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G3 Power Line Communications Data Concentrator on BeagleBone Black Platform Design Guide

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Design Resources

TIDEP0023	Tool Folder Containing Design Files
PLC Kit	More Information on PLC Kit
G3 DC Software	More Information on G3 DC Software
BeagleBone Black	More Information on BeagleBone Black

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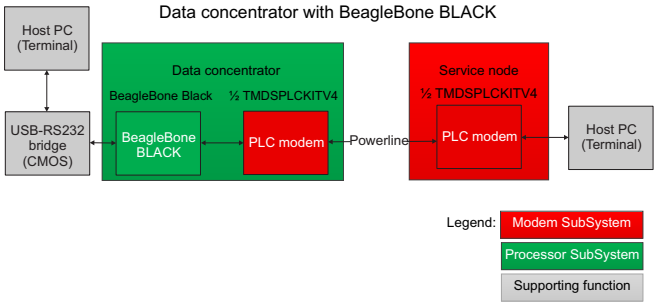
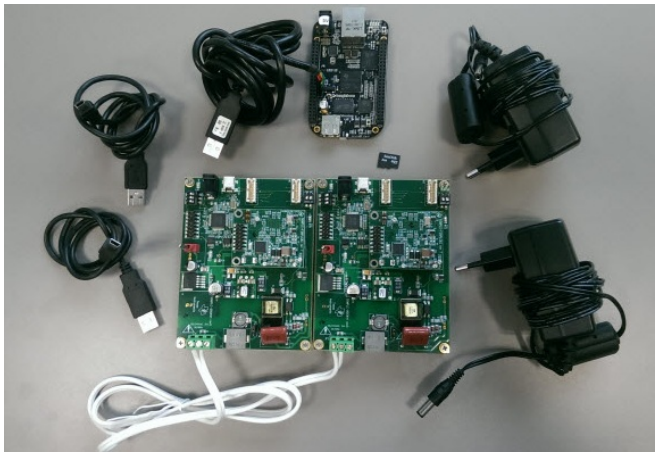
Design Features

- Simplified, Cost-Effective Solution for Evaluating G3-Power Line Communications (PLC) Using BeagleBone Black (BEAGLEBK) and TI's PLC Modem Kit (TMDSPLCKITV4-CEN kit)
- Forms a Small End-to-End G3-PLC Network Using Two Modems from TMDSPLCKIT Kit:
  - One for Data Concentrator PHY and One for Service Node
- Demonstrates Single-Phase Coupling
- Based on Kits Available from the TI Store or Distributors that Include Linux Applications, Middleware, Drivers, Hardware Schematics, Bill of Materials, and Design Files

Design Description

This PLC Data Concentrator design offers a simplified approach for evaluating G3-PLC using BeagleBone Black powered by the Sitara™ AM335x processor. Users can establish a G3-PLC network with one service node. This design supports single-phase coupling.





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1 Required Hardware

- One Linux computer, or a virtual machine running Linux
- One microSD (2GB+)
- One BeagleBone black board
- One TMDSPLCKITV4 kit
- One FTDI-RS232 bridge

2 Step-by-Step Description

This walkthrough will enable users to build a G3 PLC network with one node. Users can build up a PRIME PLC network in a similar fashion. Users will also learn how to configure and compile a Linux kernel required for this task.

Create a Standard Image on an SD Card

The base for this DC image will be the default image provided by the TI SDK. To modify the image:

1. Install the latest SDK on your Linux machine (or virtual machine).
   (a) Download the latest SDK, here “ti-sdk-am335x-evm-07.00.00.00-Linux-x86- Install.bin” from http://software-dl.ti.com/sitara_linux/esd/AM335xSDK/latest/index_FDS.html.
   (b) Install the package on the Linux machine using a console window.
   ./ti-sdk-am335x-evm-07.00.00.00-Linux-x86-Install.bin
   Use the suggested directory, for example /home/user/ti-sdk-am335x-evm-07.00.00.00/.

   NOTE: The abbreviation through the guide for this path is $SDK.

2. Make an SD card (2GB or more) available to the Linux machine and install the standard (pre-built) image on it.
   cd $SDK/bin
   sudo ./create-sdcard.sh
   Options: Create two partitions and use the pre-built image.
3. If necessary, remove and insert the SD card to mount it properly to the Linux environment.

Change and Compile the Kernel

You need to change the kernel to add certain components not included in the standard kernel:

1. Make the SDK tool chain path available (Remember $SDK is just an abbreviation and needs to be replaced with your SDK installation path).
   export PATH=$SDK/linux-devkit/sysroots/i686-aragolinux/ usr/bin:$PATH
2. Change to Linux kernel top folder.
   cd $SDK/board-support/linux-<ver>
3. Clean kernel directory.
   make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihftisdk_ am335x-evm_defconfig
4. Configure kernel.
   A comfortable GUI easily allows adding of components.
   make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- menuconfig

   The GUI will appear. Add following components to the kernel:

   (a) IPv6 functionality
   Networking support→Networking options→The IPv6 protocol <*>

   (b) Virtual tunnel networking
   Device drivers→Network device support→Universal TUN/TAP device driver support <*>

   (c) FTDI USB driver to recognize the TMDSPLCKITV4 hardware
   Device drivers→USB support→USB Serial Converter Support <*>→USB FTDI Single Port Serial Driver

   (d) Enable USB port on the beagle bone (used as host)
   Device drivers→USB support→Inventra Highspeed Dual Role Controller <*>→Platform Glue Layer <*>→[Separate window]: TI DSPS platforms (x)→Enable support for AM335x devices <*>

   Save configuration and exit.
5. Compile kernel
   make ARCH=arm CROSS_COMPILE=arm-linux-gnueabihf- LOADADDR=0x80008000 zImage

Copy Created Files to the SD Card

The new kernel must be copied to the default installation on the SD card:

1. Remove old kernel and copy new kernel to SD card (assuming you are still in **directory kernel top directory**).
   sudo rm /media/rootfs_/boot/zImage
   sudo ./arch/arm/boot/zImage /media/rootfs_/boot

Enable PLC Modem to Act as DC PHY

The PHY hardware of a DC and the service nodes are exactly the same, which means the TMDSPLCKITV4 can be used as PHY for the DC:

1. Flash image sysbios_g3_plc_dc_F2806x_AFE031_CRC16_MSB to the PLC modem, which is provided in the G3 DC software package. See the TMDSPLCKITV4 manual for a description.
2. Connect BeagleBone (P3 [USB]) and TMDSPLCKITV4 (J3 [USB]).
   The DC application accepts a UART connection to the PLC PHY hardware by using a virtual com port.
3. Power up the TMDSPLCKITV4.
   D2 of the PLC SoM module should blink with a frequency of 1 Hz.

Boot the BeagleBone Black with the SD Card

1. Remove the SD card from Linux computer and insert in BeagleBone board.
2. Connect FTDI USB-RS232 bridge to J1 of the BeagleBone board. The USB connector connects to your host computer (Linux or window).
3. Open a new console on your host and start a terminal program (for example, minicom). Make sure the FTDI bridge is tied to it.
4. Apply power to BeagleBone board through the USB socket P4. Press and hold S2 while powering up the board. The BeagleBone board should boot now. Check the minicom output.

Copy PLC Software to System

Until now, the BeagleBone software would not recognize PLC software at all. A convenient way is to connect the BeagleBone board to the Ethernet and copying the data using FTP tool like Filezilla (assuming the host computer is also connected to the Ethernet).

1. After BeagleBone powers up, log in to BeagleBone board.
   am335x-evm login: root
2. Get the IPv4 address of the BeagleBone board.
   ifconfig
3. Build a connection from host computer to BeagleBone board using an FTP program.
4. Create a directory, for example G3, in the /home/root directory of your BeagleBone environment.
5. Copy all binaries from the G3 DC software package to the /home/root/G3 directory.
   The standard PLC package has a folder SW/bin where all files for the AM335X should be copied. Copy all files with fragment “AM335x” in the file name to the BeagleBone directory. The latest G3 DC software package is available for download at http://www.ti.com/tool/TI-PLC-G3-DC.

Running the G3 DC Application

1. Back in the BeagleBone terminal window of your host machine, go to directory G3 and allow execution of all copied files.
   cd G3
   chmod +x *
2. Start the G3 application.
   ./g3_dc_AM335X_aes_msb_loadng.exe –d –c /dev/ttyUSB1
3. You can always check whether the application is running with the command.
   ps
4. Now, an SN can join the network using another PLC modem with service node software installed. See the TMDSPLCKITV4 manual on how to join a network.

Perform a Data Transfer over the Network

Once the SN has joined, you can trigger simple data transfer by using application udpIPv6App_AM335X
./udpIPv6App_AM335x –l 32 –s 0x1

The packet length is 32 bytes and the short address is 0x1. The short address will be assigned to each joining node starting at 0x1.

The G3 network should now run. These steps will work as well for PRIME standard.

3 Design Files

3.1 Schematics

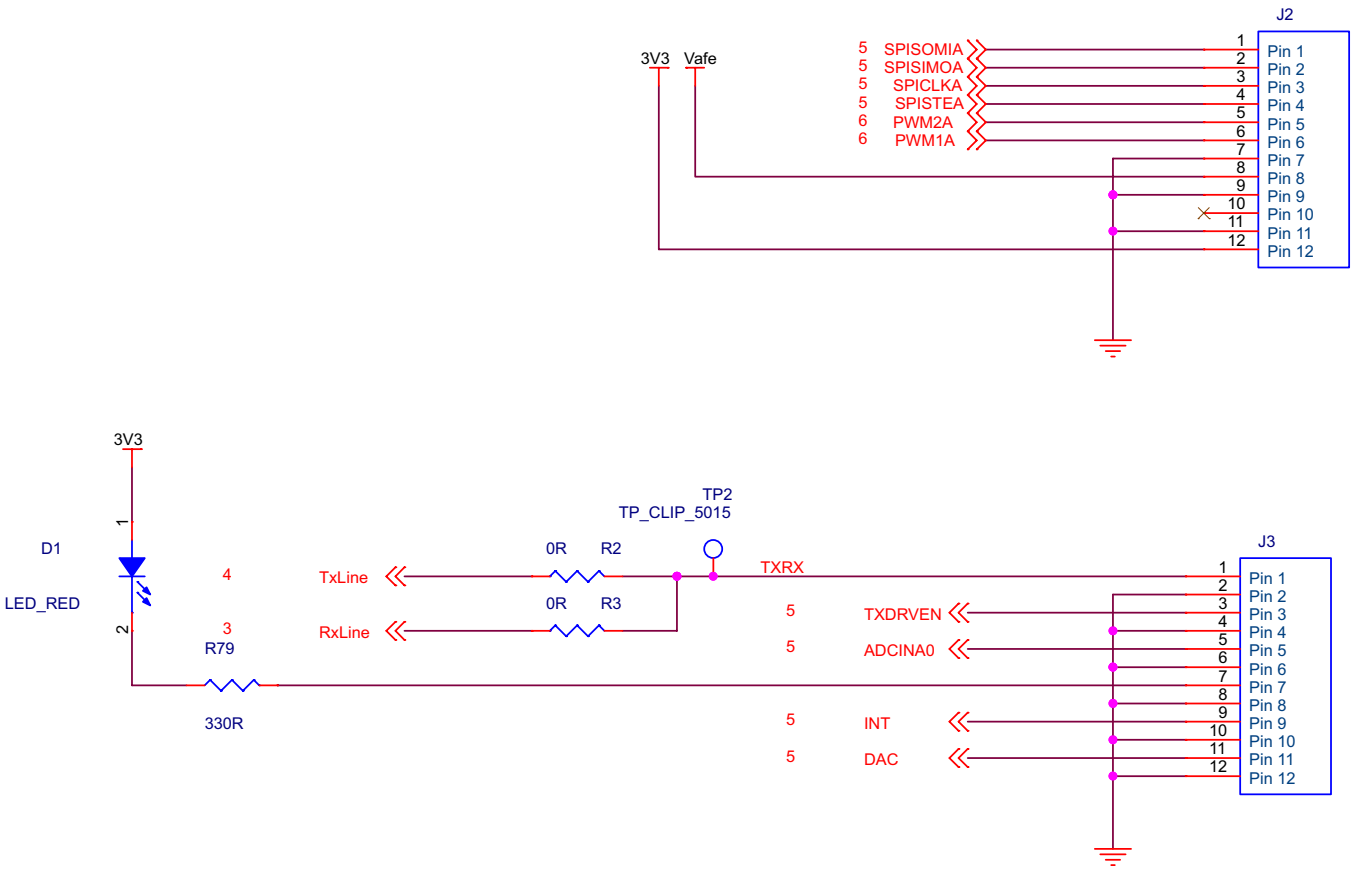

Figure 1. Connections Schematic

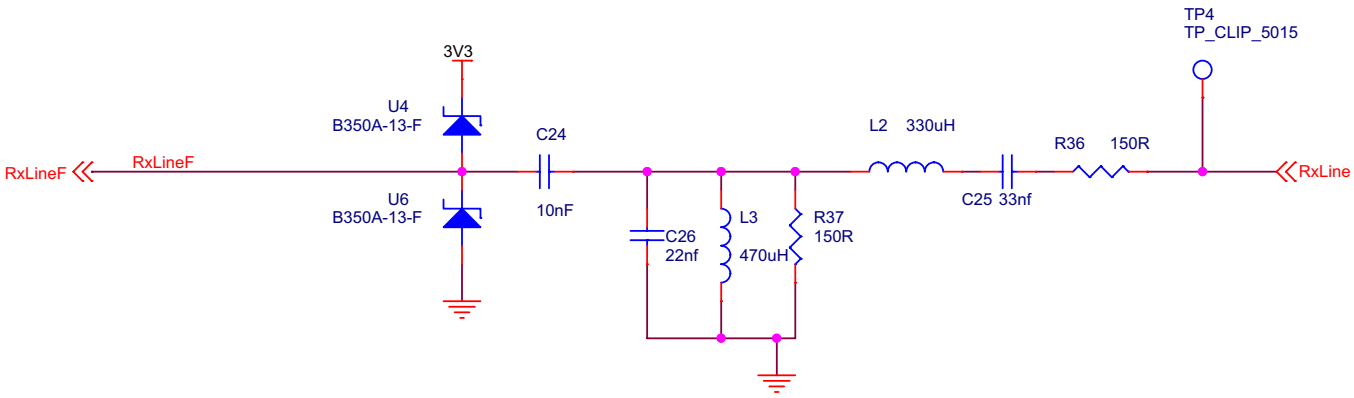

Figure 2. AFE1 (Passive RX Filter) Schematic

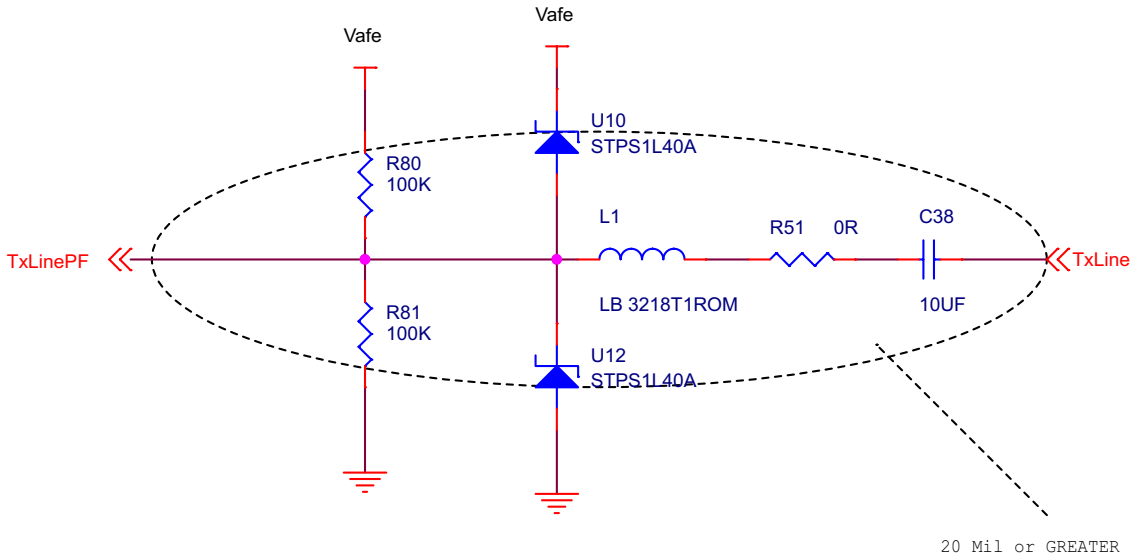

Figure 3. AFE2 (Passive TX Filter) Schematic

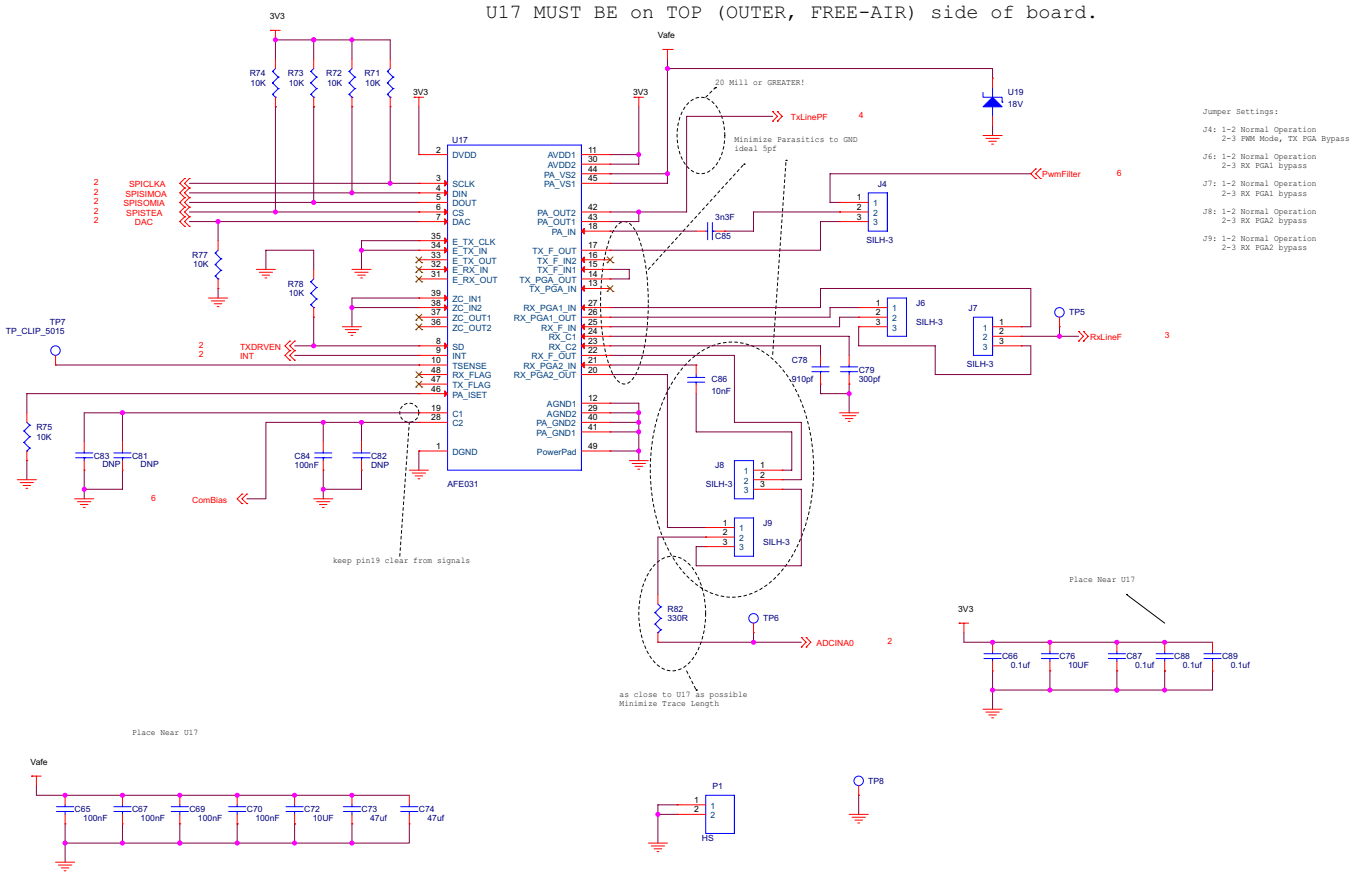

Figure 4. AFE031 Schematic

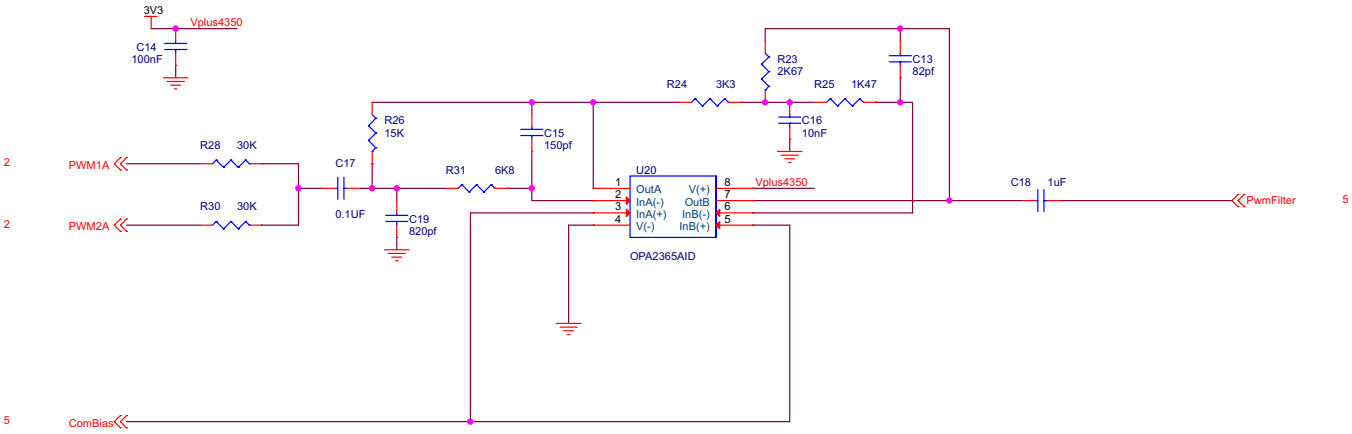

Figure 5. PWM Filter Schematic

3.2 Bill of Materials

To download the bill of materials (BOM), see the design files at TIDEP0023.

3.3 CAD Project

To download the CAD project files, see the design files at TIDEP0023.

3.4 Gerber Files

To download the Gerber files, see the design files at TIDEP0023.

3.5 Software Files

To download the software files, see the design files at TIDEP0023.

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