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AD9371 and ADRV9009 Setup with the ZCU102 or ZC706/ZYNQ3

Many Thanks to:

Pam Arpaio
Larry Prestia
Steve Reine
Jon Kraft
Phil Wallace
Danny Nauth

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Overview of the Setup Process

- What is the Purpose of this Setup Guide???
- Create (or update) the SD Card
- Setup the hardware
- Set a Static IP Address on Your Computer
- Connect via Putty
- Launch IIO_Scope
- SAFELY shutdown

Purpose of this Setup Guide

- There are wiki.analog startup guides for these products
  - To begin, please review:
    - ADRV9009: https://wiki.analog.com/resources/eval/user-guides/adrv9009/quickstart/zynqmp
    - AD9371: https://wiki.analog.com/resources/eval/user-guides/mykonos

- However, this document may assist you in going through the process step by step.
- It was compiled from the collective experience of the ADI FAEs who commonly support these products.

- We hope you find it helpful!

Create (or Update) the SD Card

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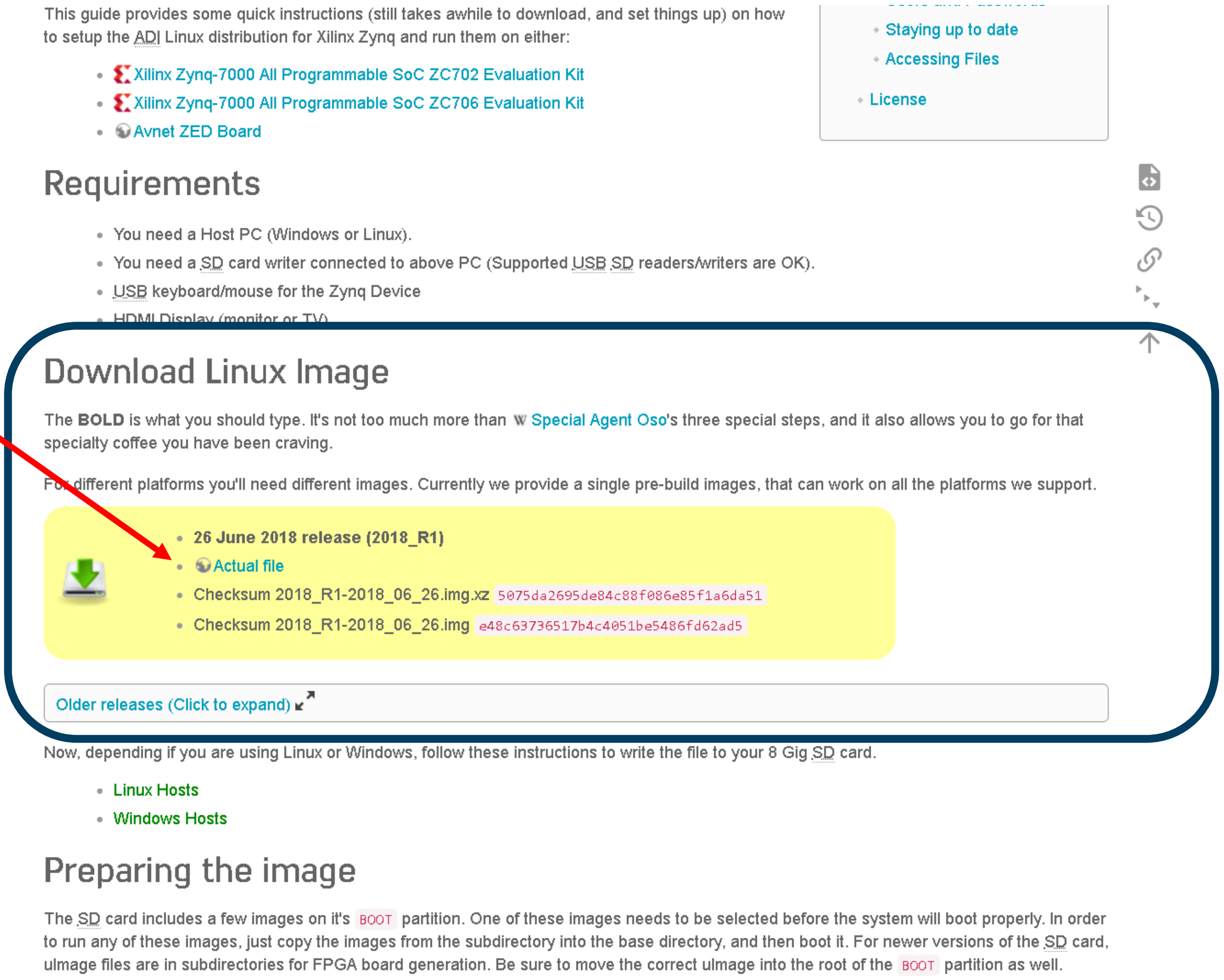
Creating the Image on SD Card (1)

- Note: you cannot use an ADI laptop or anything that would encrypt the files (i.e. bitlocker installed).
- Download the latest version of the image online & save to a folder.
  - https://wiki.analog.com/resources/tools-software/linux-software/zynq_images
- This file contains all the LIBIIO (i.e. SDR prototyping) FPGA images for all the supported FPGA and eval card combinations.
  - Later in the process, you will copy one of these images into the root of the SD card. But all get downloaded.
- Checksum info may not be needed in the rest of the process. But you can do it with md5sum as a doublecheck.


This guide provides some quick instructions (still takes awhile to download, and set things up) on how to setup the ADI Linux distribution for Xilinx Zynq and run them on either:

- Xilinx Zynq-7000 All Programmable SoC ZC702 Evaluation Kit
- Xilinx Zynq-7000 All Programmable SoC ZC706 Evaluation Kit
- Avnet ZED Board

- Staying up to date
- Accessing Files
- License

Requirements

- You need a Host PC (Windows or Linux).
- You need a SD card writer connected to above PC (Supported USB SD readers/writers are OK).
- USB keyboard/mouse for the Zynq Device
- HDMI Display (monitor or TV)

Download Linux Image

The **BOLD** is what you should type. It's not too much more than Special Agent Oso's three special steps, and it also allows you to go for that specialty coffee you have been craving.

For different platforms you'll need different images. Currently we provide a single pre-build images, that can work on all the platforms we support.

- **26 June 2018 release (2018_R1)**
- Actual file
- Checksum 2018_R1-2018_06_26.img.xz `5075da2695de84c88f086e85f1a6da51`
- Checksum 2018_R1-2018_06_26.img `e48c63736517b4c4051be5486fd62ad5`

Older releases (Click to expand)

Now, depending if you are using Linux or Windows, follow these instructions to write the file to your 8 Gig SD card.

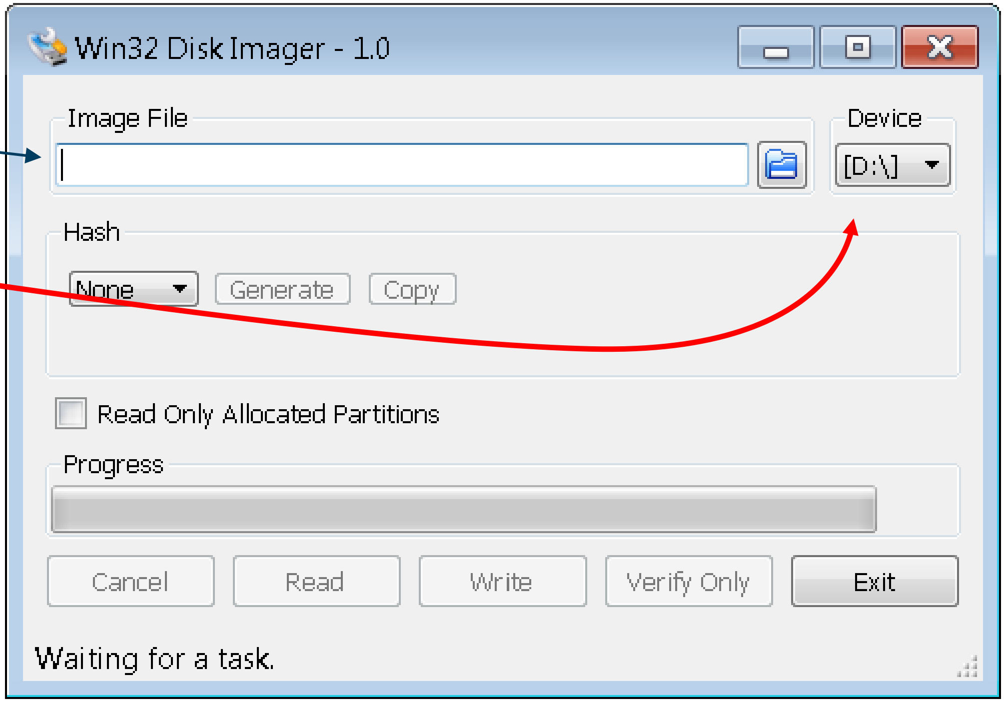
- Linux Hosts
- Windows Hosts

Preparing the image

The SD card includes a few images on it's `BOOT` partition. One of these images needs to be selected before the system will boot properly. In order to run any of these images, just copy the images from the subdirectory into the base directory, and then boot it. For newer versions of the SD card, uImage files are in subdirectories for FPGA board generation. Be sure to move the correct uImage into the root of the `BOOT` partition as well.

Creating the Image on SD Card (2)

- Unzip the file with 7-Zip
  - File extension should change from ~~~~.img.xz to ~~~~.img
- Use Win32DiskImager to image the disk
  - Image File – point to the unzipped version of the downloaded file
  - Device – point to the SD Card
    If you point to your own hard disk you will wipe your machine.
- Click Write
  - This could take 10 min or so.
- After write is complete, then open up the SD card in file explorer



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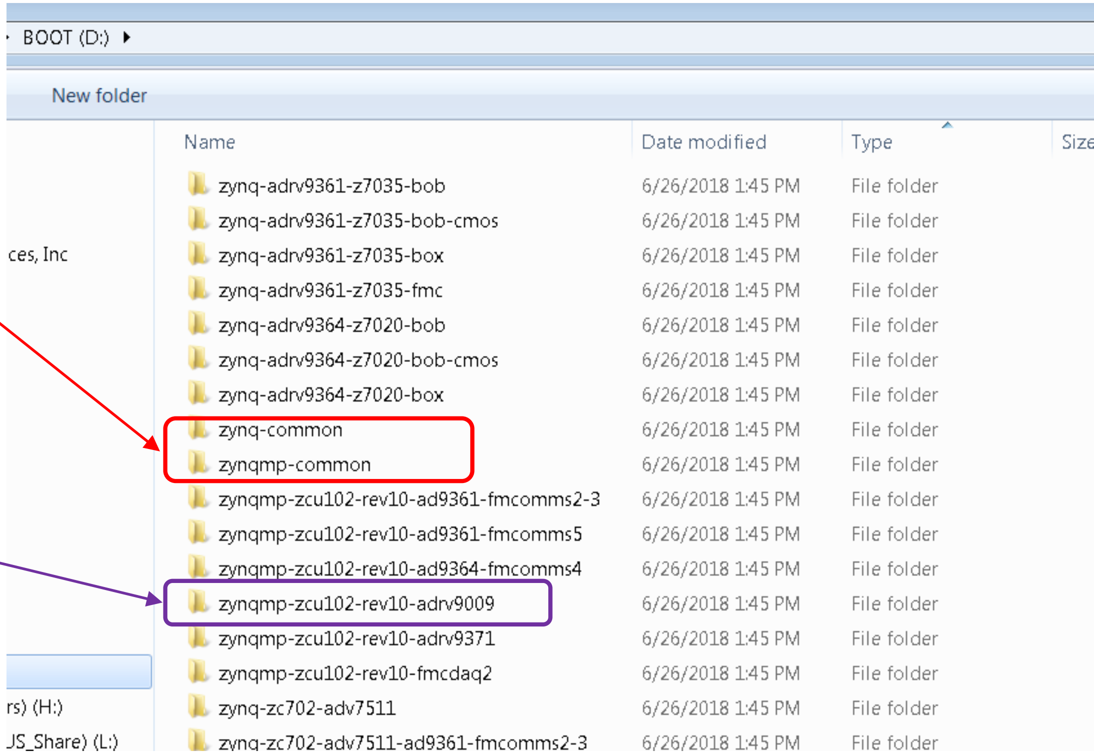
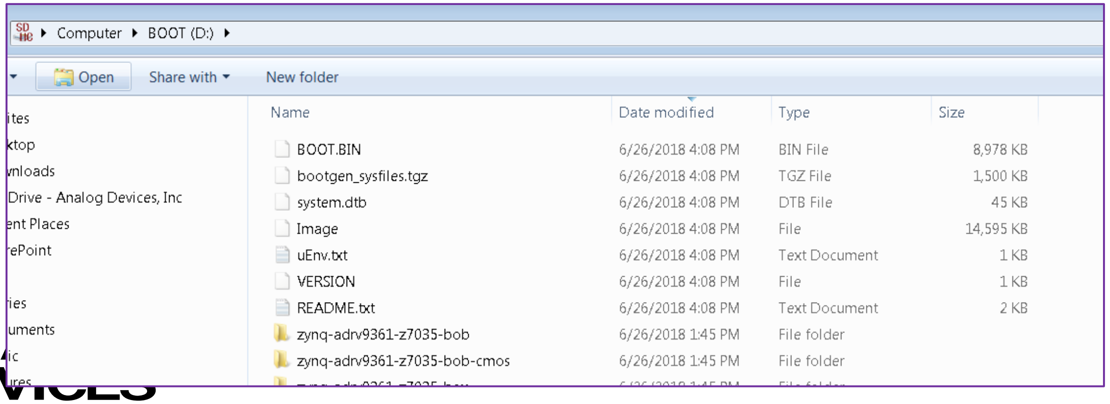
Creating the Image on SD Card (3)

- Go to the folder for the FPGA board you have and copy the files (Image or uImage) to the root directory on the SD Card
- Go to the folder for the FPGA board + SDR Board you have and copy the files to the root directory on the SD Card
- Final product looks like:





Setup the Hardware

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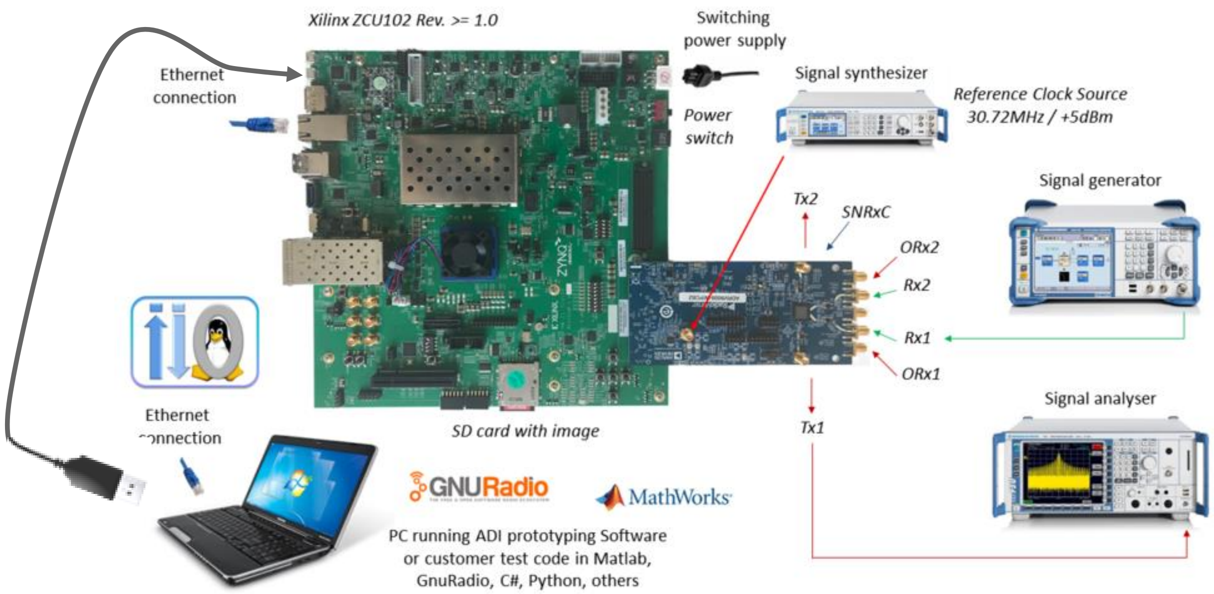
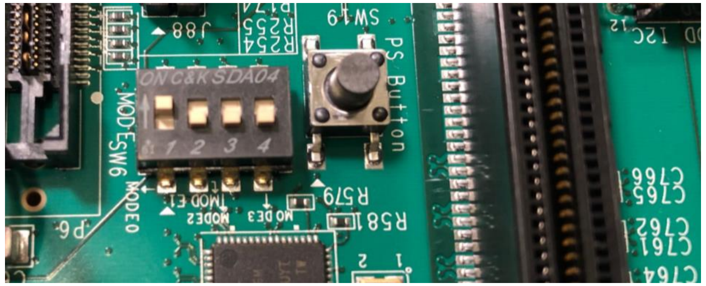
ZCU102 Hardware Setup

- Need to have:
  - SD Card in place
  - Ethernet cable between laptop & FPGA board
  - USB cable between UART and laptop (J83 on ZCU102)
  - Power cable connected
  - SDR board in the correct HPC slot:
    - AD9371 (or FMCOMMSx or DAQ2) board goes in slot 0
    - ADRV9009 board goes in HPC slot 1 (closest to SD card)
  - 30.72 MHz reference clock connected to SDR board
    - (see next slide for some options on this)



- Don't bother with HDMI or display port connections. They don't seem to work on the ZCU102
- DIP switches at SW6 need to be UP DN DN DN (up is toward SD card, DN is away from SD card)



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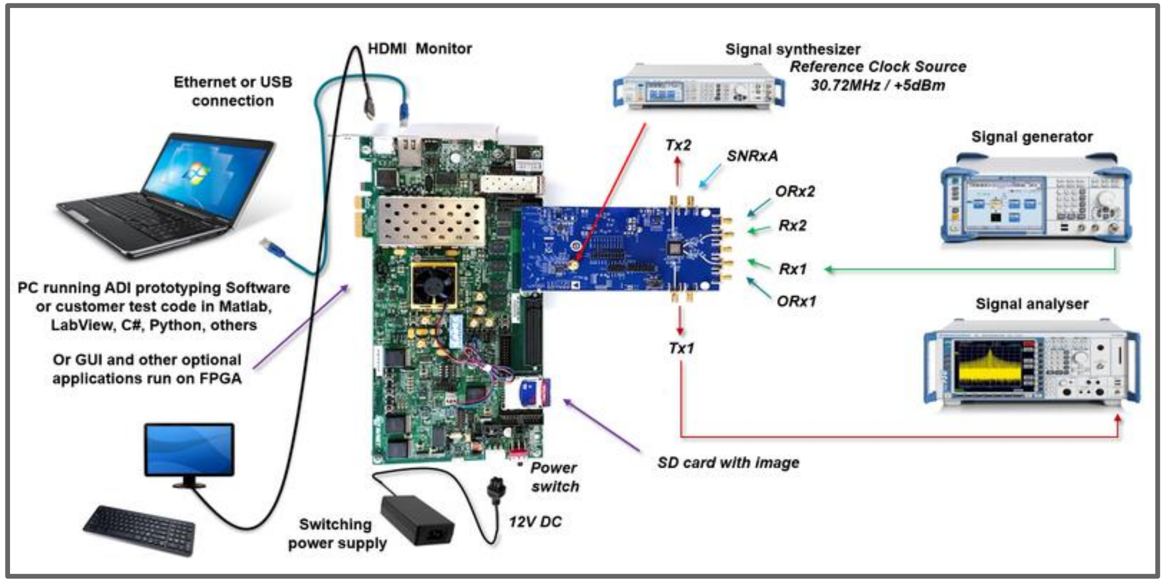
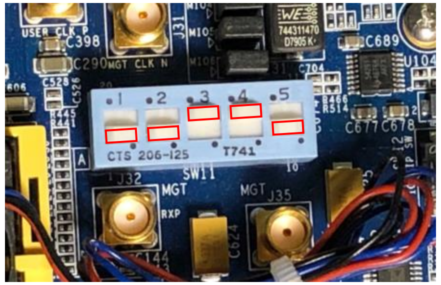
ZYNQ3 (and ZC706) Hardware Setup

- Need to have:
  - SD Card in place
  - Ethernet cable between laptop & FPGA board
  - USB cable between UART and laptop (J21 on ZC706)
  - Power cable connected
  - SDR board in the correct HPC slot:
    - AD936x (i.e. FMCOMMSx) board goes in J5 (LPC) (closest to SD card)
    - AD9371 and ADRV9009 goes in J37 (HPC) (closest to ethernet)
  - 30.72 MHz reference clock connected to SDR board
    - (see next slide for some options on this)



- DIP switches at SW11 need to be:
  - 1, 2, and 5 are down
  - 3, 4 are up



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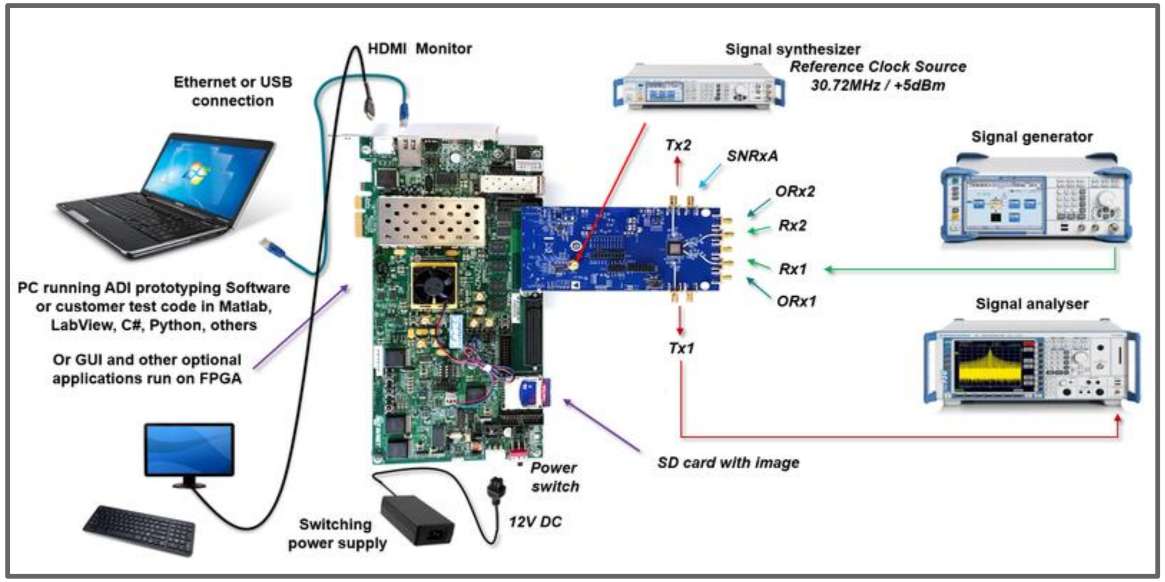
ZYNQ3 (and ZC706) Hardware Setup

- There are two ways to use the ZYNQ3 and ZC706 boards:
  1. With an HDMI Monitor Connected.
     - Connect an HDMI Monitor to P1
     - Then use a USB micro to USB OTG adapter on J2. Such as:
       - https://www.amazon.com/gp/product/B00LTHBCNM/ref=ppx_yo_dt_b_search_asin_title?ie=UTF8&psc=1
     - Connect a USB Keyboard and Mouse to the USB OTG adapter
     - Now, the FPGA board is your computer and you can interact directly with the Linux Software installed on the FPGA.

     OR
  2. Control via your Laptop.
     - We'll use the UART to assign an IP address to the FPGA board, then open IIOscope on a laptop, add that IP address, and control the radio board from IIOscope on the laptop.
     - The rest of this document explains this procedure.



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SDR Board Reference Clock Options

- The ADRV900x boards REQUIRE a reference clock (and AD9371 boards will complain if they don’t get one).
  - 30.72 MHz is the default value, but this could be changed (i.e. 61.44MHz) if required.
- A signal source works great, of course.
- But an easier solution is the Crystek CPRO33-30.72 SMA oscillator.
- These are not expensive, but they are hard to find, so here’s the part’s list for that option:

SMA 30.72 MHz clock source for the AD9371 and ADRV9008/9 boards:		
Oscillator	CPRO33-30.72	https://www.digikey.com/products/en?keywords=CPRO33-30.72
SMA to barrel adapter		https://www.digikey.com/products/en?keywords=CCADP-MM-6
3.3V power wall wart	2.1/5.5mm barrel	https://www.digikey.com/product-detail/en/kaga-electronics-usa/KTPS05-03315U-VI-P1/62-1234-ND/5820199


Set a Static IP Address

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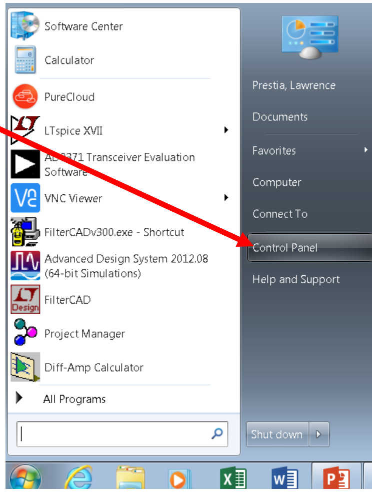
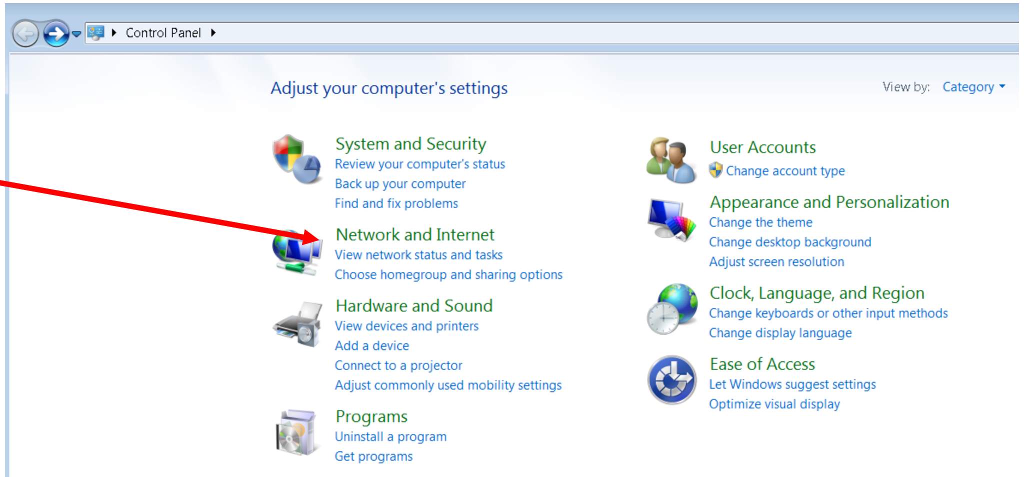
Set a Static IP Address (1)

1. **Set up LAN laptop settings for communications.**
   a) **Start, Control Panel,**



   b) **Network and Internet**



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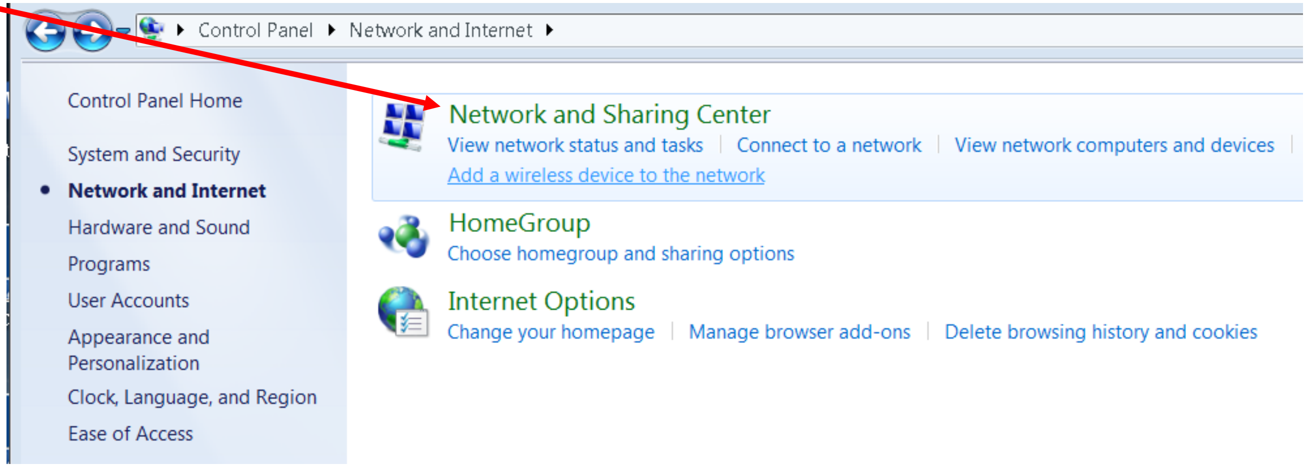
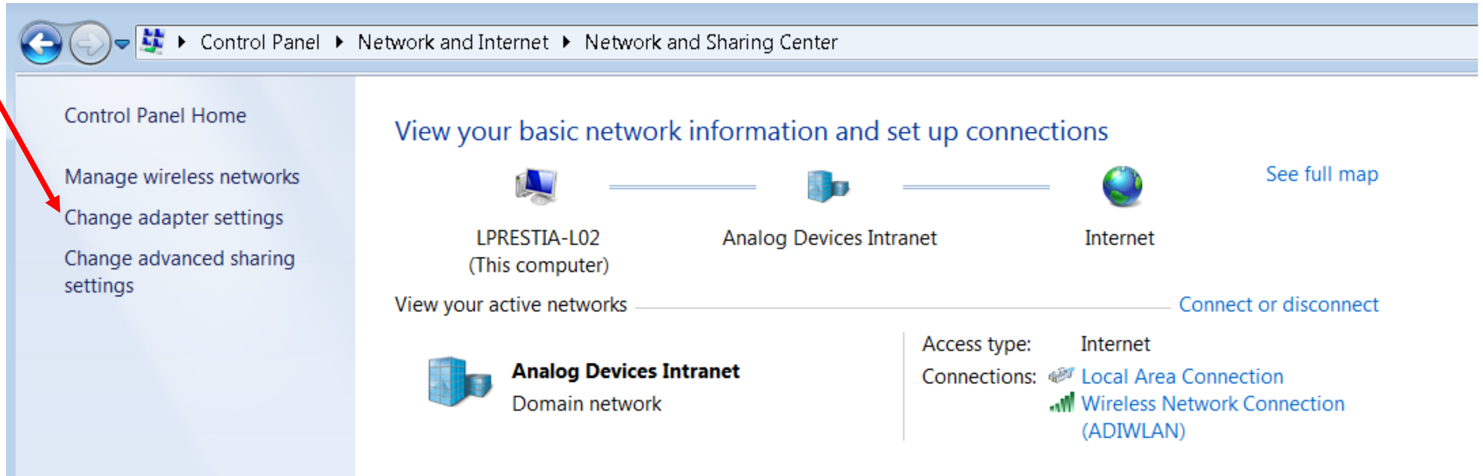
Set a Static IP Address (2)

c) Network and Sharing Center



d) Change adapter settings



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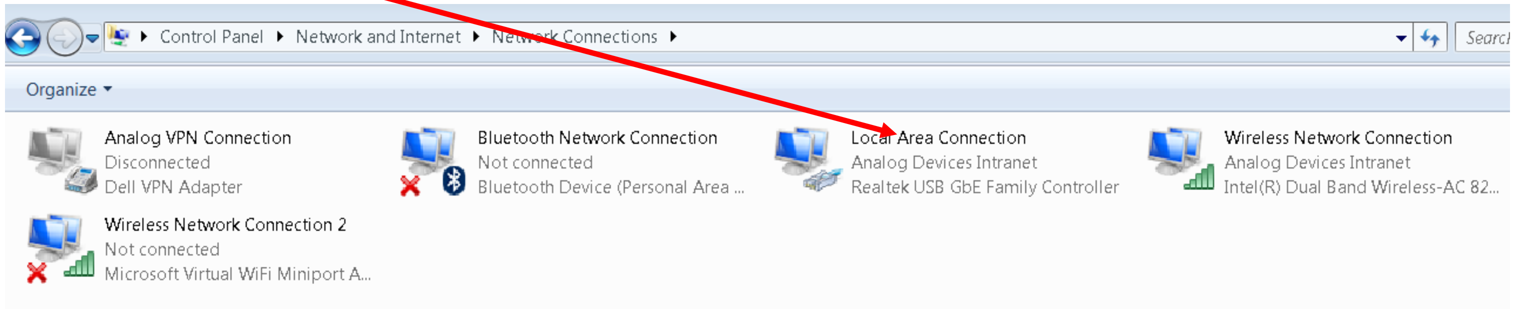
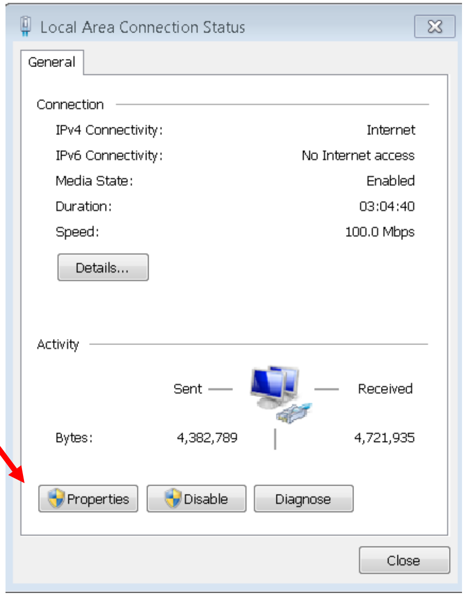
Set a Static IP Address (3)

e) Local Area Connection or Ethernet



f) Properties



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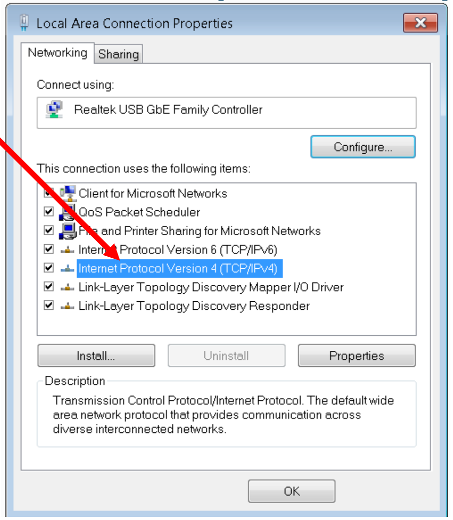
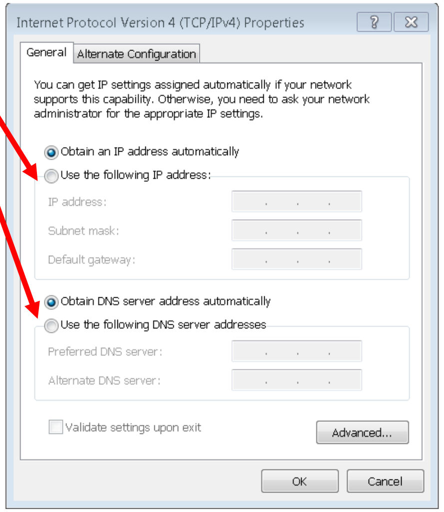
Set a Static IP Address (4)

g) Internet Protocol Version 4 (double-click)



f) Use the following…



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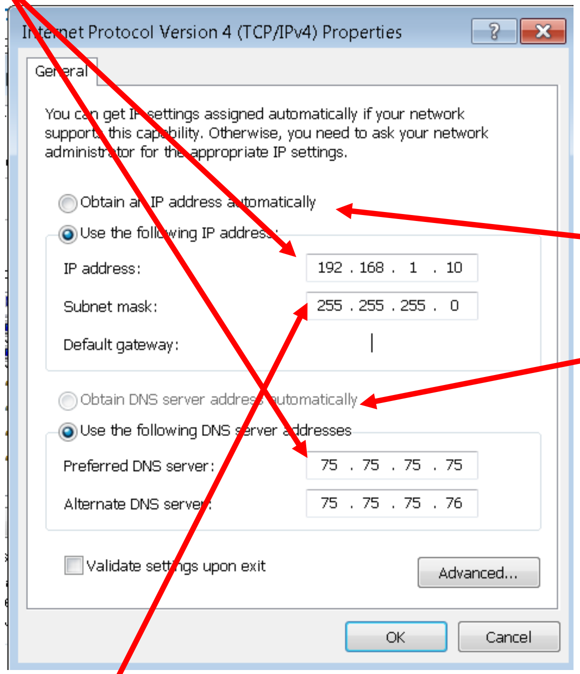
Set a Static IP Address (5)

g) Fill in IP Address, Preferred DNS, Alternate DNS with values shown



IMPORTANT – Change back to OBTAIN…AUTOMATICALLY when done

f) Subnet fills in automatic

g) OK, OK

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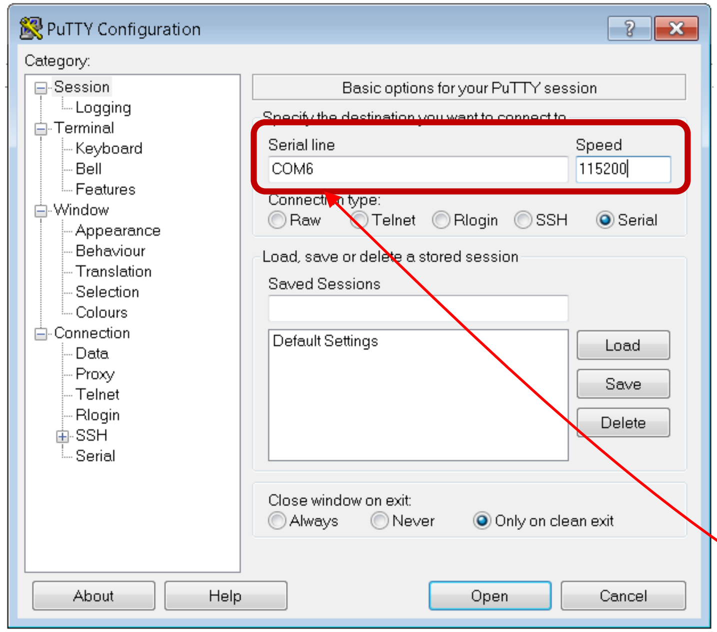
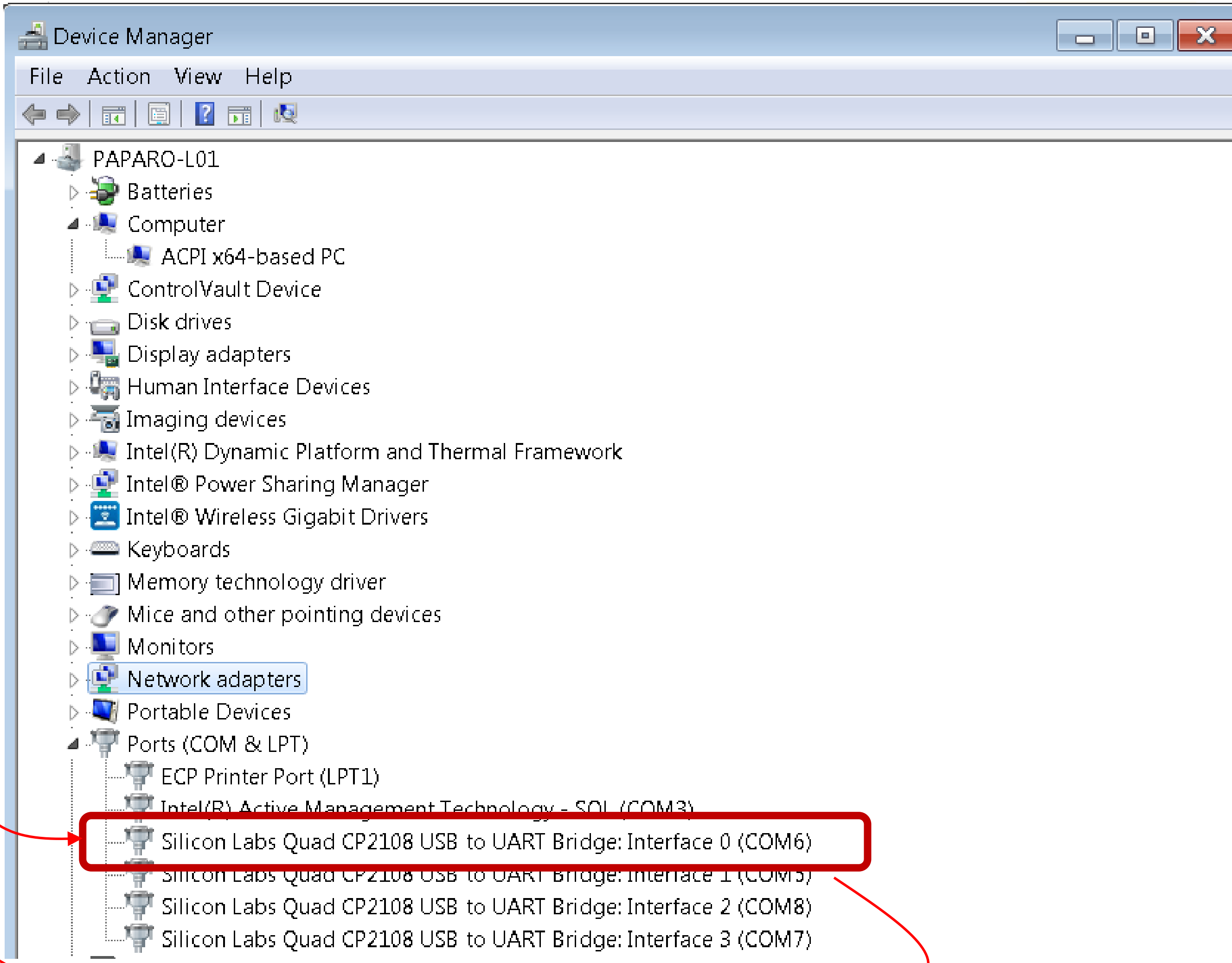
Connect Via Terminal Program (i.e. Putty or TeraTerm)

Connecting to the FPGA Board

Power Up FPGA Board

- Open Device Manager & find USB to UART Bridge “Interface 0”
  - You may need to download and install the CP2108 drivers from Silicon labs
- Open PuTTY and use Serial Link to connect to that COM port. Baud rate will be 115200.





Connecting to the FPGA Board

- When board is finished booting, you should see this, ending with the “root@analog:~#” cmd prompt
  - You may have to hit return a few times to get the command prompt

COM6 - PuTTY

```
pts:  (null)
[    9.744938] VFS: Mounted root (ext4 filesystem) on device 179:2.
[    9.753620] devtmpfs: mounted
[    9.756622] Freeing unused kernel memory: 512K (ffffffc000da0000 - ffffffc000
e20000)
Mount failed for selinuxfs on /sys/fs/selinux:  No such file or directory
[   10.527936] systemd-udevd[2569]: could not open moddep file '/lib/modules/4.9
.0-g2398d50/modules.dep.bin'
[   10.555050] systemd-udevd[2569]: could not open moddep file '/lib/modules/4.9
.0-g2398d50/modules.dep.bin'
 * Setting up X socket directories...                                    [ OK ]
 * STARTDISTCC is set to false in /etc/default/distcc
 * /usr/bin/distccd not starting
 * Starting IIO Daemon iiod                                              [ OK ]

Last login: Mon Aug  7 12:18:05 UTC 2017 on tty1
Welcome to Linaro 14.04 (GNU/Linux 4.9.0-g2398d50 aarch64)

 * Documentation:  https://wiki.analog.com/ https://ez.analog.com/

New release '16.04.4 LTS' available.
Run 'do-release-upgrade' to upgrade to it.

root@analog:~#
```

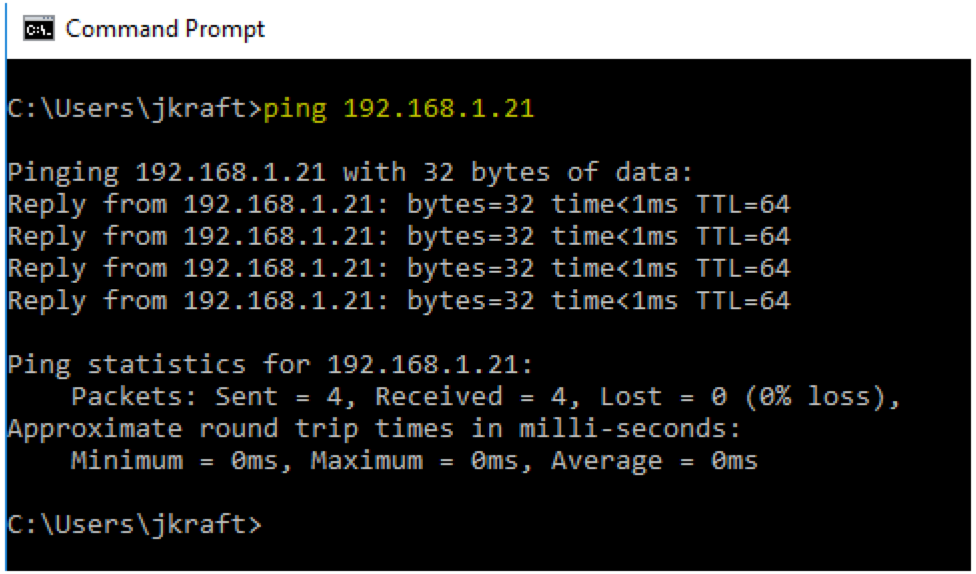
Setting IP address of FPGA Board

- First: type `ifconfig` to check if an IP address has been assigned
  - If there is no IP address, then from PuTTY window, configure the board for a static IP address by typing `enable_static_ip.sh 192.168.1.21`
    - The "1.21" ending could really be anything that doesn't conflict with something else already connected
  - If an IP address is already assigned, then you can use that address
    - Or, to change, type `ifconfig eth0 192.168.1.10` (or whatever address you want)
  - To return the FPGA to a dynamic IP address (i.e. to allow the FPGA board to access the internet via ethernet), type `sudo enable_dhcp.sh`
- To confirm the ip address, type `ifconfig`
  - You should get back a bunch of info confirming the inet6 addr
- To verify the TRx cards connected, type `iio_attr -a -d`

```
root@analog:~# iio_attr -a -d
Using auto-detected IIO context at URI "local:"
IIO context has 8 devices:
        iio:device3: ad9371-phy, found 9 device attributes
        iio:device1: ad9528-1, found 9 device attributes
        iio:device6: axi-ad9371-rx-hpc, found 0 device attributes
        iio:device4: axi-ad9371-rx-obs-hpc, found 1 device attributes
        iio:device2: ad7291, found 0 device attributes
        iio:device0: ams, found 1 device attributes
        iio_sysfs_trigger:, found 2 device attributes
        iio:device5: axi-ad9371-tx-hpc, found 0 device attributes
root@analog:~#
```

Ensure that your laptop can talk to that address

- Open Command prompt & ping the address.



- If no response:
  - check IP address of your laptop (see “Set Static IP Address” instructions above)

Launch IIO Scope

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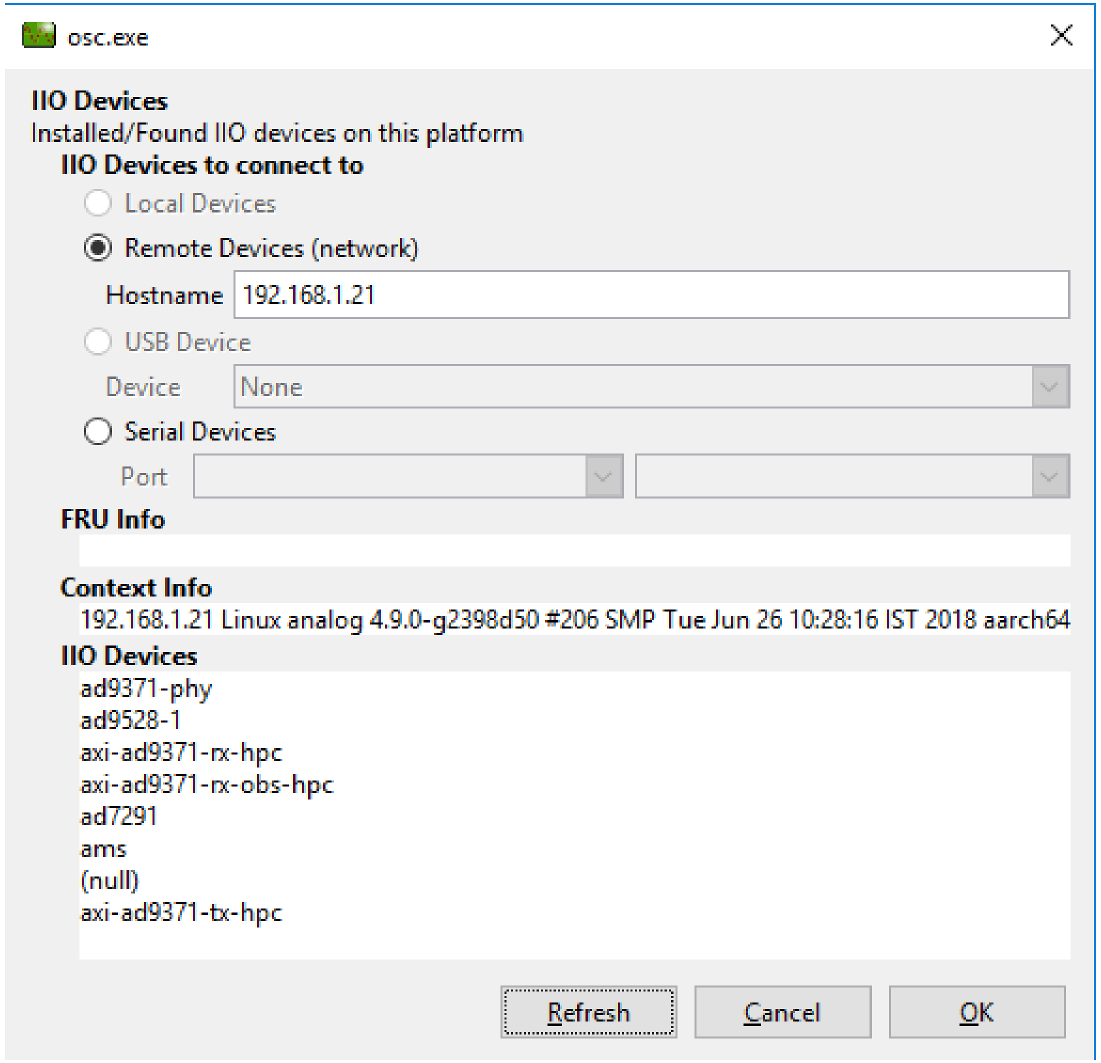
Launch IIOscope

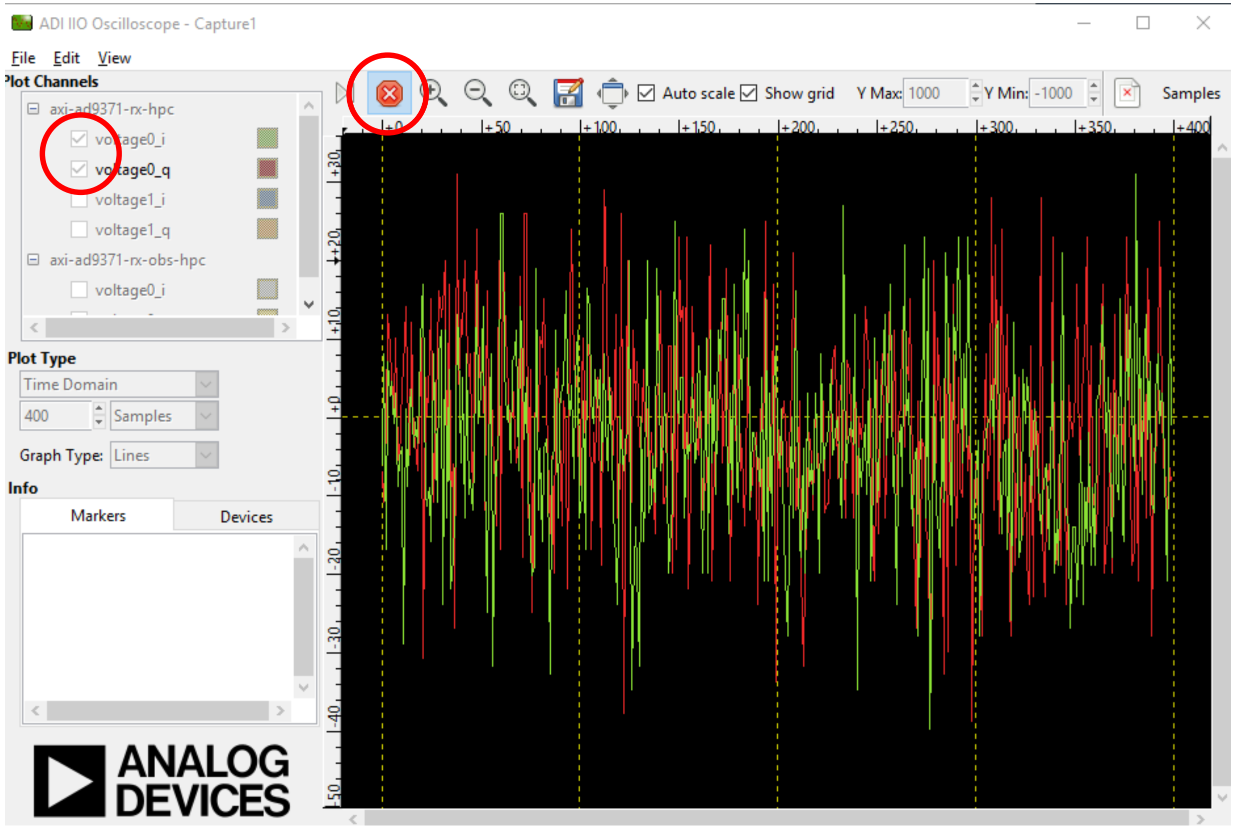
- Download IIOscope here:
  - https://wiki.analog.com/resources/tools-software/linux-software/iio_oscilloscope

- Enter the IP address you used above with the enable_static_IP.sh command (i.e. 192.168.1.21)
  - Click refresh
    - You should then see a bunch of IIO Devices listed
  - Then click ok.



Confirm IIO Scope Operation

- If a capture window is not open:
  - Then go to File→New Plot
- In the “Capture” window:
  - Click on voltage0_i and voltage 0_q
  - Then press “Play”
  - You should see a rapidly updating scope



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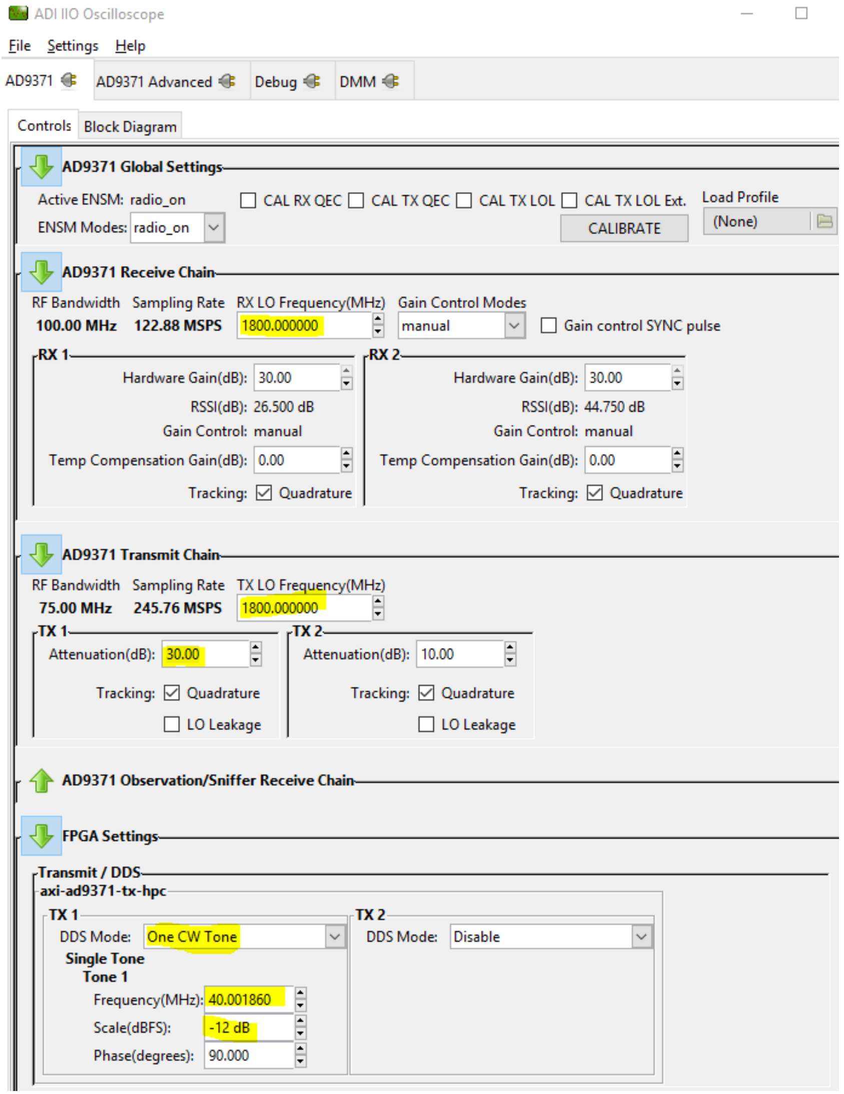
Confirm IIO Scope Operation

- ► Use an SMA cable to connect the AD9371 TX1 to RX1
- ► On the AD9371 (similar for ADRV9009) tab:
  - Set Rx and Tx LO frequencies to 1800MHz (or any frequency)
  - Set TX1 Attenuation to 30 dB
  - Under Transmit/DDS:
    - Set DDS Mode to “One CW Tone”
    - Set Freq to 40 MHz and Scale to -12 dBFs



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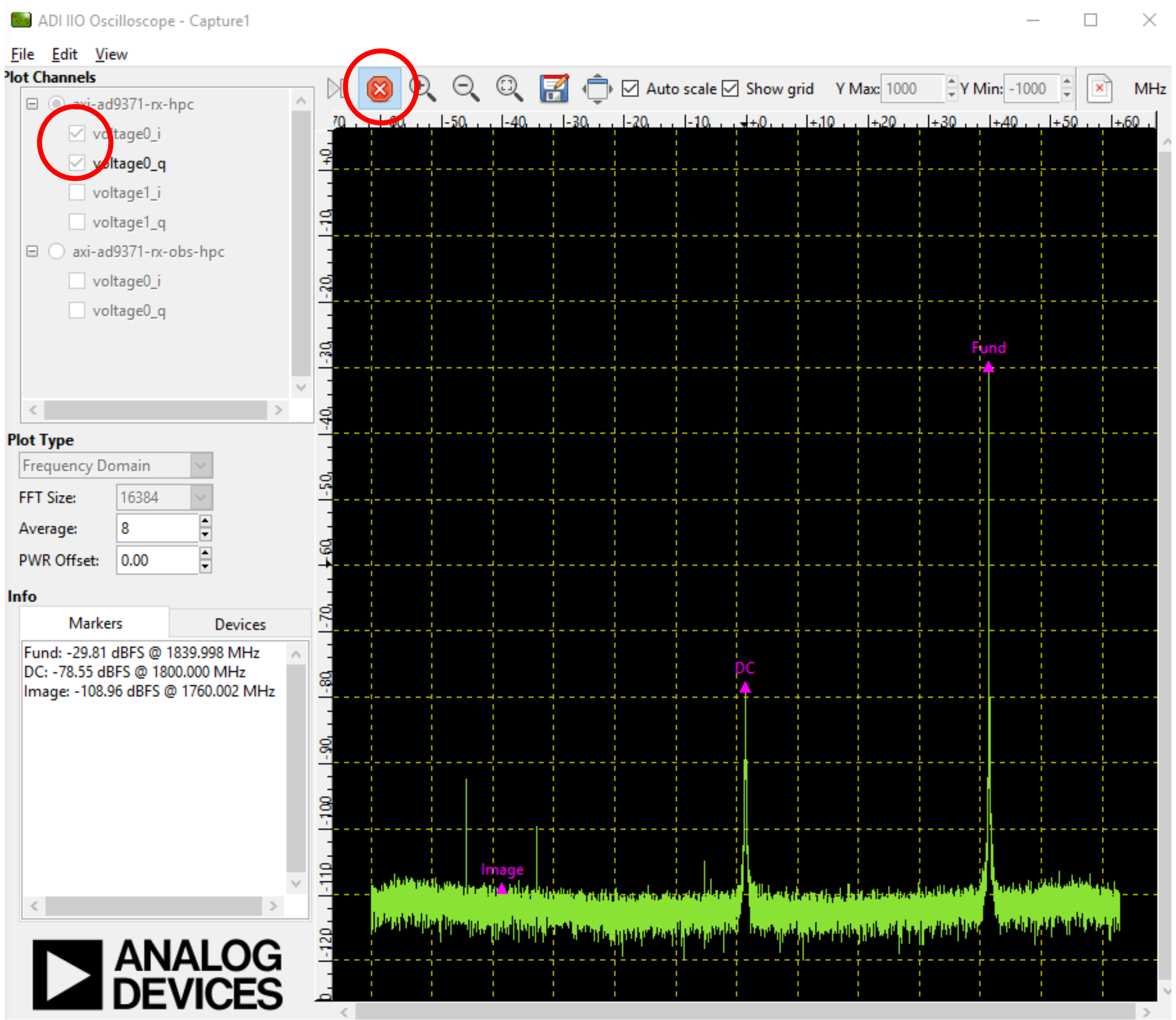
Confirm IIO Scope Operation

- In the “Capture” window:
  - Press “Stop” (if data is updating)
  - Then change “Plot Type” to “Frequency Domain”
  - Set Average to 8
  - Right click on the plot and select “Image Markers”



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Shutdown and Troubleshooting

Safely Shutdown

- To shutdown gracefully (i.e. not corrupt the SD card):
  - `sudo shutdown -h now` command from PUTTY

- Troubleshooting:
  - If unable to see devices in iio-oscilloscope, you could have the wrong HPC spot
  - If unable to boot and FPGA board and you see some red LEDs? Likely a bad SD card or SW06 in wrong position.
  - If unable to boot past first stage boot loader? Likely a bad SD card
  - If unable to connect from laptop, check the network config (see above section on configuring a static IP)

Command Summary

- Terminal Commands:
  - `enable_static_ip.sh 192.168.1.21`
    - Sets IP address (to 192.168.1.21)
  - `ifconfig`
    - Check's IP address
  - `ifconfig eth0 192.168.1.10`
    - Changes IP address (to 192.168.1.10 in this example)
  - `iio_attr -a -d`
    - See what devices are connected
  - `poweroff` or `sudo shutdown -h now`
    - Safely shutdown the FPGA