ADC-001 Instructions

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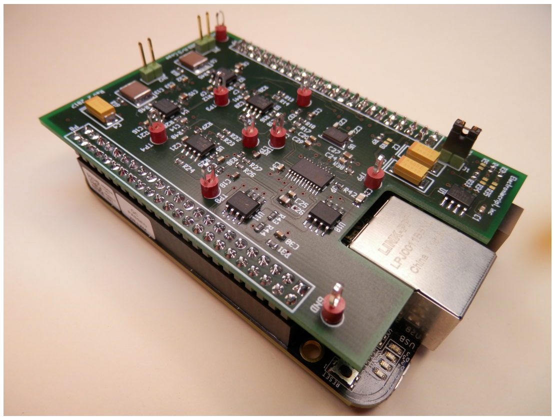
The ADC-001 is an analog-to-digital converter designed as a cape for the Beaglebone Black (BBB). The converter is targeted as an experimenter's platform for audio signal processing. It is designed for use with electret microphones. Compatible microphones are available from Electroniscript.

The ADC-001 provides a hardware and software environment you can leverage for experimentation with audio signals. However, it is not a beginner kit – these instructions assume you already have some familiarity with the Beaglebone, both as a user and a programmer. It also assumes you are comfortable with electronics. If you are new to the Beaglebone, this book and website by Derek Molloy provide a good introduction to the platform: http://derekmolloy.ie/beaglebone/.

Hardware instructions

Basic documentation regarding the ADC-001 cape is kept at GitHub under https://github.com/brorson/ADC-001_hardware_information. Users should consult that GitHub page for the latest schematics and hardware information.

Install the ADC-001 on your BBB as shown in the photo on left. The cut-out on the cape fits around the Ethernet connector on the BBB. Once the cape is installed, it is recommend to power the BBB and cape using an external 5V supply through the power connector on the BBB. A suggested 5V power supply is available from Adafruit Industries at https://www.adafruit.com/product/276.



ADC-001 shown mounted on Beaglebone Black. In the foreground is the cape's cut-out around the BBB's Ethernet connector. In the background are the two microphone connectors, CONN1 and CONN2.

The ADC-001 was designed to use electret microphones with 2.2kohm impedance and sensitivity around -44dB such as the POW-1644L-B-LW100-R from PUI Audio. To avoid 60Hz hum pick-up, the microphones should be enclosed in an electromagnetic shield and connected to the ADC-001 cape via a shielded cable. The cables are connected to connectors CONN3 and CONN4 on the board; the board connectors are Molex 0022112022. A microphone assembly including shielded mic and cable connectorized for the ADC-001 is available from Electroniscript under the part no MIC-001.

Software installation

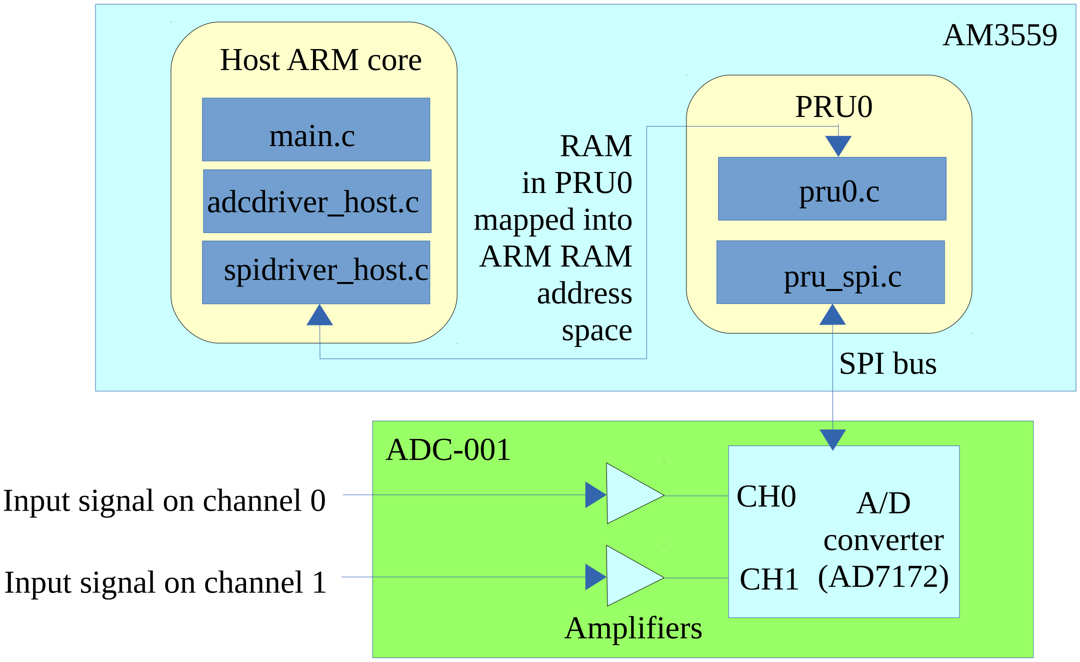
The following repository holds beginner code which you can build and run on your Beaglebone Black to run the ADC-001: https://github.com/brorson/ADC-001_basic_code. Included in that repo are:

- Example main data acquisition program.
- ADC-001 driver programs.
- C programs running on the PRU which mediate data acquisition from the cape's A/D converter via SPI bus.
- Device tree overlay file for the ADC-001 cape.
- A directory holding include files used in the build process.

Debian 9.2 2017-10-10 running on the BBB. Due to the rapid pace of development on the BBB platform, the location of various system files can change from one release to the next. The code held in the repo makes some assumptions about the BBB's directory layout (e.g. device tree overlay files live in /sys/firmware). Therefore, it is strongly recommended that you reflash your BBB to use Debian 9.2 if you wish to follow the instructions here. More information about this is given in the appendix.

To get the beginner code running on your BBB, please do the following:

1. Install the the ADC-001 cape onto your BBB.
2. Get the basic code from https://github.com/brorson/ADC-001_basic_code.
3. Either clone the repo or download the code as a .zip file from the GitHub site, and install it into a new directory on your BBB.
4. Do a build by issuing the command "make" in your code directory on the BBB. This will create the following important files:
   - The main executable called, naturally enough, "main". Then executed, this program runs through a series of tests, and exercises the AD7172 by using it to take data in a couple of different acquisition modes (e.g. single-point read, buffer read at different sample rates).
   - Binary images which will run the bit-banging SPI code on PRU0. These are called "text0.bin" and "data0.bin".
   - The device tree overlay which tells the Linux kernel details about the GPIO configuration used for communication with the AD7172. The device tree overlay image is called SDB-PRU-ADC-00A0.dtbo. The Makefile will copy this overlay file to /sys/firmware.
4. Sometimes, the uio system does not come up correctly after system boot. This is a system bug. You can check the status of the uio system by issuing the command "ls /sys/class/uio/". If the directory listing emitted is empty, then run the script "fix_uio.sh" (included in the files you downloaded). The script stops and starts the uio kernel module several times in order to get it running.
5. Run the main executable by issuing the command "./main" at the command prompt. If everything is working, the program will run through a series of tests, and print to the console its activities.



Software notes

A conceptual block diagram of an application using the A/D shield is shown above. The host ARM microprocessor (AM3359) is shown on top. The A/D shield, ADC-001 is shown beneath the ARM. The A/D itself is an Analog Devices AD7172 configured to support two input channels. Communication between the AM3359 and the A/D takes place via a SPI bus.

Communication between the main program running on the ARM and SPI program running on the PRU occurs via the UIO subsystem. Communication relies on the PRUSS subsystem developed by Texas Instruments which provides access to PRU memory to the ARM via direct read/write. More information about the overall purpose and goals of the UIO subsystem are presented at https://www.osadl.org/fileadmin/dam/interface/docbook/howtos/uio-howto.pdf. Specifics related to Texas Instrument's PRUSS system are available at http://processors.wiki.ti.com/index.php/PRU-ICSS.

Appendix: Reflashing your Beaglebone Black for use with the ADC-001

The code running the ADC-001 assumes you are using the “Debian 9.2 2017-10-10 4GB SD IoT” image available from https://beagleboard.org/latest-images. The code will likely fail miserably on other Debian releases due to version skew. I strongly recommend you reflash your Beaglebone to use this image. Instructions detailing how to reflash your Beaglebone are contained in the document “InstallingDebian9.2.pdf” which lives on GitHub at https://github.com/brorson/ADC-001_hardware_information.

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