

5110A Time Interval Analyzer

Operations and Maintenance

Manual



4775 Walnut Street
Suite 1B
Boulder, CO 80301 USA

www.timing.com
Phone: (303) 939-8481

5110A Time Interval Analyzer Operations and Maintenance Manual

Copyright © 2004-2006 Timing Solutions Corporation

Timing Solutions is a trademark of the Timing Solutions Corporation.

Other product and company names may be trademarks of their respective owners.

DOC05110A Rev G

Revision History:

Revision	Description	Date	Approved
A	Initial Release	July 2002	DF
B	Added CE information	November 2003	DF
C	Added Declaration of Conformity. Corrected typo in Sect. IV page 26. Changed address.	2/29/04	GAR
D	Software changes to make similar to 5120A	4/7/05	GAR
E	Changed 5120A references to 5110A references in PDF	9/2/05	MSS
F	Corrected rate and added more detail for serial port. Added FTP details	3/20/06	GAR
G	Corrected Phase Noise BW in Chapter 3	4/20/06	GAR

Contents

1: Introduction	1
1.1 Symbols	1
1.2 About This Manual	2
1.2.1 Conventions	2
1.3 5110A Overview	3
2: Setting Up the 5110A	5
2.1 Safety Information	5
2.2 Setting Up the 5110A	5
2.2.1 Turning On the 5110A	7
2.3 Understanding the 5110A Screen and Navigation	7
2.3.1 Using Softkeys	8
2.3.1.1 Selecting Mutually Exclusive Options Using Softkeys	9
2.3.1.2 Entering Numbers Using Softkeys	9
2.4 Using the Network Connection (Option)	11
2.5 Viewing the Model and Software Version	12
2.6 Setting the Time	12
2.7 Selecting the Color Scheme	12
3: Configuring Data Display	13
3.1 Configuring Phase Noise Data Display (Option)	13
3.1.1 Setting the Plot Scale	13
3.1.2 Setting Data Markers	14
3.1.3 Setting Up a Test Mask	16
3.2 Configuring Allan Deviation Data Display	16
3.2.1 Setting the Plot Scale	16
3.2.2 View Allan Deviation table	17
3.2.3 Setting Up a Test Mask	17
3.3 Configuring Phase Difference Data Display	17
3.3.1 Setting the Plot Scale	17
3.4 Configuring Frequency Difference Data Display	18
3.4.1 Setting the Plot Scale	18
3.5 Configuring Frequency Counter Data Display	19
3.5.1 Changing the Nominal Frequency	19
3.6 Saving and Recalling Configuration Settings	19

4: Collecting and Viewing Data Locally	21
4.1 Starting and Stopping Data Collection (Locally)	21
4.1.1 Pausing and Resuming Phase Noise Display Updates	22
4.2 Viewing Data on the Screen	23
4.2.1 Understanding Phase Noise Data	24
4.2.2 Understanding Allan Deviation Data	24
4.2.3 Understanding Phase Difference Data	25
4.2.4 Understanding Frequency Difference Data	25
4.2.5 Understanding Frequency Counter Data	25
4.3 Printing Data (Locally)	26
4.3.1 Setting Up the Printer	26
4.4 Changing the Instrument Control (Local or Remote) (Option)	27
4.5 Retrieving print files via FTP	28
5: Collecting and Viewing Data Remotely (Option)	29
5.1 Configuring the Network Connection	29
5.2 Accessing the 5110A Remotely and Exiting the Remote Session	30
5.3 Starting and Stopping Data Collection (Remotely)	31
5.4 Viewing Data (Remotely)	31
5.5 Printing Data (Remotely)	32
5.6 Viewing Help for Remote Commands	34
5.7 Changing the Instrument Control (Local or Remote)	34
5.8 Showing the Software Version	35
6: Maintaining the 5110A	37
6.1 Calibrating the 5110A	37
6.2 Cleaning the 5110A	37
7: Troubleshooting the 5110A	39
7.1 Troubleshooting Error Messages	39
7.2 Replacing Fuses	41
Declaration of Conformity	42
Appendix A: Specifications	43
A.1 Electrical Specifications	43
A.1.1 Environmental Specifications	43
A.2 Physical Specifications	44
Appendix B: Theory of Operation	45
Glossary	49
Index	51

1: Introduction



Note

FIRST READ THIS MANUAL THOROUGHLY!

This is especially true for the sections regarding **Safety** and **Setup**.

1.1 Symbols

These symbols appear throughout the manual as well as on the 5110A itself.

Symbol	Definition
Note	This symbol means the following information is a note that gives you important information that may affect how you use the 5110A.
	Caution, refer to manual. Read all instructions in this manual before using this product.
	Caution - Risk of Electrical shock
	Fuse symbol.
	LAN port, network. DO NOT CONNECT TO TELECOM CONNECTIONS THAT CARRY HAZARDOUS VOLTAGES.

1.2 About This Manual

This manual describes how to set up, maintain, and troubleshoot the 5110A.

“[Chapter 1, Introduction](#)” on page 1 explains symbols that appear in the manual and on the unit as well as documentation conventions. The chapter also briefly describes the 5110A.

“[Chapter 2, Setting Up the 5110A](#)” on page 5 contains important safety information, describes how to set up the 5110A, and describes how to navigate the menus.

“[Chapter 3, Configuring Data Display](#)” on page 13 describes how to configure the 5110A to for data display.

“[Chapter 4, Collecting and Viewing Data Locally](#)” on page 21 describes how to view and print data directly from the 5110A.

“[Chapter 5, Collecting and Viewing Data Remotely \(Option\)](#)” on page 29 describes how to view and print data remotely using the Ethernet port.

“[Chapter 6, Maintaining the 5110A](#)” on page 37 describes how to maintain the 5110A.

“[Chapter 7, Troubleshooting the 5110A](#)” on page 39 describes how to troubleshoot error messages.

“[Appendix A, Specifications](#)” on page 43 contains the detailed specifications for the 5110A.

“[Appendix B, Theory of Operation](#)” on page 45 contains the detailed information about the algorithms and underlying theories for the 5110A.

1.2.1 Conventions

This manual uses several typographical conventions to help explain how to use the 5110A.

Convention	Definition
Bold	Words in bold show: <ul style="list-style-type: none">■ Buttons and icons to click■ Menu options to select■ Commands to type■ Non-variable information displayed in response to commands
<i>Italics</i>	Words in <i>italics</i> show: <ul style="list-style-type: none">■ Names of windows and dialog boxes■ Variable information displayed in response to commands

1.3 5110A Overview

The 5110A is designed for ease of use. There is little configuration required. Just connect two signal sources to the BNC (adapters) inputs, choose the desired algorithm option, and push start. The input impedance is 50 Ω and the nominal input level ideally should be near 1 V rms. The unit calibrates itself, measures the frequencies of the input signals, configures the signal paths and collects data. The user has a choice of four primary displays: the **Configure Allan Deviation**, the **Frequency Counter**, the **Frequency Difference Plot** and the optional **Phase Difference Plot**. This instrument requires bi-annual calibration only in the verification of its internal frequency reference.

An optional Ethernet port on the rear panel provides the capability to remotely control the instrument.

Figure 1 shows the 5110A’s front panel, and Figure 2 shows the 5110A’s rear panel.

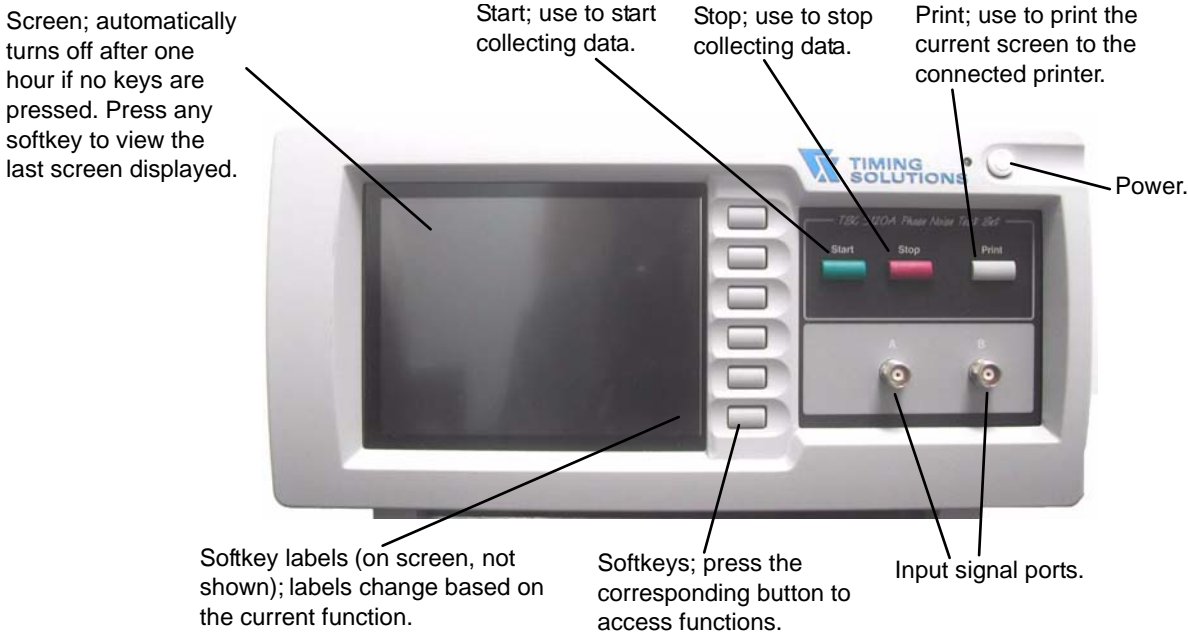


Figure 1: Front panel

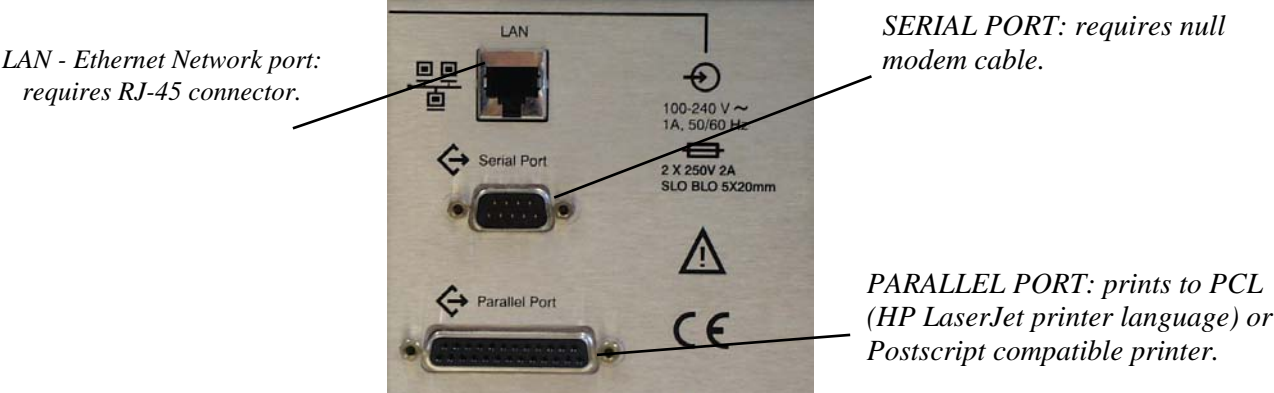


Figure 2: Rear panel

The 5110A can collect and display the following types of data:

- Allan deviation
- Phase difference
- Frequency difference
- Frequency counter
- Phase noise (Optional)

Channel A is always the reference channel. All phase noise, Allan deviation, phase, and frequency measurements are referenced to the frequency of the channel A input signal.

2: Setting Up the 5110A

You should read the safety information below before setting up the 5110A. You can then set up the instrument. For more information, see the following:

- Setting Up the 5110A (see [page 5](#))
- Understanding the 5110A Screen and Navigation (see [page 7](#))
- Using the Network Connection (Option) (see [page 11](#))
- Viewing the Model and Software Version (see [page 12](#))
- Setting the Time (see [page 12](#))
- Selecting the Color Scheme (see [page 12](#))

2.1 Safety Information



This unit is for indoor use only. It is not sealed to prevent moisture from entering the enclosure.

Do not attempt to set up or operate this equipment if you have not first acquired proper training.

Ensure that all cables are properly connected. The power cord must be located for easy removal.

Verify that input line voltage and current capacity from the supply circuit are within specifications before turning on power to the 5110A.

Operating and maintenance personnel must receive proper training before setting up or maintaining electrical equipment.

2.2 Setting Up the 5110A

The 5110A ships ready to set up on a desk, table, or other stable, flat surface.

Required for setup:

- North American or European IEC power cord. One or the other will be supplied with the instrument.
- Two TNC male to BNC female adapters are supplied with the instrument.
- Two customer-supplied 0.5-meter (approximately 19") coaxial cables terminated at one end with male BNC connectors. The other end should have the appropriate connector as determined by your application.

- Customer-supplied CAT 5 LAN cable for network connection (RJ-45), if connecting to the Ethernet port. (optional)
 - If you need to connect the 5110A directly to your computer using the Ethernet port, you must use a crossover cable instead of a standard LAN cable.

To set up the 5110A:

1. Unpack carefully and inspect the 5110A.
2. Check for physical damage.
 - If you observe physical damage, immediately contact Timing Solutions and the carrier. We recommend saving the shipping container for submitting any necessary claims to the carrier.
3. Verify that the front panel power button is turned off.
4. Plug the female end of the power cord into the male IEC-320 plug on the rear of the 5110A.
5. Plug the male end of the power cord into a 85–264 V AC, 50/60 Hz power source.



Ensure that this power supply cord is connected to a properly grounded mains receptacle.

6. Connect one coaxial cable to the reference signal source and to channel A of the 5110A. The input level should be between 0.9 Vpp and 4.5 Vpp, from 1 to 20 MHz.
7. Connect the other coaxial cable to the device under test and to channel B of the 5110A. The input level should be between 0.9 Vpp and 4.5 Vpp, from 1 to 20 MHz.
8. (Optional.) Connect a CAT 5 LAN cable to the Ethernet port on the rear panel of the 5110A.
 - For information about configuring the network connection, see [“5.1 Configuring the Network Connection”](#) on page 29.

You are now ready to turn on the 5110A.

2.2.1 Turning On the 5110A

Once you set up the 5110A, you are ready to turn it on.

To turn on the 5110A:

- Press the **Power** button on the front panel.
 - The Timing Solutions logo displays.
 - The main screen displays about 40 seconds later. The main screen defaults to the phase noise plot. The phrase “Warming Up” may display in the action field in the lower-left corner of the screen.
 - When “Ready” displays in the action field, the instrument is ready for normal operation.
 - If the “Self test has failed for the following item(s)...” message displays, call a TSC service representative for assistance.

After you see “Ready” in the action field, you can configure the instrument and collect data.

2.3 Understanding the 5110A Screen and Navigation

The screen on the front panel of the 5110A displays data and available settings for the data you collect. It defaults to the Allan deviation data plot. All steps in the guide start from that screen.

[Figure 3](#) describes the types of information on the screen. The softkey labels change based on the function you select.

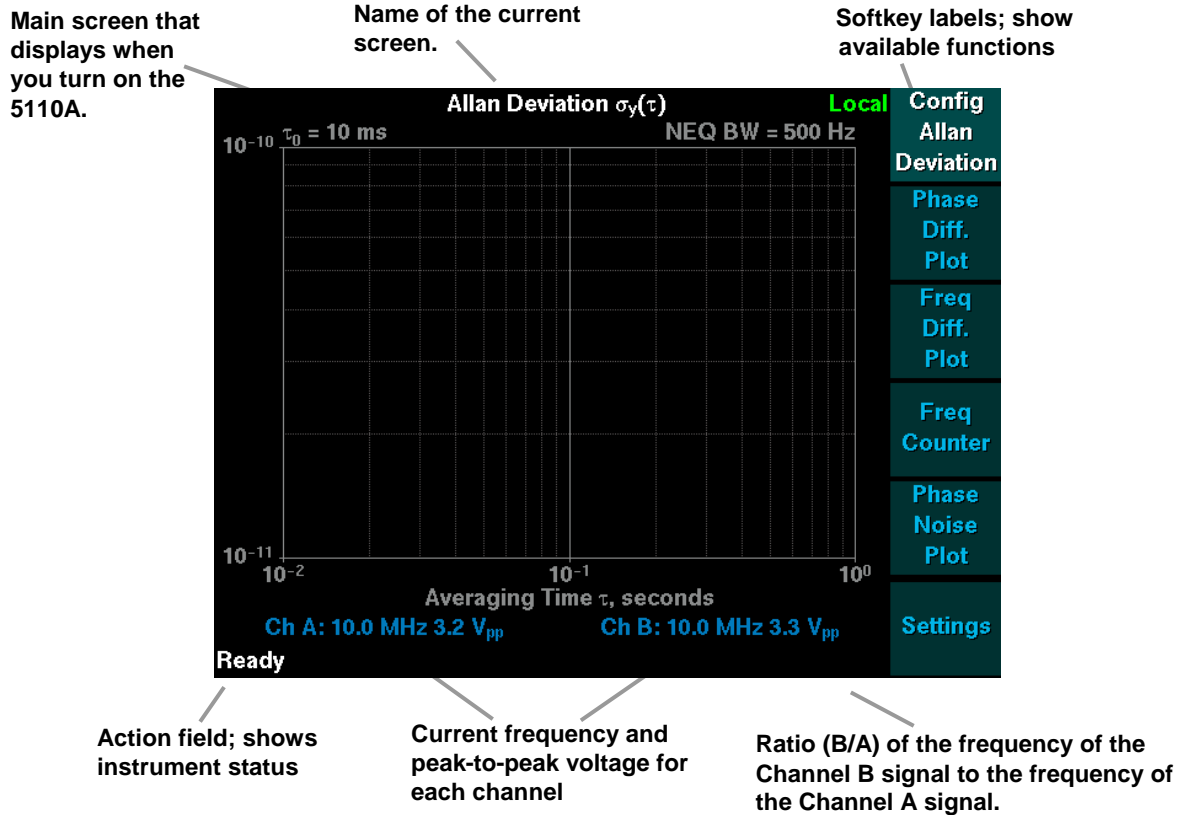


Figure 3: Default main screen

You can navigate the functions and configure data collection settings using the softkeys on the front panel. For more information, see “2.3.1 Using Softkeys” on page 8.

- Press the softkey (button) next to the label to make selections.
- The steps detailed in this manual use this method.

When you navigate to a different screen, that screen displays until you navigate to another or turn off the instrument and turn it back on again. Press **Return** to go back to the previous menu.

2.3.1 Using Softkeys

The softkeys on the right side of the 5110A are always available for use to configure and control the instrument. The labels for the softkeys display on the screen and change based on the function you are in and what is selected on the screen.

For more information, see the following:

- “2.3.1.1 Selecting Mutually Exclusive Options Using Softkeys” on page 9
- “2.3.1.2 Entering Numbers Using Softkeys” on page 9

2.3.1.1 Selecting Mutually Exclusive Options Using Softkeys

Figure 4 shows an example of how to select an option from among two or more mutually exclusive options (similar to radio button controls in other graphical user interfaces [GUIs]).

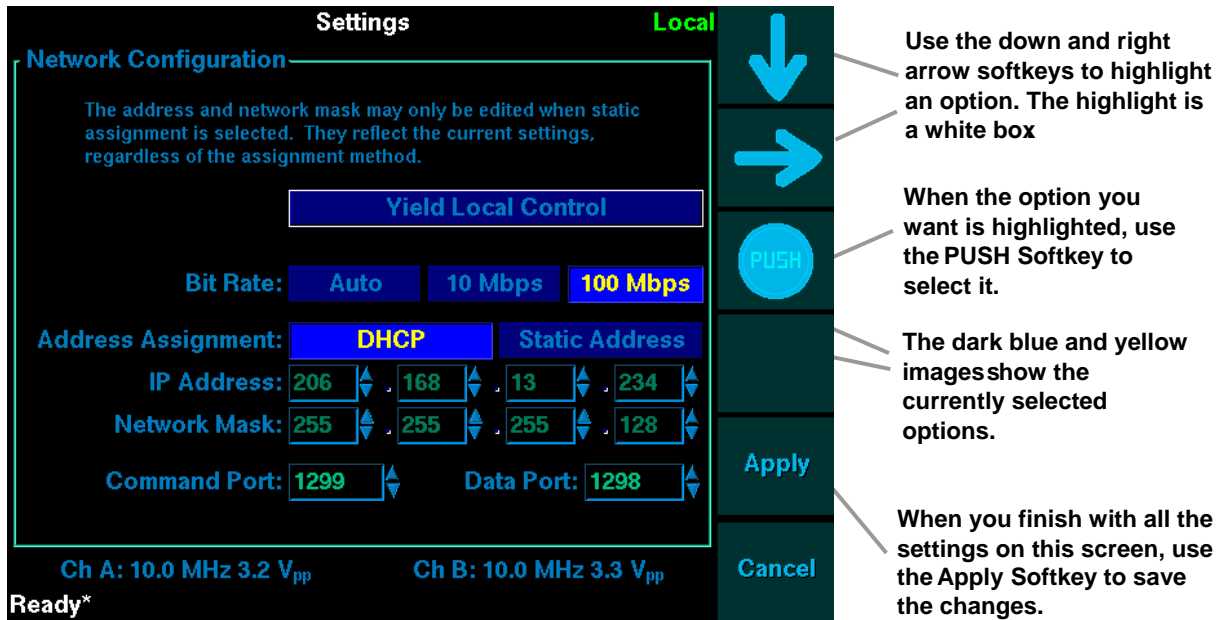


Figure 4: Selecting mutually exclusive options using the softkeys

2.3.1.2 Entering Numbers Using Softkeys

You can enter numbers into numeric fields in one of two ways using the softkeys:

- Using the + and – softkeys (see Figure 5)
- Using the number keypad (see Figure 6)

Figure 5 shows an example of how to enter a number using the + and – softkeys.

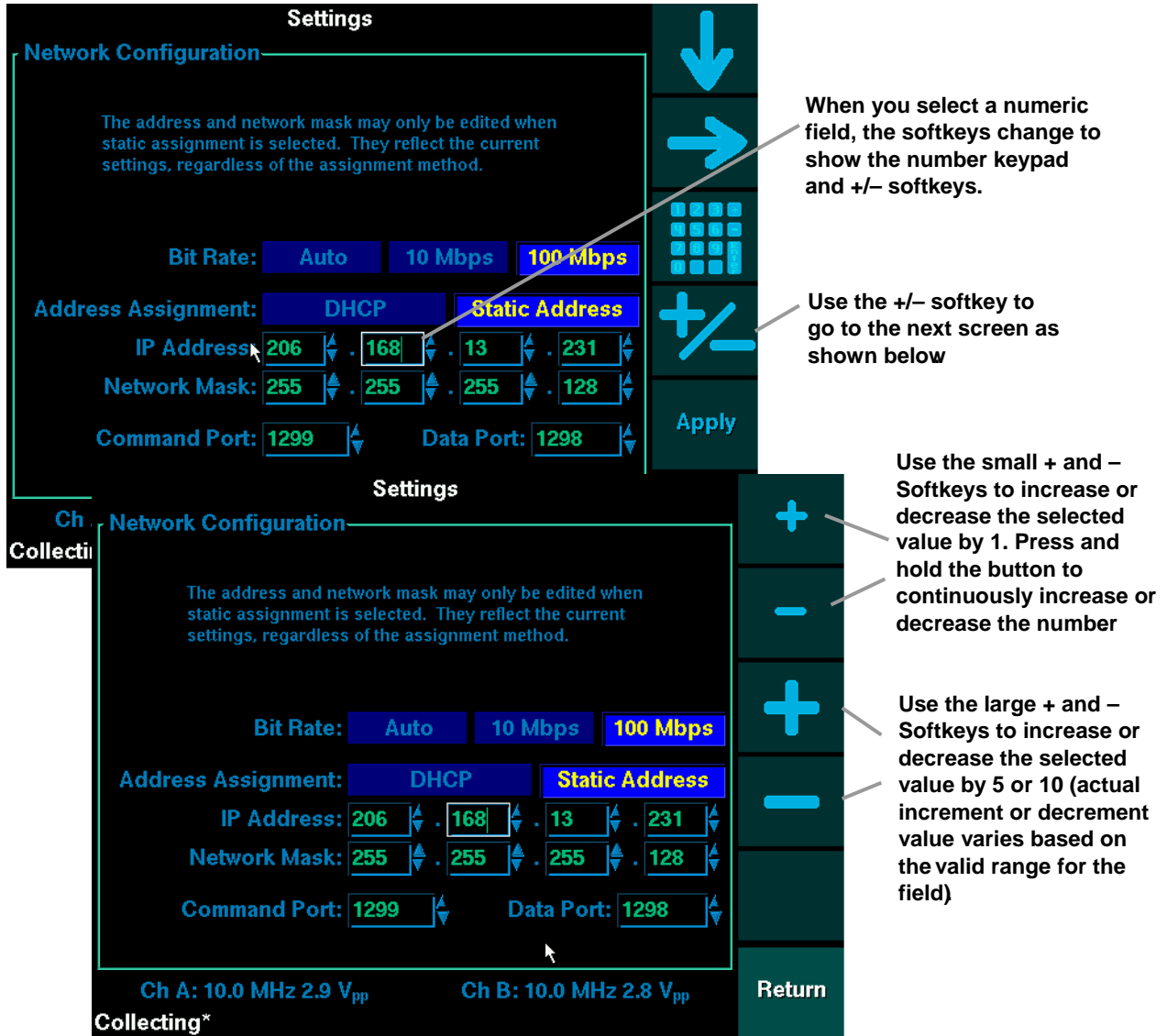


Figure 5: Entering a number using the softkeys

Figure 6 shows an example of how to enter a number using softkeys and the number keypad.

The screenshot shows the 'Settings' screen with the 'Network Configuration' section. The 'Address Assignment' is set to 'Static Address'. The IP Address field is currently showing '206 . 168 . 13 . 231'. The Network Mask is '255 . 255 . 255 . 128'. The Command Port is '1299' and the Data Port is '1298'. The screen also shows 'Ch A: 10.0 MHz 2.9 V_{pp}' and 'Ch B: 10.0 MHz 2.8 V_{pp}'.

Annotations for the main screen:

- When you select a numeric field, the softkeys change to show the number keypad and +/- softkeys.
- Use the number keypad softkey to go to the next screen as shown below.

Annotations for the number keypad:

- Use <- key as a backspace to clear the last digit.
- Use +/- key to change the number's sign.
- Use the down and right arrow softkeys to highlight a "key" on the keypad.
- When the key you want is highlighted, use the **PUSH** softkey to select it.

0			
7	8	9	<-
4	5	6	Clear
1	2	3	Apply
0	.	+/-	Cancel

Figure 6: Entering a number using the softkeys and the number keypad

2.4 Using the Network Connection (Option)

You can use the Ethernet port to perform the following functions remotely:

- Start and stop data collection
- Set control of the instrument to local or remote
- View and print data
- Show the software version
- Set a name for the instrument

- Access Allan deviation data
- Access phase difference data

You use a network connection program, such as Telnet, to send commands over the network. For more information, see [“Chapter 5, Collecting and Viewing Data Remotely”](#) on page 29.

2.5 Viewing the Model and Software Version

You can view the model number and software version for your 5110A when needed for troubleshooting.

To view the model number and software version:

1. From the front panel, press **Settings**.
 - For information about navigating using the softkeys, see [“2.3 Understanding the 5110A Screen and Navigation”](#) on page 7.
2. Press **Version Info**.
 - The Version Info screen displays, with the model number and software version.
3. Press **Return** to go back to the previous screen.

2.6 Setting the Time

You can set the time on the 5110A.

To set the time:

1. From the front panel, press **Settings**.
 - For information about navigating using the softkeys, see [“2.3 Understanding the 5110A Screen and Navigation”](#) on page 7.
2. Use the arrow softkeys to select the time settings you want.
3. Use the + and – softkeys to set the values.
4. Press **Apply**.
5. Turn off the 5110A and turn it back on again.

2.7 Selecting the Color Scheme

This function is planned for the next version.

3: Configuring Data Display

You can configure settings for the following types of data display:

- Phase Noise Data (Option) (see [page 13](#))
- Allan Deviation (see [page 16](#))
- Phase Difference (see [page 17](#))
- Frequency Difference (see [page 18](#))
- Frequency Counter (see [page 19](#))

You can also save up to six configurations and recall them for use later. For more information, see “3.6 Saving and Recalling Configuration Settings” on page 24.

3.1 Configuring Phase Noise Data Display (Option)

You can display data that shows the single side band (SSB) phase noise up to 1 Hz offset, if you have purchased the phase noise option. This data shows the SSB spectrum of the phase differences between the channel A and channel B input signals. All measurements are referenced to the frequency of input A.

You can configure the following settings for the phase noise data:

- Plot scale (see [page 13](#))
- Data markers (see [page 14](#))
- Test mask (see [page 16](#))

3.1.1 Setting the Plot Scale

You can scale the phase noise data logarithmically or linearly. You can scale the data in the following ways:

- Automatically scale the x axis:
 - Sets the x scale to logarithmic.
 - Sets the minimum offset frequency to the minimum offset frequency available.
 - Sets the maximum offset frequency to 1Hz.
- Automatically scale the y axis:
 - Sets the dB/division to the closest values that allows display of the data.
 - Allows the following scales (dB/division): 0.1, 0.2, 0.5, 1, 2, 5, 10, 15, and 20.
 - Sets the top line to an even integer times the dB/division scale.
- Fixed scale y
 - Lets you shift up and down by 1 division.

- Lets you increase or decrease the dB/division allowing the following values: 0.1, 0.2, 0.5, 1, 2, 5, 10, 15, and 20.
- Scales from the top line of the plot.
- Fixed logarithmic scale x
 - Shows from 1 to 4 decades.
 - Allows the following values (Hz): 10^{-3} , 10^{-2} , 10^{-1} , 10^0 .
- Fixed linear scale x
 - Allows minimum x value of 0 Hz.
 - Allows the following maximum values (Hz): 10^{-2} , 10^{-1} , 10^0 .

To scale the plot:

1. From the front panel, press **Phase Noise Plot**.
 - For information about navigating using the softkeys, see [“2.3 Understanding the 5110A Screen and Navigation”](#) on page 7.
2. Press **Config Phase Noise Plot**.
3. Press **Scale Plot**.
 - The highlighted softkeys show the current settings.
 - If you want to use autoscaling, press **Auto Scale X Axis** or **Auto Scale Y Axis**.
 - If you want to use a fixed scale, press one of the following:
 - **Fixed Scale Y Axis**
 - Use **Shift Up 1 Div** and **Shift Down 1 Div** to shift (scroll) the data up or down one division on the screen.
 - Use **Increase dB/Div** or **Decrease dB/Div** to increase or decrease the values for each division on the plot.
 - **Scale X-log**
 - Use **Inc Max** or **Dec Max** to increase or decrease the maximum value on the scale.
 - Use **Inc Min** or **Dec Min** to increase or decrease the minimum value on the scale.
 - **Scale X-linear**—Use **Inc Max** or **Dec Max** to increase or decrease the maximum value on the scale.

3.1.2 Setting Data Markers

Data markers let you designate two specific data points with a marker (diamond) on the screen. The first marker (normal marker) displays the actual value at that point in the plot. The second marker (Δ marker) displays the difference between it and the first marker, in addition to its own position. This lets you easily see the difference between two points on your plot as shown in [Figure 12](#).

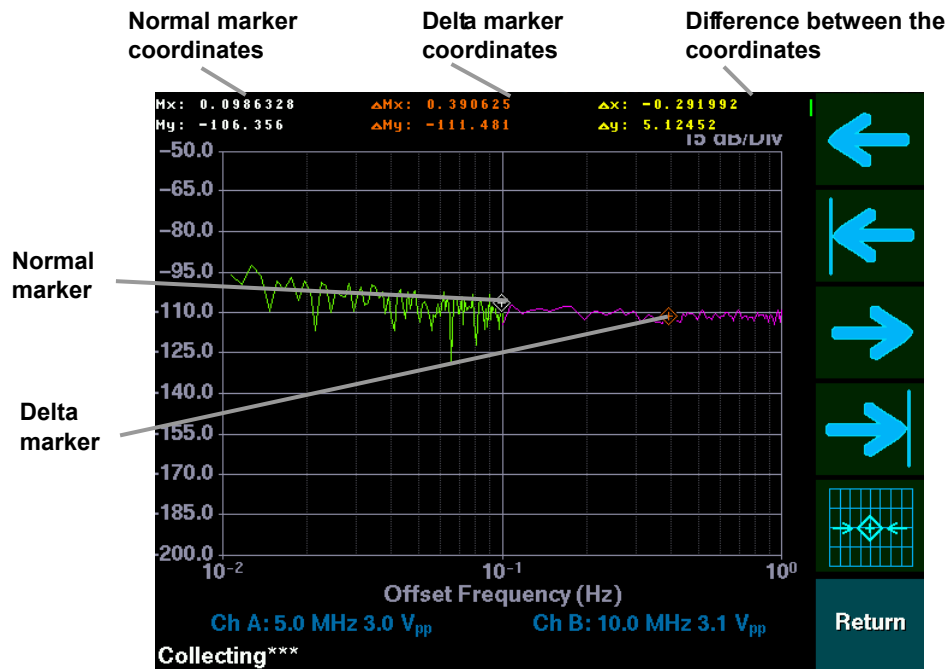





Figure 12: Example phase noise data with data markers

You can also remove all markers from the screen.

To set up markers:

1. From the front panel, press **Phase Noise Plot**.
 - For information about navigating using the softkeys, see “2.3 Understanding the 5110A Screen and Navigation” on page 7.
2. Press **Config Phase Noise Plot**.
3. Press **Markers**.
4. Press **Normal Marker**.
 - A marker (diamond) displays at the center of the plot, and its coordinates display at the top of the screen.
5. Use the arrow softkeys to move the marker where you want it.
 - The right and left arrows move the marker to the next data point in the plot in the direction of the arrow.
 - The  and  softkeys move the marker to the data point closest to the next vertical grid line.
 - The  softkey moves the marker to the center of the x axis.
6. If you want to set up a delta marker, press **Return** to go back to the previous menu.
7. Press **Δ Marker**.

- A second marker displays at the center of the plot, and its coordinates display at the top of the screen, along with the difference between its coordinates and the normal marker's coordinates.
8. Use the arrow softkeys to move the marker where you want it.
 - To move either marker to a new position, repeat the steps for setting up the marker and use the arrow keys to move marker.

To remove all markers:

1. From the front panel, press **Phase Noise Plot**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
1. Press **Config Phase Noise Plot**.
2. Press **Markers**.
3. Press **Markers Off**.
 - All markers are removed from the screen.

3.1.3 Setting Up a Test Mask

You can set up a fail level reference line for the data screen. Press **Test Mask** on the data screen to enter the menu system for this feature. You must enter at least two points to define the fail limit line. The **Show/Hide Mask** button toggles to either show or hide the test mask selected. Masks are created using the **Edit Mask** button and adding points. You can save and recall test masks using the **Load Mask** and **Save Mask** buttons.

3.2 Configuring Allan Deviation Data Display

You can display data that shows the Allan deviation. This data shows how much phase deviation there is over time between the device under test (DUT) signal and the reference signal. All measurements are referenced to Channel A, which is referred to as the reference channel.

You can configure the following settings for the Allan deviation data:

- Plot Scale (see [page 16](#))
- View Table (see [page 17](#))
- Test Mask (see [page 17](#))

3.2.1 Setting the Plot Scale

You can set the scale for the Allan deviation data. You can scale the data in the following ways:

- Automatically scale to fit the data
- Fixed scale

To scale the plot:

1. From the front panel, press **Allan Deviation Plot**.

- For information about navigating using the softkeys, see “2.3 Understanding the 5110A Screen and Navigation” on page 7.
- 2. Press **Config Allan Deviation**.
- 3. Press **Scale Plot**.
 - The highlighted softkeys show the current settings.
 - If you want to use autoscaling, press **Auto Scale X Axis** or **Auto Scale Y Axis**.
 - If you want to use a fixed scale, press one of the following:
 - **Fixed Scale Y Axis**
 - Use **Inc Min** or **Dec Min** to increase or decrease the minimum value on the scale.
 - Use **Inc Max** or **Dec Max** to increase or decrease the maximum value on the scale.
 - **Fixed Scale X Axis**
 - Use **Inc Min** or **Dec Min** to increase or decrease the minimum value on the scale.
 - Use **Inc Max** or **Dec Max** to increase or decrease the maximum value on the scale.

3.2.2 View Allan Deviation Table

Allan Deviation data can be displayed in a tabular format by pressing the **View Table** key.

3.2.3 Setting Up a Test Mask

You can set up a fail level reference line for the data screen. Press **Test Mask** on the data screen to enter the menu system for this feature. You must enter at least two points to define the fail limit line. The **Show/Hide Mask** button toggles to either show or hide the test mask selected. Masks are created using the **Edit Mask** button and adding points. You can save and recall test masks using the **Load Mask** and **Save Mask** buttons.

3.3 Configuring Phase Difference Data Display

You can collect and display data that shows the phase difference between the DUT and the reference signal. All measurements are referenced to Channel A, which is referred to as the reference channel.

You can configure the plot scale for the phase difference data.

3.3.1 Setting the Plot Scale

You can set the scale for the phase difference data. You can scale the data in the following ways:

- Automatically scale the y axis to fit the data

- Set a fixed scale for the y axis

The x axis displays 60 seconds of data per division and caches data that arrives for about eight minutes.

To scale the plot:

1. From the front panel, press **Phase Difference Plot**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
2. Press **Config Phase Difference Plot**.
 - If you want to use autoscaling, press **Auto Scale Y Axis**.
 - If you want to use a fixed scale, press **Fixed Scale Y Axis**, then press one of the following:
 - Use **Shift Up 1 Div** and **Shift Down 1 Div** to shift (scroll) the data up or down one division on the screen.
 - Use **Increase Time/Div** or **Decrease Time/Div** to increase or decrease the values for each division on the plot.
 - Use **Center Median** to center the data’s median vertical value.

3.4 Configuring Frequency Difference Data Display

You can collect and display data that shows the frequency difference between the DUT and the reference signal. All measurements are referenced to Channel A, which is referred to as the reference channel.

You can configure the plot scale for the frequency difference data.

3.4.1 Setting the Plot Scale

You can set the scale for the frequency difference data. You can scale the data in the following ways:

- Automatically scale the y axis to fit the data
- Set a fixed scale for the y axis

The x axis scale is 60 seconds per division and displays about eight minutes of data.

To scale the plot:

1. From the front panel, press **Frequency Difference Plot**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
2. Press **Config Frequency Difference Plot**.
 - If you want to use autoscaling, press **Auto Scale Y Axis**.

- If you want to use a fixed scale, press **Fixed Scale Y Axis**, then press one of the following:
 - Use **Shift Up 1 Div** and **Shift Down 1 Div** to shift (scroll) the data up or down one division on the screen.
 - Use **Increase Time/Div** or **Decrease Time/Div** to increase or decrease the values for each division on the plot.
 - Use **Center Median** to center the data's median value.

3.5 Configuring Frequency Counter Data Display

You can display data that shows the frequency of the DUT as compared to the reference signal. The 5110A displays frequency averages for both channels for the last 1, 10, and 100 seconds. All measurements are referenced to Channel A, which is referred to as the reference channel.

You can configure the precise value of the reference frequency (nominal frequency). When equal frequency inputs are being measured, the Fractional Frequency also displays.

3.5.1 Changing the Nominal Frequency

You can configure the value of the reference frequency (nominal frequency), if you want the frequency calculations to be based on a frequency other than the one automatically determined.

To change the nominal frequency:

1. From the front panel, press **Frequency Counter**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
2. Press **Enter Nominal Freq**.
3. Use the arrow softkeys to select the digit you want.
4. When the digit you want is selected, press **PUSH**.
5. Repeat steps 3 and 4 until you enter all the digits you need.
6. When you have all the digits you need, press **Apply**.

3.6 Saving and Recalling Configuration Settings

This function is planned for the next version.

4: Collecting and Viewing Data Locally

After you configure the 5110A for the types of data you want to collect, you are ready to start collecting data. You can perform the following functions:

- Start and stop data collection (see [page 21](#))
- View data on the screen (see [page 23](#))
- Print data (see [page 29](#))

4.1 Starting and Stopping Data Collection (Locally)

After you set up the 5110A, you can start collecting data. For more information on data display set-up, see “[Chapter 3, Configuring Data Display](#)” on page 13.

You can stop collecting data when you have the data you need, or when you need to change the configuration.

You can also pause the data display for phase noise. For more information, see “[4.1.1 Pausing and Resuming Phase Noise Display Updates](#)” on page 22.

To start data collection:

Be sure that you have connected the reference signal source to Channel A and the DUT to Channel B.

- For more information, see “[2.2 Setting Up the 5110A](#)” on page 5.
- From the front panel, press **Start**.



Note

Do not bump, vibrate, or otherwise disturb the 5110A or the signal cables during operation. Do not alter the frequency (more than 1 Hz) of either input when the instrument is collecting data.

- The action field displays “Starting” for a few seconds while the instrument prepares to collect data. After the action field displays “Calibrating” and then “Collecting,” data begins to display.
- The instrument starts collecting data and displays the data on the screen. If you just turned on the instrument, the screen defaults to the phase noise screen.

- You can collect data indefinitely. Allan deviation data displays values for averaging times up to 400,000 seconds.
- The instrument automatically turns off its LCD back-light if left idle or collecting data for more than 1 hour. Press any softkey to view the last displayed screen.
- You can view or print tables and plots during data collection or after stopping data collection. For more information about viewing data, see “[4.2 Viewing Data on the Screen](#)” on page 23.

To stop data collection:

- From the front panel, press **Stop**.
 - The instrument stops collecting data, but continues to display the data it collected on the screen. The action field displays “Stopped,” then “Ready*” displays after a few seconds indicating that the unit is ready to start data collection.



Note

The most recent data is retained on all screens until you start a new data collection or until you turn off the instrument.

4.1.1 Pausing and Resuming Phase Noise Display Updates

You can pause and resume the updates to the phase noise plot. When you pause the update, the 5110A continues to collect data, but does not update the display. This may be useful if you need to show someone else the current display, but you do not want to interrupt the data collection.

To pause phase noise display updates:

1. From the front panel, press **Phase Noise Plot**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
2. Press **Config Phase Noise Plot**.
 - From the front panel, press **Pause Updates**.

To resume phase noise display updates:

1. From the front panel, press **Phase Noise Plot**.
 - For information about navigating using the softkeys, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
2. Press **Config Phase Noise Plot**.
 - From the front panel, press **Resume Updates**.

4.2 Viewing Data on the Screen

After you start data collection, data starts to display on the screen. You can display any of the data screens during data collection or after you stop data collection.

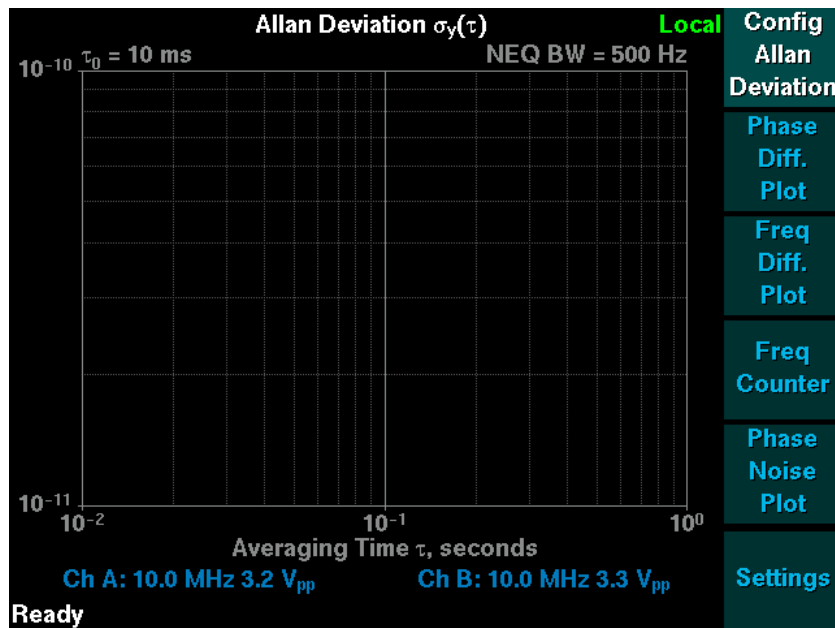


Note

If you press **Start**, all previous data is lost.

To view data on the screen:

1. From the front panel, press **Return** until the main screen displays.



2. Press any softkey to see the data you want.
 - You can display Allan deviation data as either a plot or a table. To view the table, press **Config Allan Deviation**, then press **View Table**.

4.2.1 Understanding Phase Noise Data

The SSB Phase Noise function automatically displays data out to 1 Hz. Data first displays on the screen immediately after collection starts, then the screen updates as often as a few times per second.

The first range of data displayed is from approximately 0.1 to 1 Hz. The longer the data collection period, the more data is available to display lower frequencies.

Figure 13 shows an example phase noise plot.

For information about configuring the phase noise data, see “3.1 Configuring Phase Noise Data Display” on page 13.

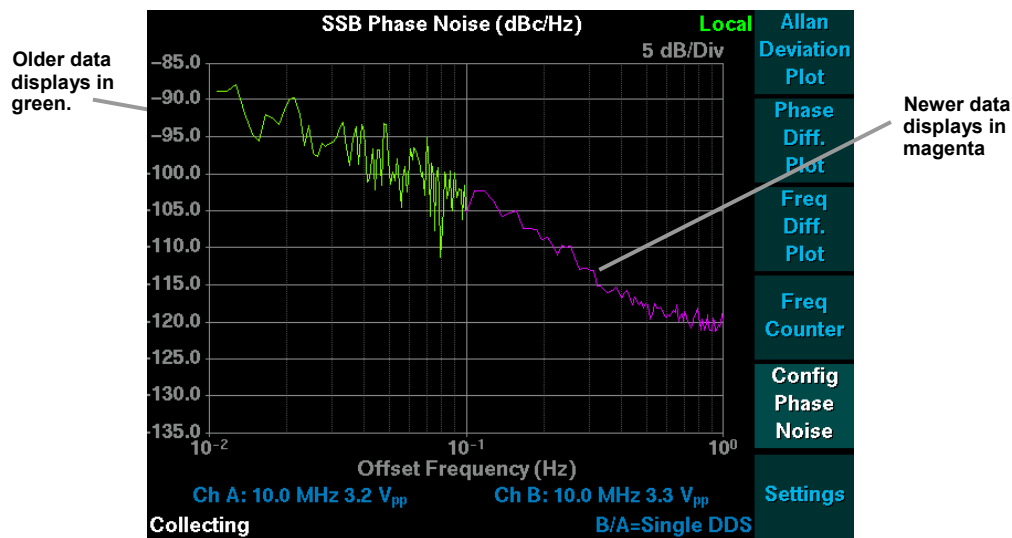


Figure 13: Example phase noise plot

4.2.2 Understanding Allan Deviation Data

The Allan deviation value for each averaging time displayed includes a \pm confidence interval. The confidence intervals are displayed as vertical red lines on the plot.

The Allan deviation plot shows the following:

- Red vertical lines show confidence interval and correspond to the \pm confidence values shown on the table. They diminish in amplitude as data is collected.
- τ_0 value is shown in the upper left corner.

When displaying the Allan deviation table, use the up and down softkeys to scroll up or down.

For information about configuring the Allan deviation data, see “3.2 Configuring Allan Deviation Data Display” on page 16.

4.2.3 Understanding Phase Difference Data

The phase difference plot shows real-time values measured each second. After approximately nine minutes, the data pans to the right so that new data is visible.

The phase difference plot shows the following:

- Value of the centerline.
- Value per division on the y axis in seconds.
- Value per division of the x axis, in seconds. You cannot change this value.

For information about configuring the phase difference data, see “[3.3 Configuring Phase Difference Data Display](#)” on page 17.

4.2.4 Understanding Frequency Difference Data

The frequency difference plot shows real-time values measured each second. After approximately nine minutes, the data pans to the right so that new data is visible.

The frequency difference plot shows the following:

- Value of the centerline.
- Value per division on the y axis in seconds.
- Value per division of the x axis, in seconds. You cannot change this value.

For information about configuring the frequency difference data, see “[3.4 Configuring Frequency Difference Data Display](#)” on page 18.

4.2.5 Understanding Frequency Counter Data

The frequency counter continually computes and displays three frequency averages (at averaging times of 1, 10, and 100 seconds) by comparing channel B to channel A. The nominal frequency value may be displayed as 0 MHz during calibrating until collecting begins, then the frequency value of Channel A displays.

The frequency counter table shows the following:

- Both average frequency and fractional frequency when both inputs are equal in frequency.
- Only the average frequency is computed when the two inputs are different frequencies.
- After 100 seconds of data collection, all three frequency averages (1, 10 and 100 seconds) display.

To change the nominal frequency default value, press **Config Freq Counter** and then **Enter Nominal Freq**. The default value is determined by the nominal frequency of Channel A.

For information about configuring the frequency counter data, see “[3.5 Configuring Frequency Counter Data Display](#)” on page 19.

4.3 Printing Data (Locally)

You can print any data plot and the Allan deviation table during data collection or after stopping data collection.

Before you can send data to a printer, you must either connect a printer to the parallel port or know the IP address and port number of a network printer (with the Ethernet option). In addition, you must set up the printer. You can also print to a file. For more information, see “2.2 Setting Up the 5110A” on page 5 and “4.3.1 Setting Up the Printer” on page 26.

After stopping data collection, the most recent data is retained on all screens until you start a new data collection or until you turn off the instrument.

To print data:

1. From the front panel, use the softkeys to display the data you want to print.
 - For information about navigating using the softkeys, see “2.3 Understanding the 5110A Screen and Navigation” on page 7.
 - From the front panel, press **Print**.



Note

The 5110A can queue up to 15 print jobs for printing. All print jobs will go to the currently selected printer.

4.3.1 Setting Up the Printer

You must set up the printer before you can print. You can print to the following destinations:

- Local—A printer connected directly to the parallel port on the 5110A.
- File—A file in any of the formats described below. You can access the file using anonymous File Transfer Protocol (FTP). You can store up to ten files, after which the oldest file is overwritten with the next file. See section 4.5 on page 28 for detailed information on retrieving the print files using FTP.
- Network (with 5110A Ethernet option)—A printer on your network that supports direct transfer of information to a port, such as the HP JetDirect using port 9100. Other spooling protocols, such as the Internet Printing Protocol (IPP), are not currently supported.

You can print to the following formats:

- Deskjet—Uses a standard Printer Control Language (PCL) format, which most modern printers that use PCL will accept.
- PostScript—Uses raw PostScript that only PostScript printers will accept.

To set up a printer:

1. From the front panel, press **Settings**.
 - For information about navigating using the softkeys, see “2.3 Understanding the 5110A Screen and Navigation” on page 7.
2. Press **Printing**.
3. Use the arrow softkeys to select the Printer destination you want.

4. Press **PUSH**.
5. If you are using a network printer, enter the Remote Host IP address and Remote Port number.
6. Use the arrow softkeys to select the Format you want.
7. Press **PUSH**.
8. Press **Apply**.
9. You can also cancel print jobs by pressing the **Cancel Print Jobs** button.

4.4 Changing the Instrument Control (Local or Remote) (With 5110A Ethernet Option)

When a remote user connects to the Command port, the word 'Remote' displays at the upper-right corner of the 5110A's screen. This lets you know that a remote user has control of the instrument.

A remote user can set the control to be either local, remote or none.

A local user can set the control to be local, overriding a remote user, if necessary.

To locally change the instrument control, do one of the following:

- From the front panel, press Start or Stop, then press Yes in response to the Attention message which will appear if the instrument is currently under remote control.
- If the instrument is under local control, you can allow a remote user to take control by doing the following: from the main screen, press **Settings**, press the down arrow until 'Yield Local Control' is selected, then press the **Push** button. This has the same effect as **set control none** on the network Command port.

4.5 Retrieving print files via FTP

To retrieve print jobs sent to files:

1. Access the test set with an ftp client using anonymous login (you will not need a password). See page 23 to determine the test set's IP address.



Note

Be sure to configure the ftp client for binary file transfer. Most command line based ftp clients accept the **bin** command for this purpose. See your ftp client software documentation for details on how to set binary file transfer.

2. Download the files from the *printfiles* directory.

The following is a transcript of a sample command line ftp session. Input from you is shown in **bold** text. Note that the test set will have a different IP address:

```
OS command prompt> ftp 206.168.13.249
Connected to 206.168.13.249.
220 ts FTP server (Version 6.00LS) ready.
User (206.168.13.249:(none)): anonymous
331 Guest login ok, send your email address as password.
Password: (no password required - just press enter here)
ftp> cd printfiles
ftp> bin
200 Type set to I.
ftp> get print0.ps.gz
150 Opening BINARY mode data connection for 'print0.ps.gz' (17358 bytes).
226 Transfer complete.
ftp> bye
```

The *print0.ps.gz* file is now on the computer from which the ftp session was initiated. The file can now be decompressed and viewed or printed using third party software such as Ghostview.

5: Collecting and Viewing Data Remotely (Option)

If the 5110A is equipped with the Ethernet option, you can control and download data remotely.

Before you can access the instrument remotely, you must configure the network settings. For more information, see “5.1 Configuring the Network Connection” on page 29.

You can perform the following remote functions:

- Access the 5110A (see [page 30](#))
- Start and stop data collection (see [page 31](#))
- View data (see [page 31](#))
- Print data (see [page 32](#))
- View help for remote commands (see [page 34](#))
- Change the control between remote and local (see [page 34](#))
- Show the software version (see [page 35](#))

5.1 Configuring the Network Connection

Before you can use the Ethernet connection, you must know the IP address and port numbers (command and data) of the 5110A. By default, the instrument uses the network settings shown in [Table 1](#).

Table 1: Default network settings

Setting	Default value
Bit rate	Auto
Set IP address via	DHCP
IP address	(none)
Netmask	(none)
Command port (TCP)	1299
Data port (TCP)	1298

If your network has a Dynamic Host Configuration Protocol (DHCP) server, you do not need to configure the IP address. You do have to look up the assigned IP address after you connect the instrument to your network. The Settings screen, as described in the steps below, displays the assigned IP address.

If you do not have a DHCP server or if you prefer to have a static IP address, you can set an IP address and subnet mask.

You can change the bit rate to 10 Mbps or 100 Mbps, if required by your network. You can also change the command and data ports used for sending commands and accessing phase difference data, if the default ports conflict with other ports on your network.

To configure the network connection with a static IP address:

1. Obtain the following information from your network administrator:
IP Address: _____
Subnet Mask: _____
2. From the front panel, press **Settings**.
 - For information about navigating using the softkeys or mouse, see “[2.3 Understanding the 5110A Screen and Navigation](#)” on page 7.
3. Press **Network**.
 - If the Network Configuration area is blank, contact your Timing Solutions representative.
4. Use the arrow softkeys to select the settings you want.
5. For the numeric fields, use the + and – softkeys to set the values.
6. Press **Apply**.

5.2 Accessing the 5110A Remotely and Exiting the Remote Session

Once you set up the network connection and connect the 5110A to your network, you can access the instrument remotely from any computer on your network. You need to know the IP address and the Command port number. You use a network connection program, such as Telnet, to send commands over the network to access the instrument. You can have only one active connection to the Command port to start, stop, and print data.

You can also use Telnet to connect to the Data port. From the Data port, you can view phase difference data and the Allan deviation table.

To access the 5110A remotely:

1. From a command prompt or your Telnet software, enter:
telnet <IP address> <Command port>
telnet <IP address> <Data port>
 - This opens two Telnet sessions and connects you to both ports so you can control the instrument and view phase difference data.
 - If someone has started data collection, the phase difference displays on the Data port. If you need to start collecting data, see “[5.3 Starting and Stopping Data Collection \(Remotely\)](#)” on page 31.
2. When you are finished with your remote session, enter the following:

quit

5.3 Starting and Stopping Data Collection (Remotely)

Using the Ethernet port and a Telnet-capable program, you can start and stop data collection remotely over a TCP socket.

To start and stop data collection remotely:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. From the Command port Telnet session, enter:
set control remote
start
 - Data collection starts. After a few seconds, phase difference data starts to display in the Data port Telnet session.
 - You can use the following command to set the control to permit either local or remote use: **set control none**.
3. When you want to stop data collection, enter:
stop

5.4 Viewing Data (Remotely)

You can view phase difference data remotely and store it in a file. The phase differences are in cycles of the input reference signal. The Data port outputs floating point numbers one number per line, 10 each second on the serial port and up to 100 each second on the Ethernet connection. See theory of operations section on page 48 for details on sampling rates.

You can also view the Allan deviation table or print from the Command port.

To view phase difference data remotely:

1. Access the Data port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. If you want to store the data in a file, tell your Telnet software to capture the data.
3. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.

4. From the Command port Telnet session, enter:
set control remote
start
 - Data collection starts. After a few seconds, phase difference data is continuously written to the Data port.
5. When you want to stop data collection, enter the following in the Command port Telnet session:
stop

To view the Allan deviation table remotely:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. From the Command port Telnet session, enter:
set control remote
start
 - Data collection starts.
3. In the Command port Telnet session, enter:
show adev
 - The Allan deviation table displays in the Command port Telnet session.
4. When you want to stop data collection, enter the following in the Command port Telnet session:
stop

5.5 Printing Data (Remotely)

You can remotely print all of the data the 5110A collects.

[Table 2](#) shows the data you can print and the corresponding command.

Table 2: Remote printing data commands

Data	Command
Allan deviation plot	print adevplot
Allan deviation table	print adevtable
Frequency counter table	print freqcounter
Frequency difference plot	print freqdiffplot
Phase difference plot	print phasediffplot
Phase noise plot	print spectplot

You can display a list of printable data using the following command:

show printables

Before you print data, you should set up the print destination and format. You can check the current print setup using the following command:

show printoptions

Table 3 shows the print destinations and their corresponding commands.

Table 3: Remote printing destination commands

Destination	Command
Local—A printer connected directly to the parallel port on the 5110A.	set print local
File—A file in any of the formats described below. You can access the file using anonymous File Transfer Protocol (FTP). You can store up to approximately ten files, after which the oldest file is overwritten with the next file. This command generates compressed files.	set print file
Network—A printer on your network that supports direct transfer of information to a port, such as the HP JetDirect using port 9100. Other spooling protocols, such as the Internet Printing Protocol (IPP), are not currently supported.	set print network <IP_address> <port>

Table 4 shows the print formats and their corresponding commands.

Table 4: Remote printing format commands

Format	Command
Deskjet—Uses a standard Printer Control Language (PCL) format, which most modern printers that use PCL will accept.	set print device deskjet
PostScript—Uses raw PostScript that only PostScript printers will accept.	set print device postscript

To print data remotely:

1. Access the Command port.
 - For more information, see “5.2 Accessing the 5110A Remotely and Exiting the Remote Session” on page 30.
2. From the Command port Telnet session, enter:

set control remote

start

 - Data collection starts. After about 33 seconds, data starts to display in the Data port Telnet session.
3. If you need to change the current print destination, enter one of the print destination commands in the Command port Telnet session:
 - See Table 3.

4. If you need to change the current print format, enter one of the print format commands in the Command port Telnet session:
 - See [Table 4](#).
5. Enter one of the data print commands in the Command port Telnet session:
 - See [Table 2](#).
 - If you need to cancel the print job and clear the print queue, you can enter:
print cancel

5.6 Viewing Help for Remote Commands

You can view help for each remote command as well as a list of all available commands.

To view a list of all available commands:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. From the Command port Telnet session, enter:
help
 - A list of all the available commands displays.

To view help for a specific command:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. From the Command port Telnet session, enter:
help <command_name>
 - The usage of the command displays.

5.7 Changing the Instrument Control (Local or Remote)

When a remote user connects to the Command port, the word ‘Remote’ displays at the upper-right corner of the 5110A’s screen. This lets you know that a remote user has control of the instrument.

A remote user can set the control to be either local, remote or none.

To remotely change the instrument control:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.

2. From the Command port, enter one of the following, depending on what you want to do:
 - set control remote**
 - set control local**
 - set control none** (You can use this command to set the control to permit both local and remote use)

A local user can set the control to be local, overriding a remote user, if necessary.

To locally change the instrument control, do one of the following:

- From the front panel, press Start or Stop, then press Yes in response to the Attention message which will appear if the instrument is currently under remote control.
- If the instrument is under local control, you can allow a remote user to take control by doing the following: from the main screen, press **Settings**, press the down arrow until 'Yield Local Control' is selected, then press the **Push** button. This has the same effect as **set control none** on the network Command port.

5.8 Showing the Software Version

You can remotely show the software version.

To remotely show the software version:

1. Access the Command port.
 - For more information, see [“5.2 Accessing the 5110A Remotely and Exiting the Remote Session”](#) on page 30.
2. From the Command port Telnet session, enter:
 - show version**

6: Maintaining the 5110A

6.1 Calibrating the 5110A

A calibration procedure is available from Timing Solutions, or Timing Solutions can calibrate the unit.

6.2 Cleaning the 5110A



Do not spray or use too much liquid when cleaning the unit. Liquid can enter the unit and damage sensitive electronic components.

Clean the main chassis with a soft cloth dampened with a mild soap and water solution.

7: Troubleshooting the 5110A

Perform all of the following procedures before returning the 5110A for service. If the instrument still appears to have a problem, call Timing Solutions Corporation (TSC) and request technical support. Have the serial number of your instrument ready to provide to a technical representative.



Caution

Do not remove the top cover of the instrument. It does not contain any user-serviceable parts. The only user-serviceable parts are the fuses. For more information, see “[7.2 Replacing Fuses](#)” on page 41.

If the instrument does not appear to be operating properly, check the following first:

1. If the instrument is turned on, press **Power** to turn it off.
2. Check for visible damage on the unit, cables, and connectors.
3. Ensure that all cables are firmly connected.
4. Determine if any input power circuit breakers have been tripped.
5. Ensure that your power source is within specification.
6. Press **Power** to turn the instrument on.
7. Check that the green LED on the front panel near the **Power** button is lit.
 - If it does not come on and your power source has been thoroughly checked, unplug the instrument from its power source and check both fuses mounted in the power entry module located on the rear of the chassis. Replace if necessary with 250-volt, 1-amp, time delay, 5 x 20 mm fuses. For more information, see “[7.2 Replacing Fuses](#)” on page 41. Check your power source if fuses need replacing before reconnecting in the power cord.
 - The Timing Solutions logo should display.
 - If the “Self test has failed for the following item(s)...” message displays during start-up, contact a TSC service representative.
8. Press **Start**.
 - The instrument should begin collecting data, as described “[2.2.1 Turning On the 5110A](#)” on page 7, and should update the data display.

7.1 Troubleshooting Error Messages

[Table 5](#) lists the error messages that display in the action field, their meaning, and what to do.

Table 5: Error messages

Error message	What it means	What to do
[Frequency out of spec]	The frequency of one of the input signals is outside the range of 1.0 MHz to 20.0 MHz.	Check the frequency of the highlighted input.
[Frequency out of range]	Data collection continues as long as the input signals do not fall below 500 kHz or go above 25.0 MHz.	Check the amplitude of the highlighted input.
[Amplitude out of spec]	The amplitude of one of the input signals is outside the range of 0.9 Vpp to 4.5 Vpp.	Check the amplitude of the highlighted input.
[Amplitude out of range]	Data collection continues as long as the input signals do not fall below 0.64 Vpp or go above 5.6 Vpp.	Check the amplitude of the highlighted input.
Stopped [Large Frequency Change]	The frequency difference between the two inputs has changed more than 5 kHz since the data collection started.	Check the frequency of the inputs.
Stopped [Data acquisition failed]	<ul style="list-style-type: none"> ■ The signal on Channel A or B was either interrupted or lost before the instrument began collecting data. ■ Both input signals must be stable during the internal calibration period that occurs after you press Start. 	<ol style="list-style-type: none"> 1. Check both inputs. 2. Turn off the 5110A, then turn it back on. 3. If this message continues to appear, call Timing Solutions Corporation and request technical support.
Failed to locate remote printer.	A connection could not be established to the specified remote printer due to a network discontinuity or the printer not being powered on.	<ol style="list-style-type: none"> 1. Check the connection from the 5110A to the network. 2. Check the connection from the printer to the network. 3. Make sure the printer is powered on. 4. Make that you used the correct IP address and port. <ul style="list-style-type: none"> • For more information, see “4.3 Printing Data (Locally)” on page 26.
Error sending print information to remote printer.	Printing stopped in the middle of transferring the information to the remote printer. This is probably due to the remote printer being powered off or a network discontinuity.	<ol style="list-style-type: none"> 1. Check the connection from the 5110A to the network. 2. Check the connection from the printer to the network. 3. Make sure printer is powered on.
Local printer not found.	Tried to print to a local parallel port printer, but could not find a printer connected to the port. Or the printer is not powered on.	Make sure the local parallel printer is connected to the parallel port and powered on.

7.2 Replacing Fuses

If you know that a local event caused blown fuses, you can replace the fuses in the 5110A power entry module on the rear panel.

Required for this procedure:

- Small flat-head screwdriver
- Replacement fuse for a standard IEC 320 power entry module with fuse (250-volt, 1-amp, time delay, 5 x 20 mm fuse, T)

To replace a fuse:

1. Disconnect the power cable from the back of the 5110A.
2. Using a small screwdriver, open the fuse cover on the back of the 5110A.
3. Replace the old fuses as necessary.
4. Close the fuse cover.
5. Reconnect the power cable to the back of the 5110A.

Declaration of Conformity

According to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Timing Solutions Corporation

Manufacturer's Address: 4775 Walnut Drive Suite 1B Boulder CO 80301 USA

Declares that the product:

Product Name: Time Interval Analyzer

Model Number:TSC 5110A

Product Options:All

Conforms to the following Product Specifications:

Safety:

EN61010-1:1993, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements

IEC 1010-1:1990, Safety Requirements for Electrical Equipment for Measurement, Control and Laboratory Use, Part 1: General Requirements

EMC

EN61326:1997, Electrical Requirements for Electrical Equipment for Measurement, Control and Laboratory Use - Part 1: General Requirements

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE-marking accordingly.

This product was tested in a typical configuration.

Boulder, CO April, 2002

Appendix A: Specifications

A.1 Electrical Specifications

Table 6 lists the electrical specifications for the 5110A.

Table 6: Electrical specifications

Item	Specification
Protection Class	Class I (Grounded Type)
Power Input Voltage	85–264 V AC Note: Fluctuations not to exceed $\pm 10\%$ of nominal supply voltage.
Power Input Frequency	50–60 Hz
Power consumption	65 W maximum
Power Inlet Type	IEC 60320 sheet C14
Power Supply Cord Set	18 AWG (0.75 mm ² minimum)
Power Mains Fuse	Two 250 V~1A T (Time delay) 5 x 20 mm.
Signal Input and Output	<ul style="list-style-type: none">■ Frequency: 1–20 MHz■ Impedance: 50 $\Omega \pm 5 \Omega$■ Input level: 0.9 Vpp - 4.5Vpp
Connectors	<ul style="list-style-type: none">■ Input: Two TNC (supplied with BNC adapters)■ DB-9 Serial port■ Parallel port■ Network: Optional RJ-45 (10 or 100 baseT)

A.1.1 Environmental Specifications



Warning

Ordinary protection: This unit is for **INDOOR USE ONLY**. It is not sealed to prevent moisture from entering the enclosure.

- Pollution Degree 2 per EN61010-1/EN 61010-1
- Installation (Over-Voltage) Category II for transient over-voltages per EN 61010-1/EN 61326-1, Class A
- Equipment suitable for continuous operation

Table 7 lists the environmental specifications for the 5110A.

Table 7: Environment specifications

Item	Temperature	Relative Humidity	Altitude
In Use	15°C to 40°C	5% to 95% (non-condensing)	3,000 meters (9,843 feet)
Storage	-25°C to 70°C	5% to 95% (non-condensing)	
Transportation	-25°C to 70°C	5% to 95% (non-condensing)	

A.2 Physical Specifications

Table 8 lists the physical specifications for the 5110A.

Table 8: Physical specifications

Item	Specification
Size	33.8 cm x 17.4 cm x 43.7 cm (13.31" x 6.84" x 17.21")
Weight	Approximately 9.5 kg (21 pounds)

Figure 14 shows the dimensions of the 5110A.

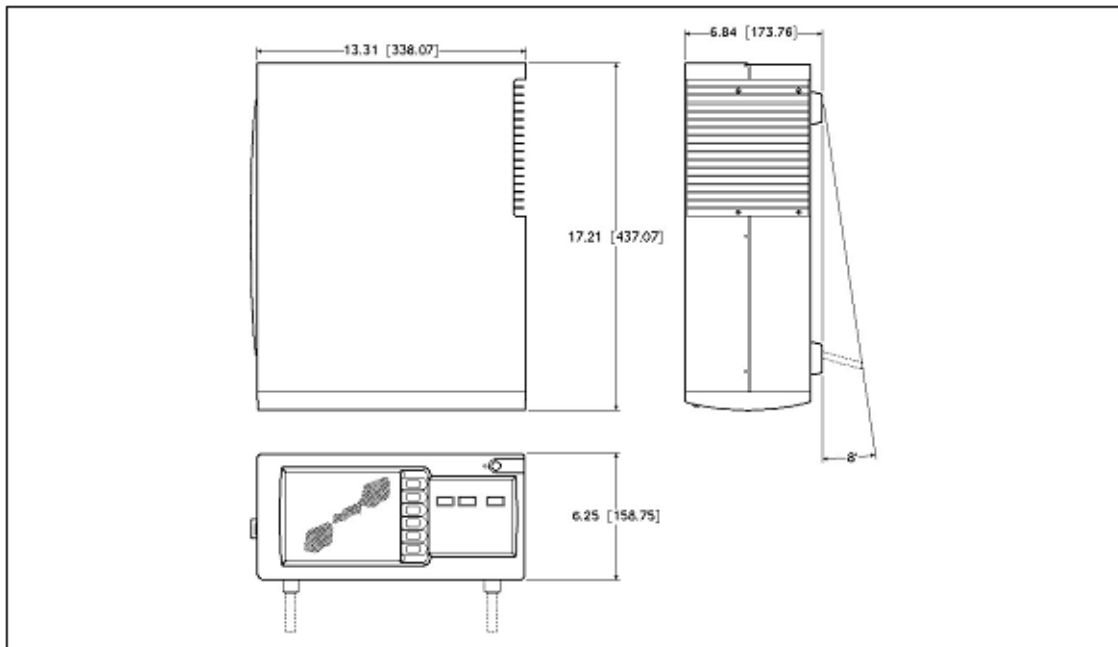


Figure 14: 5110A dimensions

Appendix B: Theory of Operation

The ALLAN DEVIATION

The Allan deviation is named after its originator, David Allan. It describes mathematically the measurement-to-measurement deviation in a sequential series of frequency measurements. Compute the Allan variance from the equation:

$$\sigma_y^2(\tau) \approx \frac{1}{2(N-1)} \sum_{j=1}^{N-1} (y_{j+1} - y_j)^2$$

where y_j is the j^{th} frequency measurement and N is the total number of frequency measurements.

Find the square root of the Allan variance. This will be the Allan deviation.

Typically, about 68% of the frequency deviations will be within the range indicated by the Allan deviation; about 95% will be within the range of two times the Allan deviation, and about 99% will be within the range of three times the Allan deviation.

SAMPLING INTERVALS

The instrument makes phase measurements using the heterodyne method using a nominal Intermediate Frequency (IF) of approximately 100 Hz when equal frequency oscillators are compared. The smallest sampling interval, or tau (τ), is one period of the IF or 10ms. After four intervals are sampled for a period of 40ms, data are displayed at the 10 msec point.

As data are collected, increasing sampling intervals are displayed. The progression of sampling intervals, in terms of seconds, is: .01, .02, .04, .1, .2, .4, 1, 2, 4, 10, 20, 40 ...etc.

In “Averaging” mode, the mean of the phase measurements within each interval are averaged and each average is used to calculate the frequency. In “Instantaneous” mode, the last phase measurement in each interval is used to compute the frequency. “Instantaneous” mode corresponds to the true Allan deviation as defined by the IEEE. “Averaging” mode reduces the measurement noise, but is a non-standard statistic. Remember that data in four intervals are collected before the Allan deviation is displayed for each τ value. For example, forty seconds will elapse before data are displayed for a τ of ten seconds.

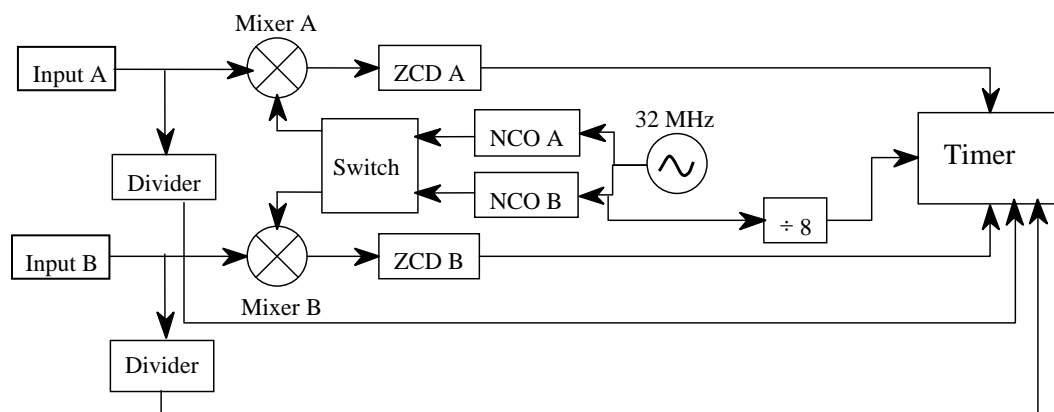
CONFIDENCE INTERVAL

See section 4.2.2 Understanding Allan Deviation Data for how the confidence interval is displayed. It is computed as $0.99/\sqrt{N}$, which is valid for white phase noise and flicker phase noise and slightly optimistic for more divergent noise types.¹

The table will fill in for increasing averaging times and continue for each averaging time until 1,000 points have been used to compute the average. After 1,000 points have been collected, the average is complete for that averaging time. When enough data has been collected to fill the screen, additional points are viewed by scrolling down the screen using the softkeys on the right of the screen. The unit will continue to update Allan deviation values until 400,000,000 seconds (12.5 years) of data has been collected.

ANALYZING METHOD

The following is a simplified block diagram of the TSC 5110A Time Interval Analyzer signal flow.



The two input signals (A & B) are mixed with offset reference signals to produce separate low frequency beat signals. Zero-crossing detectors (ZCD) enhance the slew rate of the beat signal and then the timer time tags the zero crossings and counts them.

Two dividers, which feed divided replicas of the input signal to the timer, provide the information needed for automatic operation, but do not contribute to the high precision phase difference measurements. The divided signals are used to make coarse measurements of the frequencies of the two inputs. Each of the two Numerically Controlled Oscillators (NCO) is then set to beat with its respective input to achieve an IF of

¹ P. Lesage and C. Audoin, Radio Science, Vol. 14, No. 4, pp 521-539, 1979.

approximately 100 Hz. A high precision measurement of the frequency of each input results from the determination of the period of the IF.

One of two modes of operation, which we call **Single DDS Mode** and **Dual DDS Mode**, is selected based on the frequency difference between the two inputs.

Single DDS Mode

The instrument enters Single DDS Mode when the two inputs are within 2 Hz of one another. One of the NCO's is bypassed and the switch connects the output of the remaining NCO to both mixers. The instrument operates as a standard Dual Mixer Time Difference Measurement System. The nominal frequencies of the inputs appear on the screen of the TSC 5110A and all high precision outputs should be interpreted as the time of B relative to the time of A in units of input A. For example, the "phase plot" shows the time of the signal on channel B less the time of the signal on channel A in units of seconds as determined by the nominal frequency of channel A. The slope of the plot represents the offset frequency between the two inputs. The slope is positive when the residual frequency of B minus A is positive. At 5 MHz, the maximum slope is 2 Hz or 4×10^{-7} s/s, whereas at 1 MHz, the maximum slope of 2 Hz corresponds to 2×10^{-6} s/s.

In Single DDS Mode the noise of the 32-MHz internal oscillator and the NCO cancel out for data collection periods greater than 10 ms. As a result, the instrument contributes the least possible noise to the measurements.

DUAL DDS Mode

The instrument enters Dual DDS Mode when the two inputs differ in frequency by 2 Hz or more. The switch connects the output of each NCO to its respective mixer. The nominal frequency of each input appears on the screen of the TSC 5110A and all outputs can still be interpreted as B relative to A in units of input A. For example, suppose that a 5-MHz reference has been connected to input A and a 2.048-MHz Device Under Test (DUT), which actually has a frequency of 2.04800000572 MHz, has been connected to input B. The screen shows the results of three measurements. First, the nominal frequency of A in the form Ch A: 5.0 MHz. Next, the nominal frequency of B in the form Ch B: 2.0 MHz. Finally, the ratio of the two frequencies in the form B/A=0.4096000012. This nominal ratio has been used to remove the frequency difference between the two inputs in order to plot the residual phase or frequency differences. All of the outputs should be interpreted as B relative to A in units of input A after the removal of the nominal frequency difference. The "phase plot" shows the residual time difference after removing the

nominal accumulated time difference. Once again, it is the time of the signal on channel B less the time of the signal on channel A in units of seconds as determined by the nominal frequency of channel A. The slope of the plot represents the residual offset frequency between the two inputs. The slope is positive when the frequency of B is greater than that of A. In general, the slope will be quite small since it represents a combination of the inaccuracy of the initial 33 s frequency calibration and any changes in frequency that happen after that time.

A more accurate frequency difference between ports B and A can be determined from the elapsed phase displayed on the “phase plot” or “frequency plot.” For example, the fractional frequency displayed on the “frequency plot” can be added to the displayed ratio to obtain the true ratio of the nominal frequency of the B input relative to the A input. The error represented by one-half the least significant digit of the displayed ratio is a fractional frequency of 1×10^{-13} .

Time Difference Measurements

All calculations within the TSC 5110A are performed using the measured phase difference between the signals applied to the two inputs. The phase of the input is sampled at a nominal rate of approximately 100 samples per second, but the rate may be as low as 10 samples per second. The sampling is performed by a “zero crossing detector (ZCD)” followed by an event timer that records the time of the zero crossings of the IF signal produced by the mixer. By definition, the phase increases 2π each time a positive going zero crossing has occurred. The data from each input are re-sampled to common, equally spaced, coincident time points and subtracted to obtain the final time series of the phase difference between channels A and B. When equal frequency oscillators are compared, the sample rate is 100 samples per second and the Allan variance is computed starting at a sample time of 10 ms. When unequal frequency oscillators are compared, the sampling rate is lower and the minimum sample interval for the computation of the Allan variance increases.

Glossary

\n	Line feed
\r	Carriage return
dB	decibels
dBc	Decibels referred to the carrier
dBc/Hz	Decibels per Hz referenced to the carrier
DHCP	Dynamic Host Configuration Protocol
DUT	device under test
ESD	electrostatic discharge
SSB	single side band
TSC	Timing Solutions Corporation

Index

Numerics

5110A

- calibrating 37
- cleaning 37
- front panel 3
- measurement method 48
- navigating functions 7
- overview 3
- rear panel 3
- required cables 5
- setting up 5
- theory of operation 45
- turning on 7
- understanding the screen 7
- unpacking 6

A

- accessing the 5110A remotely 29
- action field 7
- Allan deviation
 - configuring data display 16
 - setting the plot scale 16
 - understanding data 24
- Apply softkey 9
- assigning
 - gateway address 29
 - IP address 29
 - subnet mask 29

C

- cables
 - required 5
- calibrating
 - a 5110A 37
- caution symbol 1
- changing
 - 5110A control between local and remote 27, 34
 - the nominal frequency for frequency counter data collection 19
- cleaning
 - a 5110A 37
- colors
 - selecting 12
- commands
 - viewing help for remote 34
 - viewing list of remote 34
- configuration settings
 - recalling 19
 - saving 19
- configuring
 - Allan deviation data display 16
 - frequency counter data display 19
 - frequency difference data display 18
 - phase difference data display 17
 - phase noise data display 13
 - the network settings 29
- connecting
 - power 6
 - to the Ethernet port 6
- connections
 - Ethernet 3, 6

- input signals 3, 6
 - power 3, 6
- control, changing between local and remote 27, 34
- conventions, typographic 2

D

- data
 - printing 26, 32
 - understanding for Allan deviation 24
 - understanding for frequency counter 25
 - understanding for frequency difference 25
 - understanding for phase difference 25
 - understanding for phase noise 24
 - viewing on screen 23
 - viewing remotely 31
- data display
 - changing the nominal frequency for frequency counter 19
 - configuring for Allan deviation 16
 - configuring for frequency counter 19
 - configuring for frequency difference 18
 - configuring for phase difference 17
 - configuring for phase noise 13
 - starting 21, 31
 - stopping 21, 31
- data markers
 - setting 14
- declaration of conformity 42
- default settings for the network connection 29
- display updates
 - pausing for phase noise 22
 - resuming for phase noise 22
- Dual DDS Mode 47

E

- earth terminal symbol 1
- entering
 - numbers using softkeys 9
- environmental specifications 43
- error messages, troubleshooting 39
- Ethernet port 3, 6
 - accessing the 5110A using 30
 - configuring 29
 - connecting to 6
 - default settings for 29
 - using to operate the 5110A remotely 11, 29

F

- format
 - selecting for printing 26, 32
- frequency
 - for channels A and B 6
- frequency counter
 - changing the nominal frequency for 19
 - configuring data display 19
 - understanding data 25
- frequency difference
 - configuring data display 18
 - configuring the plot scale 18
 - understanding data 25
- functions, navigating 7
- fuse
 - replacing 41
 - symbol 1

G

gateway address
 assigning 29

H

help, viewing for remote commands 34

I

input plug symbol 1
input signal connectors 3
input voltage 6
installing
 the 5110A 5
IP address
 assigning 29

L

LAN port
 accessing the 5110A using 30
 configuring settings for 29
 connecting to 6
 default settings for 29
 symbol 1
 using to operate the 5110A remotely 11, 29
local control, changing to or from 34

M

main screen 8
measurement method 48
model number
 viewing 12, 35

N

navigating
 5110A functions 7
network
 accessing the 5110A using 30
 configuring settings for 29
 connecting to 6
 default settings for 29
 using to operate the 5110A remotely 11, 29
nominal frequency
 changing for frequency counter 19
number keypad
 using with softkeys 11
numbers
 entering using softkeys 9

O

options
 selecting using softkeys 9

P

panels
 front 3
 rear 3
phase difference
 configuring data display 17
 configuring the plot scale 17
 understanding data 25
phase noise
 configuring data display 13
 configuring the plot scale 13
 pausing display updates 22
 resuming display updates 22

 understanding data 28
plot scale
 configuring for Allan deviation 16
 configuring for frequency difference 18
 configuring for phase difference 17
 configuring for phase noise 13

power

 connecting 6
power connection 3
power off symbol 1
power on symbol 1
powering on the 5110A 7

printer

 selecting the output format 26
 selecting the print destination 26
 setting up 26

printing

 data 26, 32
 Files, FTP transfer 28
PUSH softkey 9

R

recalling configuration settings 19
remote commands
 viewing help for 34
 viewing list of 34
remote control, changing to or from 27, 34
remote functions
 accessing the 5110A 29
remotely using the 5110A 11, 29
replacing
 a fuse 41

S

safety instructions 5
saving configuration settings 19
scaling
 the plot for Allan deviation 16
 the plot for frequency difference 18
 the plot for phase difference 17
 the plot for phase noise 13
screen
 main 8
 understanding 7
 viewing data on 23
selecting
 colors 12
 options using softkeys 9
setting
 data markers 14
 the time 12
setting up
 a printer 26
 a test mask 16, 17
 the 5110A 5
Single DDS Mode 47
softkeys
 Apply 9
 labels for 7
 PUSH 9
 using 8
 using to enter numbers 9
 using to select mutually exclusive options 9
software version
 viewing 12, 35
specifications

- electrical 43
- environmental 43
- physical 44
- starting
 - data collection 21, 31
- stopping
 - data collection 21, 31
- subnet mask
 - assigning 29
- symbols
 - caution 1
 - earth terminal 1
 - fuse 1
 - input plug 1
 - LAN port 1
 - power off 1
 - power on 1
 - warning 1

T

- test mask
 - setting up 16, 17
- theory of operation 45
- time, setting 12
- troubleshooting
 - error messages 39
- troubleshooting procedures 39
- turning on the 5110A 7
- typographic conventions 2

U

- unpacking
 - a 5110A 6
- updates
 - pausing display of for phase noise 22
 - resuming display of for phase noise 22
- using
 - softkeys 8

V

- viewing
 - data on the screen 23
 - data remotely 31
 - help for remote commands 34
 - list of remote commands 34
 - the model number 12, 35
 - the software version 12, 35
- voltage
 - for channels A and B 6

W

- warning
 - symbol 1