

# **SR5500**

Wireless Channel Emulator

SR5500 Based MIMO System Setup Guide

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## Safety Summary

If the equipment is used in a manner not specified by the manufacturer the protection provided by the equipment may be impaired.

## Safety Symbols

The following safety symbols are used throughout this manual and may be found on the instrument. Familiarize yourself with each symbol and its meaning before operating this instrument.



Instruction manual symbol. The product is marked with this symbol when it is necessary for you to refer to the instruction manual to protect against damage to the instrument.



Frame terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Protective ground (earth) terminal. Used to identify any terminal which is intended for connection to an external protective conductor for protection against electrical shock in case of a fault, or to the terminal of a protective ground (earth) electrode.



The caution sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product or you's data.



Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Alternating current (power line).

## Résumé des règles de sécurité

Si le matériel est utilisé d'une façon non conforme aux spécifications du constructeur, la protection assurée par le matériel peut être mise en défaut.

### Symboles de sécurité

Les symboles suivants sont utilisés dans tout le manuel et peuvent être trouvés sur le matériel. Il est recommandé de se familiariser avec chaque symbole et sa signification avant de manipuler le matériel.



Symbole « manuel d'instruction ». Ce symbole apparaît sur le produit lorsqu'il est nécessaire de se référer au manuel d'instruction pour éviter une détérioration du matériel.



Masse. Ce symbole identifie une connexion au châssis du matériel (ce châssis inclut normalement toutes les structures métalliques exposées).



Terre : ce symbole identifie la connexion de terre chargée de protéger le matériel contre les chocs électriques. Cette connexion doit être raccordée vers un conducteur externe de protection ou vers une électrode de type terre.



Ce symbole désigne une opération ou une condition dite « sensible », qui, si elle n'est pas correctement réalisée, pourrait entraîner de sérieuses détériorations au matériel ou aux données utilisateur.



Ce symbole indique un voltage dangereux (connexion alimentée en interne par un voltage excédant 1000 volts).



Courant alternatif (ligne de puissance).

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# 1. Overview

This document outlines the procedure for setting up a SR5500 based 2 x 2 MIMO system. It describes the necessary setup, network connections and the TestKit configuration to setup the the MIMO system.

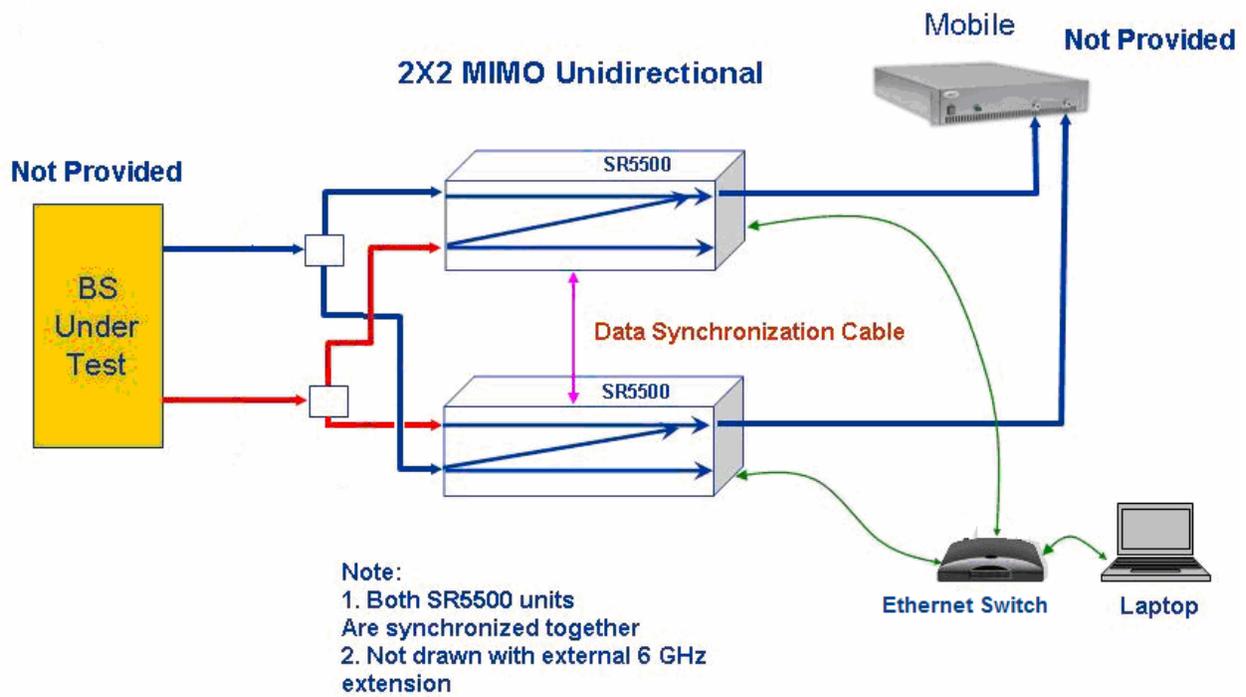


Figure 1-1: SR5500 Based 2 x 2 MIMO System



## 2. Setup

Unpack the SR5500 shipping cartons.

- The cartons should contain a packaging list detailing all the items in the carton.
- Please make sure that all items listed in the packaging list are contained in the carton.
- Save the shipping cartons and packing materials until you have completed the system installation and initial check. If you must return equipment, please use the original box and packing material.
- Check each item for physical damage. If any part appears to be damaged, contact the Spirent Communications Customer Service department.

### 2.1. System Setup

A MIMO testing system can be achieved by splitting both transmitted signals into Ch1 and Ch2 of each SR5500 and combining the signals within each SR5500. The units must be connected using synchronization cables which allow user control of the correlation and fading characteristics between the two SR5500 units. In addition, the synchronization cables allow for synchronized DEE state changes between the two SR5500s.

The following instructions describe how to connect the RF cables and control cables for the two SR5500s.

1. Connect the two transmitters to the two SR5500's using the supplied RF splitters (e.g. Mini-Circuits B76-1006) as shown in Figure 2-1.
2. At the input to each of the RF splitters, connect the output of the unit under test.
3. Synchronization of the units is attained by connecting the 10MHz Reference and Sync cables as shown in Figure 2-2 and Table 2-1.
4. The 10 MHz IN port of system 1 can be driven from an external source if desired.

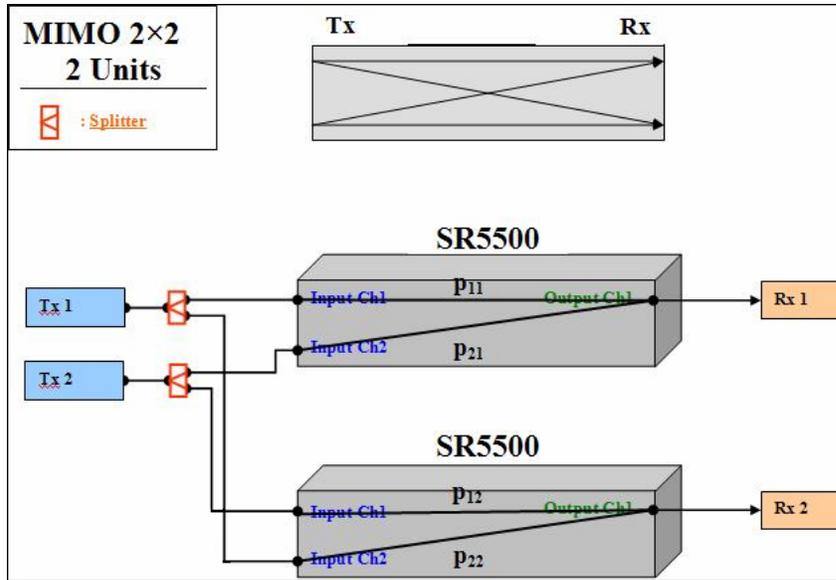


Figure 2-1: RF Connections for a SR5500 Based 2 x 2 MIMO System

UNIT #	PORT		UNIT #	PORT	TYPE
1	10 MHz OUT	->	2	10 MHz IN	BNC
1	SYNC OUT	->	2	SYNC IN	MDR Digital Cable

Table 2-1: 10 MHz Reference & Synchronization Cable Connections

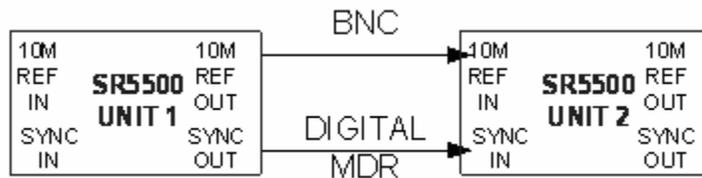


Figure 2-2: 10MHz Reference & Synchronization Connections Network Connections Setup

## 2.2. Network Connections Setup

An Ethernet switch is used to connect both the SR5500s to the 5500 laptop. The Cisco Catalyst 2960-8TC compact switch is an 8 port Ethernet switch. In the MIMO setup we use it as a hub eliminating the need for the user to configure the switch.

### 2.2.1. Setting Up and Powering the Ethernet Switch

The following instructions describe the set up and power ON sequence for the Ethernet switch.

1. Plug one end of the supplied AC power cord into the rear panel, and then plug the other end into your AC source (grounded AC outlet).
2. The power-on self-test (POST) begins. During POST, the LEDs blink while a series of tests verify that the switch functions properly. LED behavior during POST is unpredictable and might vary.
3. Wait for the switch to complete POST. It might take several minutes for the switch to complete POST.
4. Verify that POST has completed by confirming that the SYST LED rapidly blinks green. If the switch fails POST, the SYST LED turns amber. POST errors are usually fatal. Contact Spirent Technical support immediately if your switch fails POST.
5. Note that though the Ethernet switch can be configured to support advanced switching, the MIMO setup does not require the switch to be configured; it is adequate if the user powers ON the switch without configuring it.

### 2.2.2. Connecting the SR5500 Laptop to the SR5500s

The following instructions describe how to connect the SR5500 Laptop to the two SR5500s through the Cisco Ethernet switch.

1. Using Ethernet cable A, connect the SR5500 Laptop to the port labeled '1x' on the Cisco Ethernet switch. The Ethernet cable should be connected to the built-in Ethernet port on the Laptop.
2. Using Ethernet cable B, connect one of the SR5500s to the port labeled '2x' on the Cisco Ethernet switch.
3. Using Ethernet cable C, connect the other SR5500 to the port labeled '3x' on the Cisco Ethernet switch.

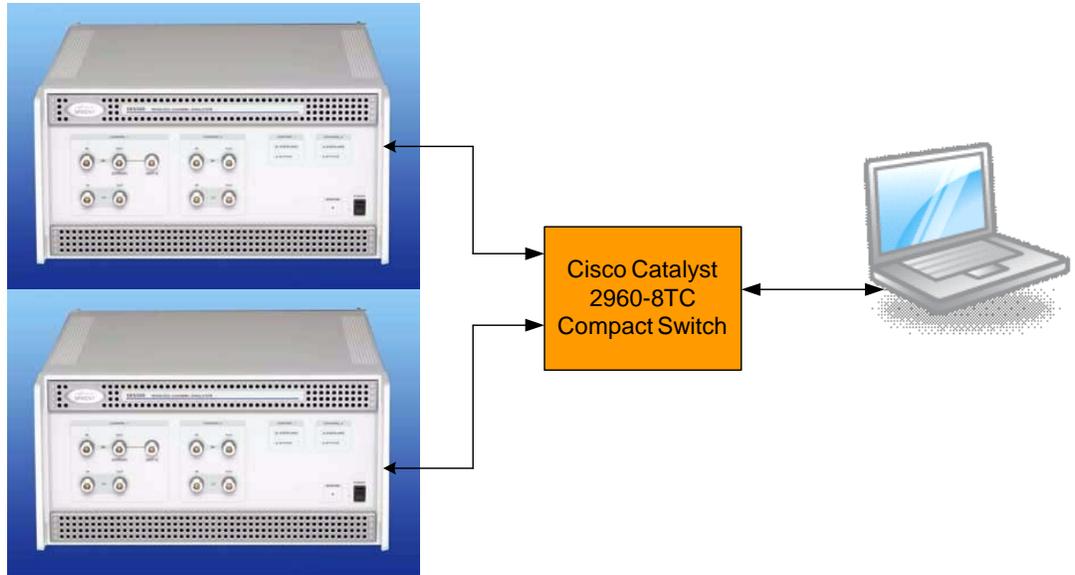
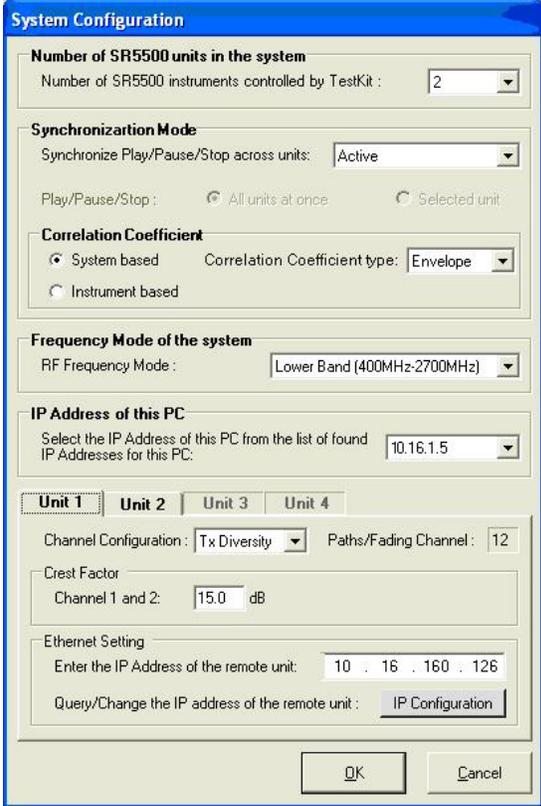


Figure 2-3: Ethernet Connections for a SR5500 Based 2 x 2 MIMO System

### 3. Configuring SR5500 TestKit for MIMO Operation

The following instructions describe the steps to configure SR5500 TestKit for MIMO operation. The number of units, IP addresses and some system related parameters need to be modified to setup the two SR5500s for MIMO operation. These can be modified through the "System/Communication Setup" accessible through the "Configuration" menu, or the System/Communication Setup icon  on the toolbar. Figure 3-1 shows the System/Communication Setup window.



The screenshot shows the "System Configuration" window with the following settings:

- Number of SR5500 units in the system:** Number of SR5500 instruments controlled by TestKit: 2
- Synchronization Mode:** Synchronize Play/Pause/Stop across units: Active; Play/Pause/Stop: All units at once (selected)
- Correlation Coefficient:** System based (selected); Correlation Coefficient type: Envelope
- Frequency Mode of the system:** RF Frequency Mode: Lower Band (400MHz-2700MHz)
- IP Address of this PC:** Select the IP Address of this PC from the list of found IP Addresses for this PC: 10.16.1.5
- Unit 1 (selected):** Channel Configuration: Tx Diversity; Paths/Fading Channel: 12; Crest Factor: Channel 1 and 2: 15.0 dB
- Ethernet Setting:** Enter the IP Address of the remote unit: 10 . 16 . 160 . 126; Query/Change the IP address of the remote unit: IP Configuration

Figure 3-1: System Configuration Window

1. *Number of SR5500 Units in the system:* Set the 'Number of SR5500 instruments controlled by TestKit' (available under System/Communication Setup) to 2 using the drop down list and click 'Ok'. A progress bar as shown in Figure 3-2 will inform the user about the progress made.

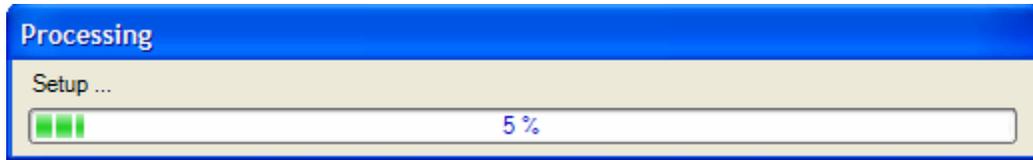


Figure 3-2: Progress Bar Displayed by SR5500 TestKit

2. *Ethernet Setting:* The IP address that TestKit will use to communicate to the instruments can be viewed and modified using the 'Enter the IP address of the remote unit' window (available under 'Ethernet Setting' under 'System/Communication Setup'). Note that this only sets the IP address that TestKit will use to communicate with the instruments; the IP address on the instrument needs to be set explicitly using the 'IP Configuration' button.

The IP address for the two units will retain the last entered value. If, this is a first time installation, they will default to 192.168.0.7 and 192.168.0.8.

Unless, the user has a preference, Spirent recommends setting the IP address on the units and TestKit to 192.168.0.71 and 192.168.0.72. After setting the IP address for both the units, click 'Ok'. Note, that it is up to the user to ensure that other instruments on the same network do not have the same IP address.

*Changing the IP address of the Instrument:*

In order to modify the IP Address of the SR5500, you will need to use the supplied RJ-45 Type connector to DB-9 Type connector serial cable. The serial cable connects the controller PC's serial interface to the SR5500's serial interface labeled SERIAL. Next, run SR5500 TestKit, but do not connect to the remote unit. Select "System/Communications Setup" from the "Configuration" menu, which displays the Communication Configuration window as shown in Figure 3-1.

SR5500 TestKit uses the COM port to communicate with the SR5500 and retrieve the current IP Address information. If multiple SR5500's are being controlled by TestKit, the serial cable must be connected to each of them in series. The IP configuration is ONLY for the system currently connected to the serial cable. If SR5500 TestKit can not communicate with the SR5500, it will display the appropriate error.

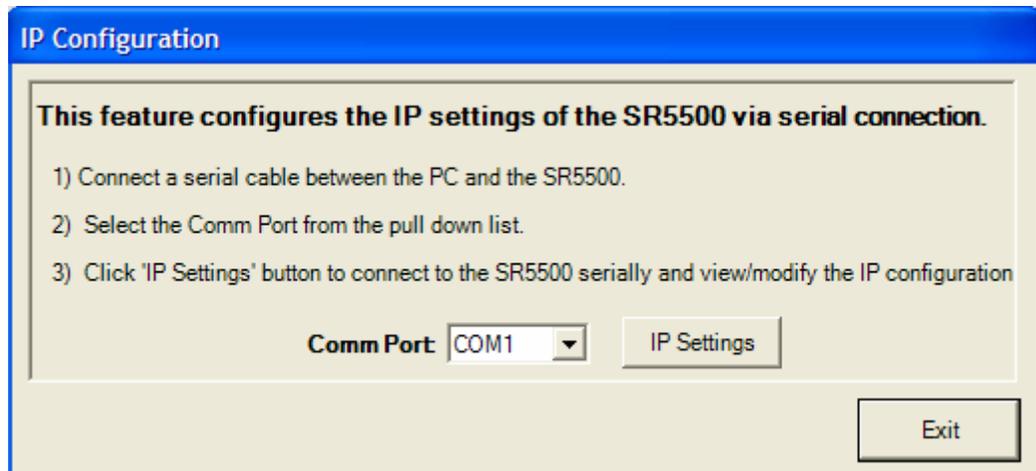


Figure 3-3: IP Configuration Window

Click the button labeled "IP Configuration". This will bring up a dialog box as shown in Figure 3-3. After choosing the appropriate Comm port using the drop down list, click the button labeled 'IP Settings'. After collecting the IP Address information from the SR5500, SR5500 TestKit will display the current IP Address information as shown in Figure 3-4; change the IP Address to the desired value. When you are finished, click OK. Your changes will be updated in the SR5500 unit. After SR5500 TestKit has updated the IP Address in the unit, it will automatically update the IP Address it uses to communicate with the SR5500. It is not necessary to change the IP Address in SR5500 TestKit to match the updated SR5500 IP Address.

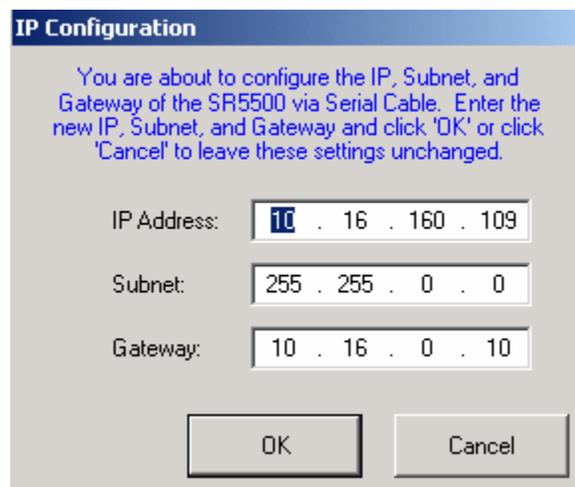


Figure 3-4: IP Configuration Window with the SR5500 IP Information

3. *Synchronization Mode*: Set the 'Synchronize Play/Pause/Stop across units' (available under System/Communication Setup) to Active using the drop down list.

The player synchronization mode should be set to Active in order for DEE and correlation to function in a multi-unit setup. When set to active, the synchronization status will be displayed with the unit selection as shown in Figure 3-5.



Figure 3-5: Unit Selection Display with the Synchronization Details

4. *Channel Configuration:* Set the 'Channel Configuration' (available under System/Communication Setup) to Tx Diversity for both the units individually, using the drop down list and click 'Ok'.

A warning message (shown in Figure 3-6) will appear, warning the user, that settings on the instruments will be set to default on changing the channel configuration. Click 'Ok' and a progress bar (as in Figure 3-2) will inform the user about the progress made.

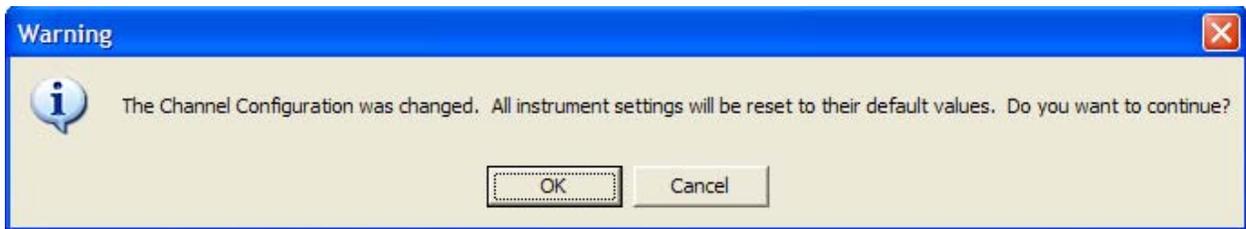


Figure 3-6: Channel Configuration Modification Warning Message Box

These channels are then summed together and output on the CH1 RF OUT port, as shown in Figure 3-7.

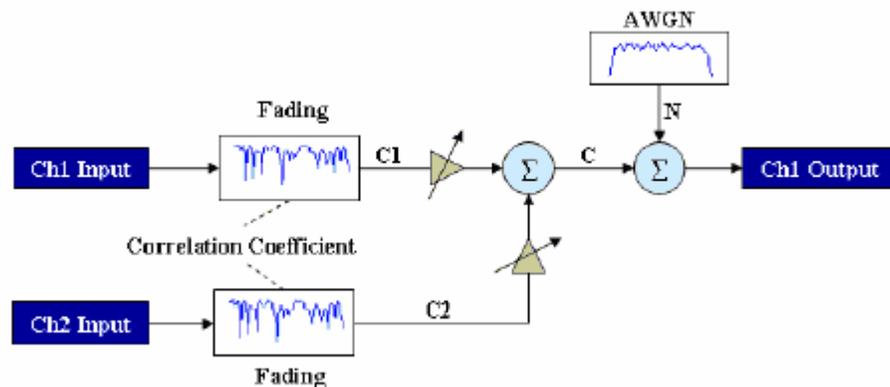
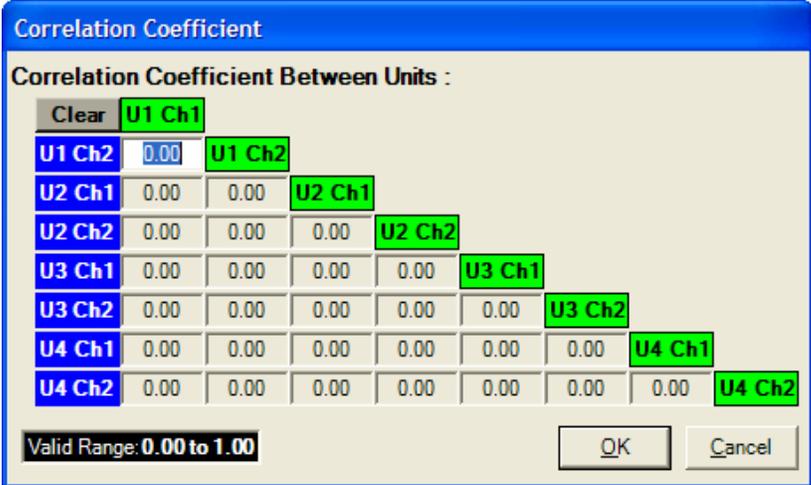


Figure 3-7: Channel Configuration in Transmit Diversity Mode

5. *Correlation Coefficient*: The 'Correlation Coefficient' (available under System/Communication Setup) should be set to System Based, by choosing the appropriate radio button. Set the 'Correlation Coefficient Type' depending on the testing needs using the drop down list.
6. *Correlation Coefficient Between Units*: The correlation coefficient can be modified through the "Correlation Coefficient Between Units" accessible through the "Configuration" menu, or the Correlation Coefficient Between Units icon  on the toolbar.

Set the channel-to-channel correlation using the Correlation Coefficients form (shown in Figures 3-8 and 3-9). Figure 3-8 shows the form for the correlation coefficients if the 'Correlation Coefficient type' is set to 'Component' or 'Envelope'. The available range for the current coefficient being entered is displayed at the bottom left of the dialog. Initially, this window will show all channels as uncorrelated. Values can be entered in any order; however, values entered "higher" in the matrix affect the range of values "lower" in the matrix. Due to these range dependencies, it is advisable to enter the values from top to bottom by tabbing through the matrix, except for very simple matrices.



The screenshot shows a dialog box titled "Correlation Coefficient" with a sub-header "Correlation Coefficient Between Units :". It features a "Clear" button and a "U1 Ch1" label. Below is an 8x8 matrix of input fields. The diagonal elements (U1 Ch1 to U4 Ch2) are highlighted in green and contain the value "0.00". The off-diagonal elements are also "0.00". At the bottom left, it says "Valid Range: 0.00 to 1.00". At the bottom right, there are "OK" and "Cancel" buttons.

U1 Ch2	0.00	U1 Ch2					
U2 Ch1	0.00	0.00	U2 Ch1				
U2 Ch2	0.00	0.00	0.00	U2 Ch2			
U3 Ch1	0.00	0.00	0.00	0.00	U3 Ch1		
U3 Ch2	0.00	0.00	0.00	0.00	0.00	U3 Ch2	
U4 Ch1	0.00	0.00	0.00	0.00	0.00	0.00	U4 Ch1
U4 Ch2	0.00	0.00	0.00	0.00	0.00	0.00	U4 Ch2

Figure 3-8: Form with Correlation Coefficients

Figure 3-9 shows the form for entering correlation coefficients when the 'Correlation Coefficient Type' is set to 'Complex'; this allows the user to set complex correlations. Complex correlation is an optional feature that is only available in version 2.30 or greater of the TestKit software. Unlike the previous case wherein the range for each value being entered is displayed in the same form, the user is informed about the validity of the values entered only after all the elements in a row have been entered. Additionally, unlike in the previous case, correlation values can be set on a per path basis. If the values entered result in an invalid correlation matrix, the 'Path Matrix Status' would change from **Valid** to **InValid** and an informational box with some details will be presented.

**Complex Correlation**

	Path 7	Path 8	Path 9	Path 10	Path 11	Path 12
	Path 1	Path 2	Path 3	Path 4	Path 5	Path 6
<b>Clear</b>						
<b>U1 Ch1</b>	1					
<b>U1 Ch2</b>	0.0000 + 0.0000 j	1				
<b>U2 Ch1</b>	0.0000 + 0.0000 j	0.0000 + 0.0000 j	1			
<b>U2 Ch2</b>	0.0000 + 0.0000 j	0.0000 + 0.0000 j	0.0000 + 0.0000 j	1		

Apply To All Paths      Path Matrix Status: **Valid**      **OK**      **Cancel**

Figure 3-9: Form with Complex Correlation Coefficients

7. *Channel Model:* The channel model can be setup by setting parameters for the paths for each of the channels on each of the units; this is available under the Channel Editor view as shown in Figure 3-10. By default, path 1 will be enabled with Static modulation on all the channels. Depending on the channel model, enable additional paths and set values for different parameters accordingly. A summary of the state of the paths for both the channels for both the units is available in the Summary view as shown in Figure 3-11.

SR5500 TestKit - [untitled]

Selected Unit: 1 Synchronized

Views: Channel Editor, Channel Player, Interference Editor, DEE, Instrument Setup, Summary, RPI

Unit 1 (Channel 1)      Unit 1 (Channel 2)

Velocity (km/h): 50.000

Path	Modulation	Fading Doppler (Hz)	Fading Doppler Vel. (km/h)	Phase Shift (Deg)	Frequency Shift (Hz)	LOS AOA (Deg)	LOS Doppler (Hz)	Rician (dB)
<input checked="" type="checkbox"/> 1	Rayleigh	41.70	50.000	0.0	0.00			
<input checked="" type="checkbox"/> 2	Static			0.0	0.00			
<input type="checkbox"/> 3	Static			0.0	0.00			
<input type="checkbox"/> 4	Static			0.0	0.00			
<input type="checkbox"/> 5	Static			0.0	0.00			
<input type="checkbox"/> 6	Static			0.0	0.00			
<input type="checkbox"/> 7	Static			0.0	0.00			
<input type="checkbox"/> 8	Static			0.0	0.00			
<input type="checkbox"/> 9	Static			0.0	0.00			
<input type="checkbox"/> 10	Static			0.0	0.00			
<input type="checkbox"/> 11	Static			0.0	0.00			
<input type="checkbox"/> 12	Static			0.0	0.00			

Playback Controls (All Units): Elapsed Time: 00:00:00.0      Player Status: [ ]

Unit 1 (Channel 1)      Unit 1 (Channel 2)

Carrier: Freq (MHz): 900.000, Band: Unknown, Channel: Unknown, Adjust Carrier

Power (dBm): Measured Input, Output, C/N (dB), Set Input, Output, Autoset

Overload, Bypass, RF Output, Cable Loss

Channel Mode: Dual    RF Band: Lower    Technology: None    Unit Under Test: Unknown    Unit Fading: Uncorrelated    Unit AWGN: Uncorrelated    Status: Not Connected

Figure 3-10: Channel Editor View

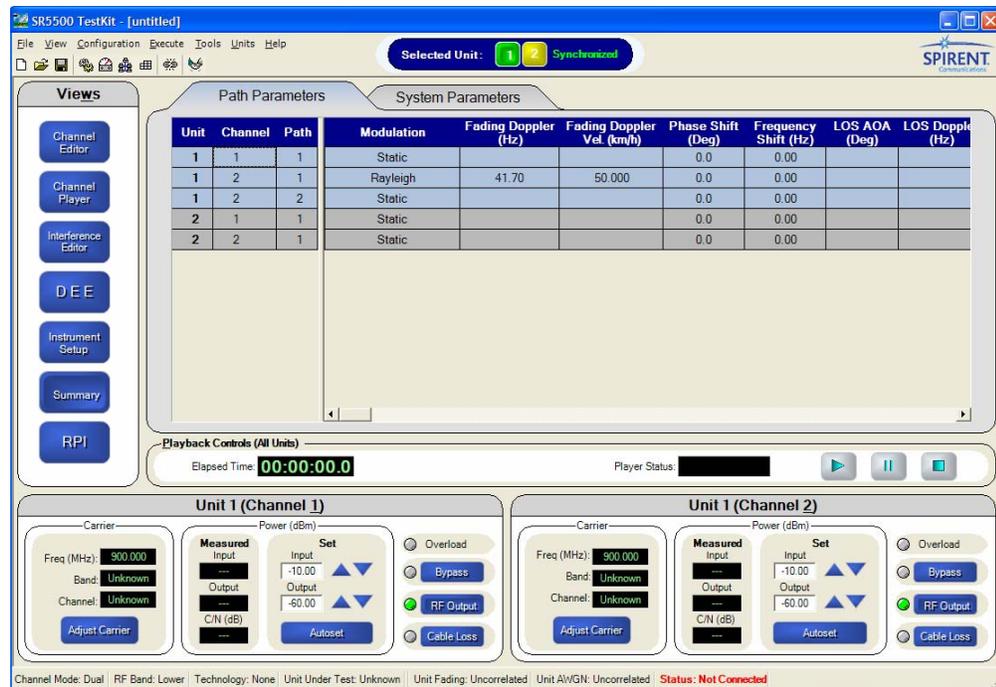


Figure 3-11: Summary View

### Performing an AutoSet:

Both the SR5500 input ranging circuit and nominal output level are user configurable. The input ranging circuitry should be set to match the RMS signal power present at the input port to the SR5500. The output level parameter will determine the nominal RMS output power present at the output port of the SR5500. Note that the output power level specified will be accurate only if the measured input power matches the set input power settings. To achieve the ideal performance from the SR5500, the SR5500 input ranging circuit should be properly configured to the RMS input power through an AutoSet operation.

Connect to the SR5500s using TestKit, Enable 'RF Output' by clicking on the 'RF Output' button and set the Output to the desired value for each of the channels on both the SR5500s as shown in Figure 3-12. The valid ranges for the input and output are -32 to 5 dBm and -110 to -30 dBm respectively. Click on the 'Autoset' button for each of the channels; A dialog box with the option to abort the Autoset will appear as shown in Figure 3-13; this will also indicate the progress made. Once an Autoset has been performed successfully, the Measured input and output fields, will display the instantaneous values for the input and the output.

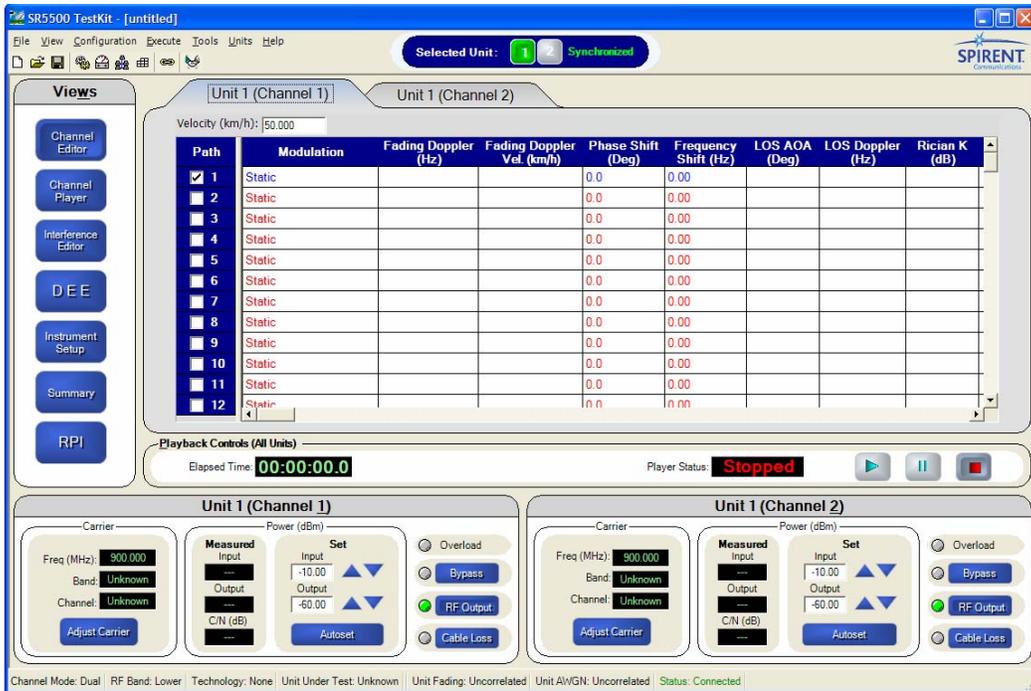


Figure 3-12: Input and Output Configuration for an Autoset

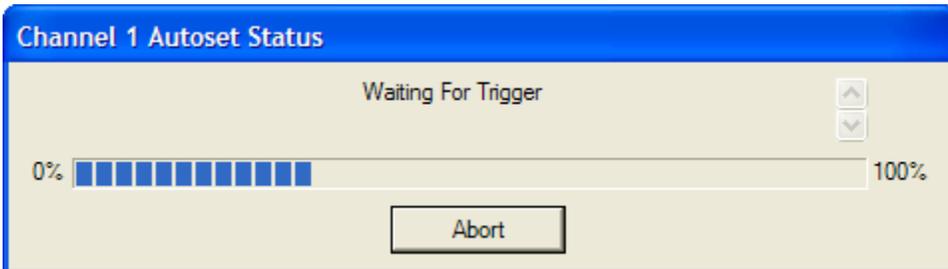


Figure 3-13: Autoset Update Progress-bar