API for RF receivers including ThinkRF WSA platform

Release

ThinkRF Corporation

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Contents

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CHAPTER 1

Manual

1.1 Installation

1.1.1 Windows Dependencies

1. Download https://s3.amazonaws.com/ThinkRF/Support-Resources/pyrf-dependencies.zip
2. Extract the contents of the zipped file
3. Install Python 2.7.6 (python-2.7.6.msi)
4. Add the following to the windows PATH ";C:/Python27;C:/Python27/Scripts"
5. Install Numpy (numpy-1.8.1-win32-superpack-python2.7)
6. Install Scipy (scipy-0.14.0-win32-superpack-python2.7)
7. Install Pyside (PySide-1.2.0.win32-py2.7)
8. Install Pyqtgraph (pyqtgraph-0.9.8.win32)
9. Install zope.interface (zope.interface-4.1.1.win32-py2.7)
10. Install twisted (Twisted-14.0.0.win32-py2.7)
11. Install pywin32 (pywin32-219.win32-py2.7)
12. Install netifaces (netifaces-0.10.4.win32-py2.7)
13. Using a command line, go to the qtreactor-qtreactor-pyrf-1.0 folder, and type 'setup.py install'
14. Using a command line, go to the setuptools-5.7 folder and type 'setup.py install'

Continue from *PyRF Installation* below.

1.1.2 Debian/Ubuntu Dependencies

Use packaged requirements:

```
apt-get install python-pyside python-twisted python-numpy \
     python-zope.interface python-setuptools \
      python-netifaces
pip install -e git://github.com/pyrf/qtreactor.git#egg=qtreactor
```

Or install GUI requirements from source:

```
apt-get install qt-sdk python-dev cmake \
     libblas-dev libatlas-dev liblapack-dev gfortran
export BLAS=/usr/lib/libblas/libblas.so
export ATLAS=/usr/lib/atlas-base/libatlas.so
export LAPACK=/usr/lib/lapack/liblapack.so
pip install -r requirements.txt
```

Continue from *PyRF Installation* below.

1.1.3 PyRF Installation

Download the development version:

```
git clone git://github.com/pyrf/pyrf.git
cd pyrf
python setup.py install
```

Or download a stable release, then from the source directory:

```
python setup.py install
```

1.2 API for WSA RF Receiver

`pyrf.devices.thinkrf.WSA` is the class that provides access to WSA4000 and WSA5000 devices. Its methods closely match the SCPI Command Set described in the Programmers Reference available in ThinkRF Resources.

There are simple examples that use this API under the "examples" directory included with the source code.

This API may be used in a blocking mode (the default) or in an asynchronous mode with using the **'Twisted'_** python library.

In blocking mode all methods that read from the device will wait to receive a response before returning.

In asynchronous mode all methods will send their commands to the device and then immediately return a Twisted Deferred object. If you need to wait for the response or completion of this command you can attach a callback to the Deferred object and the Twisted reactor will call it when ready. You may choose to use Twisted's inlineCallbacks function decorator to write Twisted code that resembles synchronous code by yielding the Deferred objects returned from the API.

To use the asynchronous when a WSA instance is created you must pass a `pyrf.connectors.twisted_async.TwistedConnector` instance as the connector parameter, as in *show_i_q.py* / *twisted_show_i_q.py*

CHAPTER 2

Reference

2.1 pyrf.devices

2.1.1 .thinkrf

class pyrf.devices.thinkrf.**WSA**(*connector=None*)
Interface for WSA4000 and WSA5000

Parameters **connector** – Connector object to use for SCPI/VRT connections, defaults to a new *PlainSocketConnector* instance

connect() must be called before other methods are used.

Note: The following methods will either block then return a result or if you passed a *TwistedConnector* instance to the constructor they will immediately return a Twisted Deferred object.

---

abort()
This command will cause the WSA to stop the data capturing, whether in the manual trace block capture, triggering or sweeping mode. The WSA will be put into the manual mode; in other words, process such as streaming, trigger and sweep will be stopped. The capturing process does not wait until the end of a packet to stop, it will stop immediately upon receiving the command.

antenna(*number=None*)
This command selects and queries the active antenna port.

Parameters **number** – 1 or 2 to set; None to query

Returns active antenna port

apply_device_settings(*settings*)
This command takes a dict of device settings, and applies them to the WSA Note this method only applies a setting if it has been changed using this method :param settings: dict containing settings such as attenuation,decimation,etc

attenuator(*enable=None*)
This command enables, disables or queries the WSA's RFE 20 dB attenuation.

Parameters **enable** – True or False to set; None to query

Returns the current attenuator state

capture(*spp*, *ppb*)
This command will start the single block capture and the return of *ppb* packets of *spp* samples each. The

data within a single block capture trace is continuous from one packet to the other, but not necessary between successive block capture commands issued.

Parameters

- **spp** – the number of samples in a packet
- **ppb** – the number of packets in a capture

connect(*host*)
connect to a wsa

Parameters **host** – the hostname or IP to connect to

decimation(*value=None*)
This command sets or queries the rate of decimation of samples in a trace capture. This decimation method consists of cascaded integrator-comb (CIC) filters and at every *value* number of samples, one sample is captured. The supported rate is 4 - 1023. When the rate is set to 1, no decimation is performed on the trace capture.

Parameters **value** (*int*) – new decimation value (1 or 4 - 1023); None to query

Returns the decimation value

disconnect()
close a connection to a wsa

eof()
Check if the VRT stream has closed.

Returns True if no more data, False if more data

errors()
Flush and return the list of errors from past commands sent to the WSA. An empty list is returned when no errors are present.

flush()
This command clears the WSA's internal data storage buffer of any data that is waiting to be sent. Thus, It is recommended that the flush command should be used when switching between different capture modes to clear up the remnants of packet.

flush_captures()
Flush capture memory of sweep captures.

freq(*freq=None*)
This command sets or queries the tuned center frequency of the WSA.

Parameters **freq** (*int*) – the new center frequency in Hz (0 - 10 GHz); None to query

Returns the frequency in Hz

fshift(*shift=None*)
This command sets or queries the frequency shift value.

Parameters **freq** (*int*) – the new frequency shift in Hz (0 - 125 MHz); None to query

Returns the amount of frequency shift

gain(*gain=None*)
This command sets or queries RFE quantized gain configuration. The RF front end (RFE) of the WSA consists of multiple quantized gain stages. The gain corresponding to each user-selectable setting has been pre-calculated for either optimal sensitivity or linearity. The parameter defines the total quantized gain of the RFE.

Parameters **gain** – 'high', 'medium', 'low' or 'vlow' to set; None to query

Returns the RF gain value

has_data()
Check if there is VRT data to read.

Returns True if there is a packet to read, False if not

have_read_perm()
Check if we have permission to read data.

Returns True if allowed to read, False if not

id()
Returns the WSA's identification information string.

Returns "<Manufacturer>,<Model>,<Serial number>,<Firmware version>"

ifgain(*gain=None*)
This command sets or queries variable IF gain stages of the RFE. The gain has a range of -10 to 34 dB. This stage of the gain is additive with the primary gain stages of the LNA that are described in `gain()`.

Parameters **gain** – float between -10 and 34 to set; None to query

Returns the ifgain in dB

locked(*modulestr*)
This command queries the lock status of the RF VCO (Voltage Control Oscillator) in the Radio Front End (RFE) or the lock status of the PLL reference clock in the digital card.

Parameters **modulestr** – 'vco' for rf lock status, 'clkref' for mobo lock status

Returns True if locked

ppb(*packets=None*)
This command sets the number of IQ packets in a capture block

Parameters **packets** – the number of samples in a packet

Returns the current ppb value if the packets parameter is None

preselect_filter(*enable=None*)
This command sets or queries the RFE preselect filter selection.

Parameters **enable** – True or False to set; None to query

Returns the RFE preselect filter selection state

raw_read(*num*)
Raw read of VRT socket data from the WSA.

Parameters **num** – the number of bytes to read

Returns bytes

read()
Read a single VRT packet from the WSA.

request_read_perm()
Acquire exclusive permission to read data from the WSA.

Returns True if allowed to read, False if not

reset()
Resets the WSA to its default settings. It does not affect the registers or queues associated with the IEEE mandated commands.

scpiget (*cmd*)
Send a SCPI command and wait for the response.

This is the lowest-level interface provided. Please see the Programmer's Guide for information about the commands available.

Parameters **cmd** (*str*) – the command to send

Returns the response back from the box if any

scpiset (*cmd*)
Send a SCPI command.

This is the lowest-level interface provided. Please see the Programmer's Guide for information about the commands available.

Parameters **cmd** (*str*) – the command to send

spp (*samples=None*)
This command sets or queries the number of Samples Per Packet (SPPacket).

The upper bound of the samples is limited by the VRT's 16-bit packet size field less the VRT header and any optional fields (i.e. Stream ID, Class ID, Timestamps, and trailer) of 32-bit wide words. However since the SPP must be a multiple of 16, the maximum is thus limited by 2**16 - 16.

Parameters **samples** – the number of samples in a packet or None

Returns the current spp value if the samples parameter is None

stream_start (*stream_id=None*)
This command begins the execution of the stream capture. It will also initiate data capturing. Data packets will be streamed (or pushed) from the WSA whenever data is available.

Parameters **stream_id** – optional unsigned 32-bit stream identifier

stream_status ()
This query returns the current running status of the stream capture mode.

Returns 'RUNNING' or 'STOPPED'

stream_stop ()
This command stops the stream capture. After receiving the command, the WSA system will stop when the current capturing VRT packet is completed.

sweep_add (*entry*)
Add an entry to the sweep list

Parameters **entry** (pyrf.config.SweepEntry) – the sweep entry to add

sweep_clear ()
Remove all entries from the sweep list.

sweep_read (*index*)
Read an entry from the sweep list.

Parameters **index** – the index of the entry to read

Returns sweep entry

Return type *pyrf.config.SweepEntry*

sweep_start (*start_id=None*)
Start the sweep engine.

sweep_stop ()
Stop the sweep engine.

trigger(*settings=None*)
This command sets or queries the type of trigger event. Setting the trigger type to "NONE" is equivalent to disabling the trigger execution; setting to any other type will enable the trigger engine.

Parameters **settings** (*dictionary*) – the new trigger settings; None to query

Returns the trigger settings

pyrf.devices.thinkrf.**parse_discovery_response**(*response*)
This function parses the WSA's raw discovery response

Parameters **response** – The WSA's raw response to a discovery query

Returns Return (model, serial, firmware version) based on a discovery

response message

2.2 pyrf.sweep_device

class pyrf.sweep_device.**SweepDevice**(*real_device*, *async_callback=None*)
Virtual device that generates power levels from a range of frequencies by sweeping the frequencies with a real device and piecing together FFT results.

Parameters

- **real_device** – device that will will be used for capturing data, typically a *pyrf.devices.thinkrf.WSA* instance.
- **callback** – callback to use for async operation (not used if real_device is using a PlainSocketConnector)

capture_power_spectrum(*fstart*, *fstop*, *rbw*, *device_settings=None*, *mode='ZIF'*, *continuous=False*, *min_points=32*)
Initiate a capture of power spectral density by setting up a sweep list and starting a single sweep.

Parameters

- **fstart** (*float*) – starting frequency in Hz
- **fstop** (*float*) – ending frequency in Hz
- **rbw** (*float*) – requested RBW in Hz (output RBW may be smaller than requested)
- **device_settings** – antenna, gain and other device settings
- **mode** (*string*) – sweep mode, 'ZIF left band', 'ZIF' or 'SH'
- **continuous** (*bool*) – async continue after first sweep
- **min_points** (*int*) – smallest number of points per capture from real_device

exception pyrf.sweep_device.**SweepDeviceError**

class pyrf.sweep_device.**SweepStep**
Data structure used by SweepDevice for planning sweeps

Parameters

- **fcenter** – starting center frequency in Hz
- **fstep** – frequency increment each step in Hz
- **fshift** – frequency shift in Hz
- **decimation** – decimation value

- **points** – samples to capture
- **bins_skip** – number of FFT bins to skip from left
- **bins_run** – number of usable FFT bins each step
- **bins_pass** – number of bins from first step to discard from left
- **bins_keep** – total number of bins to keep from all steps

steps

to_sweep_entry(*device*, *rfe_mode*, ***kwargs*)
Create a SweepEntry for device matching this SweepStep,

extra parameters (gain, antenna etc.) may be provided as keyword parameters

pyrf.sweep_device.**plan_sweep**(*device*, *fstart*, *fstop*, *rbw*, *mode*, *min_points=32*)

Parameters

- **device** – a device class or instance such as *pyrf.devices.thinkrf.WSA*
- **fstart** (*float*) – starting frequency in Hz
- **fstop** (*float*) – ending frequency in Hz
- **rbw** (*float*) – requested RBW in Hz (output RBW may be smaller than requested)
- **mode** (*string*) – sweep mode, 'ZIF left band', 'ZIF' or 'SH'
- **min_points** (*int*) – smallest number of points per capture

The following device properties are used in planning the sweep:

device.properties.FULL_BW full width of the filter in Hz

device.properties.USABLE_BW usable portion before filter drop-off at edges in Hz

device.properties.MIN_TUNABLE the lowest valid center frequency for arbitrary tuning in Hz, 0(DC) is always assumed to be available for direct digitization

device.properties.MAX_TUNABLE the highest valid center frequency for arbitrart tuning in Hz

device.properties.DC_OFFSET_BW the range of frequencies around center that may be affected by a DC offset and should not be used

device.properties.TUNING_RESOLUTION the smallest tuning increment for fcenter and fstep

Returns (actual fstart, actual fstop, list of SweepStep instances)

The caller would then use each of these tuples to do the following:

1. The first 5 values are used for a single capture or single sweep
2. An FFT is run on the points returned to produce bins in the linear domain
3. bins[bins_skip:bins_skip + bins_run] are selected
4. take logarithm of output bins and appended to the result
5. for sweeps repeat from 2 until the sweep is complete
6. bins_pass is the number of selected bins to skip from the first capture only
7. bins_keep is the total number of selected bins to keep; for single captures bins_run == bins_keep

2.3 pyrf.capture_device

class `pyrf.capture_device.`**`CaptureDevice`**(*real_device*, *async_callback=None*, *device_settings=None*)

Virtual device that returns power levels generated from a single data packet

Parameters

- **`real_device`** – device that will will be used for capturing data, typically a `pyrf.thinkrf.WSA` instance.
- **`async_callback`** – callback to use for async operation (not used if real_device is using a `PlainSocketConnector`)
- **`device_settings`** – initial device settings to use, passed to `pyrf.capture_dvice.CaptureDevice.configure_device()` if given

`capture_time_domain`(*rfe_mode*, *freq*, *rbw*, *device_settings=None*, *min_points=128*, *force_change=False*)

Initiate a capture of raw time domain IQ or I-only data

Parameters

- **`rfe_mode`** – radio front end mode, e.g. 'ZIF', 'SH', ...
- **`freq`** – center frequency
- **`rbw`** (*float*) – requested RBW in Hz (output RBW may be smaller than requested)
- **`device_settings`** – attenuator, decimation frequency shift and other device settings
- **`min_points`** (*int*) – smallest number of points per capture from real_device

`configure_device`(*device_settings*, *force_change=False*)

Configure the device settings on the next capture

Parameters **`device_settings`** – attenuator, decimation frequency shift and other device settings

`read_data`(*packet*)

exception `pyrf.capture_device.`**`CaptureDeviceError`**

2.4 pyrf.connectors

2.4.1 .blocking

class `pyrf.connectors.blocking.`**`PlainSocketConnector`**

This connector makes SCPI/VRT socket connections using plain sockets.

`connect`(*host*)

`disconnect`()

`eof`()

`has_data`()

`raw_read`(*num*)

`scpiget`(*cmd*)

`scpiset`(*cmd*)

sync_async(*gen*)
Handler for the @sync_async decorator. We convert the generator to a single return value for simple synchronous use.

pyrf.connectors.blocking.**socketread**(*socket*, *count*, *flags=None*)
Retry socket read until count data received, like reading from a file.

2.4.2 .twisted_async

class pyrf.connectors.twisted_async.**SCPIClient**

connectionMade()

dataReceived(*data*)

scpiget(*cmd*)

scpiset(*cmd*)

class pyrf.connectors.twisted_async.**SCPIClientFactory**

buildProtocol(*addr*)

clientConnectionFailed(*connector*, *reason*)

clientConnectionLost(*connector*, *reason*)

startedConnecting(*connector*)

class pyrf.connectors.twisted_async.**TwistedConnector**(*reactor*, *vrt_callback=None*)
A connector that makes SCPI/VRT connections asynchronously using Twisted.

A callback may be assigned to vrt_callback that will be called with VRT packets as they arrive. When .vrt_callback is None (the default) arriving packets will be ignored.

connect(*host*, *output_file=None*)

disconnect()

eof()

inject_recording_state(*state*)

raw_read(*num_bytes*)

scpiget(*cmd*)

scpiset(*cmd*)

set_recording_output(*output_file=None*)

sync_async(*gen*)

exception pyrf.connectors.twisted_async.**TwistedConnectorError**

class pyrf.connectors.twisted_async.**VRTClient**(*receive_callback*)
A Twisted protocol for the VRT connection

Parameters **receive_callback** – a function that will be passed a vrt DataPacket or ContextPacket when it is received

connectionLost(*reason*)

dataReceived(*data*)

eof = False

inject_recording_state (*state*)

makeConnection (*transport*)

set_recording_output (*output_file=None*)

class pyrf.connectors.twisted_async.**VRTClientFactory** (*receive_callback*)

buildProtocol (*addr*)

clientConnectionFailed (*connector*, *reason*)

clientConnectionLost (*connector*, *reason*)

startedConnecting (*connector*)

2.5 pyrf.config

class pyrf.config.**SweepEntry** (*fstart=2400000000*, *fstop=2400000000*, *fstep=100000000*, *fshift=0*, *decimation=0*, *antenna=1*, *gain='vlow'*, *ifgain=0*, *hdr_gain=-10*, *spp=1024*, *ppb=1*, *trigtype='none'*, *dwell_s=0*, *dwell_us=0*, *level_fstart=50000000*, *level_fstop=10000000000*, *level_amplitude=-100*, *attenuator=True*, *rfe_mode='ZIF'*)

Sweep entry for `pyrf.devices.thinkrf.WSA.sweep_add()`

Parameters

- **fstart** – starting frequency in Hz
- **fstop** – ending frequency in Hz
- **fstep** – frequency step in Hz
- **fshift** – the frequency shift in Hz
- **decimation** – the decimation value (0 or 4 - 1023)
- **antenna** – the antenna (1 or 2)
- **gain** – the RF gain value ('high', 'medium', 'low' or 'vlow')
- **ifgain** – the IF gain in dB (-10 - 34)
- **hdr_gain** – the HDR gain in dB (-10 - 30)
- **spp** – samples per packet
- **ppb** – packets per block
- **dwell_s** – dwell time seconds
- **dwell_us** – dwell time microseconds
- **trigtype** – trigger type ('none', 'pulse' or 'level')
- **level_fstart** – level trigger starting frequency in Hz
- **level_fstop** – level trigger ending frequency in Hz
- **level_amplitude** – level trigger minimum in dBm
- **attenuator** – enable/disable attenuator

- **rfe_mode** – RFE mode to be used

class `pyrf.config.`**`TriggerSettings`**(*trigtype='NONE'*, *fstart=None*, *fstop=None*, *amplitude=None*)

Trigger settings for `pyrf.devices.thinkrf.WSA.trigger()`.

Parameters

- **trigtype** – "LEVEL" or "NONE" to disable
- **fstart** – starting frequency in Hz
- **fstop** – ending frequency in Hz
- **amplitude** – minumum level for trigger in dBm

exception `pyrf.config.`**`TriggerSettingsError`**

2.6 pyrf.numpy_util

`pyrf.numpy_util.`**`calculate_channel_power`**(*power_spectrum*)

Return a dBm value representing the channel power of the input power spectrum. :param power_spectrum: array containing power spectrum to be used for

the channel power calculation

`pyrf.numpy_util.`**`compute_fft`**(*dut*, *data_pkt*, *context*, *correct_phase=True*, *hide_differential_dc_offset=True*, *convert_to_dbm=True*, *apply_window=True*, *apply_spec_inv=True*, *apply_reference=True*, *ref=None*)

Return an array of dBm values by computing the FFT of the passed data and reference level.

Parameters

- **dut** (pyrf.devices.thinkrf.WSA) – WSA device
- **data_pkt** (pyrf.vrt.DataPacket) – packet containing samples
- **context** – dict containing context values
- **correct_phase** – apply phase correction for captures with IQ data
- **hide_differential_dc_offset** – mask the differential DC offset present in captures with IQ data
- **convert_to_dbm** – convert the output values to dBm

Returns numpy array of dBm values as floats

2.7 pyrf.util

`pyrf.util.`**`read_data_and_context`**(*dut*, *points=1024*)

Initiate capture of one data packet, wait for and return data packet and collect preceeding context packets.

Returns (data_pkt, context_values)

Where context_values is a dict of {field_name: value} items from all the context packets received.

`pyrf.util.`**`collect_data_and_context`**(*dut*)

Wait for and return data packet and collect preceeding context packets.

2.8 pyrf.vrt

class pyrf.vrt.**ContextPacket**(*packet_type*, *count*, *size*, *tmpstr*, *has_timestamp*)
A Context Packet received from `pyrf.devices.thinkrf.WSA.read()`

fields
a dict containing field names and values from the packet

is_context_packet(*ptype=None*)

Parameters ptype – "Receiver", "Digitizer" or None for any

packet type

Returns True if this packet matches the type passed

is_data_packet()

Returns False

class pyrf.vrt.**DataArray**(*binary_data*, *bytes_per_sample*)
Data Packet values as a lazy array read from *binary_data*.

Parameters bytes_per_sample – 1 for PSD8 data, 2 for I14 data or 4 for I24 data

numpy_array()
return a numpy array for this data

class pyrf.vrt.**DataPacket**(*count*, *size*, *stream_id*, *tsi*, *tsf*, *payload*, *trailer*)
A Data Packet received from `pyrf.devices.thinkrf.WSA.read()`

data
a `pyrf.vrt.IQData` object containing the packet data

is_context_packet(*ptype=None*)

Returns False

is_data_packet()

Returns True

class pyrf.vrt.**IQData**(*binary_data*)
Data Packet values as a lazy collection of (I, Q) tuples read from *binary_data*.

This object behaves as an immutable python sequence, e.g. you may do any of the following:

```
points = len(iq_data)

i_and_q = iq_data[5]

for i, q in iq_data:
    print i, q
```

numpy_array()
Return a numpy array of I, Q values for this data similar to:

exception pyrf.vrt.**InvalidDataReceived**

pyrf.vrt.**generate_speca_packet**(*data*, *count=0*)

Parameters

- **data** – a python dict that can be serialized as JSON
- **count** – int count for the header of this packet

Returns (vrt packet bytes, next count int)

`pyrf.vrt.`**`vrt_packet_reader`**(*raw_read*)

Read a VRT packet, parse it and return an object with its data.

Implemented as a generator that yields the result of the passed raw_read function and accepts the value sent as its data.

Examples

These examples may be found in the "examples" directory included with the PyRF source code.

3.1 discovery.py / twisted_discovery.py

- discovery.py
- twisted_discovery.py

These examples detect WSA devices on the same network

Example output:

```
WSA4000 00:50:c2:ea:29:14 None at 10.126.110.111
WSA4000 00:50:c2:ea:29:26 None at 10.126.110.113
```

3.2 show_i_q.py / twisted_show_i_q.py

These examples connect to a device specified on the command line, tunes it to a center frequency of 2.450 MHz then reads and displays one capture of 1024 i, q values.

- show_i_q.py
- twisted_show_i_q.py

Example output (truncated):

```
0,-20
-8,-16
0,-24
-8,-12
0,-32
24,-24
32,-16
-12,-24
-20,0
12,-32
32,-4
0,12
-20,-16
-48,16
-12,12
```

```
0,-36
4,-12
```

3.3 matplotlib_plot_sweep.py

This example connects to a device specified on the command line, and plots a complete sweep of the spectrum using NumPy and matplotlib.

- matplotlib_plot_sweep.py

3.4 pyqtgraph_plot_block.py

This example connects to a device specified on the command line, tunes it to a center frequency of 2.450 MHz then continually captures and displays an FFT in a GUI window.

- pyqtgraph_plot_block.py

CHAPTER 4

Changelog

4.1 PyRF 2.8.0

2015-08-12

- Removed RTSA Instructions from the web page
- Fixed windows installation instructions
- Added capture spectrum function
- Added find peak function
- Added Measure noisefloor function
- Changed default span settings
- Added saturation level value for each device

4.2 PyRF 2.7.2

2014-12-16

- Added capture control widget
- Changed default save file names to represent date and time of capture
- Fixed baseband mode frequency axis issue
- Netifaces library is no longer a hard requirement
- Improved overall marker controls
- Added 'Enable mouse tune' option to frequency widget
- Default HDR gain is now 25

4.3 PyRF 2.7.1

2014-11-13

- Discovery widget now queries for new WSA's on the network every 10 seconds
- Fixed issue where switching from sweep to non-sweep wrongly changed center

frequency

- Fixed issue where Minimum control not behaving as designed
- Fixed issue where trigger controls were not disabled for non-trigger modes
- Fixed frequency axis texts
- Y-axis in the persistence plot now corresponds with spectral plot's y-axis

4.4 PyRF 2.7.0

2014-11-04

- All control widgets are now dockable
- Enabled mouse control of spectral plot's y-axis
- Added lower RBW values in non-sweep modes

4.5 PyRF 2.6.2

2014-10-10

- HDR gain control in GUI now allows values up to +20 dB
- Sweep ZIF (100 MHz steps) now only shown in GUI when developer menu is enabled
- GUI PLL Reference control now works in Sweep mode
- Darkened trace color in GUI for attenuated edges and dc offset now matches trace color
- Alternate sweep step color in GUI now matches trace color
- DC offset region now limited to middle three bins in GUI (was expanding when decimation was applied)
- Correction to usable region in ZIF and SH modes with decimation applied
- Fixed HDR center offset value
- Added device information dialog to GUI

4.6 PyRF 2.6.1

2014-09-30

- Upload corrected version with changelog

4.7 PyRF 2.6.0

2014-09-30

- Added channel power measurement feature to GUI
- Added Export to CSV feature to GUI for saving streams of processed power spectrum data
- Added a power level cursor (adjustable horizontal line) to GUI

- Added reference level offset adjustment box to GUI
- Trigger region in GUI is now a rectangle to make it visibly different than channel power measurement controls
- Update mode drop-down in GUI to include information about each mode instead of showing internal mode names
- Use netifaces for address detection to fix discover issue on non-English windows machines

4.8 PyRF 2.5.0

2014-09-09

- Added Persistence plot
- Made markers draggable in the plot
- Added version number to title bar
- Moved DSP options to developer menu, developer menu now hidden unless GUI run with -d option
- Rounded center to nearest tuning resolution step in GUI
- Fixed a number of GUI control and label issues
- Moved changelog into docs and updated

4.9 PyRF 2.4.1

2014-08-19

- Added missing reqirement
- Fixed use with CONNECTOR IQ path

4.10 PyRF 2.4.0

2014-08-19

- Improved trigger controls
- Fixed modes available with some WSA versions

4.11 PyRF 2.3.0

2014-08-12

- Added full playback support (including sweep) in GUI
- Added hdr_gain control to WSA class
- Added average mode and clear button for traces
- Added handling for different REFLEVEL_ERROR on early firmware versions
- Disable triggers for unsupported WSA firmware versions

- Added free plot adjustment developer option
- Fixed a number of GUI interface issues

4.12 PyRF 2.2.0

2014-07-15

- Added waterfall display for GUI and example program
- Added automatic re-tuning when plot dragged of zoomed
- Added recording speca state in recorded VRT files, Start/Stop recording menu
- Added GUI non-sweep playback support and command line '-p' option
- Added marker controls: peak left, right, center to marker
- Redesigned frequency controls, device controls and trace controls
- Default to Sweep SH mode in GUI
- Added developer options menu for attenuated edges etc.
- Refactored shared GUI code and panels
- SweepDevice now returns numpy arrays of dBm values
- Fixed device discovery with multiple interfaces
- Replaced reflevel adjustment properties with REFLEVEL_ERROR value
- Renamed GUI launcher to rtsa-gui

4.13 PyRF 2.1.0

2014-06-20

- Refactored GUI code to separate out device control and state
- Added SPECA defaults to device properties
- Restored trigger controls in GUI
- Added DSP panel to control fft calculations in GUI
- Fixed a number of GUI plot issues

4.14 PyRF 2.0.3

2014-06-03

- Added simple QT GUI example with frequency, attenuation and rbw controls
- Added support for more hardware versions
- Fixed plotting issues in a number of modes in GUI

4.15 PyRF 2.0.2

2014-04-29

- Removed Sweep ZIF mode from GUI
- Fixed RFE input mode GUI issues

4.16 PyRF 2.0.1

2014-04-21

- Added Sweep SH mode support to SweepDevice
- Added IQ in, DD, SHN RFE modes to GUI
- Added IQ output path and PLL reference controls to GUI
- Added discovery widget to GUI for finding devices
- Fixed a number of issues

4.17 PyRF 2.0.0

2014-01-31

- Added multiple traces and trace controls to GUI
- Added constellation and IQ plots
- Added raw VRT capture-to-file support
- Updated SweepDevice sweep plan calculation
- Created separate GUI for single capture modes
- Updated device properties for WSA5000 RFE modes
- Show attenuated edges in gray, sweep steps in different colors in GUI
- Added decimation and frequency shift controls to single capture GUI
- Fixed many issues with WSA5000 different RFE mode support
- Removed trigger controls, waiting for hardware support
- Switched to using pyinstaller for better windows build support

4.18 PyRF 1.2.0

2013-10-01

- Added WSA5000 support
- Added WSA discovery example scripts
- Renamed WSA4000 class to WSA (supports WSA5000 as well)
- Separated device properties from WSA class

4.19 PyRF 1.1.0

2013-07-19

- Fixed some py2exe issues
- Show the GUI even when not connected

4.20 PyRF 1.0.0

2013-07-18

- Switched to pyqtgraph for spectrum plot
- Added trigger controls
- Added markers
- Added hotkeys for control
- Added bandwidth control
- Renamed GUI launcher speca-gui
- Created SweepDevice to generalize spectrum analyzer-type function
- Created CaptureDevice to collect single captures and related context

4.21 PyRF 0.4.0

2013-05-18

- pyrf.connectors.twisted_async.TwistedConnector now has a vrt_callback attribute for setting a function to call when VRT packets are received.

  This new callback takes a single parameter: a pyrf.vrt.DataPacket or pyrf.vrt.ContextPacket instance.

  The old method of emulating a synchronous read() interface from a pyrf.devices.thinkrf.WSA4000 instance is no longer supported, and will now raise a pyrf.connectors.twisted_async.TwistedConnectorError exception.

- New methods added to pyrf.devices.thinkrf.WSA4000: abort(), spp(), ppb(), stream_start(), stream_stop(), stream_status()
- Added support for stream ID context packets and provide a value for sweep ID context packet not converted to a hex string
- wsa4000gui updated to use vrt callback
- “wsa4000gui -v” enables verbose mode which currently shows SCPI commands sent and responses received on stdout
- Added examples/stream.py example for testing stream data rate
- Updated examples/twisted_show_i_q.py for new vrt_callback
- Removed pyrf.twisted_util module which implemented old synchronous read() interface
- Removed now unused pyrf.connectors.twisted_async.VRTTooMuchData exception
- Removed wsa4000gui-blocking script

- Fix for power spectrum calculation in pyrf.numpy_util

4.22 PyRF 0.3.0

2013-02-01

- API now allows asynchronous use with TwistedConnector
- GUI now uses asynchronous mode, but synchronous version may still be built as wsa4000gui-blocking
- GUI moved from examples to inside the package at pyrf.gui and built from the same setup.py
- add Twisted version of show_i_q.py example
- documentation: installation instructions, requirements, py2exe instructions, user manual and many other changes
- fix support for reading WSA4000 very low frequency range
- pyrf.util.read_data_and_reflevel() was renamed to read_data_and_context()
- pyrf.util.socketread() was moved to pyrf.connectors.blocking.socketread()
- added requirements.txt for building dependencies from source

4.23 PyRF 0.2.5

2013-01-26

- fix for compute_fft calculations

4.24 PyRF 0.2.4

2013-01-19

- fix for missing devices file in setup.py

4.25 PyRF 0.2.3

2013-01-19

- add planned features to docs

4.26 PyRF 0.2.2

2013-01-17

- rename package from python-thinkrf to PyRF

4.27 python-thinkrf 0.2.1

2012-12-21

- update for WSA4000 firmware 2.5.3 decimation change

4.28 python-thinkrf 0.2.0

2012-12-09

- GUI: add BPF toggle, Antenna switching, –reset option, “Open Device” dialog, IF Gain control, Span control, RBW control, update freq on finished editing
- create basic documentation and reference and improve docstrings
- bug fixes for GUI, py2exe setup.py
- GUI perfomance improvements

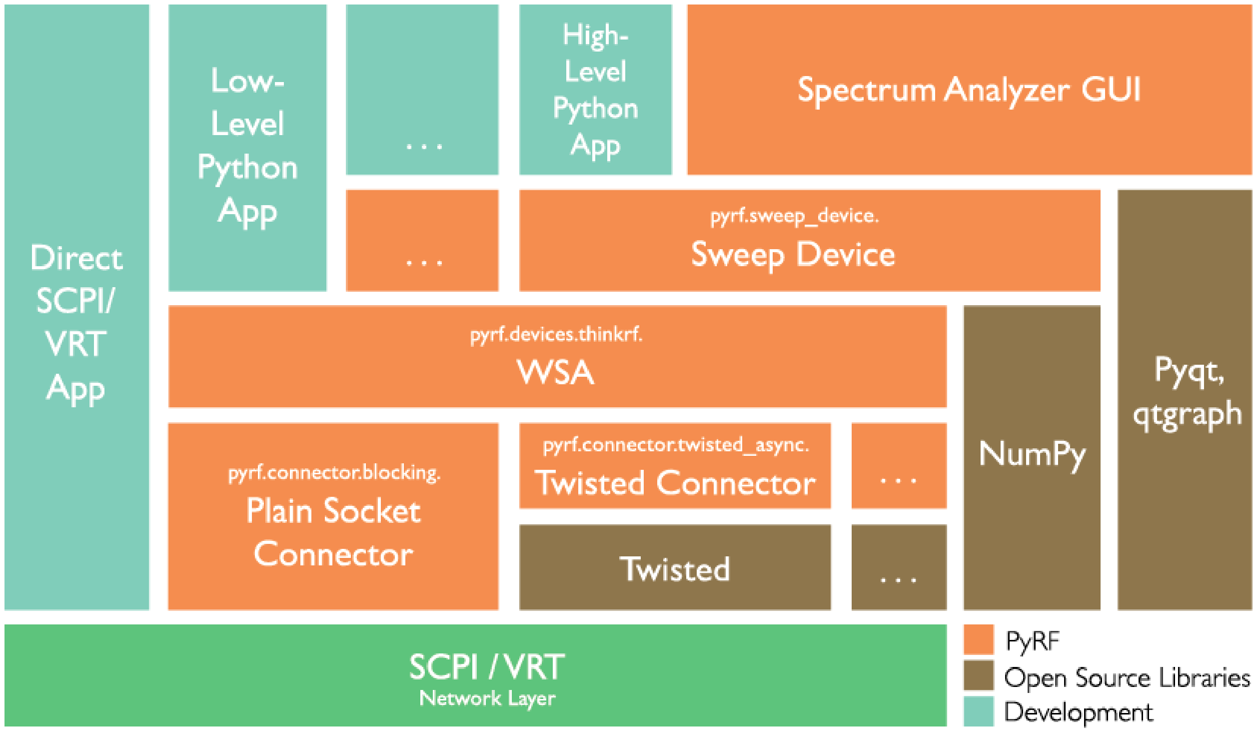
4.29 python-thinkrf 0.1.0

2012-12-01

- initial release

PyRF is an openly available, comprehensive development environment for wireless signal analysis. It enables rapid development of powerful applications that leverage the new generation of measurement-grade software-defined radio technology.

PyRF is built on the Python Programming Language and includes feature-rich libraries, example applications and source code, all specific to the requirements of signal analysis. PyRF is openly available, allowing commercialization of solutions through BSD open licensing and offering device independence via standard hardware APIs. PyRF handles the low-level details of real-time acquisition, signal processing and visualization, allowing you to concentrate on your analysis solutions.


Direct SCPI/ VRT App
Low-Level Python App
. . .
High-Level Python App
Spectrum Analyzer GUI
. . .
pyrf.sweep_device.
Sweep Device
Pyqt, qtgraph
pyrf.devices.thinkrf.
WSA
NumPy
pyrf.connector.blocking.
Plain Socket Connector
pyrf.connector.twisted_async.
Twisted Connector
. . .
Twisted
. . .
SCPI / VRT
Network Layer
PyRF
Open Source Libraries
Development

CHAPTER 5

Hardware Support

This library currently supports development for the ThinkRF WSA4000 and WSA5000 platforms.

CHAPTER 6

Links

- Official github page
- Documentation for this API
- WSA4000/WSA5000 Documentation

CHAPTER 7

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