

# Beaglebone Intro

## Login/Access Test Functions

- Connect to BeagleBone WiFi: BeagleBone-8EC2  
Wifi password: BeagleBone
- Login: `ssh debian@192.168.8.1`  
Password: `temppwd`
- Re-upload code

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

- Run smear code

```
sudo python3 Desktop/blood-smear/smear.py
```

- Edit code

```
sudo micro Desktop/blood-smear/smear.py
```

- Shutdown

```
sudo shutdown -h now
```

---

## Setup Steps

1. Flash Debian 9.5 LXQT Version
2. Connect to WiFi **Robot Control Library: Networking WiFi**
3. Repartition to use all of the microSD's memory (8GB minimum recommend)

```
sudo /opt/scripts/tools/grow_partition.sh
```

Reboot after

```
reboot
```

4. Download Micro text editor (personal preference)

```
curl https://getmic.ro | bash
```

Run it one time

```
./micro
```

Move to bin directory

```
sudo mv ~/micro /bin/micro
```

5. Update packages

```
sudo apt update
sudo apt upgrade -y
```

```
sudo apt install python3 python3-pip python3-numpy build-essential python3-dev  
autoconf-archive python3-scipy python3-tk -y  
sudo pip3 install rcpy Adafruit_BBIO  
sudo pip3 install --upgrade Adafruit_BBIO
```

## 6. Disable Bluetooth (speeds up boot time)

Open/create this file `sudo nano /etc/rc.local`

File may be blank. Add this below

```
rfkill block bluetooth  
exit 0
```

## 8. Clone GitHub repository with blood smearing device code

```
git clone https://github.com/mucolon/blood-smear.git
```

---

# Linux Commands

*Underlined text is your input (ie. yourLogin)*

## GitHub

- Establish Github connection

```
ssh -T git@github.com
```

- Clone repository

```
git clone https://github.com/mucolon/blood-smear.git
```

- Go into blood-smear repository

```
cd blood-smear
```

- Establish GitHub repository connection from within the blood-smear directory

```
git remote set-url origin git@github.com:mucolon/blood-smear.git
```

- Push latest code updates to GitHub

```
git add -A  
git commit -am "my update msg"  
git push
```

- Pull lastest code updates from GitHub

```
git pull
```

- Pull latest code updates from GitHub and overwrite current changes

```
git fetch --all  
git reset --hard origin/master  
git pull origin master # (might be unnecessary)
```

- Extra resources

[Generating a new SSH key and adding it to the ssh-agent - GitHub Help](#)

[Adding a new SSH key to your GitHub account - GitHub Help](#)

[Set up GitHub push with SSH keys · GitHub](#)

## 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_ (basic text editor)
```

```
micro _fileName_ (better text editor) (See below for download instructions)
```
- Create/Open a text file (show line numbers)
 

```
nano -c _fileName_
```
- Rename/Move 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
```

```
cat /etc/dogtag
```
- Disabling Bluetooth (speeds up boot time)
 Open this file 

```
sudo micro /etc/rc.local
```

  
 File may be blank. Add this below
 

```
rfkill block bluetooth
exit 0
```

- Update eMMC uBoot for GPIO pin access
 

```
sudo dd if=/dev/zero of=/dev/mmcblk1 bs=1M count=100
```

## 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](#)

## Micro Text Editor

- Better text editor than nano that allows for easy color customization and mouse actions over ssh

```
curl https://getmic.ro | bash (Download link)
```

```
mv /home/mae156/micro /bin/micro (Add micro to bin for use in any directory)
```

## 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/rccp: 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_
```

- Installing Java

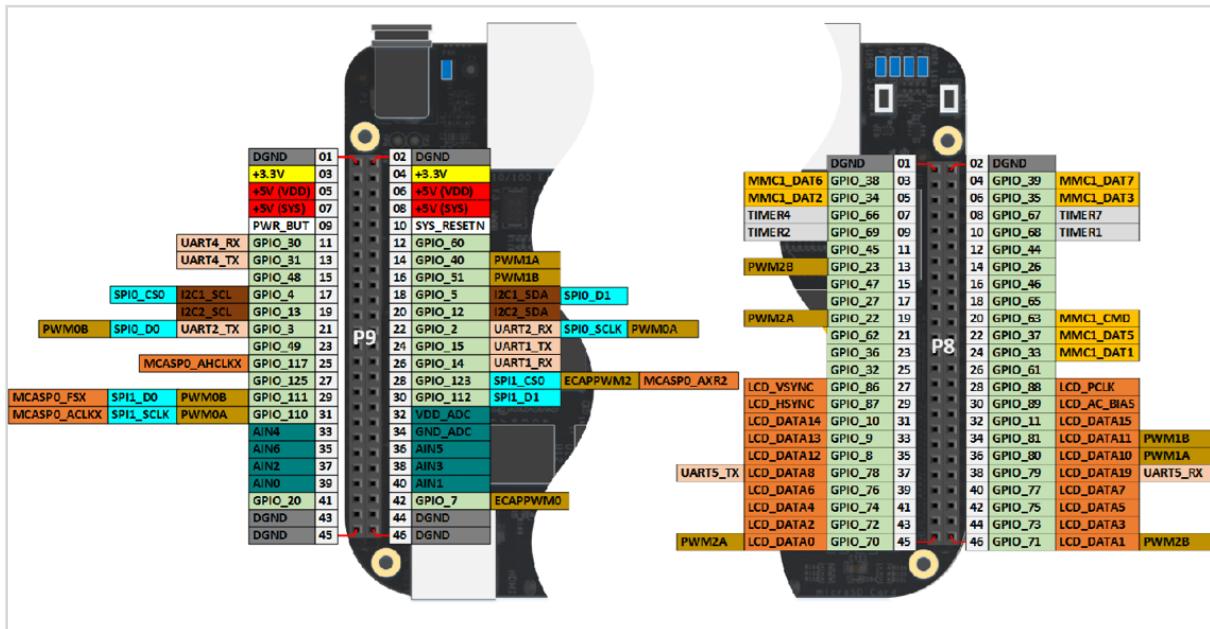
[Setting up Oracle Java 8, Gradle, and Maven On Beaglebone Green | AVR | Hackaday.io](#)

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

beaglebone\_black\_pinmap.png

<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

Header_pin	SPINS	ADDR/OFFSET	GPIO NO.	Name	Mode7	Mode6	Mode5	Mode4	Mode3	Mode2	Mode1	Mode0	PIN	Notes
PB_01	1	0x838/000	30	GND									Ground	
PB_02														Ground
PB_03	6	0x838/018	38	GPIO1_6	gpio[1 6]									
PB_04	7	0x838/01c	39	GPIO1_7	gpio[1 7]									Used on Board (Group: primux_emmc2_pins)
PB_05	2	0x808/008	34	GPIO1_2	gpio[1 2]									Used on Board (Group: primux_emmc2_pins)
PB_06	3	0x808/00c	35	GPIO1_3	gpio[1 3]									Used on Board (Group: primux_emmc2_pins)
PB_07	36	0x838/004	65	TIMER8	gpio[2 3]									Used on Board (Group: primux_emmc2_pins)
PB_08	37	0x834/004	67	TIMER7	gpio[2 3]									Used on Board (Group: primux_emmc2_pins)
PB_09	39	0x838/00c	69	TIMER8	gpio[2 5]									Used on Board (Group: primux_emmc2_pins)
PB_10	38	0x838/008	68	TIMER6	gpio[2 4]									Used on Board (Group: primux_emmc2_pins)
PB_11	13	0x834/004	45	DSI0	gpio[2 1]									Used on Board (Group: primux_emmc2_pins)
PB_12	12	0x834/004	44	GPIO1_12	gpio[1 12]	pr1_pru0_pru<_30_14	0x0f12_0x0	MMC1_DAT0	mmc1_dat0	gpmc_ae6	R9			Ground
PB_13	9	0x834/024	23	EHPWM2	gpio[2 3]									
PB_14	10	0x828/028	26	GPIO0_26	gpio[2 6]									
PB_15	15	0x838/03c	47	GPIO1_15	gpio[1 15]	pr1_pru0_pru<_31_15	eCEP2_index	mmc2_dat0	mmc1_dat7	gpmc_ae7	T9			Used on Board (Group: primux_emmc2_pins)
PB_16	14	0x838/038	46	GPIO1_14	gpio[1 14]	pr1_pru0_pru<_31_14	eCEP2_index	mmc2_dat1	mmc1_dat8	gpmc_ae8	T8			Used on Board (Group: primux_emmc2_pins)
PB_17	11	0x834/004	22	GPIO1_11	gpio[1 11]									Used on Board (Group: primux_emmc2_pins)
PB_18	35	0x838/00c	65	GPIO1_2	gpio[2 11]	mcasp0_fsr		eH PWM0	mmc2_dat2	gpmc_ae9	U12			Used on Board (Group: primux_emmc2_pins)
PB_19	8	0x830/020	22	EHPWM2A	gpio[2 2]									Used on Board (Group: primux_emmc2_pins)
PB_20	33	0x884/084	63	GPIO1_31	gpio[1 31]	pr1_pru0_pru<_31_13	pr1_pru1_pru<_30_13	mmc2_dat4	mmc1_dat9	gpmc_ae10	V9			Used on Board (Group: primux_emmc2_pins)
PB_21	21	0x880/030	62	GPIO1_30	gpio[1 30]	pr1_pru1_pru<_31_12	pr1_pru1_pru<_30_12	mmc1_clk	mmc1_cnd	gpmc_be1n	U9			Used on Board (Group: primux_emmc2_pins)
PB_22	5	0x834/014	37	GPIO1_5	gpio[1 5]									Used on Board (Group: primux_emmc2_pins)
PB_23	4	0x834/010	36	GPIO1_4	gpio[1 4]									Used on Board (Group: primux_emmc2_pins)
PB_24	1	0x834/004	33	GPIO1_1	gpio[1 1]									Used on Board (Group: primux_emmc2_pins)
PB_25	0	0x800/000	32	GPIO1_0	gpio[1 0]									Used on Board (Group: primux_emmc2_pins)
PB_26	31	0x838/01c	61	GPIO1_29	gpio[1 29]									Used on Board (Group: primux_emmc2_pins)
PB_27	56	0x838/004	86	GPIO0_22	gpio[2 22]	pr1_pru0_pru<_31_8	pr1_pru1_pru<_30_8	gpmc_ae	ldv_vsync	gpmc_ae11	V6			Allocated (Group: npl_hdmi_bonnet_pins)
PB_28	58	0x838/004	87	GPIO0_24	gpio[2 4]	pr1_pru0_pru<_31_10	pr1_pru1_pru<_30_10	gpmc_ae	ldv_a	gpmc_ae12	V5			Allocated (Group: npl_hdmi_bonnet_pins)
PB_29	57	0x838/004	87	GPIO0_22	gpio[2 2]	pr1_pru0_pru<_31_9	pr1_pru1_pru<_30_9	gpmc_ae	ldv_b	gpmc_ae13	V6			Allocated (Group: npl_hdmi_bonnet_pins)
PB_30	59	0x838/00c	89	GPIO0_25	gpio[2 25]									Allocated (Group: npl_hdmi_bonnet_pins)
PB_31	54	0x838/008	76	GPIO0_13	gpio[1 13]	uart1_ctn		uart1_rxd	mmc2_dat5	mcasp0_axr1	eCEP1_index	V4		Allocated (Group: npl_hdmi_bonnet_pins)
PB_32	55	0x838/00c	11	UART1_RTS	gpio[1 11]	uart1_rtsn		uart1_txd	mcasp0_arx3	mcasp0_axhcrx	eCEP1_strobe	T5		Allocated (Group: npl_hdmi_bonnet_pins)
PB_33	53	0x838/00c	14	UART1_CTS	gpio[1 14]	uart1_ctsn		uart1_txd	mcasp0_arx4	mcasp0_axr4	eCEP1_txr	V3		Allocated (Group: npl_hdmi_bonnet_pins)
PB_34	51	0x838/00c	81	UART3_RTAN	gpio[2 17]	uart4_ctn		uart4_txd	mcasp0_arx2	mcasp0_axr2	eH PWM1	V15		Allocated (Group: npl_hdmi_bonnet_pins)
PB_35	52	0x838/00c	80	UART3_TSIN	gpio[2 8]	uart4_ctsn		uart4_txd	mcasp0_arx2	mcasp0_axr2	eCEP1_in	V16		Allocated (Group: npl_hdmi_bonnet_pins)
PB_36	36	0x838/008	80	UART3_TSIN	gpio[2 16]	uart3_ctn		uart3_txd	mcasp0_arx1	mcasp0_axr1	eH PWM1A	V14		Allocated (Group: npl_hdmi_bonnet_pins)
PB_37	48	0x838/00c	79	UART3_TXD	gpio[2 14]	uart2_ctn		uart2_txd	mcasp0_arx2	mcasp0_axr2	eH PWM1_B	V13		Allocated (Group: npl_hdmi_bonnet_pins)
PB_38	49	0x838/00c	79	UART3_RXD	gpio[2 13]	uart2_ctsn		uart2_txd	mcasp0_arx2	mcasp0_axr2	eH PWM1_F	V12		Allocated (Group: npl_hdmi_bonnet_pins)
PB_39	40	0x838/00c	76	GPIO2_13	gpio[1 13]	uart1_ctn		uart1_txd	mcasp0_arx2	mcasp0_axr2	eH PWM1_E	V11		Allocated (Group: npl_hdmi_bonnet_pins)
PB_40	47	0x838/00c	77	GPIO2_13	gpio[1 13]	uart1_pru0_pru<_30_7	pr1_edio_data_out_r7	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eCEP2_strobe	T6		Allocated (Group: npl_hdmi_bonnet_pins)
PB_41	44	0x838/00b	74	GPIO2_10	gpio[2 10]	pr1_pru0_pru<_31_4	pr1_pru1_pru<_30_4	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eOPI2A_in	T1		Allocated (Group: npl_hdmi_bonnet_pins)
PB_42	45	0x838/00b	75	GPIO2_11	gpio[2 11]	pr1_pru0_pru<_31_5	pr1_pru1_pru<_30_5	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eOPI2B_in	T2		Allocated (Group: npl_hdmi_bonnet_pins)
PB_43	43	0x838/00b	78	GPIO2_8	gpio[2 8]	pr1_pru0_pru<_31_2	pr1_pru1_pru<_30_2	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eH PWM2	R3		Allocated (Group: npl_hdmi_bonnet_pins)
PB_44	43	0x838/00b	79	GPIO2_9	gpio[2 9]	pr1_pru0_pru<_31_3	pr1_pru1_pru<_30_3	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eH PWM2	R4		Allocated (Group: npl_hdmi_bonnet_pins)
PB_45	40	0x838/00b	70	GPIO2_10	gpio[2 10]	pr1_pru0_pru<_31_0	pr1_pru1_pru<_30_0	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eH PWM2	R1		Allocated (Group: npl_hdmi_bonnet_pins)
PB_46	41	0x838/00b	71	GPIO2_7	gpio[2 7]	pr1_pru0_pru<_31_1	pr1_pru1_pru<_30_1	uart1_rxd	mcasp0_arx2	mcasp0_axr2	eH PWM2	R2		Allocated (Group: npl_hdmi_bonnet_pins)
P9 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 <a href="http://www.derekmolloy.ie">www.derekmolloy.ie</a>
	Allocated	44e10000	(Mode 7)										PIN	
		Offset from:												
		44e10000												

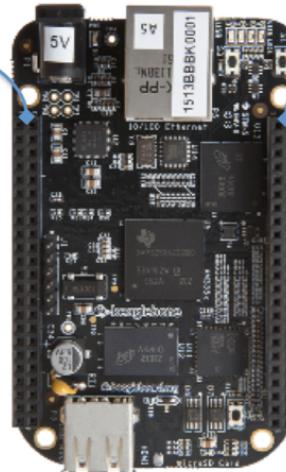
GPIO Settings														
Bit 6	Bit 5	Bit 4	Bit 3	Bit 2,1,0										
Slew Control	Receiver Active	Pullup/Pulldown	Enable/Pullup/down	Mask Mode										
0 Fast	O Disable	0 Pullup	0 Pulldown select	000 Mode 0 to 1 <th data-cs="10" data-kind="parent"></th> <th data-kind="ghost"></th>										
1 Slow	1 Pullup	1 Pulldown	1 Pullup select	1 Disabled	111 Mode 7									

e.g. OUTPUT GPIO2(mode7) #0x7 pulldown, #0x17 pullup, #0x7 no pullup/down

e.g. INPUT GPIO2(mode7) #0x27 pulldown, #0x37 pullup, #0x7 no pullup/down

Header_pin	SPINS	ADDR/OFFSET	GPIO NO.	Name	GPIO NO.	Mode 7	GPIO Settings	Mode 6	Mode 5	Mode 4	Mode 3	Mode 2	Mode 1	Mode 0	CPU	Notes
P9_01																Ground
P9_02																Ground
P9_03																250mA Max Current
P9_04																250mA Max Current
P9_05																1A Max Current (only if EC Jack powered)
P9_06																1A Max Current (only if EC Jack powered)
P9_07																250mA Max Current
P9_08																250mA Max Current
P9_09																Has a 5V Level (pulled up by TP56217C)
P9_10																NB: GPIOs limit current to 4mA output and approx. 8mA on input.
P9_11	28	0x870/070	30	UART4_RXD	30	gpio[2 30]	uart4_rxn	uart4_rxn	mmc1_scl0	rmii2_crs_dv	gpmc_cn4	mlit2_crs	RESET_OUT	A10		
P9_12	30	0x870/078	28	GPIO1_28	60	gpio[1 28]	mcasp0_aclk	mcasp0_aclk	gpmc_dir	mmc1_dat3	gpmc_cn6	mlit2_col	gpmc_be1n	T17		
P9_13	29	0x874/010	31	UART4_RXD	31	gpio[1 31]	uart4_rxn	uart4_rxn	mmc2_scl0	rmii2_nerr	gpmc_cn5	mlit2_xerr	gpmc_wpt	U17		
P9_14	18	0x844/048	30	UART4_RXD	31	gpio[1 30]	uart4_rxn	uart4_rxn	mmc2_dat3	rmii2_txr	gpmc_ax1	mlit2_txd1	gpmc_ax2	U18		
P9_15	26	0x844/048	30	UART4_RXD	31	gpio[1 36]	eh PWM1_L	eh PWM1_L	gpmc_ax1	mmc2_dat4	gpmc_ax2	mlit2_txd2	gpmc_ax3	U19		
P9_16	19	0x958/156	14	EHPWM1B	50	gpio[1 16]	eh PWM1_B	eh PWM1_B	gpmc_ax1	mmc2_dat5	gpmc_ax2	mlit2_txd3	gpmc_ax4	U20		
P9_17	27	0x958/156	14	EHPWM1B	51	gpio[1 19]	eh PWM1_B	eh PWM1_B	gpmc_ax1	mmc2_dat6	gpmc_ax2	mlit2_txd4	gpmc_ax5	U21		
P9_18	86	0x958/158	14	EHPWM1B	51	gpio[1 20]	eh PWM1_B	eh PWM1_B	gpmc_ax1	mmc2_dat7	gpmc_ax2	mlit2_txd5	gpmc_ax6	U22		
P9_19	97	0x958/158	14	EHPWM1B	51	gpio[1 21]	eh PWM1_B	eh PWM1_B	gpmc_ax1	mmc2_dat8	gpmc_ax2	mlit2_txd6	gpmc_ax7	U23		
P9_20	98	0x958/158	14	EHPWM1B	52	gpio[1 22]	eh PWM1_B	eh PWM1_B	gpmc_ax1	mmc2_dat9	gpmc_ax2	mlit2_txd7	gpmc_ax8	U24		
P9_21	85	0x958/154	14	EHPWM1B	53	gpio[1 33]	EMU3_muX1	EMU3_muX1	gpmc_ax1	mmc2_dat0	gpmc_ax2	mlit2_txd8	gpmc_ax9	U25		
P9_22	17	0x958/154	17	EHPWM1B	54	gpio[1 34]	EMU3_muX2									

# 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

Esc	normal mode											
~ toggle case	! external filter	@ play macro	# prev ident	\$ col	% goto match	^ "soft" bol	& repeat :s	* next ident	( begin sentence	) end sentence	"soft" bol _ down	+ next line
~* goto mark	1	2	3	4	5	6	7	8	9	0 "hard" bol	- prev line	= autoformat
Q ex mode	W next WORD	E end WORD	R replace mode	T back 'till	Y yank line	U undo line	I insert at bol	O open above	P paste before	{ begin parag.	}	end parag.
Q record macro	W next word	E end word	R replace char	T 'till	Y yank	U undo	I insert mode	O open below	P paste after	{ misc	}	misc
A append at eol	S subst line	D delete to eol	F "back" find ch	G eof/ln	H screen top	J join lines	K help	L screen bottom	: ex cmd line	!! reg. spec	bol/ goto col	
a append	s subst char	d delete	f find char	g extra cmds	h ←	j ↓	k ↑	l →	; repeat ; t/f/F	' goto mk. bol	\ not used!	
Z quit ^	X back-space	C change to eol	V visual lines	B prev WORD	N prev (find)	M screen mid'	< un- ^	> indent ^	? find (rev.)			
Z extra ^	X delete char	C change	V visual mode	b prev word	n next (find)	m set mark	, reverse , t/F/f/F	+ repeat cmd	/ find			
Q·												
motion	moves the cursor, or defines the range for an operator	command	direct action command, if red, it enters insert mode	operator	requires a motion afterwards, operates between cursor & destination	extra	special functions, requires extra input	visual mode:	Main command line commands ('ex'):	Notes:		
								:w (save), :q (quit), :q! (quit w/o saving)	(1) use "x before a yank/paste/del command to use that register ('clipboard') (x=a..z,*)			
								:e f (open file f), :%s/x/y/g (replace 'x' by 'y' filewide), :h (help in vim), :new (new file in vim),	(e.g.: "\$y\$ 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)			

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](#)