

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- Upgrade to the latest version of the RobotControlLib (may be out of date)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

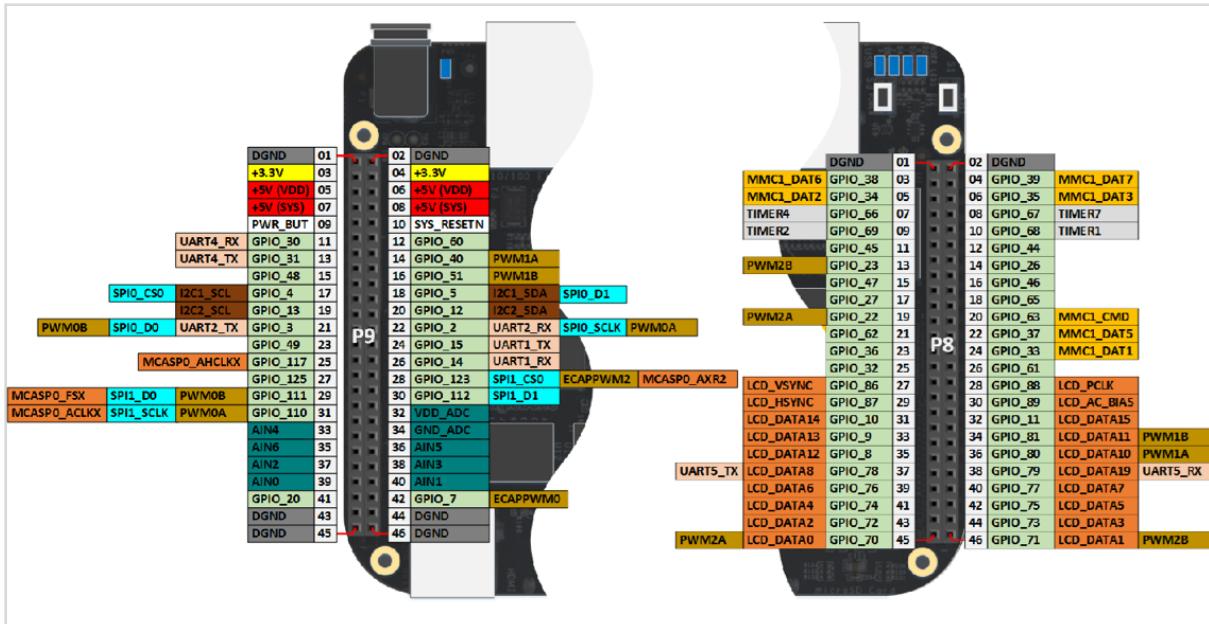
apt command	the command it replaces	function of the command
apt install	apt-get install	Installs a package
apt remove	apt-get remove	Removes a package
apt purge	apt-get purge	Removes package with configuration
apt update	apt-get update	Refreshes repository index
apt upgrade	apt-get upgrade	Upgrades all 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



<b>P8</b>				<b>P9</b>				
	1	2		1	2			
	<b>GND</b>	 	<b>GND</b>		<b>GND</b>	 	<b>GND</b>	
GPIO1_6	P8.3	 	P8.4	GPIO1_7		<b>VDD 3.3V</b>	 	<b>VDD 3.3V</b>
GPIO1_2	P8.5	 	P8.6	GPIO1_3		<b>VDD 5V</b>	 	<b>VDD 5V</b>
GPIO2_2	P8.7	 	P8.8	GPIO2_3		<b>SYS 5V</b>	 	<b>SYS 5V</b>
GPIO2_5	P8.9	 	P8.10	GPIO2_4		<b>PWR_BUT</b>	 	<b>SYS_RESETn</b>
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	 	<b>VDD_ADC(1.8V)</b>
GPIO0_9	P8.33	 	P8.34	GPIO2_17	AIN4	P9.33	 	<b>GNDA_ADC</b>
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		<b>GND</b>	 	<b>GND</b>
GPIO2_6	P8.45	 	P8.46	GPIO2_7		<b>GND</b>	 	<b>GND</b>
	45	46			45	46		

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

## Beaglebone Black P8 Header

Head_pin	SPINS	ADDR/OFFSET	GPIO NO.	Name	Mode7	Mode6	Mode5	Mode4	Mode3	Mode2	Mode1	Mode0	PIN	Notes
					D/GND									Ground
P0_03	6	0x818/018	38	GPIO0_16	gpio[1 6]									
P0_04	7	0x818/01c	39	GPIO0_17	gpio[1 7]									
P0_05	2	0x808/008	34	GPIO0_12	gpio[1 2]									
P0_06	3	0x808/00c	35	GPIO0_11	gpio[1 11]									
P0_07	36	0x808/000	60	TIIMER8	gpio[1 0]									
P0_08	37	0x894/074	67	TIMER8	gpio[1 3]									
P0_09	39	0x898/095	69	TIMERS	gpio[1 5]									
P0_10	38	0x898/098	68	TIMERS	gpio[1 4]									
P0_11	13	0x834/034	45	GPIO0_13	gpio[1 13]	pr1_pru0_pru_r0_15	eQEP2B_in	mmc0_d2 1	mmc1_d4 5	lcd_data18	gpmc_a13	R9	Used on Board (Group: pinnx_emmc2_pins)	
P0_12	12	0x834/030	44	GPIO0_14	gpio[1 12]	pr1_pru0_pru_r0_14	eQEP2A_in	mmc0_d2 4	MMC1_d4 10	LCD_D0 data10	gpmc_a12	T12		
P0_13	11	0x834/034	33	GPIO0_15	gpio[1 15]	pr1_pru0_pru_r0_15	eQEP2B_strobe	mmc0_d2 5	MMC1_d4 11	lcd_data20	gpmc_a10	T9		
P0_14	10	0x828/028	26	GPIO0_26	gpio[1 26]		ehprm01_trigpose_in	mmc0_d2 6	mmc1_d4 2	lcd_data21	gpmc_a10	T11		
P0_15	15	0x838/037	47	GPIO0_15	gpio[1 15]	pr1_pru0_pru_r0_11	eQEP2B_strobe	mmc0_d2 3	mmc1_d4 7	lcd_data16	gpmc_a15	U11		
P0_16	14	0x838/038	46	GPIO0_14	gpio[1 14]	pr1_pru0_pru_r0_14	eQEP2_index	mmc0_d2 2	mmc1_d4 6	lcd_data17	gpmc_a14	V13		
P0_17	11	0x828/022	27	GPIO0_27	gpio[1 27]		ehprm01_sync	mmc0_d2 4	mmc1_d4 3	lcd_data20	gpmc_a11	U12		
P0_18	9	0x828/020	25	GPIO0_25	gpio[1 25]	mcasp0_fir	mmc2_d2 1	mmc1_d4 1	mmc1_d4 0	lcd_mcasp0_clk	gpmc_d12	V10		
P0_19	8	0x828/020	23	EHPRM01	gpio[1 23]		ehprm02A	mmc2_d2 2	mmc1_d4 0	lcd_mcasp0_d23	gpmc_d10	U10		
P0_20	33	0x884/084	63	GPIO0_11	gpio[1 11]	pr1_pru0_pru_r0_13	pr1_pru0_pru_r0_13	mmc1_cmd	gpmc_be1n	gpmc_c20	V9	Used on Board (Group: pinnx_emmc2_pins)		
P0_21	32	0x880/080	62	GPIO0_10	gpio[1 10]	pr1_pru0_pru_r0_12	pr1_pru0_pru_r0_12	mmc1_clk	gpmc_be1l	gpmc_c19	U9	Used on Board (Group: pinnx_emmc2_pins)		
P0_22	5	0x814/014	37	GPIO0_15	gpio[1 15]			mmc1_d4 5	gpmc_a5	U8	Used on Board (Group: pinnx_emmc2_pins)			
P0_23	4	0x810/010	36	GPIO0_14	gpio[1 14]			mmc1_d4 1	gpmc_a4	U8	Used on Board (Group: pinnx_emmc2_pins)			
P0_24	3	0x810/013	33	GPIO0_13	gpio[1 13]			mmc1_d4 1	gpmc_a1	V7	Used on Board (Group: pinnx_emmc2_pins)			
P0_25	0	0x800/000	32	GPIO0_10	gpio[1 10]			mmc1_d4 0	gpmc_d8	U7	Used on Board (Group: pinnx_emmc2_pins)			
P0_26	31	0x87/077	61	GPIO0_19	gpio[1 29]									
P0_27	56	0x80/060	86	GPIO0_22	gpio[1 22]	pr1_pru0_pru_r0_18	pr1_pru0_pru_r0_8				gpmc_a8		Allocated (Group: npx_hdmi_boneli_pins)	
P0_28	58	0x80/060	88	GPIO0_24	gpio[1 24]	pr1_pru0_pru_r0_10	pr1_pru0_pru_r0_10				gpmc_a10		Allocated (Group: npx_hdmi_boneli_pins)	
P0_29	57	0x80/064	87	GPIO0_22	gpio[1 22]	pr1_pru0_pru_r0_19	pr1_pru0_pru_r0_9				gpmc_d10		Allocated (Group: npx_hdmi_boneli_pins)	
P0_30	0	0x80/060	89	GPIO0_25	gpio[1 25]						gpmc_a11		Allocated (Group: npx_hdmi_boneli_pins)	
P0_31	54	0x828/008	10	UART0_CTSN	gpio[1 10]	uart5_ctsn	uart5_rxd	mcasp0_axr1	eQEP1_index	gpmc_a18	U14	Allocated (Group: npx_hdmi_boneli_pins)		
P0_32	55	0x828/008	11	UART0_RTSN	gpio[1 11]	uart5_ctsn	mcasp0_ax3	mcasp0_axhcrx	eQEP1_strobe	gpmc_a19	U15	Allocated (Group: npx_hdmi_boneli_pins)		
P0_33	53	0x848/044	9	UART0_RTSN	gpio[1 9]	uart4_ctsn	uart4_rxn	mcasp0_ax3	mcasp0_fsr	eQEP1b_in	gpmc_a17	V3	Allocated (Group: npx_hdmi_boneli_pins)	
P0_34	51	0x848/0cc	81	UART0_RTSN	gpio[1 17]	uart3_ctsn	uart3_rxn	mcasp0_ax2	mcasp0_axhcrx	ehprm01B	gpmc_a15	U11	Allocated (Group: npx_hdmi_boneli_pins)	
P0_35	52	0x848/0cc	80	UART0_CTSN	gpio[1 16]	uart3_ctsn	uart3_rxn	mcasp0_ax2	mcasp0_axhcrx	ehprm01B	gpmc_a16	V2	Allocated (Group: npx_hdmi_boneli_pins)	
P0_36	49	0x848/0dc	80	UART0_RTSN	gpio[1 15]	uart2_ctsn	uart2_rxn	mcasp0_ax0	mcasp0_axhcrx	ehprm01A	gpmc_a14	U10	Allocated (Group: npx_hdmi_boneli_pins)	
P0_37	48	0x848/07d	78	UART0_TxDN	gpio[1 14]	uart2_ctsn	uart5_rxd	mcasp0_ax0	ehprm01_trigpose_in	gpmc_a13	U12	Allocated (Group: npx_hdmi_boneli_pins)		
P0_38	49	0x848/0dc	79	UART0_RXD	gpio[1 15]	uart2_ctsn	uart5_rxd	mcasp0_fx	ehprm01_sync	gpmc_a13	U12	Allocated (Group: npx_hdmi_boneli_pins)		
P0_39	46	0x80/088	76	GPIO0_12	gpio[1 12]	pr1_pru0_pru_r0_16	pr1_pru0_pru_r0_6				gpmc_a6	T3	Allocated (Group: npx_hdmi_boneli_pins)	
P0_40	47	0x80/08c	77	GPIO0_13	gpio[1 13]	pr1_pru0_pru_r0_17	pr1_pru0_pru_r0_7				gpmc_a7	T4	Allocated (Group: npx_hdmi_boneli_pins)	
P0_41	48	0x80/08c	78	GPIO0_14	gpio[1 14]	pr1_pru0_pru_r0_18	pr1_pru0_pru_r0_8				gpmc_a4	T1	Allocated (Group: npx_hdmi_boneli_pins)	
P0_42	45	0x80/08c	75	GPIO0_11	gpio[1 11]	pr1_pru0_pru_r0_15	pr1_pru0_pru_r0_5				gpmc_a5	T3	Allocated (Group: npx_hdmi_boneli_pins)	
P0_43	42	0x80/088	72	GPIO0_28	gpio[1 8]	pr1_pru0_pru_r0_19	pr1_pru0_pru_r0_2				gpmc_a2	R3	Allocated (Group: npx_hdmi_boneli_pins)	
P0_44	43	0x80/08c	73	GPIO0_29	gpio[1 9]	pr1_pru0_pru_r0_13	pr1_pru0_pru_r0_3				gpmc_a3	R4	Allocated (Group: npx_hdmi_boneli_pins)	
P0_45	40	0x80/080	70	GPIO0_26	gpio[1 6]	pr1_pru0_pru_r0_10	pr1_pru0_pru_r0_0				gpmc_a0	R1	Allocated (Group: npx_hdmi_boneli_pins)	
P0_46	41	0x80/084	71	GPIO0_27	gpio[1 7]	pr1_pru0_pru_r0_11	pr1_pru0_pru_r0_1				gpmc_a1	R2	Allocated (Group: npx_hdmi_boneli_pins)	

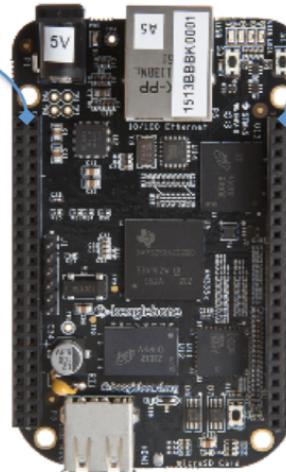
<https://vadl.github.io/images/bbb/P8Header.png>

## Beaglebone Black P9 Header

Head pin	SPINS	ADDR/OFFSET	Name	GPIO NO.	Mode7	Mode6	Mode5	Mode4	Mode3	Mode2	Mode1	Mode0	PIN	Notes
P9_01			GND											Ground
P9_02			GND											Ground
P9_03			DC_3.3V											250mA Max Current
P9_04			DC_5.0V											250mA Max Current
P9_05			VDD_5V											1A Max Current if DC Jack powered
P9_06			VDD_5V											1A Max Current only if DC Jack powered
P9_07			SYS_5V											250mA Max Current
P9_08			SYS_5V											250mA Max Current
P9_09			PWRKEY											Has a 5V level pulled up by 1P56S21C/L
P9_10			SYS_RESETn											Has a 5V level pulled up by 1P56S21C/L
P9_11	28	0x870/070	UART2_RXD	30	gpio[30]	wart4_rxrd_mux2	mmc1_sdcl	rml02_crs_dv	gmcic_csn4	ml02_crs	RESET_OUT	A10		
P9_12	30	0x870/070	GP01_028	60	gpio[128]	mcasp0_aclk_rxrd_mux3	gmcic_dir	mmci2_dat3	gmcic_csn6	ml02_col	gmcic_wrt0			
P9_13	29	0x874/074	UART2_TXD	11	gpio[11]	wart4_txrd_mux2	mmc2_sdcl	rml02_cswrr	gmcic_csn5	ml02_cswr	gmcic_be1			
P9_14	18	0x874/074	EHRPWM16	50	gpio[50]	ehrpwm0_trigzone	mmc1_sdcl	rml02_txrd	gmcic_csn4	ml02_txrd	gmcic_wpt			
P9_15	16	0x840/040	GP01_16	48	gpio[116]	ehrpwm0_trigzone_input	gmcic_a16	mmci2_txen	ml02_txcl	gmcic_txm	gmcic_a0			
P9_16	19	0x84c/04c	EHRPWM18	51	gpio[119]	ehrpwm0_tx1 mux1	gmcic_a19	mmci2_dat2	rml02_tdr	ml02_txrd2	gmcic_a3			
P9_17	87	0x95c/1c1	I2CL_SDA	5	gpio[5]	ehrpwm0_sync1	I2C1_SCL	mmci2_sdwp	sp0_tdi0					
P9_18	86	0x95c/158	I2CL_SDA	4	gpio[4]	ehrpwm0_trigzone	I2C1_SDA	mmci2_sdwp	sp0_tdi1					
P9_19	89	0x95c/158	I2CL_SDA	3	gpio[3]	ehrpwm0_trigzone	I2C1_SDA	mmci2_sdwp	sp0_tdi2					
P9_20	94	0x878/130	I2CL_SDA	12	gpio[12]	pr1_uart0_rts_n	I2C2_SDA	mmci2_sdwp	sp0_tdi3					Allocated (Group: plimms [2x pin])
P9_21	85	0x945/154	UART2_RXD	3	gpio[3]	EMU3_mux1	pr1_uart0_rts_n	I2C2_SDA	mmci2_sdwp	sp0_tdi4				Allocated (Group: plimms [2x pin])
P9_22	84	0x945/154	UART2_RXD	2	gpio[2]	EMU2_mux1	pr1_uart0_rts_n	I2C2_SDA	mmci2_sdwp	sp0_tdi5				
P9_23	97	0x944/184	UART1_RXD	49	gpio[49]	pr1_uart0_rts_n	gmcic_a17	mmci2_sdwp	sp0_tdi6					
P9_24	97	0x944/184	UART1_RXD	15	gpio[15]	pr1_uart0_rts_n	I2C1_SCL	dcanc1_tx	mmci2_sdwp	sp0_tdi7				
P9_25	107	0x944/184	GP01_021	117	gpio[121]	pr1_pru0_pru1_31_7	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi8				Allocated (Group: mcasp0_pins)
P9_26	96	0x880/180	UART1_RXD	14	gpio[14]	pr1_pru0_pru1_31_16	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi9				
P9_27	105	0x944/184	GP01_029	115	gpio[130]	pr1_pru0_pru1_31_5	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi10				
P9_28	98	0x944/184	UART1_RXD	13	gpio[13]	pr1_pru0_pru1_31_3	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi11				
P9_29	101	0x944/184	SP1L_D0	111	gpio[115]	pr1_pru0_pru1_31_1	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi12				
P9_30	102	0x998/198	SP1L_D1	112	gpio[116]	pr1_pru0_pru1_31_2	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi13				
P9_31	100	0x990/190	SP1L_SCLK	130	gpio[14]	pr1_pru0_pru1_31_0	I2C1_SDA	dcanc1_tx	mmci2_sdwp	sp0_tdi14				
P9_32			VADC											Voltage Reference for ADC (NB: 1.8V)
P9_33			AIN1											
P9_34			AGND											CB NB: 1.8V tolerant
P9_35			AIN6											Ground for ADC
P9_36			AINS											NB: 1.8V tolerant
P9_37			AIN2											NB: 1.8V tolerant
P9_38			AIN3											NB: 1.8V tolerant
P9_39			AIN0											NB: 1.8V tolerant
P9_40			AIN1											C7 NB: 1.8V tolerant
P9_41A	109	0x9f4/1b4	CLKOUT2	20	gpio[20]	EMU3_mux0	pr1_pru0_pru1_31_16	timer7_mux1	clkout2	tc1kin	adma_event_intr1			D14 Both signals are connected to P22 / P11
P9_41B	109	0x9f4/1b4	GP01_020	216	gpio[20]	pr1_pru0_pru1_31_6	pr1_pru0_pru1_30_6	emu3	Masp1_arx0	eOEPO_index	mcasp0_arv1			D15 Both signals are connected to P22 / P11
P9_42A	89	0x9d4/164	GPIO_7	7	gpio[7]	sdma_event_intr2	mmc0_sdwp	sp0_tck	pr1_ecap0_ecap_caplin_apem_o	sp0_tcs1	uart3_tdr	eCAP0_IN_PWDN_out		Both signals are connected to P22 / P11
P9_42B	0x9f4/1a0	GP01_023	114	gpio[18]	pr1_pru0_pru1_31_4	pr1_pru0_pru1_30_4	Masp1_arlkx	Masp0_arx2	eOEPA_in	Masp0_arclk	B12	Allocated? Mcasp0_pins? Check...		
P9_43			GP0											- See Pg 50 of the SRM
P9_44			GP0											
P9_45			GND											Ground
P9_46			GND											Ground
P9 Header	cat SPINS	ADDR + Offset from:	Name	GPIO NO.	Mode 7 (Mode 0)									Notes
	44+10000				(Mode 7)									
	Allocated													Please e-mail directly at: <a href="mailto:derk@derkeuken.nl">derk@derkeuken.nl</a>
														If you notice a mistake
														Thanks Frank for the PRU work!
														For updates see: <a href="http://www.derkeuken.nl">www.derkeuken.nl</a>

<https://vadl.github.io/images/bbb/P9Header.png>

# 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
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
SPI0_CS0	17	18	SPI0_D1
SPI1_CS1	19	20	SPI1_CS0
SPI0_DO	21	22	SPI0_SCLK
GPIO_49	23	24	GPIO_15
GPIO_117	25	26	GPIO_14
GPIO_115	27	28	SPI1_CS0
SPI1_DO	29	30	SPI1_D1
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	SPI1_CS1
DGND	43	44	DGND
DGND	45	46	DGND

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

BeagleBoard.org - bone101

version 1.1  
April 1st, 06

### vi / vim graphical cheat sheet

<b>Esc</b> normal mode																
~ toggle case `* goto mark	! external filter	@ play macro	# prev ident	\$ col	% goto match	^ "soft" bol	& repeat :s	* next ident	( begin sentence	) end sentence	"soft" bol	_ down	+ next line			
1	2	3	4	5	6	7	8	9	0 "hard" bol	- prev line	= autoformat					
Q ex mode q record macro	W next WORD w next word	E end WORD e end word	R replace mode r replace char	T back 'till t 'till	Y yank line y yank	U undo line u undo	I insert at bol i insert mode	O open above o open below	P paste before p paste after	{ begin parag. [ begin misc	}	end parag. ] end misc				
A append at eol a append	S subst line s subst char	D delete to eol d delete	F "back" find ch f find char	G eof/ln g extra cmd	H screen top h <	J join lines j ↓	K help k ↑	L screen bottom l →	: ex cmd line : repeat ; t/f/F	!! reg. spec ! . goto mk. bol	bol/ goto col \\ not used!					
Z quit ^Z Z extra ^X Z cmd	X back-space X delete char	C change to eol C change	V visual lines V visual mode	B prev WORD b prev word	N prev (find) n next (find)	M screen mid'l m set mark	< un- <sup>3</sup> , reverse , t/f/F	> indent <sup>3</sup> + repeat cmd	? find (rev.) / find							
<b>motion</b> moves the cursor, or defines the range for an operator	<b>command</b> direct action command, if red, it enters insert mode	<b>operator</b> requires a motion afterwards, operates between cursor & destination	<b>extra</b> special functions, requires extra input	<b>Q</b> commands with a dot need a char argument afterwards	Main command line commands ('ex'): :w (save), :q (quit), :q! (quit w/o saving) :e f (open file f), :%s/x/y/g (replace 'x' by 'y' filewide), :h (help in vim), :new (new file in vim), Other important commands: CTRL-R: redo (vim), CTRL-F/-B: page up/down, CTRL-E/-Y: scroll line up/down, CTRL-V: block-visual mode (vim only)	Notes: (1) use "x before a yank/paste/del command to use that register ('clipboard') (x=a..z,*) (e.g.: "ay\$ to copy rest of line to reg 'a') (2) type in a number before any action to repeat it that number of times (e.g.: 2p, d2w, 5i, d4j) (3) duplicate operator to act on current line (dd = delete line, >> = indent line) (4) ZZ to save & quit, ZQ to quit w/o saving (5) zt: scroll cursor to top, zb: bottom, zz: center (6) gg: top of file (vim only), gf: open file under cursor (vim only)										
bol = beginning of line, eol = end of line, mk = mark, yank = copy words: quux(foo, bar, baz); WORDS: quux(foo, bar, baz);																

For a graphical vi/vim tutorial & more tips, go to [www.viemu.com](http://www.viemu.com) - home of ViEmu, vi/vim emulation for Microsoft Visual Studio

Vim(Terminal Text Editor) Cheat Sheet

- 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](#)

[Extending Micro SD Card space for Beaglebone Bl... | element14 | BeagleBoard](#)

[How to resize Debian 9.2 root partition to fit SD card - SomLabs Wiki](#)

[Noob's guide to Embedded Systems: How to Increase Memory of Beaglebone Black](#)

- Running program on boot

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

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