

Beaglebone Intro

Login/Access Test Functions

- Connect to BeagleBone-4D65
- Wifi password: BeagleBone
- Terminal Input

```
ssh mae156@192.168.8.1
```

Password: smear

- Reupload code

```
sudo rm -R blood-smear  
git clone git://github.com/mucolon/blood-smear.git
```

- Run basic smear code

```
sudo python3 blood-smear/test/basic_smear.py
```

- Edit code

```
sudo nano blood-smear/test/basic_smear.py
```

- Shutdown

```
sudo shutdown -h now
```

Linux Commands

Underlined text is your input (ie. yourLogin)

Account Management

- Add new user account

```
sudo useradd -m _yourLogin_
```

- Add user password (You will be prompted to enter your new password)

```
sudo passwd _yourLogin_
```

- Add user to the sudo group

```
sudo usermod -aG sudo _yourLogin_
```

- Edit the /etc/passwd to set terminal to bash instead of dash

```
sudo nano /etc/passwd
```

Add /bin/bash at the very end of the file after the last : of your added username

General

- Shutdown
`sudo shutdown -h now`
- Logout
`logout` or `sudo logout`
- List contents of current directory
`ls`
- Show current directory
`pwd`
- Change directory (folder)
 - `cd _directoryName_`
 - `cd /` (Beaglebone root directory)
 - `cd ~` (User home directory)
 - `cd ..` (Previous directory)
- Make a new directory (folder)
`mkdir _directoryName_`
- Create/Open a text file
`nano _fileName_`
- Create/Open a text file (show line numbers)
`nano -c _fileName_`
- Rename file
`mv _oldFileName_ _newFileName_`
- Remove directory or file
`rm -R _fileName_`
- Superuser login/logout
 - `sudo su` (login)
 - `sudo -s` (login)
 - `exit` (logout)

Troubleshooting

- Resetting remote host ID
`ssh-keygen -R 192.168.8.1`
- Check Debian version
`cat /etc/debian_version`
- Disabling Bluetooth (speeds up boot time)
 Open this file `sudo nano /etc/rc.local`
 File may be blank. Add this below


```
rfkill block bluetooth
```

```
exit 0
```

Networking

Robot Control Library: Networking WiFi

Upgrading Packages (RobotControlLib)

- Update the list of available packages

```
sudo apt update
```

- Upgrade important package

```
sudo apt upgrade apt
```

- Upgrade to the latest version of the RobotControlLib (may be out of date)

```
sudo apt upgrade RobotControlLib
```

- Test if everything is working correctly

```
rc_test_drivers
```

- Making a Program Run on Boot

Robot Control Library: Making a Program Run on Boot

- Background Services

Robot Control Library: Background Services

Hardware

- 5V pins

VDD: input pins to power beaglebone

SYS: output pins to power external components

Running Programs

- Python

```
sudo python3 _programName.py_
```

Python Libraries

```
sudo apt update  
sudo apt install python3 python3-pip python3-numpy  
sudo apt install build-essential python-dev python-pip -y  
sudo pip3 install Adafruit_BBIO  
sudo pip3 install --upgrade Adafruit_BBIO
```

```
sudo apt install autoconf-archive python3-scipy  
sudo pip3 install rcpy
```

GitHub - mucolon/adafruit-beaglebone-io-python: Adafruit's BeagleBone IO Python Library

GitHub - mucolon/rcpy: Python Library for Robotics Cape on Beaglebone Black and Beaglebone Blue

- Interrupts

Detecting Interrupts and Distinguishing between Rising and Falling · Issue #16 · adafruit/adafruit-beaglebone-io-python · GitHub

UART

UART | Setting up IO Python Library on BeagleBone Black | Adafruit Learning System

RoboGoby - ROV/AUV Submersible: April 2014

Extras

- Kill a user's session

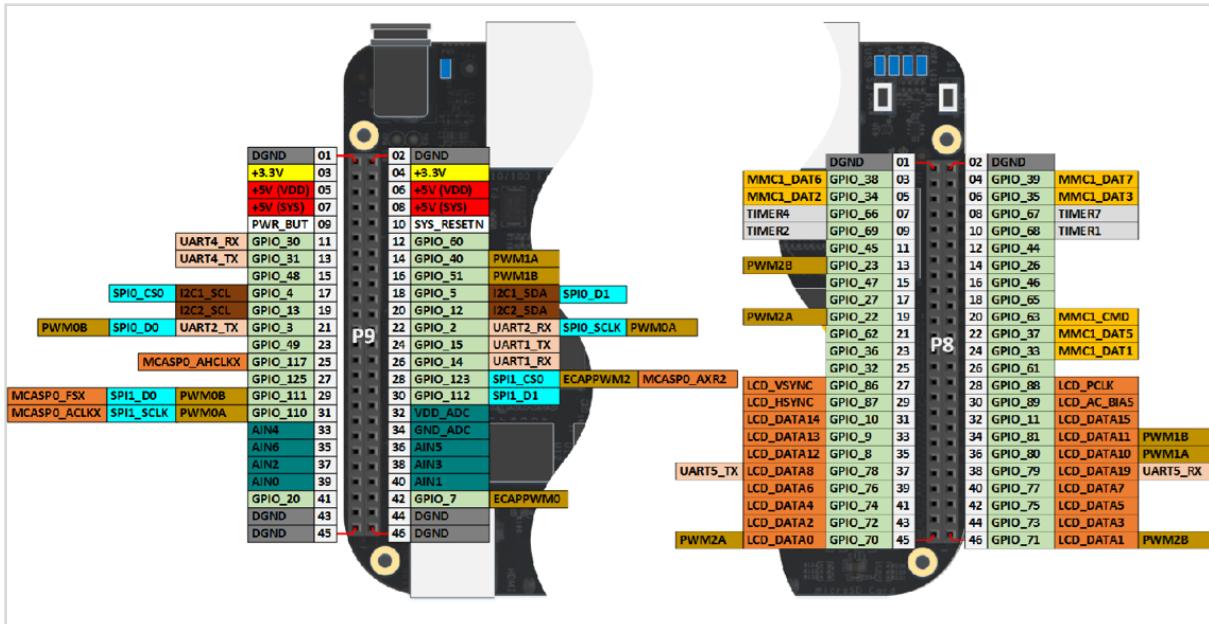
```
sudo pkill -9 -u _userName_
```

apt command	the command it replaces	function of the command
apt install	apt-get install	Installs a package
apt remove	apt-get remove	Removes a package
apt purge	apt-get purge	Removes package with configuration
apt update	apt-get update	Refreshes repository index
apt upgrade	apt-get upgrade	Upgrades all upgradable packages
apt autoremove	apt-get autoremove	Removes unwanted packages
apt full-upgrade	apt-get dist-upgrade	Upgrades packages with auto-handling of dependencies
apt search	apt-cache search	Searches for the program
apt show	apt-cache show	Shows package details

new apt command	function of the command
apt list	Lists packages with criteria (installed, upgradable etc)
apt edit-sources	Edits sources list

Resources

- Pin Setup



https://www.mathworks.com/help/supportpkg/beagleboneio/ug/beaglebone_black_pinmap.png

beaglebone_black_pinmap.png

P8				P9				
	1	2		1	2			
	GND	 	GND		GND	 	GND	
GPIO1_6	P8.3	 	P8.4	GPIO1_7		VDD 3.3V	 	VDD 3.3V
GPIO1_2	P8.5	 	P8.6	GPIO1_3		VDD 5V	 	VDD 5V
GPIO2_2	P8.7	 	P8.8	GPIO2_3		SYS 5V	 	SYS 5V
GPIO2_5	P8.9	 	P8.10	GPIO2_4		PWR_BUT	 	SYS_RESETn
GPIO1_13	P8.11	 	P8.12	GPIO1_12	GPIO0_30	P9.11	 	P9.12 GPIO1_28
GPIO0_23	P8.13	 	P8.14	GPIO0_26	GPIO0_31	P9.13	 	P9.14 GPIO1_18
GPIO1_15	P8.15	 	P8.16	GPIO1_14	GPIO1_16	P9.15	 	P9.16 GPIO1_19
GPIO0_27	P8.17	 	P8.18	GPIO2_1	GPIO0_5	P9.17	 	P9.18 GPIO0_4
GPIO0_22	P8.19	 	P8.20	GPIO1_31	GPIO0_13	P9.19	 	P9.20 GPIO0_12
GPIO1_30	P8.21	 	P8.22	GPIO1_5	GPIO0_3	P9.21	 	P9.22 GPIO0_2
GPIO1_4	P8.23	 	P8.24	GPIO1_1	GPIO1_17	P9.23	 	P9.24 GPIO0_15
GPIO1_0	P8.25	 	P8.26	GPIO1_29	GPIO3_21	P9.25	 	P9.26 GPIO0_14
GPIO2_22	P8.27	 	P8.28	GPIO2_24	GPIO3_19	P9.27	 	P9.28 GPIO3_17
GPIO2_23	P8.29	 	P8.30	GPIO2_25	GPIO3_15	P9.29	 	P9.30 GPIO3_16
GPIO0_10	P8.31	 	P8.32	GPIO0_11	GPIO3_14	P9.31	 	VDD_ADC(1.8V)
GPIO0_9	P8.33	 	P8.34	GPIO2_17	AIN4	P9.33	 	GNDA_ADC
GPIO0_8	P8.35	 	P8.36	GPIO2_16	AIN6	P9.35	 	P9.36 AIN5
GPIO2_14	P8.37	 	P8.38	GPIO2_15	AIN2	P9.37	 	P9.38 AIN3
GPIO2_12	P8.39	 	P8.40	GPIO2_13	AIN0	P9.39	 	P9.40 AIN1
GPIO2_10	P8.41	 	P8.42	GPIO2_11	GPIO0_20	P9.41	 	P9.42 GPIO0_7
GPIO2_8	P8.43	 	P8.44	GPIO2_9		GND	 	GND
GPIO2_6	P8.45	 	P8.46	GPIO2_7		GND	 	GND
	45	46			45	46		

<http://mkaczanowski.com/wp-content/uploads/2014/03/resizedimage600667-hwio-beaglebone-ports2.png>

Beaglebone Black P8 Header

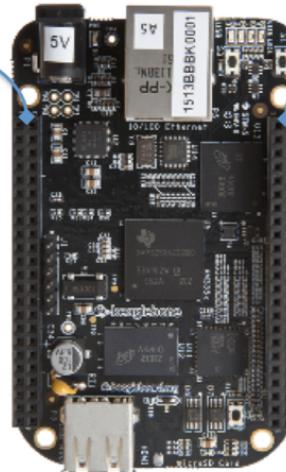
Header_pin	SPINS	ADDR/OFFSET	GPIO NO.	Name	Mode7	Mode6	Mode5	Mode4	Mode3	Mode2	Mode1	Mode0	PIN	Notes
P8_01			GND											Ground
P8_02			GND											Ground
P8_03	6	0x838/018	38	GPIO1_6	gpio[1 6]									
P8_04	7	0x838/01c	39	GPIO1_7	gpio[1 7]									Used on Board (Group: pinmax_emmc2_pins)
P8_05	2	0x808/008	34	GPIO1_2	gpio[1 2]									Used on Board (Group: pinmax_emmc2_pins)
P8_06	3	0x808/00c	35	GPIO1_3	gpio[1 3]									Used on Board (Group: pinmax_emmc2_pins)
P8_07	36	0x838/008	66	TIMER8	gpio[2 3]									Used on Board (Group: pinmax_emmc2_pins)
P8_08	37	0x834/004	67	TIMER7	gpio[2 3]									Used on Board (Group: pinmax_emmc2_pins)
P8_09	39	0x838/00c	69	TIMER8	gpio[2 5]									Used on Board (Group: pinmax_emmc2_pins)
P8_10	38	0x838/008	68	TIMER6	gpio[2 4]									Used on Board (Group: pinmax_emmc2_pins)
P8_11	13	0x834/034	45	SDR_SIO	gpio[2 1]									Used on Board (Group: pinmax_emmc2_pins)
P8_12	12	0x834/030	44	GPIO1_12	gpio[1 12]	pr1_pru0_pru<_30_14	eOP12B_in	mmc1_dat5	gpmc_acd6	R9				Ground
P8_13	9	0x834/024	23	EHPWM2	gpio[2 3]									
P8_14	10	0x828/028	26	GPIO0_26	gpio[2 6]									
P8_15	15	0x838/03c	47	GPIO1_15	gpio[1 15]	pr1_pru0_pru<_31_15	eOP2_trigone_in	mmc2_dat6	mmc1_dat7	gpmc_acd7	T9			Used on Board (Group: pinmax_emmc2_pins)
P8_16	14	0x838/038	46	GPIO1_14	gpio[1 14]	pr1_pru0_pru<_31_14	eOP2_index	mmc2_dat7	mmc1_dat2	gpmc_acd2	R8			Used on Board (Group: pinmax_emmc2_pins)
P8_17	11	0x834/024	22	GPIO1_11	gpio[1 11]									
P8_18	35	0x838/028	65	GPIO1_2	gpio[2 1]									
P8_19	8	0x830/020	22	EHPWM2A	gpio[2 2]									
P8_20	33	0x884/084	63	GPIO1_31	gpio[1 31]	pr1_pru0_pru<_31_13	pr1_pru1_pru<_30_13	mmc2_dat4	mmc1_dat5	gpmc_acd5	U12			
P8_21	5	0x834/034	37	GPIO1_5	gpio[1 5]	pr1_pru1_pru<_31_12	pr1_pru1_pru<_30_12	mmc1_clk	gpmc_be1n	gpmc_cen	V7			
P8_22	4	0x834/030	36	GPIO1_4	gpio[1 4]									
P8_24	1	0x834/004	33	GPIO1_1	gpio[1 1]									
P8_25	0	0x800/000	32	GPIO1_0	gpio[1 0]									
P8_26	31	0x838/07c	61	GPIO1_29	gpio[1 29]									
P8_27	56	0x830/008	86	GPIO2_22	gpio[2 22]	pr1_pru1_pru<_31_8	pr1_pru1_pru<_30_8	gpmc_ac	gpmc_ac1	ldv_vsync	U6			Allocated (Group: npl_hdmi_bonel_pins)
P8_28	58	0x830/008	87	GPIO2_24	gpio[2 24]	pr1_pru1_pru<_31_10	pr1_pru1_pru<_30_10	gpmc_a1	gpmc_a10	ldv_tx	V5			Allocated (Group: npl_hdmi_bonel_pins)
P8_29	57	0x830/004	87	GPIO2_23	gpio[2 23]	pr1_pru1_pru<_31_9	pr1_pru1_pru<_30_9	gpmc_a9	gpmc_a9	ldv_hsync	R5			Allocated (Group: npl_hdmi_bonel_pins)
P8_30	59	0x838/0ec	89	GPIO2_25	gpio[2 25]									Allocated (Group: npl_hdmi_bonel_pins)
P8_31	54	0x830/088	76	GPIO2_13	gpio[1 13]	uart1_ctn	uart1_rx	mmc2_dat5	mcasp0_axr1	eOP1_index	V4			Allocated (Group: npl_hdmi_bonel_pins)
P8_32	55	0x830/0dc	11	UART1_RTS	gpio[1 11]	uart1_rtsn	mcasp0_arx3	mcasp0_axh1x	eOP1B_in	ldc_data15	T5			Allocated (Group: npl_hdmi_bonel_pins)
P8_33	53	0x830/0dc	14	UART1_CTS	gpio[1 14]	uart1_rts	mcasp0_arx1	mcasp0_axh1	eOP1B_out	ldc_data13	V3			Allocated (Group: npl_hdmi_bonel_pins)
P8_34	51	0x830/0ec	81	UART3_RTAN	gpio[2 17]	uart1_rtsn	mcasp0_arx2	mcasp0_axh2	eOP1B_in	ldc_data11	U4			Allocated (Group: npl_hdmi_bonel_pins)
P8_35	52	0x830/0dc	8	UART3_CTSN	gpio[2 8]	uart1_ctsn	mcasp0_axr2	mcasp0_axl1	eOP1A_in	ldc_data12	V2			Allocated (Group: npl_hdmi_bonel_pins)
P8_36	30	0x838/008	80	UART3_TxD	gpio[2 16]	uart1_ctsn	mcasp0_axl1	mcasp0_axr1	eOP1A_out	ldc_data10	U3			Allocated (Group: npl_hdmi_bonel_pins)
P8_37	48	0x830/0dc	79	UART3_RXD	gpio[2 14]	uart2_ctsn	uart2_rx	mmc1_dat4	eOP1m_sync	mcasp1_a12	ldc_data8	U1		Allocated (Group: npl_hdmi_bonel_pins)
P8_38	49	0x830/0dc	79	UART3_RXD	gpio[2 13]	uart2_rx	mcasp1_axr1	mcasp1_axl1	eOP1m_fx	mcasp1_a11	ldc_data9	U2		Allocated (Group: npl_hdmi_bonel_pins)
P8_39	40	0x830/0dc	76	GPIO2_13	gpio[2 13]	uart1_rx	uart1_tx	mmc1_dat6	mcasp1_axr1	ldc_data10	T3			Allocated (Group: npl_hdmi_bonel_pins)
P8_40	47	0x830/0bc	77	GPIO2_13	gpio[1 13]	uart1_pru<_30_7	pr1_pru0_pru<_30_7	mmc1_dat7	gpmc_a7	ldc_data7	T6			Allocated (Group: npl_hdmi_bonel_pins)
P8_41	44	0x830/0bc	74	GPIO2_10	gpio[2 10]	pr1_pru0_pru<_31_4	pr1_pru1_pru<_30_4	mmc1_dat8	eOP2A_in	ldc_data4	T1			Allocated (Group: npl_hdmi_bonel_pins)
P8_42	45	0x830/0bc	75	GPIO2_11	gpio[2 11]	pr1_pru0_pru<_31_5	pr1_pru1_pru<_30_5	mmc1_dat9	eOP2B_in	ldc_data5	T2			Allocated (Group: npl_hdmi_bonel_pins)
P8_43	43	0x830/0bc	78	GPIO2_8	gpio[2 8]	pr1_pru0_pru<_31_2	pr1_pru1_pru<_30_2	mmc1_dat10	eOP2m_sync	ldc12_SDA	R3			Allocated (Group: npl_hdmi_bonel_pins)
P8_44	43	0x830/0bc	73	GPIO2_9	gpio[2 9]	pr1_pru0_pru<_31_3	pr1_pru1_pru<_30_3	mmc1_dat11	gpmc_a3	ldc12_tx	R4			Allocated (Group: npl_hdmi_bonel_pins)
P8_45	40	0x830/0bc	70	GPIO2_10	gpio[2 10]	pr1_pru0_pru<_31_0	pr1_pru1_pru<_30_0	mmc1_dat12	eOP2B_in	ldc12_data0	R1			Allocated (Group: npl_hdmi_bonel_pins)
P8_46	41	0x830/0bc	71	GPIO2_7	gpio[2 7]	pr1_pru0_pru<_31_1	pr1_pru1_pru<_30_1	mmc1_dat13	gpmc_a2	ldc12_data1	R2			Allocated (Group: npl_hdmi_bonel_pins)
P8 Header	cat SPINS	ADDR +	GPIO NO.	Name	Mode 7	Mode 6	Mode 5	Mode 4	Mode 3	Mode 2	Mode 1	Mode 0	CPU	Updates Available at www.derekmolloy.ie
		44e10000	(Mode 7)										PIN	
		Offset from:												
		44e10000												

GPIO Settings														
Bit 6	Bit 5	Bit 4	Bit 3	Bit 2,1,0										
Slew Control	Receiver Active	Pullup/Pulldown	Enable/Pullup/down	Mask Mode										
0 Fast	O Disable	O Pullup	O Pulldown select	000 Mode 0 to 1										
1 Slow	1 Pullup	1 Select	1 Pullup select	111 Mode 7										

e.g. OUTPUT GPIO17(mode7) #0x7 pulldown, #0x17 pullup, #0xF no pullup/down
e.g. INPUT GPIO17(mode7) #0x27 pulldown, #0x37 pullup, #0xF no pullup/down

Header_pin	SPINS	ADDR/OFFSET	GPIO NO.	Name	GPIO NO.	Mode 7	Mode 6	Mode 5	Mode 4	Mode 3	Mode 2	Mode 1	Mode 0	CPU	Notes
P9_01			GND												Ground
P9_02			GND												Ground
P9_03			DC_3_V												250mA Max Current
P9_04			DC_3_V												250mA Max Current
P9_05			VDD_3V												250mA Max Current
P9_06			VDD_3V												250mA Max Current
P9_07			SYS_5V												1A Max Current (only if DC Jack powered)
P9_08			SYS_5V												1A Max Current (only if DC Jack powered)
P9_09			PWR_5V												250mA Max Current
P9_10			PWR_5V												Has a 5V Level (pulled up by TP56217C)
P9_11	28	0x870/070	UART4_RXD	30	gpio[1 30]	uart4_rx	uart4_mux2	mmc1_scl0	rmii2_crs_dv	gpmc_cn4	ml2_crs	RESET_OUT	A10		
P9_12	30	0x870/078	GPIO1_28	60	gpio[1 28]	mcasp0_ackr_mux3	gpmc_dir	mmc1_dat3	gpmc_cn6	ml2_col	gpmc_be1n	T17			
P9_13	29	0x874/010	UART4_RXD	31	gpio[1 31]	uart4_ted_mux2	mmc2_scl0	mmc2_nerr	gpmc_cn5	ml2_cxerr	gpmc_wpt	U17			
P9_14	18	0x844/048	UART4_TXD	50	gpio[1 50]	uart4_tx	ehpmw1_ax1	mmc2_dat3	mmc2_dat1	rmii2_tx0	gpmc_ax1	U18			
P9_15	25	0x844/048	UART4_TXD	48	gpio[1 48]	ehpmw1_trigone_input	mmc2_ax1	mmc2_dat4	mmc2_dat2	rmii2_tx1	gpmc_ax2	U19			
P9_16	19	0x958/156	EHPWM1B	51	gpio[1 51]	ehpmw1_B_mux1	mmc2_ax2	mmc2_dat5	mmc2_dat3	rmii2_tx2	gpmc_ax3	U20			
P9_17	27	0x958/156	I2C1_SCL	52	gpio[1 52]	pr1_uart0_rx	ehpmw0_A	IC2_C_SDA	uart2_rx	sp1_crd	sp1_sdq	D16			
P9_18	86	0x958/154	I2C1_SDA	53	gpio[1 53]	EMU3_mux1	pr1_uart0_tx	IC2_C_SDA	uart2_tx	sp1_crd	sp1_sdq	B17			
P9_19	97	0x958/154	I2C1_SDA	53	gpio[1 53]	pr1_uart0_rx	ehpmw0_B	IC2_C_SDA	uart2_rx	sp1_crd	sp1_sdq	C18			
P9_20	107	0x830/21	I2C1_SDA	127	gpio[1 127]	pr1_pru0_pru<_31_7	pr1_pru1_pru<_30_7	mmc1_dat6	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	A14			
P9_26	96	0x980/108	IUART1_RXD	14	gpio[1 14]	pr1_pru0_pru<_31_16	pr1_pru1_pru<_30_16	mmc1_dat7	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	A14			
P9_27	105	0x984/164	IUART1_RXD	115	gpio[1 115]	pr1_pru0_pru<_31_5	pr1_pru1_pru<_30_5	mmc1_dat8	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	C13			
P9_28	101	0x984/164	SPI1_CS0	113	gpio[1 113]	pr1_pru0_pru<_31_3	pr1_pru1_pru<_30_3	mmc1_dat9	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	C12			
P9_29	102	0x984/164	SPI1_CS0	110	gpio[1 110]	pr1_pru0_pru<_31_2	pr1_pru1_pru<_30_2	mmc1_dat10	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	B11			
P9_30	102	0x984/198	SPI1_CS1	112	gpio[1 112]	pr1_pru0_pru<_31_2	pr1_pru1_pru<_30_2	mmc1_dat11	mcasp1_axr2	mcasp1_axr3	mcasp1_axh1x	D12	</td		

Cape Expansion Headers



P9

DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3
VDD_5V	5	6	VDD_5V
SYS_5V	7	8	SYS_5V
PWR_BUT	9	10	SYS_RESETN
UART4_RXD	11	12	GPIO_60
UART4_TXD	13	14	EHRPWM1A
GPIO_48	15	16	EHRPWM1B
SPI0_CS0	17	18	SPI0_D1
I2C2_SCL	19	20	I2C2_SDA
SPI0_DO	21	22	SPI0_SCLK
GPIO_49	23	24	UART1_TXD
GPIO_117	25	26	UART1_RXD
GPIO_115	27	28	SPI1_CS0
SPI1_DO	29	30	GPIO_112
SPI1_SCLK	31	32	VDD_ADC
AIN4	33	34	GNDA_ADC
AIN6	35	36	AIN5
AIN2	37	38	AIN3
AIN0	39	40	AIN1
GPIO_20	41	42	ECAPPWM0
DGND	43	44	DGND
DGND	45	46	DGND

P8

DGND	1	2	DGND
MMC1_DAT6	3	4	MMC1_DAT7
MMC1_DAT2	5	6	MMC1_DAT3
GPIO_66	7	8	GPIO_67
GPIO_69	9	10	GPIO_68
GPIO_45	11	12	GPIO_44
EHRPWM2B	13	14	GPIO_26
GPIO_47	15	16	GPIO_46
GPIO_27	17	18	GPIO_65
EHRPWM2A	19	20	MMC1_CMD
MMC1_CLK	21	22	MMC1_DAT5
MMC1_DAT4	23	24	MMC1_DAT1
MMC1_DATO	25	26	GPIO_61
LCD_VSYNC	27	28	LCD_PCLK
LCD_HSYNC	29	30	LCD_AC_BIAS
LCD_DATA14	31	32	LCD_DATA15
LCD_DATA13	33	34	LCD_DATA11
LCD_DATA12	35	36	LCD_DATA10
LCD_DATA8	37	38	LCD_DATA9
LCD_DATA6	39	40	LCD_DATA7
LCD_DATA4	41	42	LCD_DATA5
LCD_DATA2	43	44	LCD_DATA3
LCD_DATA0	45	46	LCD_DATA1

LEGEND

- POWER/GROUND/RESET
- AVAILABLE DIGITAL
- AVAILABLE PWM
- SHARED I2C BUS
- RECONFIGURABLE DIGITAL
- ANALOG INPUTS (1.8V)

Each digital I/O pin has 8 different modes that can be selected, including GPIO.

65 possible digital I/Os

P9				P8			
DGND	1	2	DGND	DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3	GPIO_38	3	4	GPIO_39
VDD_5V	5	6	VDD_5V	GPIO_34	5	6	GPIO_35
SYS_5V	7	8	SYS_5V	GPIO_66	7	8	GPIO_67
PWR_BUT	9	10	SYS_RESETN	GPIO_69	9	10	GPIO_68
GPIO_30	11	12	GPIO_60	GPIO_45	11	12	GPIO_44
GPIO_31	13	14	GPIO_50	GPIO_23	13	14	GPIO_26
GPIO_48	15	16	GPIO_51	GPIO_47	15	16	GPIO_46
GPIO_5	17	18	GPIO_4	GPIO_27	17	18	GPIO_65
I2C2_SCL	19	20	I2C2_SDA	GPIO_22	19	20	GPIO_63
GPIO_3	21	22	GPIO_2	GPIO_62	21	22	GPIO_37
GPIO_49	23	24	GPIO_15	GPIO_36	23	24	GPIO_33
GPIO_117	25	26	GPIO_14	GPIO_32	25	26	GPIO_61
GPIO_115	27	28	GPIO_113	GPIO_86	27	28	GPIO_88
GPIO_111	29	30	GPIO_112	GPIO_87	29	30	GPIO_89
GPIO_110	31	32	VDD_ADC	GPIO_10	31	32	GPIO_11
AIN4	33	34	GNDA_ADC	GPIO_9	33	34	GPIO_81
AIN6	35	36	AIN5	GPIO_8	35	36	GPIO_80
AIN2	37	38	AIN3	GPIO_78	37	38	GPIO_79
AIN0	39	40	AIN1	GPIO_76	39	40	GPIO_77
GPIO_20	41	42	GPIO_7	GPIO_74	41	42	GPIO_75
DGND	43	44	DGND	GPIO_72	43	44	GPIO_73
DGND	45	46	DGND	GPIO_70	45	46	GPIO_71

In GPIO mode, each digital I/O can produce interrupts.

8 PWMs and 4 timers

P9				P8			
DGND	1	2	DGND	DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3	GPIO_38	3	4	GPIO_39
VDD_5V	5	6	VDD_5V	GPIO_34	5	6	GPIO_35
SYS_5V	7	8	SYS_5V	TIMER4	7	8	TIMER7
PWR_BUT	9	10	SYS_RESETN	TIMER5	9	10	TIMER6
GPIO_30	11	12	GPIO_60	GPIO_45	11	12	GPIO_44
GPIO_31	13	14	EHRPWM1A	EHRPWM2B	13	14	GPIO_26
GPIO_48	15	16	EHRPWM1B	GPIO_47	15	16	GPIO_46
GPIO_5	17	18	GPIO_4	GPIO_27	17	18	GPIO_65
I2C2_SCL	19	20	I2C2_SDA	EHRPWM2A	19	20	GPIO_63
EHRPWMOB	21	22	EHRPMOA	GPIO_62	21	22	GPIO_37
GPIO_49	23	24	GPIO_15	GPIO_36	23	24	GPIO_33
GPIO_117	25	26	GPIO_14	GPIO_32	25	26	GPIO_61
GPIO_115	27	28	ECAPPWM2	GPIO_86	27	28	GPIO_88
EHRPWMOB	29	30	GPIO_112	GPIO_87	29	30	GPIO_89
EHRPMOA	31	32	VDD_ADC	GPIO_10	31	32	GPIO_11
AIN4	33	34	GNDA_ADC	GPIO_9	33	34	EHRPWM1B
AIN6	35	36	AIN5	GPIO_8	35	36	EHRPWM1A
AIN2	37	38	AIN3	GPIO_78	37	38	GPIO_79
AIN0	39	40	AIN1	GPIO_76	39	40	GPIO_77
GPIO_20	41	42	ECAPPWMO	GPIO_74	41	42	GPIO_75
DGND	43	44	DGND	GPIO_72	43	44	GPIO_73
DGND	45	46	DGND	EHRPWM2A	45	46	EHRPWM2B

Up to 8 digital I/O pins can be configured with pulse-width modulators (PWM) to produce signals to control motors or create analog voltage levels, without taking up any extra CPU cycles.

7 analog inputs (1.8V)

P9				P8			
DGND	1	2	DGND	DGND	1	2	DGND
VDD_3V3	3	4	VDD_3V3	GPIO_38	3	4	GPIO_39
VDD_5V	5	6	VDD_5V	GPIO_34	5	6	GPIO_35
SYS_5V	7	8	SYS_5V	GPIO_66	7	8	GPIO_67
PWR_BUT	9	10	SYS_RESETN	GPIO_69	9	10	GPIO_68
GPIO_30	11	12	GPIO_60	GPIO_45	11	12	GPIO_44
GPIO_31	13	14	GPIO_50	GPIO_23	13	14	GPIO_26
GPIO_48	15	16	GPIO_51	GPIO_47	15	16	GPIO_46
GPIO_5	17	18	GPIO_4	GPIO_27	17	18	GPIO_65
I2C2_SCL	19	20	I2C2_SDA	GPIO_22	19	20	GPIO_63
GPIO_3	21	22	GPIO_2	GPIO_62	21	22	GPIO_37
GPIO_49	23	24	GPIO_15	GPIO_36	23	24	GPIO_33
GPIO_117	25	26	GPIO_14	GPIO_32	25	26	GPIO_61
GPIO_115	27	28	GPIO_113	GPIO_86	27	28	GPIO_88
GPIO_111	29	30	GPIO_112	GPIO_87	29	30	GPIO_89
GPIO_110	31	32	VDD_ADC	GPIO_10	31	32	GPIO_11
AIN4	33	34	GNDA_ADC	GPIO_9	33	34	GPIO_81
AIN6	35	36	AIN5	GPIO_8	35	36	GPIO_80
AIN2	37	38	AIN3	GPIO_78	37	38	GPIO_79
AIN0	39	40	AIN1	GPIO_76	39	40	GPIO_77
GPIO_20	41	42	GPIO_7	GPIO_74	41	42	GPIO_75
DGND	43	44	DGND	GPIO_72	43	44	GPIO_73
DGND	45	46	DGND	GPIO_70	45	46	GPIO_71

Make sure you don't input more than 1.8V to the analog input pins.

This is a single 12-bit analog-to-digital converter with 8 channels, 7 of which are made available on the headers.

2 I2C ports					
P9			P8		
DGND	1	2	DGND		
VDD_3V3	3	4	VDD_3V3		
VDD_5V	5	6	VDD_5V		
SYS_5V	7	8	SYS_5V		
PWR_BUT	9	10	SYS_RESETN		
GPIO_30	11	12	GPIO_60		
GPIO_31	13	14	GPIO_50		
GPIO_48	15	16	GPIO_51		
I2C1_SCL	17	18	I2C1_SDA		
I2C2_SCL	19	20	I2C2_SDA		
I2C2_SCL	21	22	I2C2_SDA		
GPIO_49	23	24	I2C1_SCL		
GPIO_117	25	26	I2C1_SDA		
GPIO_115	27	28	GPIO_113		
GPIO_111	29	30	GPIO_112		
GPIO_110	31	32	VDD_ADC		
AIN4	33	34	GND_ADC		
AIN6	35	36	AIN5		
AIN2	37	38	AIN3		
AIN0	39	40	AIN1		
GPIO_20	41	42	GPIO_7		
DGND	43	44	DGND		
DGND	45	46	DGND		

The first I2C bus is utilized for reading EEPROMS on cape add-on boards and can't be used for other digital I/O operations without interfering with that function, but you can still use it to add other I2C devices at available addresses.

The second I2C bus is available for you to configure and use.

2 SPI ports

P9			P8		
DGND	1	2	DGND	1	2
VDD_3V3	3	4	VDD_3V3	3	4
VDD_5V	5	6	VDD_5V	5	6
SYS_5V	7	8	SYS_5V	7	8
PWR_BUT	9	10	SYS_RESETN	9	10
GPIO_30	11	12	GPIO_60	11	12
GPIO_31	13	14	GPIO_50	13	14
GPIO_48	15	16	GPIO_51	15	16
SPI0_CS0	17	18	SPI0_D1	17	18
SPI1_CS1	19	20	SPI1_CS0	19	20
SPI0_DO	21	22	SPI0_SCLK	21	22
GPIO_49	23	24	GPIO_15	23	24
GPIO_117	25	26	GPIO_14	25	26
GPIO_115	27	28	SPI1_CS0	27	28
SPI1_DO	29	30	SPI1_D1	29	30
SPI1_SCLK	31	32	VDD_ADC	31	32
AIN4	33	34	GND_ADC	33	34
AIN6	35	36	AIN5	35	36
AIN2	37	38	AIN3	37	38
AIN0	39	40	AIN1	39	40
GPIO_20	41	42	SPI1_CS1	41	42
DGND	43	44	DGND	43	44
DGND	45	46	DGND	45	46

For shifting out data fast, you might consider using one of the SPI ports.

[BeagleBoard.org - bone101](#)

- Flashing

[Updating the software image on a BeagleBone Black - Zageo LLC - Medium](#)

[Forum | Factory defaults for a Beaglebone Black - GHI Electronics](#)

- Expanding Storage

[Beagleboard:Expanding File System Partition On A microSD - eLinux.org](#)

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- Running program on boot

[Booting Beaglebone Black with Autorun Python Script](#)

[BeagleBone Black Launch Python Script at Boot like Arduino Sketch | Billwaa's Blog](#)