Spectrum Analyzer (MSP-SA430-SUB1GHZ)

This document describes how to install, setup, run, and use the Spectrum Analyzer.

The Spectrum Analyzer kit (MSP-SA430-SUB1GHZ) can be ordered from the TI eStore.

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1 Introduction

TI's MSP-SA430-SUB1GHZ Spectrum Analyzer is an easy-to-use and affordable tool to jumpstart radio frequency (RF) development in the sub-GHz frequency range.

More and more electronic devices include a built-in RF link. RF transceivers are inexpensive, but the equipment to design and debug such systems is not. The purpose of this Spectrum Analyzer is to provide an affordable development tool that reduces the time you need to spend using expensive measurement equipment.

The Spectrum Analyzer (SA430) connects to a PC through USB and is operated from a powerful yet simple graphical user interface (GUI).

1.1 Hardware Specification

Frequency ranges: 300 MHz to 348 MHz, 389 MHz to 464 MHz, and 779 MHz to 928 MHz

Minimum frequency step: 397 Hz (typical)

Maximum input level: -40 dBm (typical) (range extendable with attenuators)

Minimum detectable level: -100 dBm (typical)

Level resolution: 0.5 dB

1.2 System Requirements

Screen resolution: Minimum: 800x600, Recommended: 1024x768

Operating system: Windows® XP 32 bit, Windows Vista® 32/64 bit, Windows 7 32/64 bit

Hard drive space: 200MB free drive space

Connection: One USB 2.0 port

1.3 Product Regulatory Compliance

1.3.1 FCC

This device has been tested and verified to comply with Part 15, Class B, of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Note: See EVALUATION BOARD/KIT/MODULE (EVM) ADDITIONAL TERMS for further regulatory compliance statements.

1.3.2 CE

This device has been tested and found to comply with the requirements set up in the EMC Directive 2004/108/EC and the harmonized standard EN 61326-1.

1.3.3 Canadian ICES-003

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

2 Preparing for Operation

2.1 Install Software

The MSP-SA430-SUB1GZ is shipped with a CD that contains all of the required software. To download the latest versions of the software, go to www.ti.com/sa430.

A standard Windows® installer simplifies the software installation. To start the installer, run setup.exe from the root of the CD. All required files and resources are installed to a user-selectable path, referred to as %sa430_install_path% in the following sections. The default installation path is C:\Program Files\Texas Instruments\SA430 Spectrum Analyzer\.

2.2 Install Driver

A standard CDC USB driver is used for communication between the PC and the Spectrum Analyzer (SA430). Therefore, no additional driver is required; however, Windows requires an inf file to register the device properly. Setup.exe installs the inf file to the correct location. The file is also available in the %sa430_install_path%\driver\ folder.

2.3 Connect Hardware

After all software has been installed, connect the SA430 to the PC with a standard USB 2.0 Mini cable.

The Microsoft® certified driver is automatically detected and installed as the MSP-SA430-SUB1GHZ – CDC virtual COM port device. On Windows® XP, this device can be viewed with the Device Manager (devmgmt.msc) in the Ports (COM & LPT) section.

When the SA430 is connected to the PC, the SA430 blinks a green LED followed by a steady red LED. The SA430 is now ready to be used.

2.4 Connect RF

The MSP-SA430-SUB1GHZ is equipped with a standard 50-Ω SMA connector. This allows easy connection to multiple systems.

CAUTION

Absolute maximum input level is +0 dBm. Exceeding this level can damage the SA430.

2.4.1 Antenna

A center fed dipole antenna is supplied with the SA430 kit. This antenna works for most applications, but it has some drawbacks. A dipole antenna is tuned to work best within a small frequency range. The antenna that is supplied in the kit is a λ/2 antenna with a center frequency of 868 MHz and a recommended span of 30 MHz. Using the antenna outside this range impacts the level reading.

For better accuracy outside of this frequency range, use a 50-Ω antenna designed for the intended frequency range (915 MHz, 315 MHz, or 868 MHz).

However, it is difficult to determine the true level at the transmitter in an RF system, because the transmit level and the received level depend on so many factors. In most cases, the effect of the antenna can be neglected, especially during the prototyping phase.

2.4.2 Cable

To improve power reading accuracy, a 50-Ω SMA cable can directly connect the Spectrum Analyzer with the target system / transmitter.

To reduce influences from impedance mismatch, 50-Ω attenuators should be connected next to the SMA connector of the Spectrum Analyzer. Depending on the target impedance, a 1-dB attenuator is sufficient.

CAUTION

Absolute maximum input level is +0 dBm. Exceeding this level can damage the SA430.

2.5 Start Spectrum Analyzer Software

2.5.1 Launch

By default, setup.exe creates a shortcut to the software in the Windows® Start Menu and on the Desktop from where it can easily be launched. It can also be started by running %sa430_install_path%\SA430GUI.exe.

2.5.2 Connect with Hardware

The SA430 GUI starts in the Hardware tab to allow selection of the desired hardware (see Figure 1).

Figure 1. Hardware Tab

Assuming only one SA430 connected to this computer the connection can easily be made by pressing the Connect symbol or the Connect button in the hardware tab (see Figure 2).

Figure 2. Connect Symbol

The hardware tab now shows additional information about the connected device such as the firmware version found on the device.

2.5.3 Firmware Update

The Spectrum Analyzer GUI provides a built-in updater that can update the SA430 firmware for new features and bug fixes.

If the Spectrum Analyzer GUI determines that a firmware update is required, a message is displayed. Click Update Firmware to start the update or click Decline to keep the existing firmware. Note that declining a required update can prevent the SA430 GUI from using the SA430 hardware.

NOTE: Do not remove the SA430 from USB while updating firmware. This could lead to an undefined state.

2.5.4 Ready for Operation

After the GUI establishes communication with the SA430 hardware, the connect icon is disabled and the status bar shows a message to which COM port and device the GUI is connected (see Figure 3). The software is now ready for the first measurement.

Figure 3. Device Connection Message

3 First Measurement

After the SA430 hardware is connected (Tip: Connection status is displayed on left side of the status bar; see Figure 3) the Spectrum Analyzer is ready to operate. Set the desired Frequency and Amplitude, then click the Start button (see Figure 4) to start measurement.

Figure 4. Start Button

Pressing the Start button not only starts a measurement, it also applies the RF settings for measurement. To change RF settings during measurement, first enter the new settings and then apply them by pressing the Start button again.

By default, the graph shows all settings and the measurement results (see Figure 5). Two traces are automatically enabled. Trace 0 shows the actual (ACT) measured values, and trace 1 shows the maximum (MAX) value for each measured frequency point since the start button was last pressed.

Results are displayed immediately in the graph window, which also shows all RF parameters.

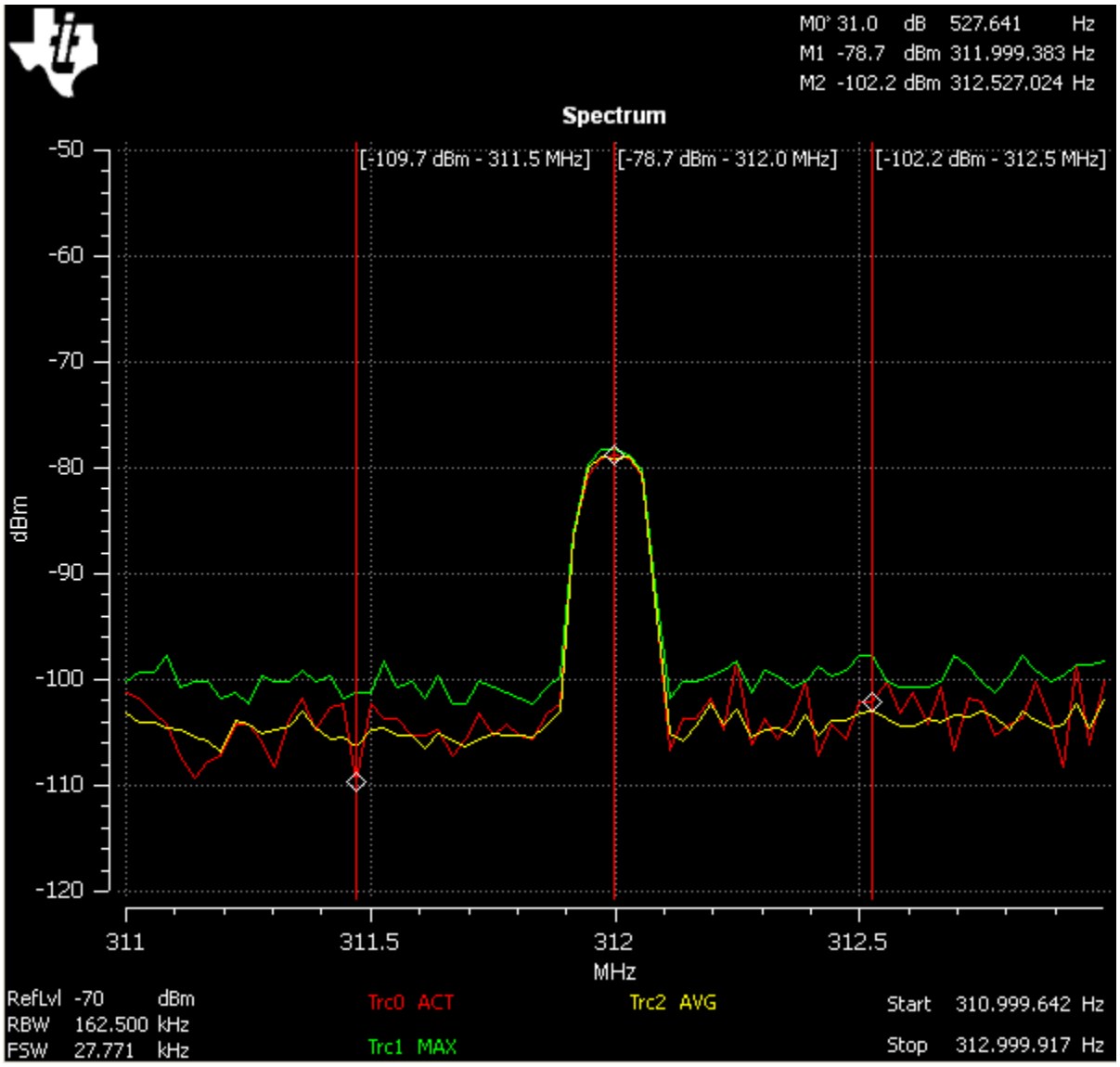

Figure 5. Frequency Graph

NOTE: Frequency parameters shown in the graph may be slightly different from the parameters that were set in the RF tab. This is caused by the frequency resolution of the hardware.

For a full feature description of the SA430 Spectrum Analyzer GUI, see Section 4.

4 Spectrum Analyzer Software Reference

This section explains functions provided by the Spectrum Analyzer GUI.

The software layout consists of five main areas (see Figure 6):

- Graph: Displays measurement results
- Tabs: Measurement and display options
- Icon Bar: Quick access to frequently used functions
- Menu Bar: File, Hardware, Grid, and Help menus
- Status Bar: Provides an overview of connection and status

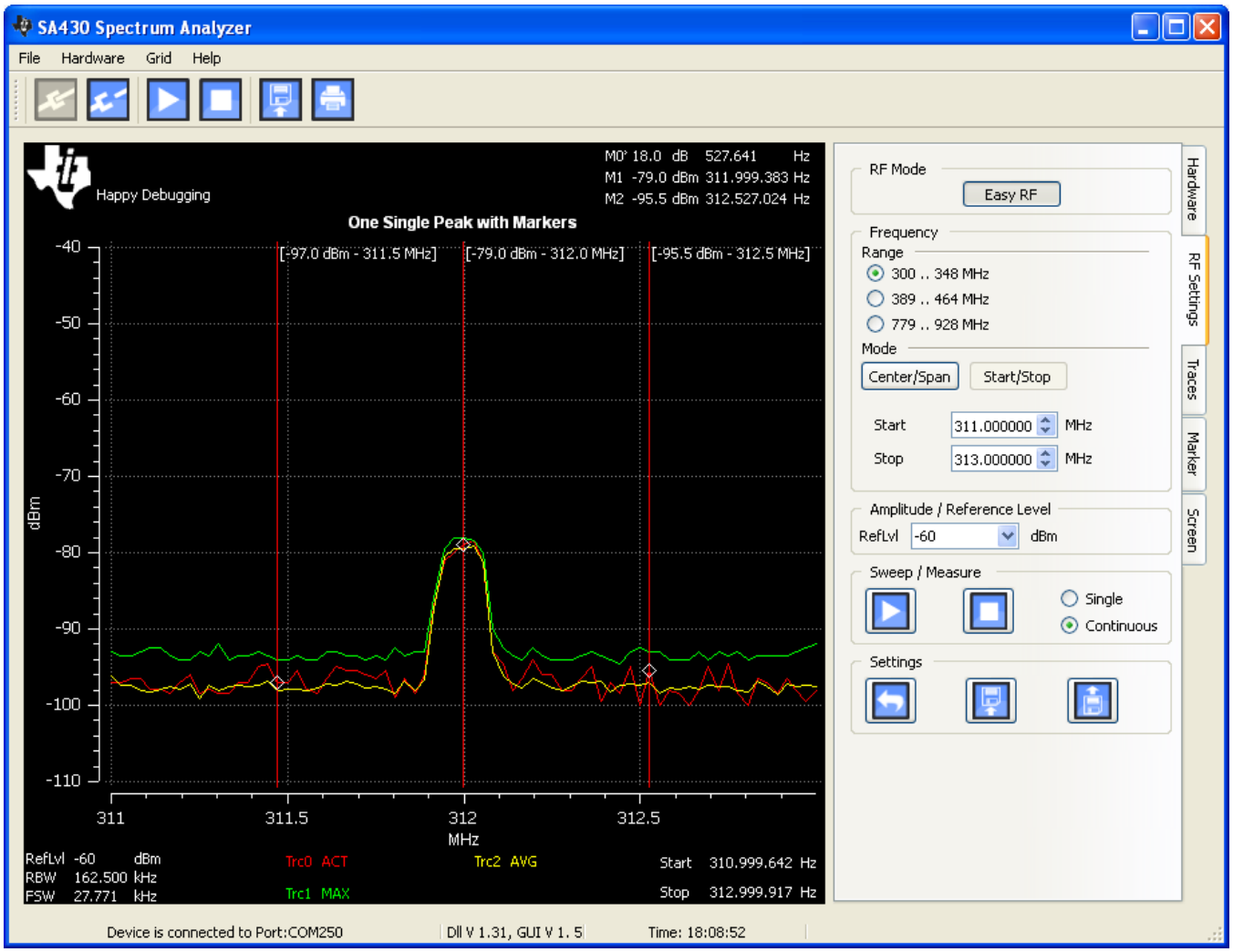

Figure 6. Spectrum Analyzer GUI

4.1 RF Settings

The most important part of using a Spectrum Analyzer is the selection of measurement parameters. All of these settings can be made in the RF Settings tab. The following sections describe the options available in this tab.

Changes to settings can be made while a measurement is running. After all settings are adjusted in the RF Settings tab, apply the settings by clicking the Start button. New measurement data and updated RF settings are now displayed in the graph.

NOTE: Frequency parameters shown in the graph may be slightly different from the parameters that were set in the RF Settings tab. This is caused by the frequency resolution of the hardware.

4.1.1 Frequency

In the RF Settings tab, first select the frequency range (one of the three supported ranges), then specify the center frequency and span to measure (see Figure 7).

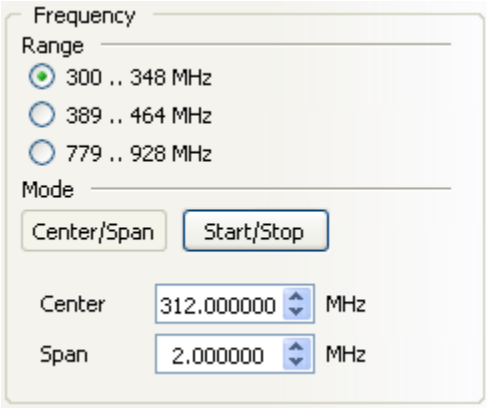

Figure 7. RF Settings Tab, Frequency

This can be done either with Center frequency (for example, 312 MHz) and Span (for example, 2 MHz) or the equivalent Start (for example, 311 MHz) and Stop (for example, 313 MHz). Both result in the same output: a spectrum from 311 MHz to 313 MHz.

4.1.2 Amplitude

Select the Reference Level (RefLvL) accordingly to the expected input level (see Figure 8). The reference level sets the maximum power level that can be measured without saturating the measurement device. If a power level higher than the reference level is applied, the measurement result contains signal artifacts (power) close to the input signal frequency.

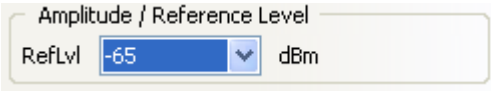

Figure 8. RF Settings Tab, Amplitude / Reference Level

If signal strength is not known, it is a good idea to start with a low reference level and increase it if high readings or artifacts are seen.

NOTE: In saturation, the Spectrum Analyzer shows incorrect results but is not damaged unless the absolute maximum input level of +0 dBm is exceeded.

4.1.3 Sweep

In Continuous Sweep mode, each measurement result is displayed and a new measurement is triggered, resulting in continuous updates. In single mode, only one measurement is taken when the Start button is pressed. To take another measurement in single sweep mode, press the Start button again (see Figure 9).

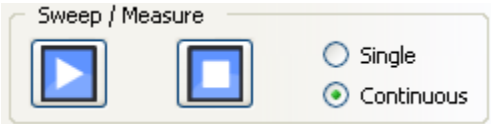

Figure 9. RF Settings Tab, Sweep / Measure

4.1.4 Band Width

The band width determines the frequency resolution of a measurement. The general rule is that a larger frequency range of interest (span) requires a larger bandwidth.

In Easy RF mode, these settings are managed automatically, and the user does not need to change them. However, it might be necessary under certain circumstances to apply special settings. The Easy RF mode can be turned off by clicking the Easy RF mode button (see Figure 10).

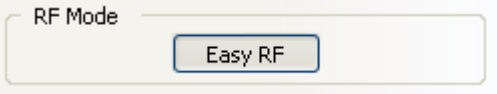

Figure 10. RF Settings Tab, RF Mode

Two different settings are then available and closely linked to each other (see Figure 11).

Figure 11. RF Settings Tab, Band Width

4.1.4.1 Filter Step Width

The SA430 has an analog heterodyne receiver that is digitally controlled. The filter step width (FSW) determines the frequency distance between two measured power levels. As every measured level is shown on the graph it also gives the frequency distance between two points in the graph. The number of points is defined by span divided by the FSW plus one.

A number that is small compared to the span gives more samples but takes more time to measure.

4.1.4.2 Resolution Band Width

The resolution band width (RBW) gives the frequency size of the input filter that is applied to the input signal. This filter is applied at each measured frequency point.

A small number gives better frequency resolution but covers a smaller frequency area. For larger frequency spans, therefore, it is better to have a larger RBW.

RBW and FSW depend on each other. To avoid losing signal information, the distance between two measurements (FSW) needs to be smaller than the filter width RBW.

4.1.5 Settings

To make repetitive tasks easier, all RF settings can be exported and imported to an application specific XML file. The settings are not tied to this computer or equipment so a measurement setting can be shared easily with others.

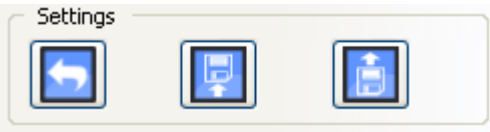

Figure 12. RF Settings Tab, Settings

An undo to last settings button is available to quickly go back to the last setting.

4.2 Traces

All measurement data is stored in traces. A total of four traces are available and a function or mode can be assigned to each of them in the Traces tab (see Figure 13).

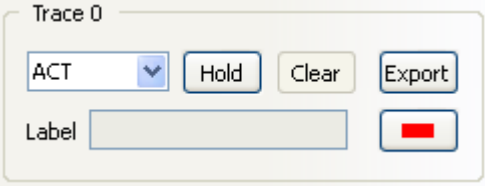

Figure 13. Traces Tab, Trace 0

Four modes are available and define the function of each trace.

- ACT (Actual) gives the current measured value
- MAX (Maximum) shows the maximum value measured per frequency point since the last measurement start button press.
- AVG (Average) shows an average value per frequency point since the last measurement start.
- OFF removes the trace from the graph

For the average function a sliding weighted average function is implemented. The formula looks like: AVG = (5*AVG[last measurement] + 1*ACT)/6.

Starting a measurement by pressing the Start button sets AVG and MAX to ACT values. In Single Sweep mode all traces will show the same result.

Pressing the Clear Button resets the average and maximum trace, so MAX or AVG will be identical with next ACT trace measurement.

The Hold button will stop updates to this trace. It will not stop the measurement – it only stops updating data on a selected trace. This feature is Useful to compare for example two devices or settings.

Each trace can be exported to a comma separated text file (csv) with frequency and dBm values. This is useful to store or share measurement results. Good file names are key.

4.3 Marker

Markers are available to allow for easier reading of measurement results. They are enabled in the Marker tab by selecting a trace (see Figure 14).

Figure 14. Marker Tab, Marker 1

With the jog dial the markers can be moved in frequency. The jog dial is assigned to the marker associated with the button being pressed (see Figure 15).

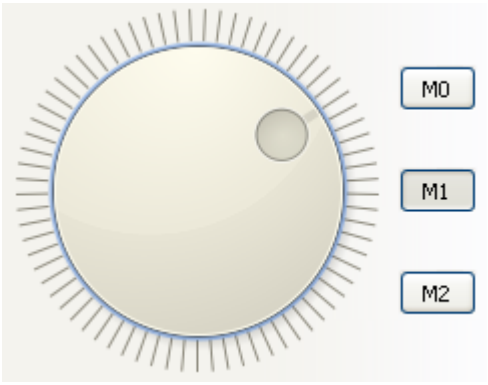

Figure 15. Marker Tab, Jog Dial

Marker 0 and 2 can be made relative (delta) to marker 1, allowing to measure for example the spacing to neighbor signals. An asterisk after the marker number will indicate delta mode in the graph window.

4.4 Screen Tab

The graph output, including grid and displayed items, can be configured (see Figure 16).

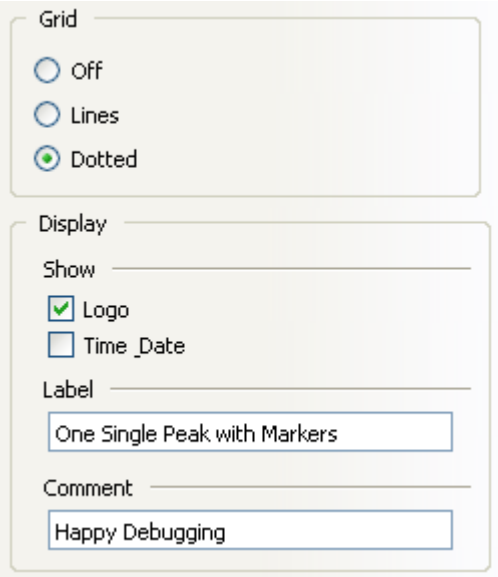

Figure 16. Screen Tab, Grid and Display

Printing to any installed printer is supported including an invert color switch to easier read the results (see Figure 17).

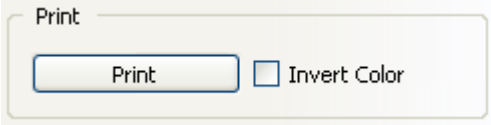

Figure 17. Screen Tab, Print

A screenshot of the application or only the graph only can be saved in many formats including pdf and png (see Figure 18).

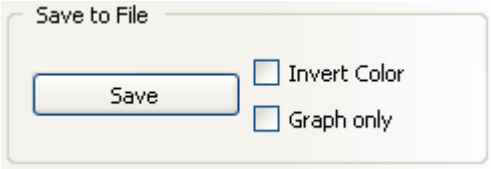

Figure 18. Screen Tab, Save to File

5 Troubleshooting

5.1 FAQ

Q: The hardware is connected, but it is not shown as available in the hardware tab.
A: Scan for connected devices (see Figure 1). Maybe the device was plugged in after the software was started.

Q: My device is still not shown!
A: Check the red LED–it should be on. Make sure that the COM port is shown in the device manager.

Q: Now–after I really connected the USB–the device is shown, but I cannot connect to it.
A: Make sure that the port is not used by any other software. Some applications connect to everything they can and block access to the port. Make sure that no other instances of SA430GUI.exe are running. Remove the SA430 hardware from USB and reinsert it.

Q: What if the PC loses power?
A: Make sure to use the export RF settings function to save your work for later reference.

Q: I see an issue that is not described here. What should I do?
A: Go online to e2e.ti.com and post a question.

5.2 Known Limitations

The SA430 hardware functions with Linux, because it uses a standard USB CDC driver. However, the SA430 GUI software is not available for Linux.

At very low reference level settings, the internal VCO is measured. This can happen at multiples of 26 MHz.

The software is tested on multiple platforms but issues and errors can occur. Please report findings on www.ti.com/sa430 so that the software can be improved.

This is not a high-end spectrum analyzer (there is a reason why high end devices are expensive); however, the MSP-SA430-SUB1GHZ works well during prototyping and development of RF links. In this stage, the typical questions that need to be answered are whether or not a signal is generated at all and whether or not it is at the expected frequency.

5.3 Additional Resources

For more information and to download the latest software, go to www.ti.com/sa430.

Question on how to use the Spectrum Analyzer or how to debug a RF link? Question on how to use TI parts? The TI online support community can help: e2e.ti.com.

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