



# GNU Radio Suite

Software Defined Radio for Python Programming

## Let's first explain a Software Defined Radio (SDR):

A software-defined radio is a radio system which performs the required signal processing in software instead of using dedicated integrated circuits in hardware. The benefit is that since software can be easily replaced in the radio system, the same hardware can be used to create many kinds of radios for many different transmission standards; thus, one software radio can be used for a variety of applications!

## So what is GNU Radio and why do I want it?

GNU radio is a free open-source software development toolkit that provides signal processing functions to implement software radios. It can be used with readily-available low-cost external RF hardware to create software-defined radios, or without hardware in a simulation-like environment.

## So what exactly does GNU Radio do?

GNU Radio performs all the signal processing. You can use it to write applications to receive data out of digital streams or to push data into digital streams, which is then transmitted using hardware. GNU Radio has filters, channel codes, synchronization elements, equalizers, demodulators, vocoders, decoders and many other elements which are typically found in radio systems. (in GNU Radio jargon, these elements are called “blocks”)

More importantly, it includes a method of connecting these blocks and then manages how data is passed from one block to another. Extending GNU Radio is also quite easy; if you find a specific block that is missing you can quickly create and add it.

GNU Radio applications are primarily written using the Python programming language while the supplied, performance-critical, signal processing path is implemented in C++ using processor floating point extensions where available.



# GNU Radio Companion (GRC)

Ham Friendly Digital Signal Processing



SDR is a relatively new and, at times, confusing technology for many radio operators and experimenters.

A simplifying and universal concept for the beginner to keep in mind is that SDR's consist of only two essential ingredients:

A hardware 'front end' paired with a DSP 'back end'

GRC embodies the DSP or 'back end' half of an SDR. The 'back end' DSP can control various 'front end' tuning parameters but the main task of the DSP 'back end' is to perform digital realm signal modulation/demodulation and filtering, and provide a graphical control and display interface to complete what is necessary to build and operate a Software Defined Radio.



The primary resource for authoritative information on GNU Radio is the GNURadio wiki page:

<http://gnuradio.org/redmine/projects/gnuradio/wiki>

The tabs across the top of the page will assist you in navigation of this complex website for additional in-depth information on specific areas of interest.

The blog posts by Tom Rondeau (KB3UKZ), one of the principal developers for GRC, are very informative on specific technical topics as well as GNU organizational details:

<http://www.trondeau.com/>

Explore his blog site for additional information regarding GRC.

What you will need -

Hardware: PC that is powerful (64-bit processor) and at least 2Gb of RAM  
RTL-SDR USB dongle (~\$20.00)

Software: Linux or a bootable Linux Ubuntu Image with GNU Radio support (pre-built .iso file)  
NOTE: you do not need to be familiar with Linux to use GRC

Additional Hardware Requirements (for Windows users):  
USB Flash Drive (at least 4Gb in size)  
The PC's BIOS **must** support booting from a USB drive

If you already run a recent Linux version then pre-compiled binaries come packaged with your distribution. See the following link for information on installing GNU Radio from binaries under Linux:

<http://gnuradio.org/redmine/projects/gnuradio/wiki/InstallingGR>

If you are using Windows follow these steps to create a bootable USB drive with Ubuntu:

Download the ISO image [ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.1..iso](#) from:  
<http://gnuradio.org/redmine/projects/gnuradio/wiki/GNURadioLiveDVD>

Download the Universal USB Installer from:  
<http://www.pendrivelinux.com/universal-usb-installer-easy-as-1-2-3/>

First download the Live DVD .iso image for Ubuntu including GNU Radio/SDR support (ubuntu-12.04.1-desktop-amd64-gnuradio-3.7.6.1.iso), this is a big file (approx. 2Gb) and will take some time to download.



The screenshot shows a Windows Internet Explorer browser window displaying the GNU Radio Live SDR Environment page. The browser's address bar shows the URL <http://gnuradio.org/redmine/projects/gnuradio/wiki/GNURadioLiveDVD>. The page features the GNU Radio logo and navigation tabs for Overview, Activity, Roadmap, Issues, News, Wiki, Files, and Repository. The main content area is titled "GNU Radio Live SDR Environment" and includes a description of the bootable Ubuntu Linux DVD or USB drive image, instructions on how to obtain it via BitTorrent, and a list of mirror sites. A table of MD5 sums is provided at the bottom of the main content area. On the right side, there is a "Latest news" section with two entries: "SWIG 3.0.3" and "Version 3.7.6 Code Freeze". A "Quick finder" section lists links to the Installation Guide, FAQ, Tutorials, and Contributor Guide. A "Donate" link is also visible at the bottom right.

GNU Radio Live SDR Environment

The GNU Radio Live SDR Environment, produced by [Corgan Labs](#), is a bootable Ubuntu Linux DVD or USB drive image, with GNU Radio and third party software pre-installed. It is designed for quick and easy testing and experimentation with GNU Radio without having to make any permanent modifications to a PC or laptop. It does not, however, provide for permanent installation.

It is supplied as a DVD ISO image to be downloaded and burned onto a recordable DVD disc. The Live DVD image may also be converted into a bootable USB thumb drive using a utility such as the [Ubuntu Startup Disk Creator](#) (Ubuntu Linux OS) or [Unetbootin](#) (Windows, MacOS, Linux). Creating a USB drive from the image will provide much faster booting and operation, and allow making changes and storing files.

The preferred method to obtain the DVD image is to use a BitTorrent client with the following link:

- <http://s3-dist.gnuradio.org/ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.1.torrent>

The use of BitTorrent reduces the load on the GNU Radio web server and lowers project bandwidth costs.

If a BitTorrent client is not available or its use is restricted, you may download the ISO image file by choosing from one of the following mirror sites:

- <http://s3-dist.gnuradio.org/ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.1.iso>
- <http://eu1-dist.gnuradio.org/s3/ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.1.iso>
- <http://eu2-dist.gnuradio.org/ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.1.iso>

MD5 sums:

688e2cc756b20cd1aec90db79b8afe82	ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.iso
f25a08b898a73a64d0c34e590edfad3	ubuntu-14.04.1-desktop-amd64-gnuradio-3.7.6.torrent

Contents

Latest news

- SWIG 3.0.3** (2 comments)  
*Current issue with SWIG version 3.0.3 only*  
Added by **Tom Rondeau** about 1 month ago
- Version 3.7.6 Code Freeze**  
*Code Freeze for 3.7.6 features starting on Dec. 21, 2014.*  
Added by **Tom Rondeau** 3 months ago

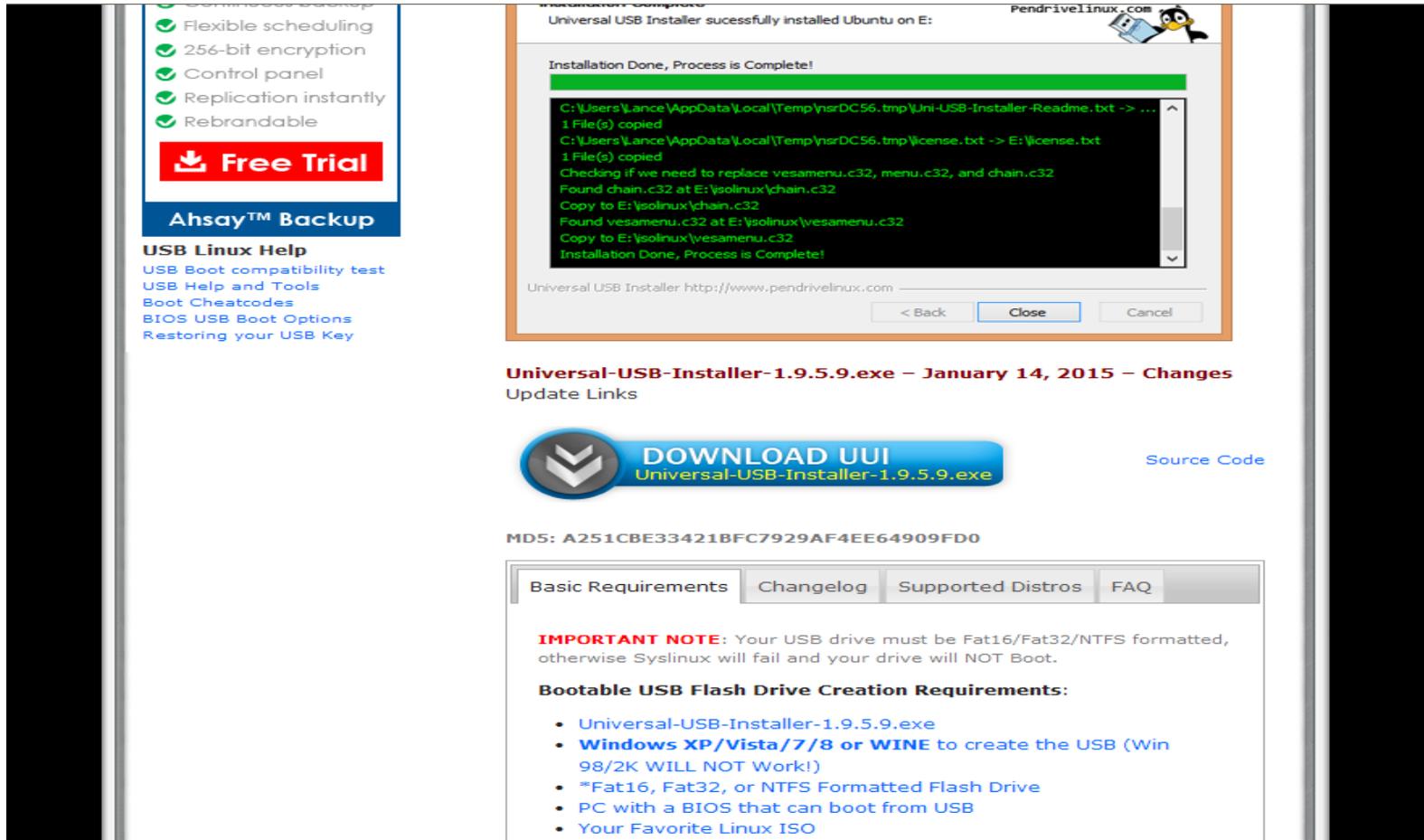
More news, and the official GNU Radio blog [can be found here](#).

Quick finder

- [Installation Guide](#)
- [FAQ](#)
- [Tutorials](#)
- [Contributor Guide](#)

Donate

Then download, in the same folder as the .iso image, the Universal USB Installer package. The link to download the file is semi-hidden in the middle of the page:



The screenshot displays the Universal USB Installer website. On the left, there is a sidebar with a list of features: Flexible scheduling, 256-bit encryption, Control panel, Replication instantly, and Rebrandable. Below this is a red 'Free Trial' button with a download icon, followed by the 'Ahsay™ Backup' logo and a 'USB Linux Help' section containing links for 'USB Boot compatibility test', 'USB Help and Tools', 'Boot Cheatcodes', 'BIOS USB Boot Options', and 'Restoring your USB Key'.

The main content area features a terminal window titled 'Installation Done, Process is Complete!'. The terminal output shows the following commands and results:

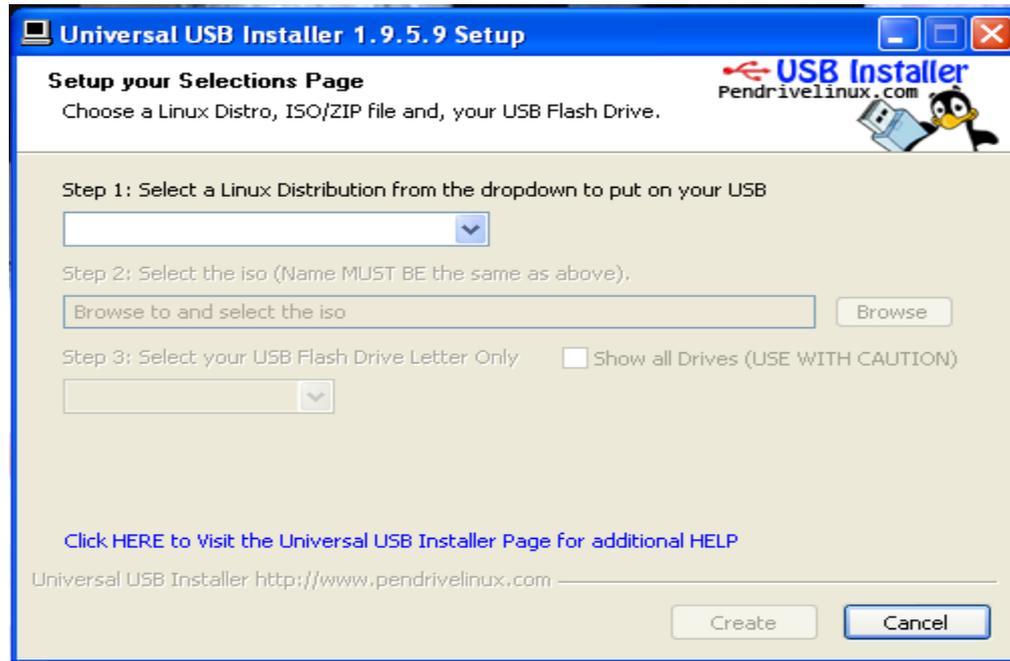
```
C:\Users\Lance\AppData\Local\Temp\ysrDC56.tmp\Uni-USB-Installer-Readme.txt -> ...
1 File(s) copied
C:\Users\Lance\AppData\Local\Temp\ysrDC56.tmp\license.txt -> E:\license.txt
1 File(s) copied
Checking if we need to replace vesamenu.c32, menu.c32, and chain.c32
Found chain.c32 at E:\syslinux\chain.c32
Copy to E:\syslinux\chain.c32
Found vesamenu.c32 at E:\syslinux\vesamenu.c32
Copy to E:\syslinux\vesamenu.c32
Installation Done, Process is Complete!
```

Below the terminal window, the text reads 'Universal USB Installer http://www.pendrivelinux.com' with '< Back', 'Close', and 'Cancel' buttons. Further down, the page title is 'Universal-USB-Installer-1.9.5.9.exe – January 14, 2015 – Changes Update Links'. A prominent blue button with a download icon is labeled 'DOWNLOAD UII Universal-USB-Installer-1.9.5.9.exe', with a 'Source Code' link to its right. The MD5 hash 'MD5: A251CBE33421BFC7929AF4EE64909FD0' is displayed below.

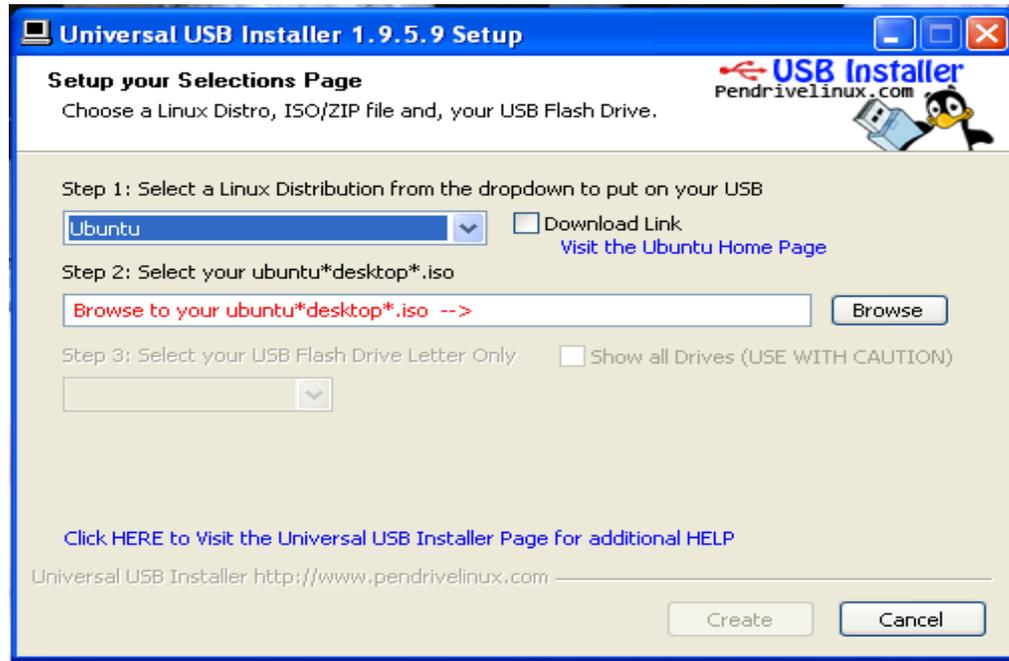
At the bottom, there is a navigation bar with tabs for 'Basic Requirements', 'Changelog', 'Supported Distros', and 'FAQ'. The 'Basic Requirements' tab is active, showing an 'IMPORTANT NOTE' that the USB drive must be formatted as Fat16/Fat32/NTFS. Below this, the 'Bootable USB Flash Drive Creation Requirements' are listed:

- [Universal-USB-Installer-1.9.5.9.exe](#)
- **Windows XP/Vista/7/8 or WINE** to create the USB (Win 98/2K WILL NOT Work!)
- \*Fat16, Fat32, or NTFS Formatted Flash Drive
- PC with a BIOS that can boot from USB
- Your Favorite Linux ISO

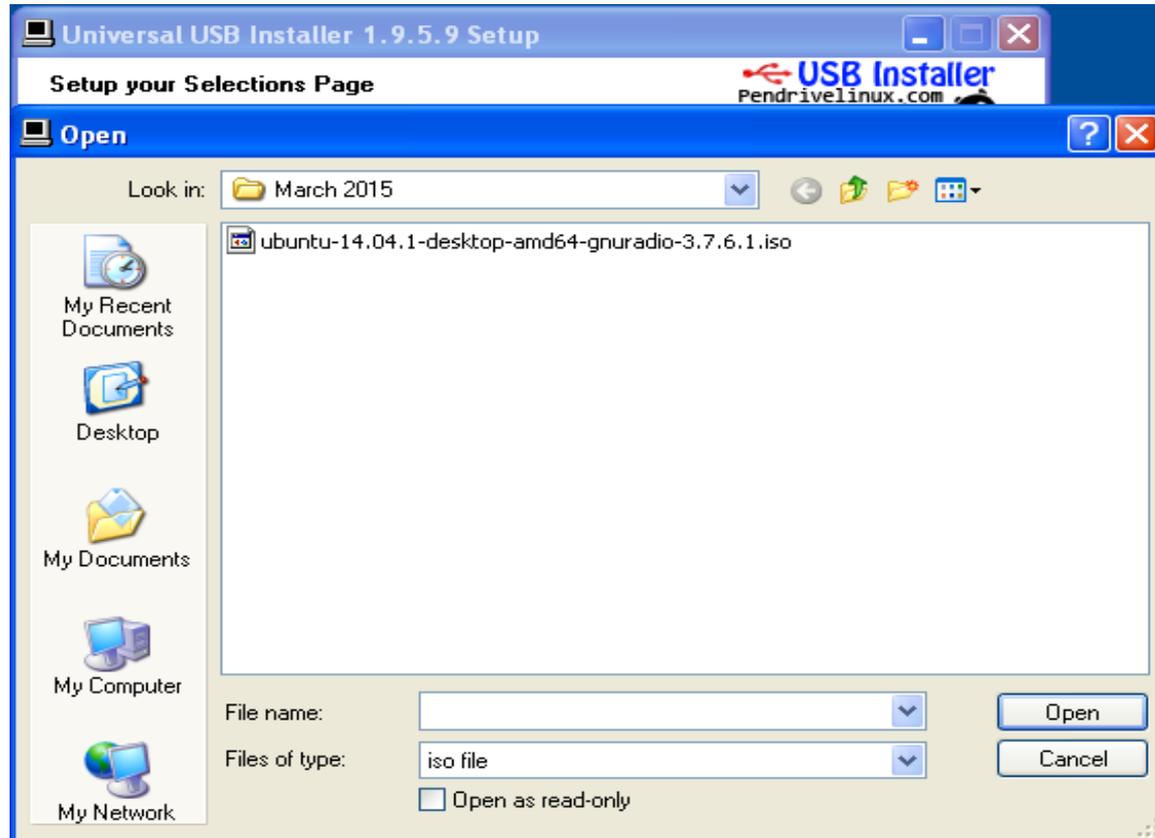
Stick your USB drive into a USB port on your PC and then run the UUI program, agree to the license agreement and the program should launch. Select Ubuntu from the dropdown list shown in “Step 1”:



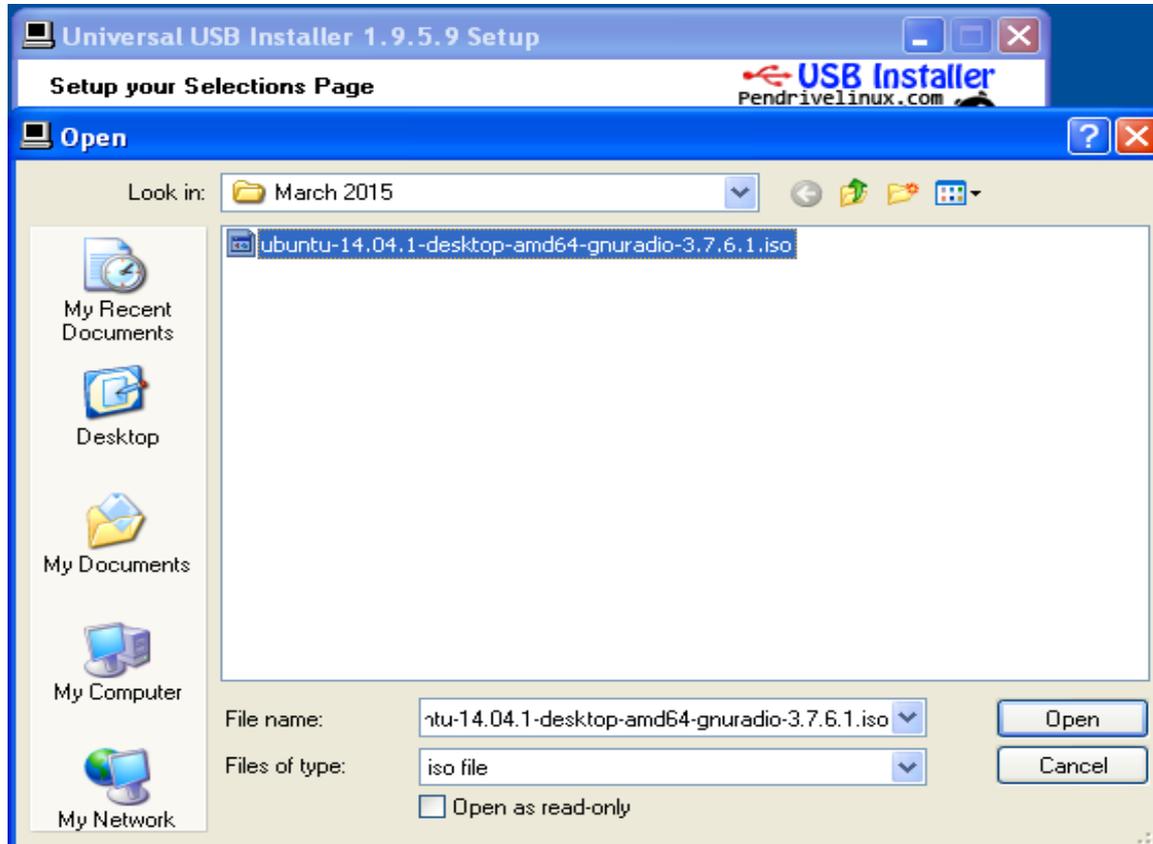
Click on the “Browse” button (Step 2) to select the Ubuntu .iso file:



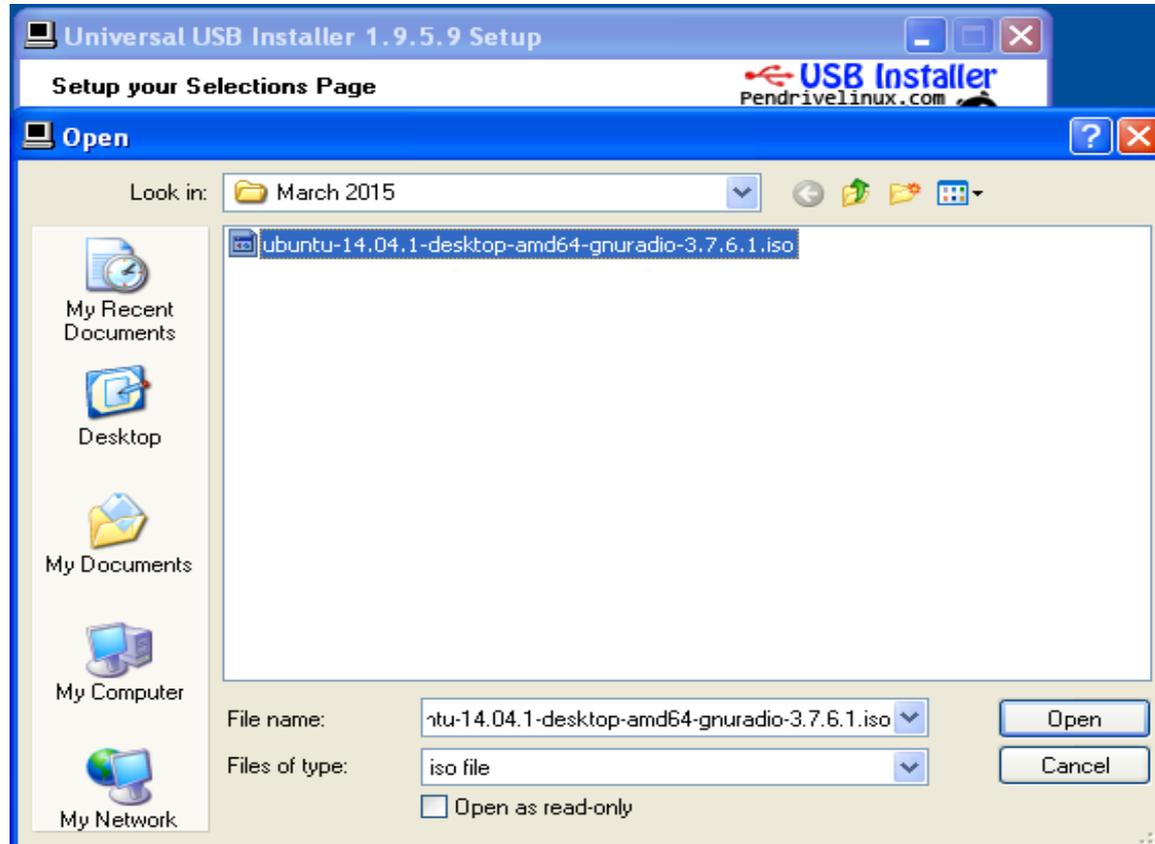
You should see the filename displayed in the file browser window. If not begin typing the filename in the file name box and it should be displayed in the file list.



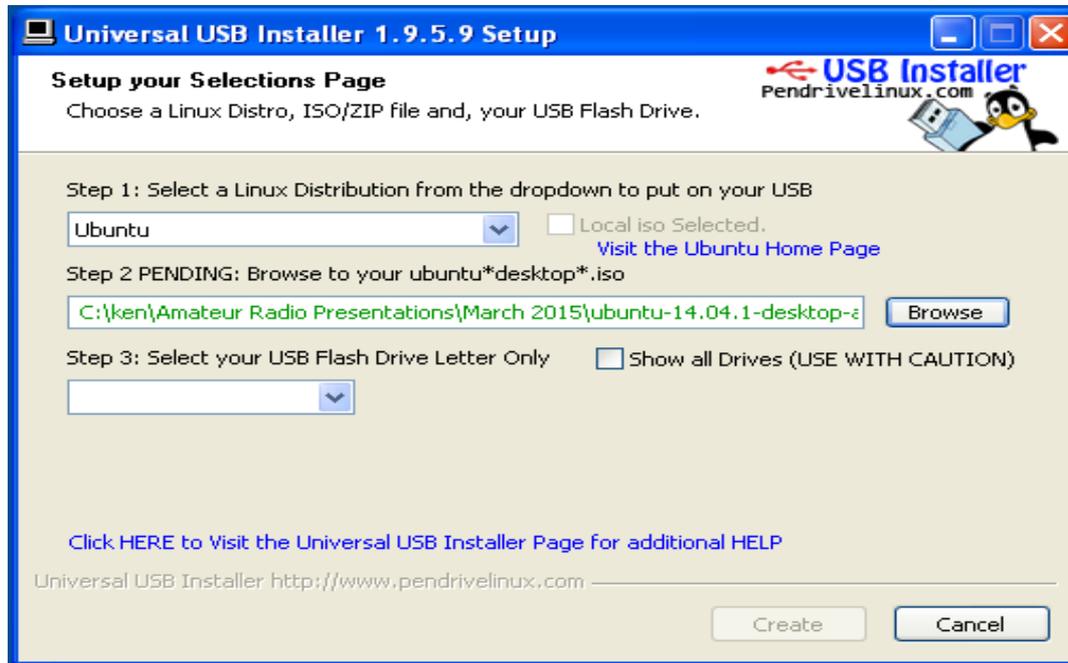
Click on the .iso filename in the list to place it in the file name box:



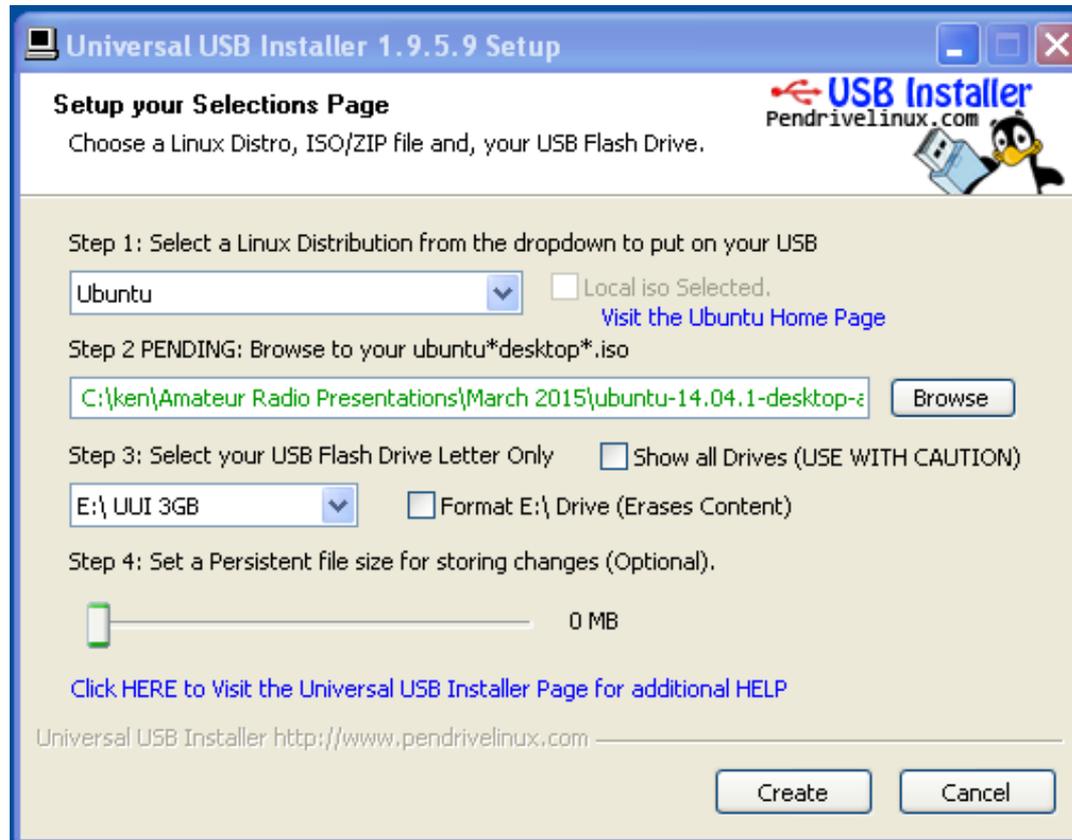
With the correct .iso file listed in the file name box click on “Open”:



The .iso file should now be shown in the “Step 2” box, click on the dropdown box in “Step 3” and select your USB drive (**WARNING** make sure the drive is correct):



The drive letter of your USB memory stick should be displayed, verify that the drive letter (your drive letter may not be the same as in the example) and size is correct and then click on the check box to format the drive during the install :



In Step 4 use the slider to select an amount of space to be reserved for file space on the drive. Usually around 1000 MB (1Gb) is sufficient but use what you want if you have a larger drive. NOTE: if you don't allocate any space you will not be able to save your projects or system settings.

**Universal USB Installer 1.9.5.9 Setup**

**Setup your Selections Page**  
Choose a Linux Distro, ISO/ZIP file and, your USB Flash Drive.

Step 1: Select a Linux Distribution from the dropdown to put on your USB

Ubuntu  Local iso Selected. [Visit the Ubuntu Home Page](#)

Step 2 BROWSE: Browse to your ubuntu\*desktop\*.iso

C:\ken\Amateur Radio Presentations\March 2015\ubuntu-14.04.1-desktop-i

Step 3: Select your USB Flash Drive Letter Only  Show all Drives (USE WITH CAUTION)

E:\ UII 3GB  We will format E:\ Drive as Fat32.

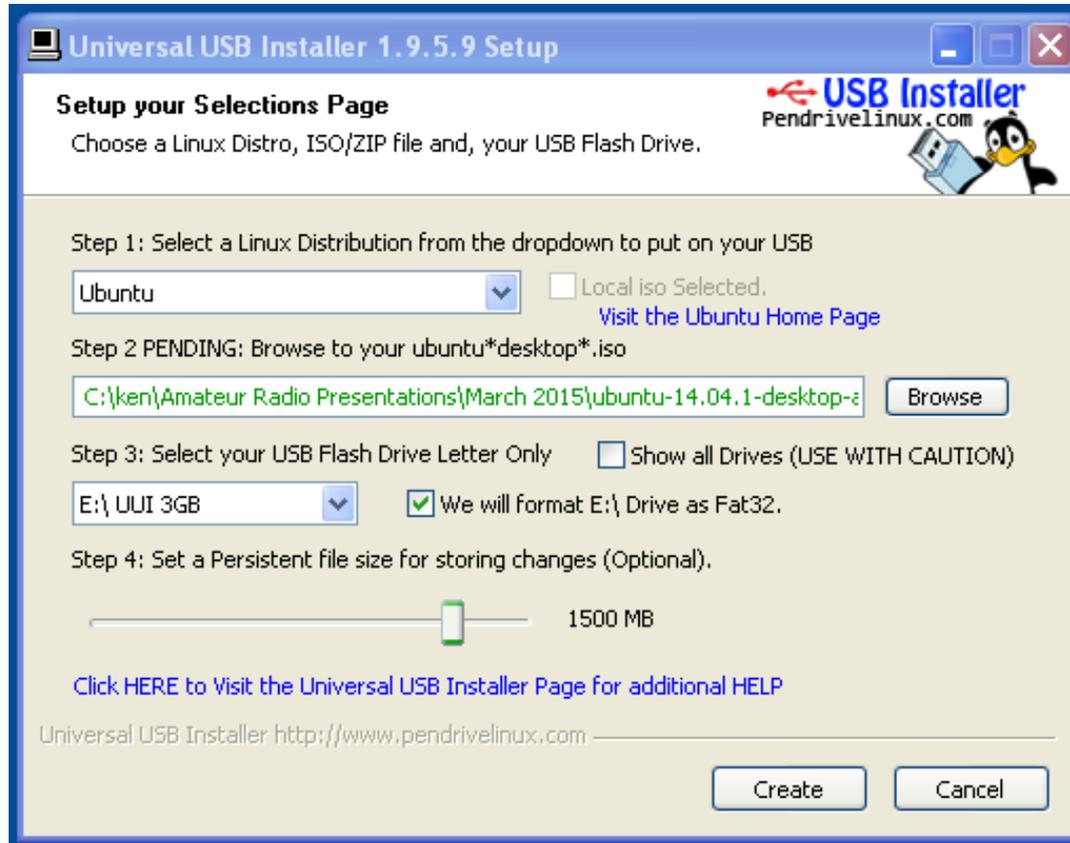
Step 4: Set a Persistent file size for storing changes (Optional).

0 MB

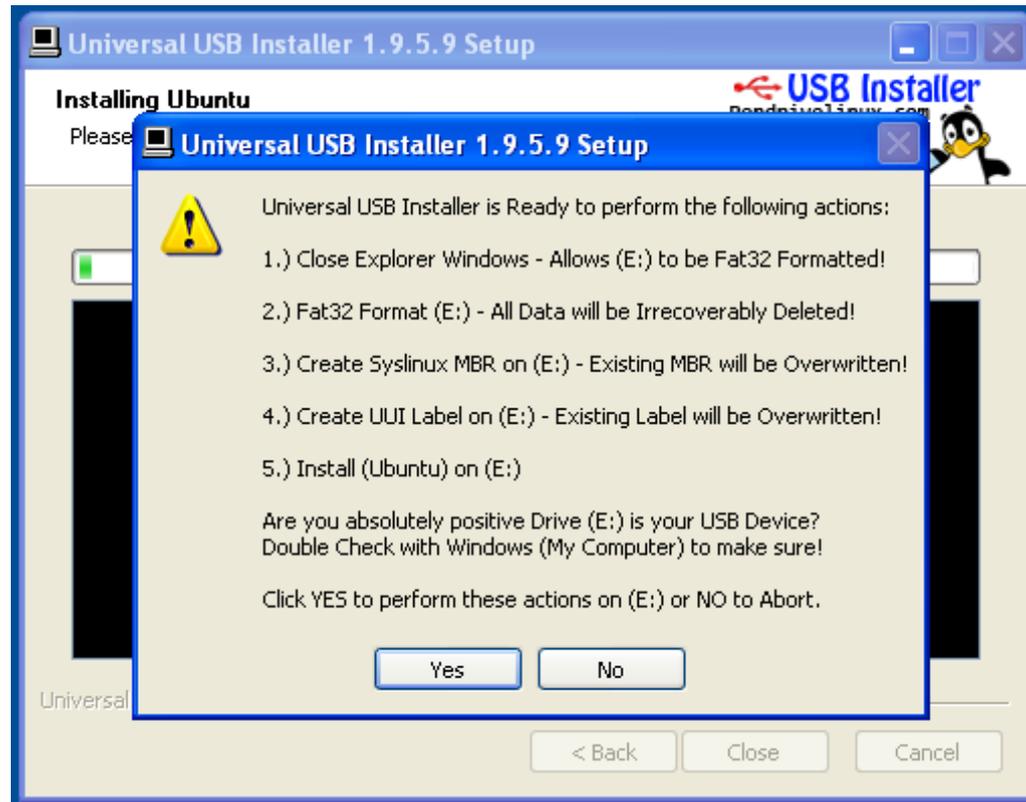
[Click HERE to Visit the Universal USB Installer Page for additional HELP](#)

Universal USB Installer <http://www.pendrivelinux.com>

When you have completed all 4 steps click the “Create” button:



You will be given a list of actions that will be taken and one final chance to verify that you are using the correct drive. **WARNING** make sure that the drive letter is correct, if the wrong drive is selected you could end up wiping your hard disk.



After the drive has been successfully created reboot your PC and use the BIOS option to boot from the USB stick instead of the Hard Disk. You should see a boot screen for Ubuntu and after a few moments the Ubuntu desktop should appear.

Plug in the RTL-SDR (DVB-T) USB stick and open a terminal window by clicking on the terminal window icon on the menu bar side of the desktop.

Verify that Ubuntu can “see” the SDR hardware by first listing the USB devices found. At the command prompt type “lsusb” (no quotes) and you should see a list of USB devices attached to your PC. In this list one of the devices should be “Realtek Semiconductor Corp”.

We will then test to verify that the RTL-SDR drivers are able to communicate with the RTL-SDR dongle by typing, at the same command prompt:

```
rtl_test -t
```

You should see something like this:

```
rtl_test -t  
Found 1 device(s):  
0: ezcap USB 2.0 DVB-T/DAB/FM dongle
```

```
Using device 0: ezcap USB 2.0 DVB-T/DAB/FM dongle  
Found Rafael Micro R820T tuner  
Supported gain values (29): 0.0 0.9 1.4 2.7 3.7 7.7 8.7 12.5 14.4 15.7 16.6 19.7 20.7 22.9  
25.4 28.0 29.7 32.8 33.8 36.4 37.2 38.6 40.2 42.1 43.4 43.9 44.5 48.0 49.6  
No E4000 tuner found, aborting.
```

You may also see additional information if your DVT-B dongle supports the Elonics E4000 tuner

At this point everything checks out, type `gnuradio-companion` at the command prompt and `gnuradio-companion` should launch. You can also use the “GRC” icon on the desktop or from the menu bar side of the desktop to launch GRC.



Examples on the web:

Lots of “YouTube” videos

<http://superkuh.com/rtlsdr.html>

<http://www.oz9aec.net/index.php/grc-examples>

<http://www.sharebrained.com/2013/06/15/wireless-microphones-and-hackrf/>

<http://tapiovalli.wordpress.com/2014/08/02/rtl-sdr-gnu-radio-and-building-my-own-am-receiver/>



Information from:

<http://w7fu.com>

<http://gnuradio.org>

<http://gnuradio.org/redmine/projects/gnuradio/wiki>

<http://www.trondeau.com/>

<http://blog.opensecurityresearch.com/2012/06/getting-started-with-gnu-radio-and-rtl.html>

[http://www.inguardians.com/pubs/GRC\\_signal\\_analysis\\_InGuardians\\_v1.pdf](http://www.inguardians.com/pubs/GRC_signal_analysis_InGuardians_v1.pdf)