` will result in a greyscale image.
- **-co or --contrast (Contrast)**—Adjusts the contrast of the captured image or video. Possible values for this option are whole numbers ranging from –100 (minimum contrast) to 100 (maximum contrast).
- **-d or --demo (Demonstration Mode)**—The `-d` option runs either `raspistill` or `raspivid` in demonstration mode, which displays a preview that cycles through various camera options. In this mode, no image is captured—even if you specify an output file using the `--output` option.
- **-drc or --drc (Dynamic Range Control)**—Modifies the image by increasing the range available for capturing darker image areas and decreasing the range available for lighter areas, boosting the image visibility in low-light conditions. Possible values are `off`, `low`, `medium`, and `high`.

- **-ev or --ev (Exposure Value)**—Allows the camera to increase or decrease its exposure value, brightening or darkening the captured image or video. Unlike the brightness and contrast settings, which apply post-capture modifications to the image, this affects the actual capturing of the image or video. Possible values are `-10` to `10`, with `0` being the default.
- **-ex or --exposure (Exposure Mode)**—Sets the camera's automatic exposure setting, which controls how long the camera spends capturing an individual image or frame and is largely a factor of available light or the speed of the subject: fast-moving objects need a short exposure time in order to remain in focus, while low-light shooting demands a long exposure time. Possible values for this option are: `off`, `auto`, `night`, `nightpreview`, `backlight`, `spotlight`, `sports`, `snow`, `beach`, `verylong`, `fixedfps`, `antishake`, `fireworks`.
- **-f or --fullscreen (Fullscreen Preview)**—Makes the preview image fill the screen, overriding any other preview option you may have set.
- **-h or --height (Height)**—Specifies the height, or vertical resolution, of the captured image or video. This should be set to the desired height in pixels; for example, a Full HD capture would require a height value of 1080. The minimum value is 64; the maximum depends on whether video or still images are being captured and on the model (5 megapixel or 8 megapixel) of camera in use.
- **-hf or --hflip (Horizontal Flip)**—Flips the captured image or video along its horizontal axis, as though it has been viewed in a mirror.
- **-ifx or --imxfx (Image Effects)**—Enables one of a number of preconfigured special effects on the image or video. Possible values for this option are `none`, `negative`, `solarise`, `sketch`, `denoise`, `emboss`, `oilpaint`, `hatch`, `gpen`, `pastel`, `watercolour`, `film`, `blur`, `saturation`, `colourswap`, `washedout`, `posterise`, `colourpoint`, `colourbalance`, `cartoon`. These settings can be seen in action using the Demonstration Mode option.
- **-ISO or --ISO (ISO Sensitivity)**—Sets the camera's sensitivity to light. A lower ISO value provides a clearer image, but requires longer exposures; a higher ISO value can shoot at very low exposure times to capture fast-moving or badly lit subjects, but creates a *noisier* image. Values from 100 to 800 are supported.
- **-k or --keypress (Keypress Capture Mode)**—Captures images or video when the Enter key is pressed, rather than automatically. When capturing still images, one image will be taken on each key press; when capturing video, Enter will toggle between record and pause modes. In both cases, pressing the X key followed by Enter will quit the application and stop the capture process.

- **-md or --mode (Sensor Mode)**—Sets the sensor mode, which controls resolution, aspect ratio, frame rates, field of view (FoV), and binning.
  - 0—Automatically chooses the appropriate mode.
  - 1—Selects 1920x1080 (Full HD) 16:9 mode with 1-30fps framerate, partial FoV, and no binning.
  - 2—Sets a 2592x1944 4:3 mode with 1-15fps framerate, full FoV, and no binning.
  - 3—Sets a 2592x1944 4:3 mode with a 0.1666-1fps framerate, full FoV, and no binning.
  - 4—Sets a 1296x972 4:3 mode with 1-42fps framerate, full FoV, and 2x2 binning.
  - 5—Sets a 1296x730 16:9 mode with 1-49fps framerate, full FoV, and 2x2 binning.
  - 6—Sets a 640x480 4:3 mode with 42.1-60fps framerate, full FoV, and 2x2 plus sklp binning.
  - 7—Sets a 640x480 4:3 mode with 60.1-90fps framerate, full FoV, and 2x2 plus skip binning.
- **-mm or --metering (Metering Mode)**—Sets the light metering mode for image or video capture, which controls the automatic exposure, white balance and ISO sensitivity options. Possible values for this option are `average`, `spot`, `backlit`, `matrix`.
- **-n or --nopreview (No Preview)**—Does not display a preview window while capturing.
- **-o or --output (Output File)**—Sets the name of the file to be saved. The value for this option can be either a filename, in which case the file will be created in the current directory, or an absolute path. If you are using `raspistill` or `raspivid` along with another application that expects image or video data through standard input, you can divert the data through standard output by using a hyphen (`-`) character as the filename.
- **-op or --opacity (Preview Opacity)**—Controls how transparent the preview window appears. Possible values are any whole number from 0 to 255, where 0 is completely transparent and thus invisible and 255 is completely visible. Using a value around 128 allows you to see the live preview, but also read the text behind the preview.
- **-p or --preview (Preview Window Control)**—Sets the size of the preview window and where it appears. The value should be given as `X,Y,W,H`—where `X` and `Y` are the pixel coordinates where the window's top-left corner should be drawn, and `W` and `H` the width and height of the preview window in pixels, respectively.

- **-roi or --roi (Region of Interest)**—Allows part of the camera sensor to be specified as the capture source, rather than the entire sensor—effectively cropping the captured image. This option takes floating-point normalised XY coordinates between 0.0 and 1.0. To use the quarter of the sensor at the upper left, for example, the values 0,0,0.25,0.25 should be used.
- **-rot or --rotation (Rotate Capture)**—Rotates the captured image or video through any arbitrary angle. Values for this option should be given as a whole number of clockwise degrees, where 0 is no rotation and 359 the maximum possible rotation. Values given will be rounded down to the nearest 90 degrees, giving actual rotations of 0, 90, 180, and 270 degrees.
- **-sa or --saturation (Saturation)**—Adjusts the colour saturation of the captured image or video. Possible values for this option are whole numbers ranging from –100 (minimum saturation) to 100 (maximum saturation).
- **-sh or --sharpness (Sharpness)**—Adjusts the sharpness of the captured image or video. Possible values for this option are whole numbers ranging from –100 (minimum sharpness) to 100 (maximum sharpness).
- **-sh or --sharpness (Signal Mode)**—Controls the capture of images or video through a USR1 signal, sent from another process on the system. Toggles capture or recording in the same way as the Keypress Mode option.
- **-ss or --shutter (Shutter Speed)**—Manually controls the speed of the camera's shutter in microseconds, up to a limit of 6000000us (6 seconds).
- **-st or --stats (Statistics Display)**—Displays statistics regarding the capture, including exposure, gains, and white-balance settings, during the capture process.
- **-t or --timeout (Capture Timeout)**—Controls the timeout, in milliseconds, that the preview window will appear. While shared between the tools, the action of the `--timeout` option is different: in `raspistill`, the `--timeout` option will set the time until the picture is captured; in `raspivid`, the option will set the time for which video will be recorded. A value of 0 in `raspistill` will display the preview indefinitely and never capture an image; a value of 0 in `raspivid` continues to record indefinitely. If not specified, the timeout defaults to 5 seconds (i.e., 5000 milliseconds).
- **-v or --verbose (Verbose Messaging)**—Verbose mode tells the capture application to output as much detail as possible about what it is doing to the console or terminal. This is generally used only for debugging errors in the software, as it allows the user to see at what point the capture fails.
- **-vf or --vflip (Vertical Flip)**—Flips the image through the vertical axis. Most commonly used when the camera cannot be positioned the correct way up, with the connecting ribbon cable exiting from the bottom. If the camera is at an angle other than upside down, try using the rotation option to control the final captured image.

- **-vs or --vstab (Video Stabilisation)**—Attempts to correct for the camera's sensor shaking. Commonly used when the Raspberry Pi or its Camera Module is held in the hand or attached to a robot, vehicle, or other moving platform.
- **-w or --width (Width)**—Specifies the width, or horizontal resolution, of the captured image or video. This should be set to the desired width in pixels; for example, a Full HD capture would require a width value of 1920. The minimum value is 64; the maximum depends on whether a still image or a video is being captured.

Raspistill Options

Designed to capture still images, `raspistill` has some specific options that do not apply to `raspivid`. Those options are listed here:

- **-bm or --burst (Burst Capture Mode)**—Captures multiple still images without switching the camera back into preview mode, which prevents dropped frames while capturing images on a short delay.
- **-dt or --datetime (Date Time Mode)**—When capturing multiple images, uses the current date and time in the filename (in YearMonthDayHourMinuteSecond format) instead of an incrementing frame number.
- **-e or --encoding (Encoding Format)**—Sets the format of the output image. This does not affect the file extension of the output file, which must be changed manually using the `--output` option. Possible values for this option are `jpg`, `bmp`, `gif`, and png.
- **-fp or –fullpreview (Full Preview Mode)**—Uses the same resolution for the live preview image as set for the capture. This provides a true what-you-see-is-what-you-get representation of the capture, but is limited to 15 frames per second. It also eliminates the sensor switching delay during rapid capture in much the same way as the Burst Mode option; the two do not need to be used together.
- **-fs or –framestart (Starting Frame Number)**—Specifies the number at which to start counting captured frames, used in the output filename. Can be used to continue an interrupted capture sequence without overwriting any existing files.
- **-g or –gl (GL Texture Preview)**—Draws the preview image to a GL texture rather than using the video renderer component.
- **-gc or –glcapture (Save GL Framebuffer)**—Saves the GL framebuffer data rather than the camera image.
- **-gs or –glscene (GL Scene Render)**—Renders the user's choice of GL ES 2.0 scene using the image data from the camera.

- **-gw or –glwin (GL Window)**—Draws a GL ES 2.0 window, specified as single-quote-enclosed coordinates for the upper-left corner followed by width and height (for example, '0,0,1920,1080').
- **-l or –latest (Link to Latest Image)**—Creates a file-system link to the most recently captured image using a user-supplied filename.
- **-q or --quality (JPEG Quality)**—Sets the compression level of the saved JPEG, and has no effect when using any other encoding format. The lower the value, the smaller the final image file; a value of 100 will provide the best possible quality, while a value of 0 will provide the smallest file size. A value of 90 is a good trade-off between size and quality.
- **-r or --raw (Save Bayer Data)**—Saves the output of the camera's Bayer colour filter as metadata in the JPEG image and has no effect when using any other encoding format. This extra data, the output of the camera's sensor without interpolation, can be used in image editing applications to reconstruct a higher quality or more detailed image, but is not normally required.
- **-th or --thumb (Thumbnail Settings)**—Sets the size and quality of the thumbnail saved with JPEG images and has no effect when used with any other encoding format. The value should be given as X:Y:Q, where X is the width, Y the height, and Q the JPEG quality from 0 to 100 of the thumbnail, or give the value `none` to turn off thumbnails.
- **-tl or --timelapse (Timelapse Mode)**—Puts `raspistill` into timelapse mode, where images will be captured at a set interval. Most useful when using `raspistill` with a script or third-party application by setting the Output file to the standard output with a hyphen (-) character; when used with a filename in the `--output` option, the file will be overwritten every time a new image is captured. The value for this option should be the delay between captures in milliseconds. `raspistill` will still terminate after --`timeout` seconds.
- **-ts or --timestamp (Timestamp Mode)**—When capturing multiple images, uses the current date and time in the filename (in UNIX timestamp format) instead of an incrementing frame number.
- **-x or --exif (EXIF Tag)**—Allows custom Exchangable Image File Format (EXIF) tags to be written to a JPEG image and has no effect when used with any other encoding formats. Tags should be formatted as 'key=value' with one possible example being setting the name of the photographer using `-x 'Author=Gareth Halfacree'`. Or give the setting --`x none` to turn off EXIF tags.

Raspivid Options

Designed to capture moving images, `raspivid` has some specific options that do not apply to `raspistill`. Those options are listed here:

- **-b or --bitrate (Encoding Bitrate)**—Sets the bitrate of the captured video, in bits per second (BPS). The higher the bitrate, the higher the quality of the finished video—but the larger the file size. Unless you have a specific requirement from your video, this should typically be left at the default setting.
- **-c or --circular (Circular Buffer)**—Constantly records video into a memory buffer, writing the most recent chunk (specified by the `-t` or `--timeout` option) to disk when the Enter key is pressed or a USR1 signal is received.
- **-cd or --codec (Codec)**—Chooses between two possible recording codecs: H264 (the default) or MJPEG.
- **-e or --penc (Encoding Preview)**—Uses the preview window to show video frames after they have been passed through the encoder, rather than before. Provides an accurate preview of the final video and is most commonly used when tweaking the Encoding Bitrate.
- **-fl or --flush (Flush Buffers)**—Flushes buffers as a way to reduce latency.
- **-fps or --framerate (Video Framerate)**—Sets the frame rate of the captured video, in frames per second. Higher figures give smoother motion, while lower figures take up less disk space. Recording at a rate above 30 frames per second, which can be turned into slow-motion video with a video editing application, will likely work only at lower resolutions (set with the `--width` and `--height` options).
- **-g or --intra (Intra Refresh Period)**—Sets how often a key frame, also known as an *intra-coded picture* or *I frame*, should be captured. A key frame is an entire image, rather than the changes recorded since the last image. More frequent key frames can result in higher quality video when recording rapidly changing scenes, but will result in larger file sizes.
- **-i or --initial (Initial Mode)**—Controls which mode `raspivid` will be in when it launches: record (default) or pause.
- **-if or --irefresh (Intra Refresh Type)**—Sets the type of key frame that should be used, from a choice of cyclic, adaptive, both, and cyclicrows.
- **-ih or --inline (Inline Headers)**—Inserts inline (SPS, PPS) headers into the video stream.
- **-pf or --profile (Codec Profile)**—Chooses a profile to use when encoding video with the H264 codec, from baseline, main, and high.

- **-pts or –save-pts (Timestamps)**—Saves timestamps to the output video file, which can be used by `mkvmerge`.
- **-qp or --qp (Quantisation)**—Enables quantisation with a parameter value, which should be set between 10 and 40, with 0 (the default) disabling quantisation.
- **-sg or --segment (Segmented Output)**—Segments the output into multiple files, with the length of each file to be specified in milliseconds.
- **-sn or --start (Segment Start)**—`Specifies` a segment number at which segmented output should begin, rather than the default of 1.
- **-sp or --split (Split)**—When using a key- or signal-based trigger mode or the timed mode, the split option will begin a fresh file for each time the software is placed into record mode, rather than appending the footage to the end of the existing file.
- **-td or --timed (Timed Mode)**—Continuously switches between recording and pause modes based on times provided in milliseconds in the format record,pause (so to record for 30 seconds then pause for a minute, the option would be -td 30000,60000).
- **-wr or --wrap (Segment Wrap)**—Specifies a segment number after which the software should wrap back to the first segment and begin overwriting existing files.
- **-x or --vectors (Output Motion Vectors)**—Outputs the inline motion vectors to the specified filename.