

LINTEST SYSTEMS

PiCapture™ HD1

High Definition Video Capture for the Raspberry Pi®

User Documentation: v1.0

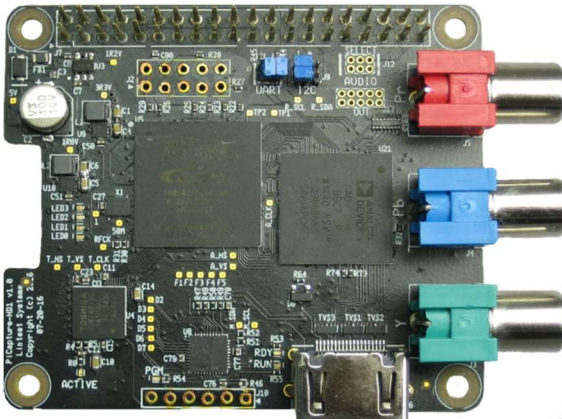
PiCapture™ HD1

High Definition Video capture solution for the Raspberry Pi®

Overview

PiCapture is a unique video capture solution that enables all of the video processing capability of the Raspberry Pi Graphics Processing Unit (GPU). By using the Raspberry Pi CSI-2 camera interface and providing complete camera emulation, all of the video encoding and management capabilities of the Raspberry Pi are usable with any compatible video source. In addition, applications that require large amounts of Raspberry Pi resources (e.g. real-time image processing) are now enabled since CPU intensive USB capture devices are not required.

The PiCapture HD1 captures high-definition progressive video from HDMI or YPbPr Component sources at 480p, 720p, and 1080p resolutions.



PiCapture HD1

The PiCapture board is compatible with the “HAT” form factor and plugs directly into I/O header of the Raspberry Pi. Standoffs and screws are supplied for securely mounting the PiCapture to the Raspberry Pi as shown above. A ribbon cable connects to the CSI-2 camera interface.

Power is provided through the Raspberry Pi, with a standard 5V AC Adapter. Pass-through connection header pins are provided for the Raspberry Pi I/O header so that additional devices may be attached.

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PiCapture and PiVideo are trademarks of Lintest Systems

PiCapture HD1 Specifications

PiCapture HD1		
Compatibility	Raspberry Pi 1 A+,B+	Requires 40 pin GPIO connector
	Raspberry Pi 2	
	Raspberry Pi 3	
Physical Dimensions	65mm x 56.5mm	HAT form factor
Interface connectors	40 pin GPIO connector	Pass-through header is provided
	CSI-2 MIPI camera connector	
Power Requirements	5V @ 300 mA	Supplied by Raspberry Pi
Supported Video Formats	480p	640x480 – Camera Mode 6
	720p	1296x730 – Camera Mode 5
	1080p	1920x1080 – Camera Mode 1
Video Inputs	HDMI	
	YPbPr Component	
Input Connectors	1 HDMI	Standard HDMI connector
	3 RCA/Phono	For component video
Status Indicators	Red “ACTIVE” LED	“Camera active” indicator (same as Raspberry Pi camera)
	Green “RUN” LED	PiCapture Ready indicator
	Blue “READY” LED	Video Active indicator
	Yellow “PGM” LED	Programming / PiVideo Control Active Indicator
	4 Green “FORMAT” LEDs	PiCapture Video Processor source type / status
Configuration Jumpers	UART Select (2x2)	Remove to disconnect from serial port
	I2C Select (3x2)	Select I2C port, or remove to disconnect from both I2C ports
Included Accessories	CSI-2 MIPI interface cable	
	Mounting hardware	Spacers and screws for securing the PiCapture board
Software	PiVideo control software	Used to manage the PiCapture video processor

Hardware Installation

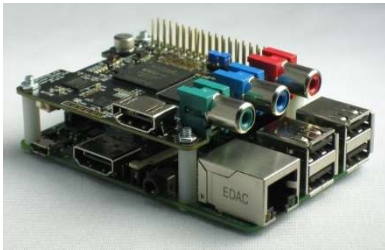
Installing the PiCapture hardware is straightforward:

1. Connect the CSI-2 Ribbon Cable



Hold the PiCapture board above the Raspberry Pi and make sure that it is oriented so that the 40-pin connectors will mate. Pull up on the ribbon cable locking mechanism, insert the ribbon cable, and push down on the locking mechanism to secure the cable.

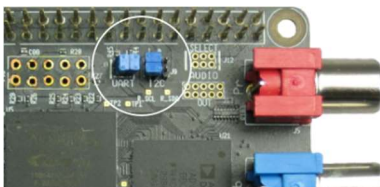
2. Mount the PiCapture board to the Raspberry Pi



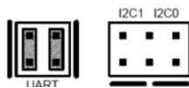
Carefully connect the 40-pin connectors along the side of the boards. Use the provided screws and spacers to secure the PiCapture board to the Raspberry Pi.

Note that the size of the mounting holes may vary slightly, and it may be necessary to gently ream out the holes slightly for the screws to fit.

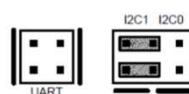
3. Check the interface jumpers



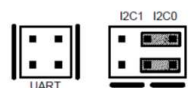
The jumpers used to select the communications mode are located directly behind the red RCA connector. There are two blocks: a 2x2 block used to enable serial communication, and a 2x3 block used to select either I2C0 or I2C1.



The jumpers should be placed vertically on the block marked "UART" for serial communication



The jumpers should be placed horizontally on the left using the pins marked "I2C1" for i2c communication on port 1. This is the default configuration.



The jumpers should be placed horizontally on the right using the pins marked "I2C0" for i2c communication on port 0.

Software Installation

The Raspberry Pi Camera driver must be enabled. Detailed instructions are provided for Raspbian in Appendix A of this document. The process is similar for other operating systems.

The PiCapture board communicates with the Raspberry Pi through the CSI-2 camera interface. In addition, it can be controlled using software provided through either the I2C or Asynchronous Serial Interface ports. This flexibility is provided so that the PiCapture board is compatible with other devices or applications that may require use of these ports. A jumper is used to select the interface port.

The PiVideo™ software, for control of the PiCapture board, provides a Python module that may be used with your software. A command line interface based upon this module is also provided. This software may be downloaded through the Python Package Index (PyPI) or is available at <http://littestsystems.com>.

Using PiCapture

Because PiCapture works by emulating the Raspberry Pi Camera, you can use the same software that you would normally use with a camera. For example, raspivid and the picamera library will both work with PiCapture. There are some important considerations when using this software:

- You should use the status LEDs on the PiCapture board to verify that it is operating properly and receiving video. If the Blue “Video Detected” LED is not lit, you may receive an MMAL error if you attempt to capture video.
- The resolution of the “camera mode” selected should correspond to the resolution of the video source. For PiCapture HD1, the green “Format” LEDs indicate the detected resolution. Please refer to the table below.
- The Raspberry Pi camera drivers will attempt to “correct” the video received as if it were the camera. It will improve the quality of the PiCapture image to disable some of these functions. As an example, the Automatic White Balance function does not generally help with PiCapture.

The following command will show 1080p video in a preview window, with the AWB and exposure control functions turned off: ***raspivid -md 1 -awbg 1.0,1.0 -awb off -ex off -o***
It is recommended that you use these command line switches for the highest quality video captures.

Captured video can be optimized by using other command line switches available in raspivid such as *--sharpness (-sh)*, *--contrast (-co)*, *--brightness (-br)*, and *--saturation (-sa)*. Consult the raspivid documentation for more information.

For some HDMI sources you may consider reducing both the brightness and saturation levels with the PiCapture HD1.

Because the frame rate is dependent upon the video source, playback of a recorded video may not be at the same rate and it will likely appear to be “slowed down”. One way to correct this is with the program “MP4box”, which will package the recorded video with a wrapper that specifies the frame rate.

To install this software, use the command:

```
sudo apt-get install gpac
```

Then, run the program using:

```
MP4Box -fps 60 -add xxx.h264 yyy.mp4
```

This takes an h.264 format video named “xxx” and create an mp4 file named “yyy” with the frame rate specified.

You may also use the PiVideo Control Software to reduce the captured frame rate by half, with the “—skip” option. This will, for example, cause source vide at 60fps to be captured at 30fps which will match the default camera frame rate.

PiCapture has two video inputs, and will attempt to search these inputs for a valid source automatically. As an alternative, you can specify the desired source using the PiVideo control software or from application software using the PiVideo class.

With the PiCapture HD1 you could have:

- A single HDMI video source
- A single YPbPr component video source.

There are several LED indicators on the PiCapture board:

- GREEN** Indicates that the video processor is operating properly
- BLUE** Indicates that input video has been detected and is available to the Raspberry Pi. Note that if you attempt to capture video when the blue light is not on, you may receive an “MMAL” (camera driver) error on the Raspberry Pi. In some cases, it may be necessary to restart the Raspberry Pi in order to recover.
- YELLOW** Indicates that the Raspberry Pi is communicating with the video processor. This light will flash during software updates.

There are also 4 “Format” LEDs (labeled LED0 - LED3) that indicate the video standard detected:

DETECTED MODES	Not Locked	480p	720p	1080i	1080p
LED 0		Flashing	Flashing	Flashing	Flashing
LED 1			On	On	On
LED 2				On	On
LED 3					On
Output		640x480	1296x730	960x540	1920x1080
Mode		6	5	5	1
Comments			Padded from 1280x720	Must set region of interest	

If the camera mode set in the Raspberry Pi does not match the locked video, you may receive an “MMAL” (camera driver) error or see random noise in the captured frame.

1080i Video Sources

Although the PiCapture HD1 is designed for progressive video sources, we have implemented a mode to allow the capture of 1080i video at reduced resolution. The resulting 960x540 video does not correspond to an existing Raspberry Pi camera mode, and capturing this video requires using “Mode 5” and setting the “region of interest” to match the captured resolution using the “-roi” option:

```
raspivid -md 5 -awbg 1.0,1.0 -awb off -ex off -roi 0.0,0.0,0.74,0.74 -o
```

PiVideo Control Software

The PiVideo software may be used to control the PiCapture processor. Some of the functions provided by this software include:

- Automatic or manual video source selection
- Optional on-screen source indication
- Test mode control, including solid color, and color pattern display
- A firmware update utility

By default, the PiVideo software communicates with the PiCapture processor using the Raspberry Pi i2c port 1. If you are using this port for other applications, jumpers may be used to select either i2c port 0 or the serial port as an alternative. The default I2C address is 0x40, and the PiCapture can operate with other I2C slave devices attached to the port. The serial port is required to perform software updates.

PiVideo Commands

There are several arguments for the command line software:

Argument	Possible values	Description
--port, -p	I2c1 , i2c0, serial	Specify the communications port selected by jumpers
--verbose, -v		Show detailed messages
--query, -q		Query the status of the video processor
--source, -s	auto , hdmi, component	Set the video source input. In auto mode, PiCapture will search for video on either input
--slow, -slow		Reduce the captured framerate by half
--update, -u	[filename]	Update the PiCapture software. The serial communications port must be used
--force, -force		Used with --update to force update using downlevel PiCapture software
--effect, -e	none , colors, nomsg	colors shows a fixed display nomsg suppresses source messages in auto source mode
--led, -l	normal , min, off	min shows only the status LEDs off turns off all LEDs
--config, -c	none , save, restore, reset	save writes the current settings to eeprom as new defaults restore reloads the saved settings reset clears saved settings; defaults will be used
--address, -a		Used to specify the I2C address or the serial port device used for communication. Default for serial is /dev/serial0

Example use:

```
pivideo -q           Query the status of the video processor
pivideo -q -v       Query the status, with additional information including the serial number
pivideo -p serial -s component  Select the YPbPr component video source, using serial communications
```


Appendix A: Software setup for PiCapture under Raspbian

The PiCapture HD1 will operate “out of the box” using the Raspberry Pi camera interface and software. At a minimum, the camera interface must be enabled on your Raspberry Pi. For additional control of the various features and options it is necessary to configure the interface and install the control software.

Please note that these procedures are based on the currently released Raspbian code, but there have been changes between releases. If you have difficulty, please consult the Raspberry Pi camera documentation or our website at <http://lintestsystems.com>.

Enabling Camera Support

From the desktop, navigate: “Menu” → “Preferences” → “Raspberry Pi Configuration”

On the “Interfaces” tab:

Make sure that “Camera” is enabled.

Enabling the desired control interface

The serial port interface is required to apply software updates to the PiCapture video processor. The simplest interface to use for all other operations is I2C-1.

From the desktop, navigate: “Menu” → “Preferences” → “Raspberry Pi Configuration”

On the “Interfaces” tab:

If you want to use I2C for control of the PiCapture, make sure “I2C” is enabled.

If you want to use Serial for control of the PiCapture, make sure “Serial” is enabled.

You will need to reboot your Raspberry Pi when prompted for these changes to take effect.

Additional setup for the serial interface

If you want to use Serial for control, you must also disable the serial console interface

Note that the steps needed to disable the serial console interface have changed for various releases of Raspbian. If you receive an error message from PiVideo that it is unable to access the serial port, it is likely that the console or another program is already using the port.

With the Raspberry Pi 3 the device names have changed as well. The PiCapture uses the serial port that is mapped to physical pins 8 and 10 on the 40-pin connector.

Additional setup for the I2C-0 interface

The I2C-1 port will operate without additional configuration, but if you have a conflict and would like to use I2C-0 you must enable application access to that port by adding the following lines to `/boot/config.txt`:

```
dtparam=i2c_arm=on  
dtparam=i2c_vc=on  
device_tree_param=i2c0=on  
device_tree_param=i2c=on
```

Ensure that the jumpers on the PiCapture board are in place to enable the desired I2C port connection.

Installing the PiCapture control software

It is recommended that you use pip to install the control software directly from the PiPy repository. Simply enter:

```
sudo pip install pivideo
```

You can safely ignore error messages as long as the process concludes with “Successfully installed pivideo.”

An alternative is to download the Python package from <http://lintestsystems.com>.

If you will be using the I2C bus to communicate with PiCapture, you will also need to install Python support for I2C with:

```
sudo apt-get install python-smbus
```

I2C port one is the default for PiVideo.

PiCapture HD1 Limited Warranty

Lintest Systems LLC provides a limited warranty for our products for 90 days from the date of first consumer purchase. If the product is not purchased directly from Lintest Systems, a copy of the original dated bill of sale must be presented whenever warranty service is requested.

WHAT IS COVERED BY THIS WARRANTY

Except as specified below, the Lintest Systems warranty covers all defects in material and workmanship. The following are NOT covered: Damage caused by accident, misuse, abuse, product modification, or neglect; damage occurring during shipment; damage from failure to follow instructions contained the owner's guide; damage resulting from the performance of repairs by someone not authorized by Lintest Systems; damage caused by installation of parts that do not conform to Lintest Systems specifications; any claims based on misrepresentations by the seller; products sold on an "as-is" or final sale basis; or the cost of installing, removing, or re-installing the unit.

Lintest Systems liability is limited to the repair or replacement, at our option, of any defective product and shall not include incidental or consequential damages. Lintest Systems reserves the right to replace a discontinued model with a comparable model. Any replacement units or parts may be new or rebuilt.

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