

# Synchronized Sweep with External I and Q Output Ports

The ThinkRF Real Time Spectrum Analyzer comes integrated with external GPIOs, I and Q output ports, among others. The external GPIOs consist of the external trigger feature, enabling synchronized sweep setup to automate spectrum scanning and capture with the use of external hardware and/or multiple ThinkRF RTSA devices. Meanwhile, the I and Q output ports facilitate integration with external high speed digitizers. This application note explains how to setup a synchronized sweep with signals feed to external I and Q output ports, as well as providing the GPIO setup requirement.

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## Overview

The ThinkRF Real Time Spectrum Analyzer (RTSA) is a high-performance software-defined RF receiver, digitizer and analyzer. The product comes with I and Q output (IQout) ports such that they can be used to mate the RTSA's RF front-end with an external, high speed digitizer. The IQout ports can be used with RTSA's synchronized sweep engine and the GPIO (General Purpose Input and Output) port to automate the spectrum scanning process, minimizing the RF front-end control interaction. The synchronized sweep used in conjunction with the GPIO port, hence, facilitate multiple devices control and sweep capture synchronization, useful for applications such as a wide area signal detection and analysis, direction finding, time of arrival determination, to name a few.

Note that, an RTSA could be used either as a master or slave for the external trigger setup. However, external hardware, such as GPIO mating port with desired cable length which satisfied the power required for the trigger pulse, are not provided by ThinkRF. Consult ThinkRF (see [Contact us for more information](#)) for suggestion if needed.

This application note provides the software and hardware details necessary for setting up a synchronized sweep with the IQout ports. It assumes that the user knows how to program a RTSA, has access to a RTSA, as well as the necessary external trigger hardware that provides trigger pulse for this application and device(s) to analyze the IQout data.

Refer to ThinkRF's Programmer's Guide and User Guide as needed, both available at <https://www.thinkrf.com/documentation/>

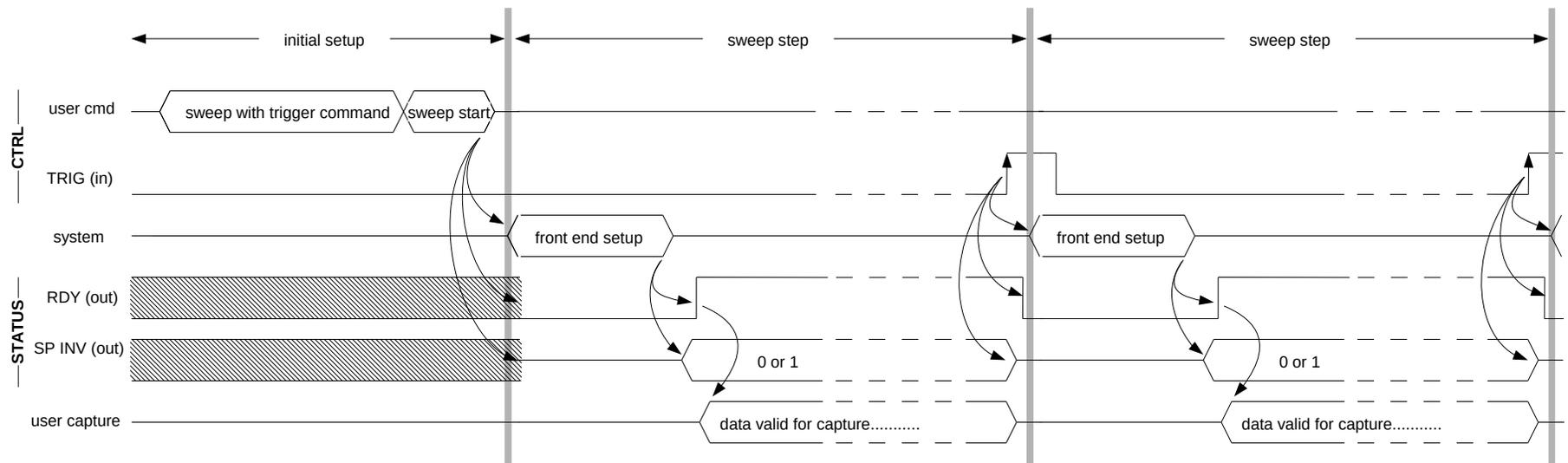
## Setting Up Synchronized Sweep with IQout

The steps below provide the sequence of events for setting up the Synchronized Sweep with IQout. This document uses external trigger PULSE type to simplify the explanation. All the GPIO signals involved are described in [GPIO Port Setup](#) section. See the timing diagram following these steps for the flow of the process as well as the hand-shaking sequence.

1. Set the RTSA to IQout mode using the SCPI command:  
:OUTPUT:IQ:MODE CONNECTOR
2. Setup required Sweep settings including pulse trigger via SCPI command  
:SWEep:ENTRY:TRIGger:TYPE PULSE
3. Initiate Sweep Start via SCPI command to start the first sweep step  
:SWEep:LIST:START
4. Wait for the system RDY (out) signal of the GPIO port to go high to indicate the system including front-end setup is ready/completed
5. User performs data capture. Note the SP\_INV (out) signal for indication of spectral inversion requirements (see in Programmer's Guide the "Trailer Word Format" section for explanation regarding spectral inversion and suggested action to take)
6. Pulse TRIG (in) high to inform the RTSA to setup the next sweep step
7. Repeat steps 4-6 until all sweep entries performed.

See the [Code Example](#) section for a set-up example with sweep settings.

## Synchronized Sweep for IQout



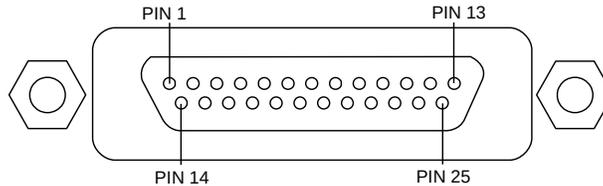
### Notes:

- The TRIG pulse strobe could be of any length since the device uses edge triggering.
- Once the RDY signal goes high after a setup, ensure there is enough time for data capture until the next rising TRIG (in) strobe. This can be calculated simply as, for example,  $\text{capture time} = \text{samples size} * (1/\text{sample rate})$ . Adjust this capture time accordingly as needed by your data capture and/or data process application.

# GPIO Port Setup

## GPIO Pinouts

The micro-DB25 as view from the RTSA's end-plate:



An example of the mating connector is [NorComp's Micro-D CCA-025-YYYYR152](#) or [Molex's Micro-D 83424-9019](#).

The list of GPIO pins and voltage required for the synchronized sweep setup:

Pin	Direction	Voltage	Signal
3	out	3.3 V	TRIG OUT
4	in	3.3 V	TRIG IN
16	out	3.3 V	SP(ectral) INV(ersion)
17	out	3.3 V	RDY
23-25	power	6 V	VCC
9,15,21-22	ground	0 V	GND

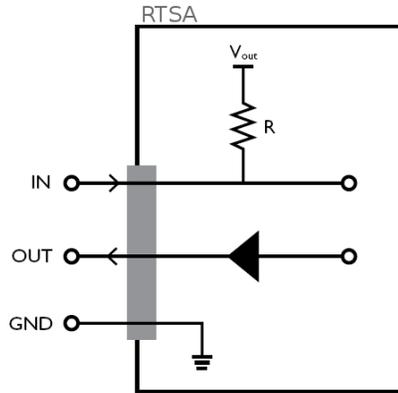
## DC Characteristics

The DC characteristics for the GPIO pins is:

	Min	Max	Units
$V_{IH}$	2		V
$V_{IL}$		0.8	V
$V_{OH}$		3.3	V
$V_{OL}$	0		V
$I_{supply}$ (From VCC)		1.5	A
$I_{sink/source}$		12	mA

## Circuit Diagrams

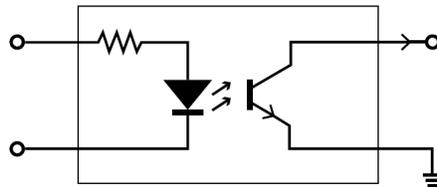
The following circuit diagram illustrates a simplified schematic for the Input and Output pins of the GPIO.



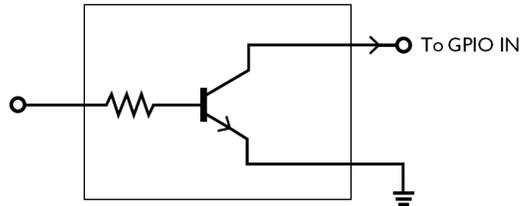
Where:  
 $V_{out} = 3.3 \text{ V}$   
 $R = 10 \text{ k}\Omega$

The following circuit diagrams illustrate, as examples, two different methods of setting up your own circuit to interface to an OUTPUT pin of the GPIO port. The ground (GND) of the interface circuit should be common to the GPIO GND.

#### Opto-Isolator Interface



#### Transistor Interface



**Note:** The cable in this interface should be **much less than 10 m** long.

## Code Example

The following program is a simple SCPI setup example using pyRF, an open-source Python API developed to interface with RTSA devices (contact ThinkRF for more information).

```
# Import libraries
import sys
from pyrf.devices.thinkrf import WSA

# Define handle & connect to RTSA
dut = WSA()
dut.connect(sys.argv[1])

# Reset RTSA configuration and clean the internal buffer
dut.reset()
dut.flush()

# Set IQ path to use external connector port instead of internal digitizer
dut.scpiiset('OUTPUT:IQ:MODE CONNECTOR')

# Set the RTSA's sync state to slave, default is OFF
dut.scpiiset('SYSTEM:SYNC:MASTER OFF')

#####
# Create a sweep entry
# Repeat this section to create multiple sweep entries
# See Programmer's Guide for more sweep settings
#####

# Set RFE mode, see Programmer's Guide for mode and data output types
dut.scpiiset('SWEEP:ENTRY:MODE ZIF')

# Set frequency range and step size
dut.scpiiset('SWEEP:ENTRY:FREQ:CENT 1200 MHZ, 3200 MHZ')
dut.scpiiset('SWEEP:ENTRY:FREQ:STEP 10 MHZ')

# Set the RTSA's trigger type in the sweep entry to use pulse type
dut.scpiiset('SWEEP:ENTRY:TRIGGER:TYPE PULSE')

# Set number of iteration to 1 time, default is 0 for infinity
dut.scpiiset('SWEEP:LIST:ITERATION 1')

# Save the sweep entry
dut.scpiiset('SWEEP:ENTRY:SAVE 0')

#####
# Control sweep and do any additional tasks
#####

# Start sweep mode
dut.scpiiset('SWEEP:LIST:START')

# Add code here to perform additional tasks
....

# Stop sweep mode if want to break early or when infinite iteration is set
# dut.scpiiset('SWEEP:LIST:STOP')
```

## Document Revision History

This section summarizes document revision history.

Document Version	Release Date	Revisions and Notes
v1.0	Mar 10, 2018	First release

## Contact us for more information

ThinkRF Support website provides online technical documents for ThinkRF products at <http://www.thinkrf.com/resources>.

For all customers who hold a valid end-user license, ThinkRF provides technical assistance 9 AM to 5 PM Eastern Time, Monday to Friday. Contact us at <https://www.thinkrf.com/support/> or by calling **+1.613.369.5104**.

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