

**Spirent Communications
TAS 4500
RF Channel Emulator
Operations Manual**

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 the user 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.

Caution

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 the user's data.



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



Alternating current (power line).

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This manual applies to the TAS 4500, Version 5.31 and higher

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1.0. INTRODUCTION

1.1. Overview

The TAS 4500 FLEX RF Channel Emulator provides a convenient, thorough approach for testing wireless communications equipment by emulating the delay, fast and slow fading, and path loss characteristics of RF mobile communication channels. The 4500 FLEX allows thorough testing in a laboratory setting and drastically reduces the time required for product tests. The 4500 FLEX can be used to test a wide range of wireless voice and data communication equipment, including cellular telephones, cellular modems, personal communication terminals, wireless LANs, pagers, wireless network equipment, and much more.

TAS 4500 FLEX provides advanced signal processing features to address a wide range of wireless communications technologies. The 4500 FLEX delivers these features in a modular format, so your test system can evolve to meet your testing needs for years to come. The TAS 4500 FLEX has the following features:

- Plug-In RF Front End Modules
- Plug-In Local Oscillator Modules
- Plug-In Wide Bandwidth Signal Processing Modules
- Plug-In System Software PCMCIA Card

A single TAS 4500 emulates two independent wide bandwidth RF channels, each with up to six transmission paths, see Figure 1-1. Delay, path loss, Rayleigh fading, and log-normal fading characteristics can be programmed for each path. Two six-path channels can be combined to make one 12-path channel, and two, three, or four TAS 4500s can be combined and synchronized for multi-channel applications.

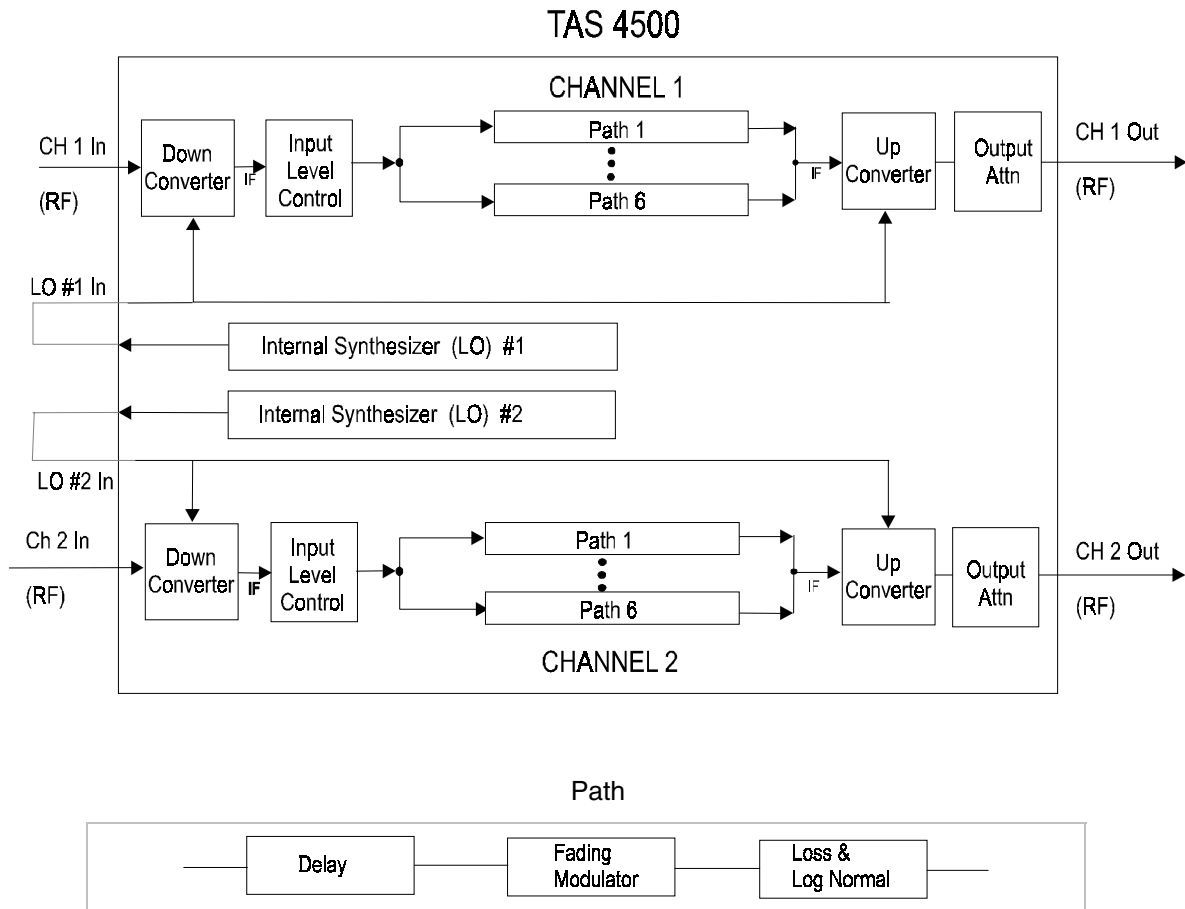


Figure 1-1. TAS 4500 Block Diagram

TAS 4500 provides powerful features that are new for an instrument of this type. Built-in calculation of fading coefficients and the built-in user interface eliminate the need for an external computer and greatly enhance testing speed and convenience. Built-in GPIB and RS-232 control ports make it easy to include the TAS 4500 in automatic test systems.

1.1.1. Product Highlights

- Wideband channel emulation capability meets or exceeds requirements of most wireless communications standards, including AMPS, IS-95 (CDMA), IS-54/136 (TDMA), GSM, CT2, TETRA, DCS-1800 and JDC.
- Emulates important radio channel characteristics, including Rayleigh fading, Rician fading, Suzuki fading, Nakagami fading, log-normal shadowing, delay spread/multi-path distortion, and path loss. See feature summary in Table 1-1.
- TAS 4500's modular architecture lets your test system capabilities grow as your testing requirements grow. The modular 4500 FLEX architecture lets you select the number of RF channels and frequency synthesizers required to fit both existing and future testing applications.
- The FLEX-RF™ front end offers a host of high-performance features, including excellent rejection of the local oscillator signal and a built-in RF attenuator. These features greatly enhance dynamic range and improve testing performance at low RF receive levels.
- The FLEX-LO™ modules completely address the testing needs of both cordless phone, paging, cellular and PCS applications, eliminating the need for external signal generators.
- Built-in digital signal processors and user interface provide generation and control of fading signals in real time: no external PC required, no long signal processing delays.
- Advanced Fading Features such as selectable fading method, fading repetition rate and fading power spectrum allow comprehensive testing using multiple fading models.
- The Dynamic Environment Emulation (DEE) feature allows the user an advanced method to enter and play back data emulating dynamic channel models.
- The 3GPDP feature provides easy access to the dynamic test capability of DEE required for Third Generation (3G) Wireless testing.
- Fine delay resolution makes TAS 4500 suitable for testing mobile, wireless LAN, and PBX applications.
- Built-in configurations for industry-standard test procedures.
- GPIB and RS-232 control ports make it easy to include TAS 4500 in automatic test systems.
- Field-upgradeable PCMCIA System Software Card allows quick and easy access to the latest firmware revisions and features.
- Flexible architecture provides easy configuration of test setups for 2, 4, 6, or 8-channel receivers.

RF FRONT END MODULE¹	800-3000 MHz	25-3000 MHz
Double Conversion	●	●
RF Image and LO Feedthrough Suppression	○	○
Programmable Output Attenuator	○	○
RF Channel Bypass	○	○

IF SIGNAL PROCESSING MODULE	
Rayleigh Fading	●
Advanced Fading Features	●
Dynamic Environment Emulation	●
3GPDP Support	●
Rician Fading	●
Suzuki Fading	●
Nakagami Fading	●
Frequency Shift	●
Phase Shift	●
Rayleigh Fading with Freq. Shift	●
Rician Fading with Freq. Shift	●
Log Normal Fading	●
Relative Path Loss	●
Relative Path Delay	●
Extended Relative Path Delay	○

OPTIONAL INTERNAL LO MODULE NUMBER	CARRIER FREQUENCY RANGE SUPPORTED
LO Number 3	60-260 MHz 340-540 MHz
LO Number 4	800-3000MHz

● - Standard Feature ○ - Optional Feature

¹ Consult factory for additional carrier frequency ranges

Table 1-1. Feature Summary for TAS 4500 FLEX System Configurations

1.1.2. TAS 4500 Applications

The TAS 4500 provides many emulation features for testing wireless telecommunications equipment for product development, manufacturing and evaluation applications.

Product Development and Engineering Test

Product development and engineering test organizations can use the TAS 4500 to test and evaluate the performance of wireless communications equipment in the presence of real world conditions such as Rayleigh fading, and delay spread. Repeatable and realistic testing is crucial to the successful development of wireless systems because they typically require complex signal processing techniques to mitigate the effects of RF channel impairments.

Quality Assurance (QA) Testing

The QA organization of a wireless equipment manufacturer can use the TAS 4500 to monitor product quality by testing if the manufactured product is consistently meeting the targeted performance levels. This can be a major issue particularly for high volume products such as cellular telephone and modems.

Evaluation and Acceptance Testing

Communications equipment users often need to evaluate the performance of wireless telecommunication equipment as part of their procurement process for such equipment. This typically requires the equipment from candidate suppliers to be tested against an established set of performance specifications. These types of tests require test equipment that is very flexible, accurate and easy to use. The TAS 4500 possesses these characteristics and provides the functionality for the user to evaluate wireless communication equipment against a wide variety of domestic and international testing specifications.

1.2. Guided Tour

The front panel keys and display provide access to all the features of the TAS 4500. The front panel enables the definition of channel characteristics, control of the input reference level, set up of general system configuration parameters, and saving and recalling configuration files.

1.2.1. Front Panel Description

Figure 1-2 shows the TAS 4500 front panel. The following sections describe each front panel feature.

The buttons and displays on the front panel of the TAS 4500 are partitioned into logical groups to provide a user-friendly interface. These consist of a SELECT/EDIT group, a MENU group, an INPUT group, and a BYPASS group. The MENU group contains the CHANNEL 1, CHANNEL 2, CONFIG, and FILE KEYS. The SELECT/EDIT group contains the UP, DOWN, LEFT, and RIGHT arrow keys; the PLUS, MINUS, ENTER, and ESCAPE keys; the CURSOR LEFT and CURSOR RIGHT keys; and the LOCAL key. The INPUT group contains the CHANNEL 1 and CHANNEL 2 Autorange keys and Overload LEDs. The BYPASS group contains the Bypass keys and LEDs.

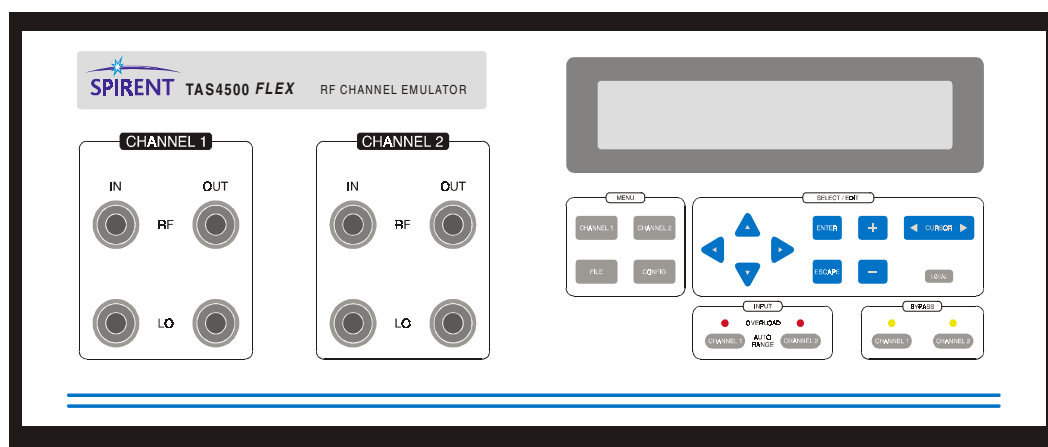


Figure 1-2. TAS 4500 Front Panel

Front Panel Buttons and Displays

Channel 1 Key

The channel 1 menu group controls the simulated unidirectional RF channel that consists of up to six independently programmable transmission paths. This menu group allows I/O parameters (carrier frequency, LO frequency, input reference level, and output attenuation) as well as RF channel parameters (number of paths in the channel model, relative path delay, fast and slow fading, frequency shift, phase shift, and relative path attenuation) to be viewed and controlled.

Channel 2 Key

The channel 2 menu group controls the second simulated unidirectional RF channel that consists of up to six independently programmable transmission paths. This menu group allows I/O parameters (carrier frequency, LO frequency, input reference level and output attenuation) as well as RF channel parameters (number of paths in the channel model, relative path delay, fast and slow fading, frequency shift, phase shift, and relative path attenuation) to be viewed and controlled.

CONFIG Key

The configure menu group allows the configuration of the remote control interface, selects the displayed units for the path characteristics, sets the fading parameters and sets the LCD contrast. The system summary displays the instrument's software version, diagnostic status and hardware configuration.

FILE Key

The file menu group allows you to load both user and TAS defined parameter profiles and to save user define parameter configurations.

Menu Navigation Up & Down Arrow Keys

To move between screens of the same menu, the Menu Navigation Up & Down Arrow keys are used. They are located together with the Menu Navigation Left & Right Arrow keys as a group under the front panel display.

Menu Navigation Left & Right Arrow Keys

The Menu Navigation Left and Right Arrow Keys move the cursor between parameter fields of the same menu screen. They are located together with the Menu Navigation Up & Down Arrow keys as a group under the front panel display.

Cursor Left & Right Arrow Keys

The Cursor Left and Right Arrow Keys move the cursor between digits within a parameter field.

ENTER Key

The ENTER key accesses a submenu. A carriage return symbol (↵) appears at the right side of each menu item that has a submenu.

ESC Key

The ESC key allows you to exit a submenu, or clear an error condition.

Value + & - Keys

The Value + and - keys are used to modify the value of the parameter field that is currently active. The Value + key increments the value of the field while the Value - key decrements the value of the field.

CHANNEL 1 and CHANNEL 2 Autorange Keys and Overload LEDs

These keys are located near the lower right of the front panel to provide direct access to the input level control function for both channels. The invoked button causes the channel emulator to measure the peak level of the transmit signal that is present at the input (RF IN) of the associated channel. The results of this measurement are then used to configure the channel's input level control circuit. The 4500 automatically forces the present INPUT REFERENCE LEVEL to the appropriate value to adjust the level of the input signal to approximately 3 dB below the full scale dynamic range of the channel. This provides the signal processing circuitry of the 4500 with the optimum conditions to emulate channel characteristics. When performing an input range, the overload LED will light momentarily, indicating that the TAS 4500 is optimizing the signal level.

The overload LEDs should be monitored to be sure the signal applied at the RF Channel input is within the specified range. When lit, the LED indicates the RF input signal has peak levels above the permitted range and will be clipped by the instruments input circuitry. If an overload condition occurs, the input reference level parameter should be increased and/or the input signal level should be reduced.

CHANNEL 1 and CHANNEL 2 BYPASS Keys

The bypass keys enable and disable the bypass feature for each channel. When the bypass for a channel is active, the bypass LED will be illuminated. When bypass is enabled, a minimum-loss, no-impairments path from the RF IN connector to the RF OUT connector is created.

LOCAL Key

The Local key disables remote control operation. When remote operation is enabled, menu parameters cannot be changed from the front panel. However, the menu navigation keys can still be used to view parameter values. The letter 'R' appears in the upper right corner of the display when the 4500 is in Remote Control Mode.

Main Display

The main display is located in the upper right quadrant of the front panel. It shows all control menus and level measurement results.

Signal Input/Output Connectors**RF Input/Output N-Connectors**

There are two N-type connectors per channel located on the upper left hand side of the TAS 4500 front panel for RF input and output.

LO Input/Output N-Connectors

There are two N-type connectors per channel located on the lower left half side of the TAS 4500 front panel for LO (Local Oscillator) input and output. An LO signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal.

1.2.2. Rear Panel Description

Figure 1-3 shows the rear panel of a standard 4500.

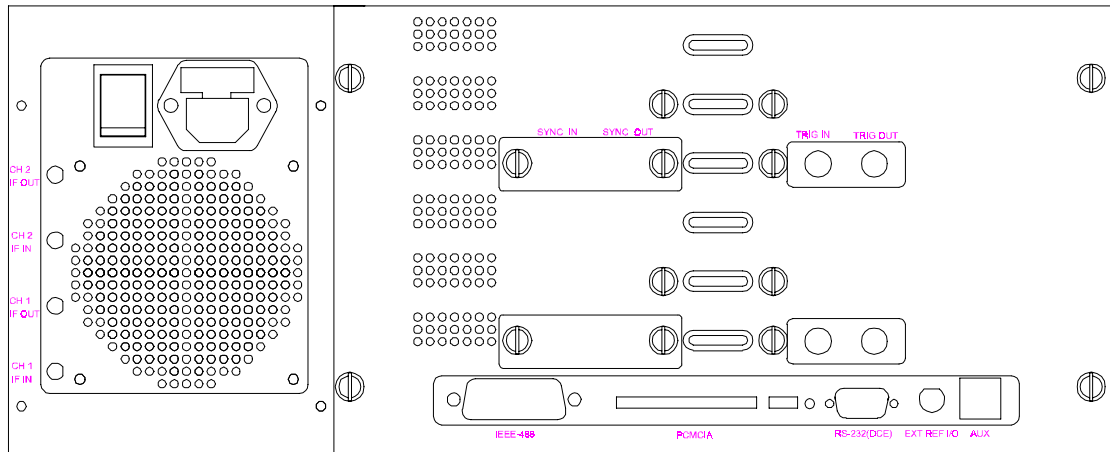


Figure 1-3. Rear Panel of the TAS 4500

PCMCIA System Software Interface

The system software for the TAS 4500 is resident on a PCMCIA memory card, which plugs into the PCMCIA System Software Interface on the lower portion of the instrument's rear panel. This PCMCIA card makes it easy to upgrade to the latest firmware version.

IEEE-488 Remote Control Port

The CONTROL (IEEE-488) port is a 24 pin IEEE-488 receptacle which supports the IEEE-488 (GPIB) protocol. This port must be connected to an IEEE-488 controller to control the TAS 4500 via IEEE-488. This connection may be either direct or via multi-point bus which contains other IEEE-488 controlled equipment.

The IEEE-488 controller can be a generic PC with an embedded IEEE-488 control card installed, an IEEE-488 computer, an RS-232 to IEEE-488 converter, or some other IEEE-488 controller.

RS-232 (DCE) Remote Control Port

The CONTROL (DCE) port is a 9 pin D-sub connector which supports RS-232C. The control port is wired as a Data Communications Equipment (DCE). All RS-232C remote control of the TAS 4500 must be done via this port. An RS-232C terminal or a PC (IBM compatible) can control the TAS 4500 through this via a regular RS-232 cable. It is important to note that a null modem cable is not required. Two protocols are supported in RS-232 control mode, ACK/NAK (ACKnowledge/Negative ACKnowledge), and CR/LF (Carriage Return/Line Feed). Both of these protocols are explained in full detail in Section 5.0 "Remote Operation".

AUX Port

The AUX (auxiliary) port is a RJ-45 connector that is currently not used.

SYNC IN(OUT) Connectors

The SYNC input(output) connectors shown in Figure 1-3 are RJ-45 type connectors. The TTL digital signals on this connector are used to provide synchronization of the digital signal processing between units that are configured in a multiple system test setup.

TRIG IN(OUT) Connectors

The TRIG input(output) connectors shown in Figure 1-3 are BNC type connectors. The TRIG IN port is used to provide an external TTL trigger and synchronization mechanism. The state transitions in the Random Angle of Arrival Test and Dynamic Environment Emulation mode can be triggered using this interface. The TRIG OUT port can be used to track the state progression of a DEE test. A TTL output signal from the box indicates state transitions when in DEE mode.

CH1 IF IN/OUT and CH2 IF IN/OUT Connectors

The IF IN/OUT SMA type connectors shown in Figure 1-3 are part of the IFBO (IF Breakout) Option. These connectors provide access to the 140 MHz IF signal in the 4500 Up Converter. Additional information on the application of these signals can be found in Section 4.4.8 of the manual. These four holes will be filled with metal plugs if this option is not installed.

EXTERNAL REFERENCE I/O Connector

The External Reference Input/Output connector is a BNC type connector that provides a 10 MHz sine wave reference signal as an output when the TAS 4500 is using its own internal reference. This connector can also accept an externally supplied 10 MHz sine wave reference signal which can be used to drive the internal signal processing circuitry of the TAS 4500 as a software selectable option.

AC Power Receptacle

The AC universal power receptacle is located on the upper left corner of the rear panel. This receptacle also contains the AC on/off switch and the fuse for the unit.

Fan Vent Areas

The rear panel of the TAS 4500 contains two fan vent areas. One vent area is below the AC power receptacle, the other to the right of this vent. The area behind these vents should be unobstructed for proper air flow to cool the TAS 4500.

1.3. Installation

This section describes a simple and straightforward procedure for installing TAS 4500.

1.3.1. Quick Start Procedure

To prepare the TAS 4500 for initial operation, perform the following steps:

1. Unpack the TAS 4500 shipping carton. The carton should contain a packing list as well as all the items shown on the list.
2. Please make sure that all parts listed on the packing list are contained in your TAS 4500 shipping carton. Save the shipping carton 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.
3. Check each item for physical damage. If any part appears to be damaged, contact the TAS Customer Service department immediately.
4. Read Section 1.2 of this manual.
5. Follow the installation instructions in Section 1.3.2.
6. Read Sections 2.1 and 2.2 and perform the exercise described in Section 2.2.

1.3.2. Installation Guide

The following information describes the basic steps that should be followed to install the TAS 4500.

1. Plug one end of the AC power cord into the TAS 4500, then plug the other end into the AC source.
2. Setup the TAS 4500 for one of the standard test configurations described in Sections 1.3.3. through 1.3.5. or in a user defined configuration. See Section 1.3.6. for setup instructions for multiple system test configurations.

3. Set the AC power switch at the upper right corner (when viewed from the front of the 4500) of the rear panel to the "1" position. The TAS 4500 now executes its power-up self test and calibration sequence for a few seconds, while it displays the following message on the MAIN DISPLAY:

```

tas 4500
System diagnostics & initialization...
```

If the TAS 4500 detects an error, it shows the appropriate error message on the main display. If the TAS 4500 detects no errors it will display the first screen of the CH 1 (Channel 1) menu.

Consult Section 2.0. "Local Operation", for further information. If you intend to use a computer or data terminal to control the TAS 4500, consult Section 5.0. "Remote Operation".

NOTE: If the TAS 4500 encounters a failure during its initial diagnostic operation, record the error code displayed on the front panel, and refer Section 7.0. "Error Codes" of this manual.

1.3.3. Single Channel 3, 6, or 12 Path Configuration Test Setup

The TAS 4500 may be easily used in a single channel 3, 6, or 12 path configuration in which an RF transmitter is connected to the emulator's channel input with a compatible receiver connected to the channel output. This unidirectional setup requires all the paths being used to be equipped in Channel 1.

The 3 or 6 path configurations require only a single channel unit with the desired number of paths installed. The 3/6 paths are then available with the default dual channel mode Channel Configuration setting.

The 12 path configuration requires a 2 Channel unit with 12 installed paths. The two channels can then be internally mapped to one channel by setting the Channel Configuration mode to single channel. Details on the Channel Configuration parameter can be found in Section 2.4.10 "Setting the Channel Configuration."

This setup is illustrated in Figure 1-4.

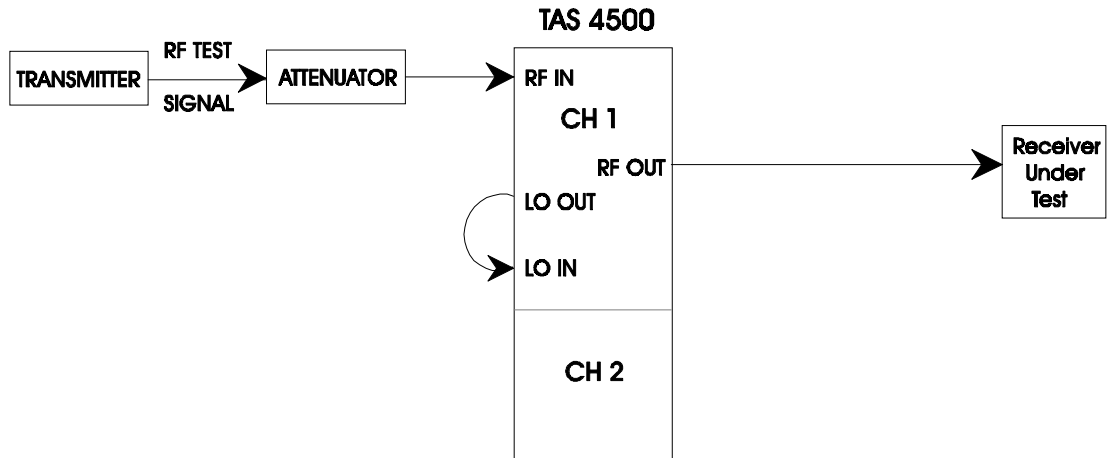


Figure 1-4. Single Channel 3, 6, or 12 Path Configuration

Signal Interconnect:

1. Install a cable from the antenna jack of the RF transmitter to the input of a 50 dB RF attenuator.

The attenuator is required if the transmit power is greater than the specified input signal level range of the 4500 (-10 dBm is the nominal, see technical specifications for limits). The loss required by the RF attenuator depends on the transmitter's output power. A 6 watt (38 dBm) transmitter with a 50 dB attenuator would present an input power of -12 dBm (38 dBm - 50 dB).

2. Install a cable from the output of the RF attenuator to the N type connector on the front panel of the TAS 4500 labeled "CHANNEL 1 RF IN".
3. Install a short cable from the N type connector labeled "CHANNEL 1 LO OUT" to the "CHANNEL 1 LO IN" connector on the front panel of the TAS 4500. If no internal synthesizer is configured then the LO IN port must be connected to an external user supplied RF frequency synthesizer.

An LO (Local Oscillator) signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal. Refer to Section 8.0 "Technical Specifications" for the required LO frequency and level.

4. Install a cable from the N type connector on the front panel of the TAS 4500 labeled "RF OUT" to the input of the RF receiver.

Parameter Settings:

5. Basic installation is complete once the equipment has been setup as described in steps 1 to 4 above. You are now ready to set the parameters of the TAS 4500 to the values that are needed to conduct the test.

NOTE: Be sure that the input level control circuit is properly configured (see Section 2.5). Typically the most convenient method to configure the input level control is to press the CHANNEL 1 AUTORANGE button on the front panel of the TAS 4500 after the transmit signal is present at the RF IN port.

1.3.4. Duplex Channel Configuration Test Setup

The TAS 4500 may be easily used in a duplex channel configuration with 3 or 6 paths in each direction in which transmitter A communicates with receiver B through Channel 1 and transmitter B and receiver A through Channel 2 of the TAS 4500. This setup is illustrated in Figure 1-5.

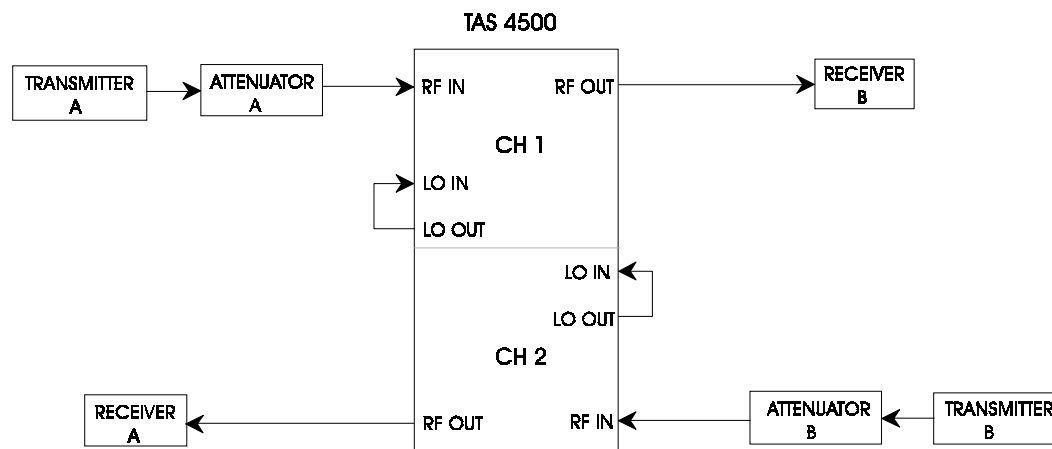


Figure 1-5. Duplex Channel Configuration

Signal Interconnect:

1. Install a cable from the antenna jack of RF transmitter A to the input of a 50 dB RF attenuator A.

The attenuator is required if the transmit power is greater than the specified input signal level range of the 4500 (-10 dBm is the nominal; see technical specifications for limits). The loss required by the RF attenuator depends on the transmitter's output power. A 6 watt (38 dBm) transmitter with a 50 dB attenuator would present an input power of -12 dBm (38 dBm - 50 dB).

2. Install a cable from the output of the RF attenuator A to the N type connector on the front panel of the TAS 4500 labeled "CHANNEL 1 RF IN".
3. Repeat steps 1 and 2 above for transmitter B, attenuator B and channel 2 of the TAS 4500.

4. Install a short cable from the N type connector labeled "CHANNEL 1 LO OUT" to the "CHANNEL 1 LO IN" connector on the front panel of the TAS 4500. If no internal synthesizer is configured then the LO OUT connector will be blanked and the LO IN port must be connected to an external user supplied RF frequency synthesizer.

An LO (Local Oscillator) signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal. Consult the technical specifications of your model 4500 for the required LO frequency and level.

5. Repeat steps 4 above for the channel 2 LO of the TAS 4500.
6. Install a cable from the N type connector on the front panel of the TAS 4500 labeled "CHANNEL 1 RF OUT" to the input of the RF receiver B.
7. Repeat steps 6 above for the "CHANNEL 2 RF OUT" of the TAS 4500 and RF receiver A.

Parameter Settings:

8. Basic installation is complete once the equipment has been setup as described in steps 1 to 7 above. You are now ready to set the parameters of the TAS 4500 to the values that are needed to conduct the test.

<p>NOTE: Be sure that the input level control circuit is properly configured (see section 2.5.). Typically the most convenient method to configure the input level control is to press the CHANNEL 1 and CHANNEL 2 AUTORANGE buttons on the front panel of the TAS 4500 after the transmit signal is present at both the RF IN ports.</p>
--

1.3.5. Setup Requirements for Multiple System Test Configurations

This section provides information on the hardware setup requirements for applications that require multiple TAS 4500 units. There are two primary modes of operation supported in the 4500 that may integrate more than one unit. The first such application is the four, six, and eight branch diversity and smart antenna test systems. The second application is the Dynamic Environment Emulation Mode. The hardware setup requirements are the same for both multi-system applications.

The interconnection of the SYNC IN/SYNC OUT signals and the 10 MHz Reference signal is necessary to synchronize the signal processing between units. The supported four, six, and eight channel configurations correspond to two, three, or four TAS 4500 systems respectively.

Control of these multi-unit test systems is provided by the TASKIT/4500 software interface and is not available from the front panel of the 4500. The typical configuration requirements for providing TASKIT control are also outlined in the sections that follow.

Additional information on the diversity and smart antenna applications can be found in Section 3.3. Details on the Dynamic Environment Emulation application can be found in Section 3.2.

1.3.5.1. Four Channel System Setup

The following operations are required for the proper installation of a 4-channel TAS 4500 test setup:

1. Unit 1 (Primary) - Channel 1 and 2 configuration requirements
2. Unit 2 - Channel 3 and 4 configuration requirements
3. 10 MHz Reference distribution
4. Synchronization signal distribution
5. Configuration of the Local Oscillator (LO)
6. Interconnect of the RF transmit and receive signals
7. Configuration of the test system control interfaces
8. Connection of an optional external trigger

Unit 1 (Primary) - Channel 1 and 2 Configuration Requirements

The TAS 4500 that is designated as Unit 1 (primary) will provide channels 1 and 2 of the 4-channel setup. This unit must provide the SYNC and 10 MHz reference signals to Unit 2.

Unit 2 - Channel 3 and 4 Configuration Requirements

The TAS 4500 that is designated as Unit 2 will provide channels 3 and 4 of the 4-channel setup. This unit must input the SYNC and 10 MHz reference signals from Unit 1 (Primary).

10 MHz Reference Distribution

A 10 MHz reference signal is used to synchronize the processing clocks in each of the TAS 4500s. A 10 MHz signal is output from the rear panel of Unit 1 and distributed to Unit 2. The 10 MHz distribution includes the following cables and accessories:

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (3 feet) Cable between TAS 4500s

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	EXT REF I/O connector on the Unit 1 (Primary)	EXT REF I/O connector on Unit 2

Synchronization Signal Distribution

System synchronization signals are output from the rear panel of Unit 1 (primary) and distributed to Unit 2. These TTL digital signals are used to provide synchronization of the digital signal processing between the two 4500 units that are configured in a 4-channel test setup. The 4500 that is programmed to be Unit 1 (primary) is the source of the hardware sync signals used by Unit 2. To access the RJ-45 jacks required to make the connections outlined below, the cover plate on the rear panel of each unit over the SYNC IN and SYNC OUT ports will need to be removed. This can be accomplished by loosening the two thumb screws holding the cover plate in place using a regular screw driver. See Section 1.2.2 to locate the SYNC IN/SYNC OUT connectors on the rear panel.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	RJ-45 to RJ-45 Cable (3 foot) Cable between two TAS 4500 for synchronization

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
RJ-45 (4 foot)	SYNC OUT connector on Unit 1	SYNC IN connector on Unit 2

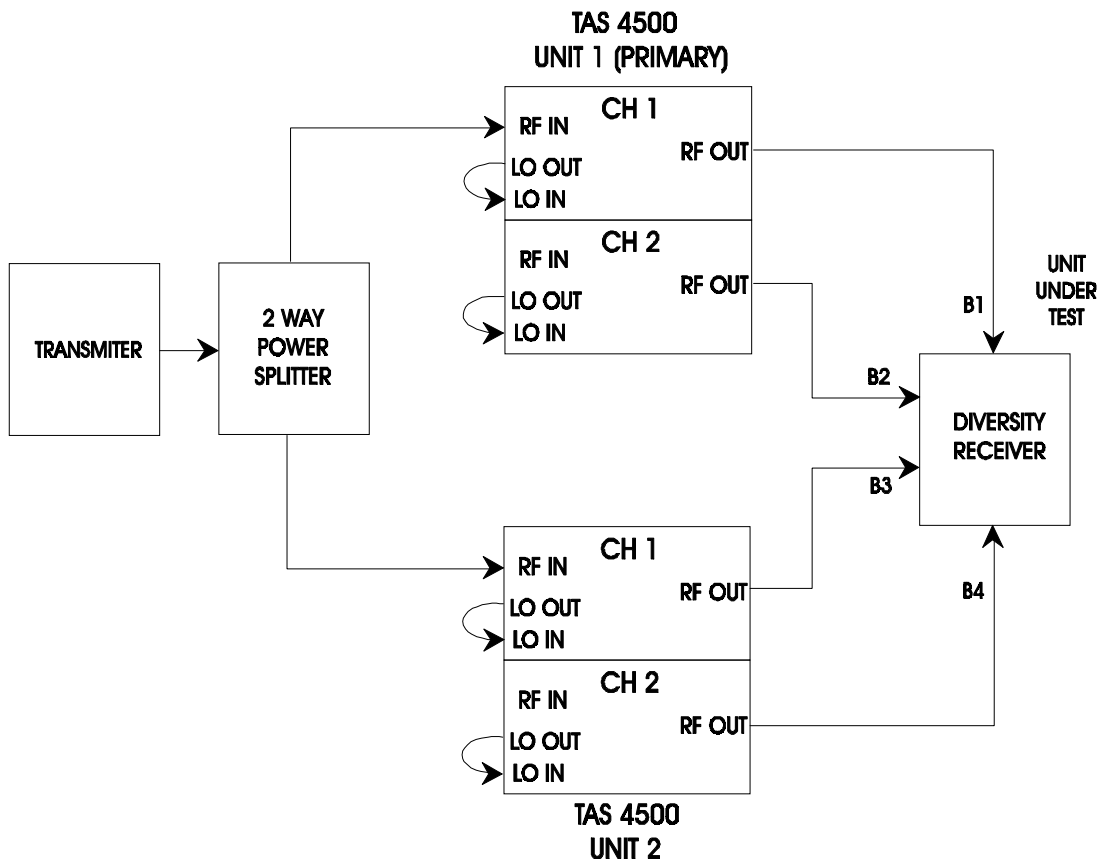


Figure 1-6. 4-channel RF Signal Distribution

Configuration of the Local Oscillator (LO)

NOTE: The configuration of the LOs described below is a simple and cost effective approach for providing each channel of the 4500 with its required LO. However, there are several other LO configurations that may be suitable for your test setup.

An LO (Local Oscillator) signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal. Refer to Section 8.0. "Technical Specifications" for the required LO frequency and level.

1. For each 4500, install a short cable from the N type connector labeled "CHANNEL 1 LO OUT" to the "CHANNEL 1 LO IN" connector on the front panel of the TAS 4500 shown in Figure 1-6.
2. For each 4500, install a short cable from the N type connector labeled "CHANNEL 2 LO OUT" to the "CHANNEL 2 LO IN" connector on the front panel of the 4500.

Interconnect of the RF Transmit and Receive Signals

NOTE: An attenuator is required if the transmit power is greater than the specified input signal level range of the 4500 (-10 dBm is the nominal; see technical specifications for limits). The loss required by the RF attenuator depends on the transmitter's output power. A 6 watt (38 dBm) transmitter with a 50 dB attenuator would present the power splitter with -12 dBm (38 dBm-50 dB).

1. Install a cable from the antenna jack of the RF transmitter to the input of a 50 Ω 1 to 2 power splitter. The power splitter is needed to split the transmit signal to drive the channel inputs of this dual TAS 4500 setup. In this case, the Channel Configuration parameter should be set to "diversity" mode to allow the Channel 1 RF Input to be shared by both Channel 1 and Channel 2. See Section 2.4.10 for additional details on setting the Channel Configuration parameter.
2. Install a cable from the two splitter outputs to the "CHANNEL 1 RF IN" N type connectors on the front panel of both of the units in the test setup.
3. Install a cable from the "CHANNEL 1 RF OUT" and "CHANNEL 2 RF OUT" N type connectors on the two units to each of the four inputs of the receiver.

Configuration of the Test System Control Interfaces

The TAS 4500 4-channel test system is controlled by TASKIT/4500 software that executes on an IBM compatible PC. The required method for communication with the TAS 4500 units is via direct GPIB control. This setup is shown in the diagram below.

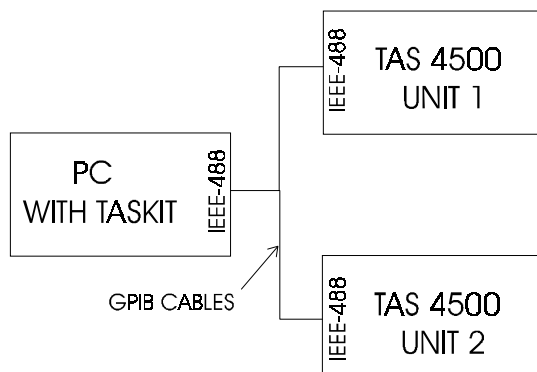


Figure 1-7. 4-channel Test Setup

The following is a list of helpful tips that should be considered when using TASKIT/4500 to control a TAS 4500 4-channel test system.

1. The remote protocol configuration for both 4500 units must be setup to match the selections in the COMMUNICATIONS OPTIONS menu of TASKIT. The remote protocol is configured from the CONFIG menu on the front panel of the 4500. Typical selections are as follows:

INSTRUMENT	PROTOCOL	GPIB ADDRESS
Unit 1 (Primary)	GPIB	01
Unit 2	GPIB	02

2. Each instrument will be placed in remote control mode when TASKIT connects to the units. Do not take the TAS 4500 units out of remote control mode once communication has been established with the test system. If the 4500 is put into local mode then back to remote mode it will be placed into a state that is not compatible with the control requirements of the TASKIT software. This will result in improper operation of the test system.
3. Additional information on the diversity and smart antenna applications can be found in Section 3.3. Details on the Dynamic Environment Emulation application can be found in Section 3.2.

Connection of an Optional External Trigger

NOTE: The external trigger is not a required input and does not need to be provided unless external synchronization is necessary for the test application.

If you wish to use an external trigger input to control the state changes in either Dynamic Environment Emulation or the Random Angle of Arrival Test, you must add the following cable connection.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (6 feet) Cable from external trigger source to Unit 1(Primary)

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	External trigger source	TRIG IN connector on Unit 1 (Primary)

NOTE: The external trigger source is only provided to Unit 1 (Primary). The remaining units in the test system receive synchronization information from Unit 1 (Primary) through the SYNC IN/ SYNC OUT interconnection outlined above.

Additional information on the signaling requirements for the external trigger can be found in Section 8.0 “Technical Specifications.”

Details on how to apply the external trigger in the RAOA test can found in Section 3.3. Details on the application of the external trigger in Dynamic Environment Emulation Mode can be found in Section 3.2.

1.3.5.2. Six Channel System Setup

The following operations are required for the proper installation of a 6-channel test setup:

1. Unit 1 (Primary) - Channel 1 and 2 configuration requirements
2. Unit 2 (Channel 3 and 4) and Unit 3 (Channel 5 and 6) configuration requirements
3. 10 MHz reference distribution
4. Synchronization signal distribution
5. Configuration of the Local Oscillator (LO)
6. Interconnect of the RF transmit and receive signals
7. Configuration of the test system control interfaces
8. Connection of an optional external trigger

Unit 1 (Primary) - Channel 1 and 2 Configuration Requirements

The TAS 4500 that is designated as Unit 1 (primary) will provide channels 1 and 2 of the 6-channel setup. This unit must provide the SYNC and 10 MHz reference signals to Unit 2 and Unit 3.

Unit 2 (Channel 3 and 4) And Unit 3 (Channel 5 and 6) Configuration Requirements

The TAS 4500s that are designated as Unit 2 and Unit 3 will provide channels 3, 4, 5, and 6 of the 6-channel setup. These units must input the SYNC and 10 MHz reference signals from Unit 1 (Primary).

10 MHz Reference Distribution

A 10 MHz reference signal is used to synchronize the processing clocks in each of the TAS 4500s. A 10 MHz signal is output from the rear panel of Unit 1 and distributed to Unit 2 and Unit 3. The 10 MHz distribution includes the following cables and accessories:

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
3	BNC to BNC Cable (3 feet) Cable between TAS 4500s
1	1-to-3 splitter For splitting the 10 MHz Reference signal
1	BNC 50 Ω termination

The following connections are required.

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	EXT REF I/O connector on the Unit 1 (Primary)	"S" port on the 1 to 3 splitter
BNC	Port 1 of the 1 to 3 splitter	EXT REF I/O connector on Unit 2
BNC	Port 2 of the 1 to 3 splitter	EXT REF I/O connector on Unit 3
50 Ω term	Port 3 of the 1 to 3 splitter	

Synchronization Signal Distribution

System synchronization signals are output from the rear panel of Unit 1 (primary) and distributed to Unit 2 and Unit 3. These TTL digital signals are used to provide synchronization of the digital signal processing between the three 4500 units that are configured in a 6-channel test setup. The 4500 that is programmed to be Unit 1 (primary) is the source of the hardware sync signals used by Unit 2 and Unit 3. To access the RJ-45 jacks required to make the connections outlined below, the cover plate on the rear panel of each unit over the SYNC IN and SYNC OUT ports will need to be removed. This can be accomplished by loosening the two thumb screws holding the cover plate in place using a regular screw driver. See Section 1.2.2 to locate the SYNC IN/SYNC OUT connectors on the rear panel.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
2	RJ-45 to RJ-45 Cable (3 feet) Cable between TAS 4500s for synchronization

The following connections are required.

CABLE TYPE	CONNECT FROM	CONNECT TO
RJ-45 (4 foot)	SYNC OUT connector on Unit 1	SYNC IN connector on Unit 2
RJ-45 (4 foot)	SYNC OUT connector on Unit 2	SYNC IN connector on Unit 3

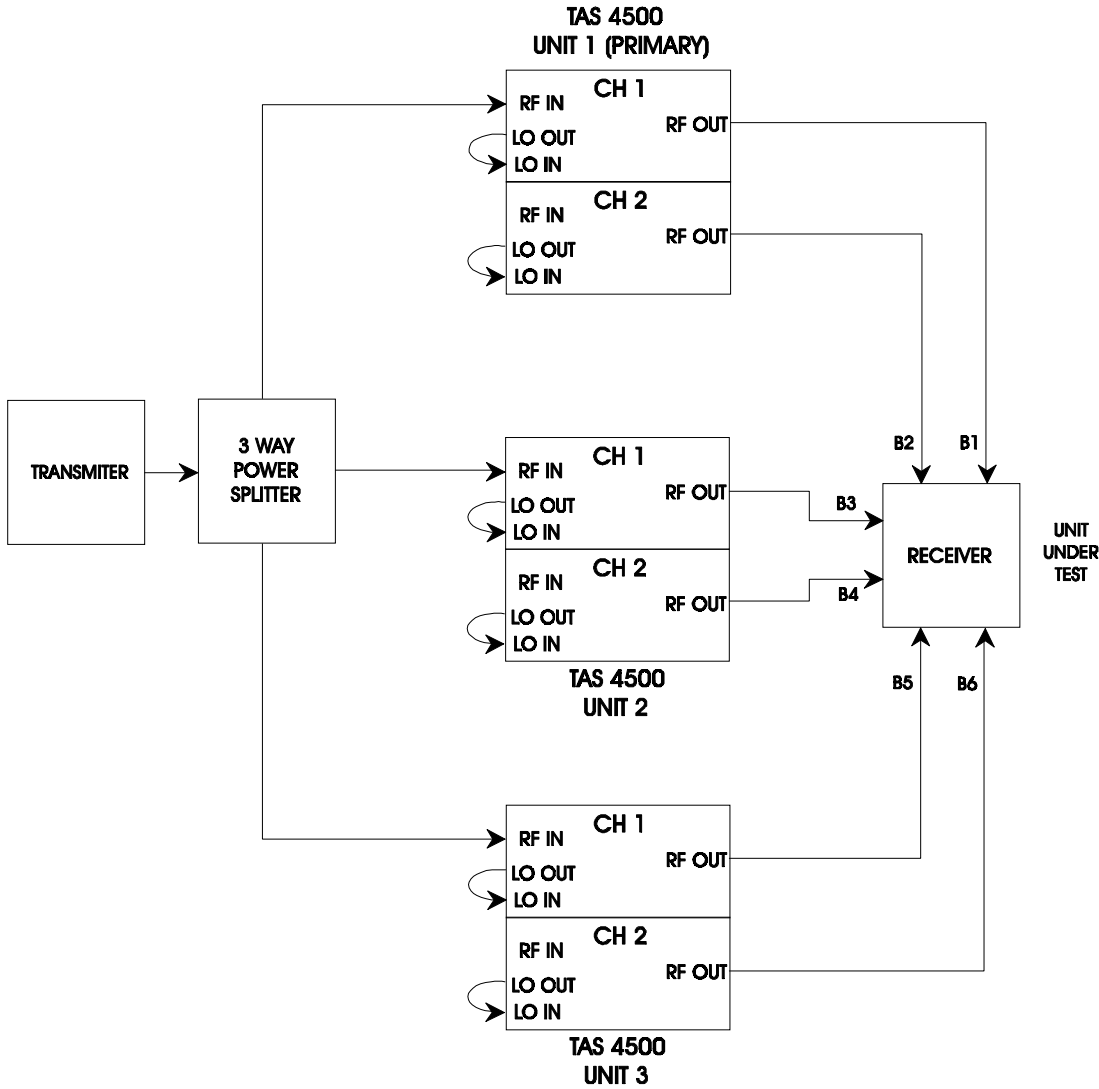


Figure 1-8. 6-channel RF Signal Distribution

Configuration of the Local Oscillator (LO)

NOTE: The configuration of the LOs described below is a simple and cost effective approach for providing each channel of the 4500 with its required LO. However there are several other LO configurations that may be suitable for your test setup.

An LO (Local Oscillator) signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal. Refer to Section 8.0. "Technical Specifications" for the required LO frequency and level.

1. For each 4500, install a short cable from the N type connector labeled "CHANNEL 1 LO OUT" to the "CHANNEL 1 LO IN" connector on the front panel of the TAS 4500 shown in Figure 1-10.
2. For each 4500, install a short cable from the N type connector labeled "CHANNEL 2 LO OUT" to the "CHANNEL 2 LO IN" connector on the front panel of the 4500.

Interconnect of the RF Transmit and Receive Signals

NOTE: An attenuator is required if the transmit power is greater than the specified input signal level range of the 4500 (-10 dBm is the nominal; see technical specifications for limits). The loss required by the RF attenuator depends on the transmitter's output power. A 6 watt (38 dBm) transmitter with a 50 dB attenuator would present the power splitter with -12 dBm (38 dBm-50 dB).

1. Install a cable from the antenna jack of the RF transmitter to the input of a 50 Ω 1 to 3 power splitter. The power splitter is needed to split the transmit signal to drive the channel inputs of this multiple TAS 4500 setup. In this case, the Channel Configuration parameter should be set to "diversity" mode to allow the Channel 1 RF Input to be shared by both Channel 1 and Channel 2. See Section 2.4.10 for additional details on setting the Channel Configuration parameter.
2. Install a cable from each of the three splitter outputs to the "CHANNEL 1 RF IN" N type connectors on the front panel of each of the three units in the test setup.
3. Install a cable from the "CHANNEL 1 RF OUT" and "CHANNEL 2 RF OUT" N type connectors on the three units to each of the six inputs of the receiver.

Configuration of the Test System Control Interfaces

The TAS 4500 6-channel test system is controlled by TASKIT/4500 software that executes on an IBM compatible PC. The required method for communication with the TAS 4500 units is via direct GPIB control. This setup is shown in the diagram below.

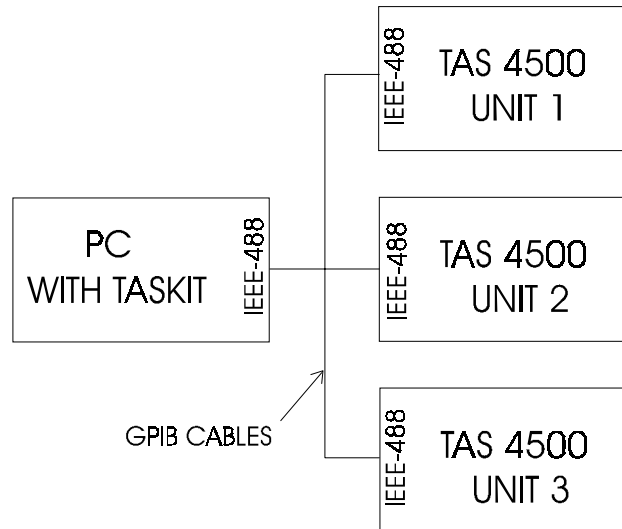


Figure 1-9. 6-channel Test Setup

The following is a list of helpful tips that should be considered when using TASKIT/4500 to control the TAS 4500 6-channel test system.

1. The remote protocol configuration for all 4500 units must be setup to match the selections in the COMMUNICATIONS OPTIONS menu of TASKIT. The remote protocol is configured from the CONFIG menu on the front panel of the 4500. Typical selections are as follows:

INSTRUMENT	PROTOCOL	GPIB ADDRESS
Unit 1 (Primary)	GPIB	01
Unit 2	GPIB	02
Unit 3	GPIB	03

2. Each instrument will be placed in remote control mode when TASKIT connects to the units. Do not take the TAS 4500 units out of remote control mode once communication has been established with the test system. If the 4500 is put into local mode then back to remote mode it will be placed into a state that is not compatible with the control requirements of the TASKIT software. This will result in improper operation of the test system.

3. Additional information on the diversity and smart antenna applications can be found in Section 3.3. Details on the Dynamic Environment Emulation application can be found in Section 3.2.

Connection of an Optional External Trigger

NOTE: The external trigger is not a required input and does not need to be provided unless external synchronization is necessary for the test application.

If you wish to use an external trigger input to control the state changes in either Dynamic Environment Emulation or the Random Angle of Arrival Test, you must add the following cable connection.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (6 feet) Cable from external trigger source to Unit 1(Primary)

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	External trigger source	TRIG IN connector on Unit 1 (Primary)

NOTE: The external trigger source is only provided to Unit 1 (Primary). The remaining units in the test system receive synchronization information from Unit 1 (Primary) through the SYNC IN/ SYNC OUT interconnection outlined above.

Additional information on the signaling requirements for the external trigger can be found in Section 8.0 “Technical Specifications.”

Details on how to apply the external trigger in the RAOA test can found in Section 3.3. Details on the application of the external trigger in Dynamic Environment Emulation Mode can be found in Section 3.2.

1.3.5.3. Eight Channel System Setup

The following operations are required for the proper installation of an 8-channel TAS 4500 test setup:

1. Unit 1 (primary) – channel 1 and 2 configuration requirements
2. Unit 2 (channel 3 and 4), Unit 3 (channel 5 and 6), and Unit 4 (channel 7 and 8) configuration requirements
3. Interconnect of the 10 MHz Reference signals
4. Interconnect of the synchronization signals
5. Interconnect of the RF transmit and receive signals
6. Configuration of the Local Oscillator (LO)
7. Configuration of the test system control interfaces
8. Connection of an optional external trigger

Unit 1 (Primary) – Channel 1 and 2 Configuration Requirements

The TAS 4500 that is designated as Unit 1 (primary) will provide channels 1 and 2 of the 8-channel setup. This unit must provide the SYNC and 10 MHz reference signals to Unit 2, Unit 3, and Unit 4.

Unit 2 (Channel 3 and 4), Unit 3 (Channel 5 and 6), and Unit 4 (Channel 7 and 8) Configuration Requirements

The TAS 4500s that are designated as Unit 2, Unit 3, and Unit 4 will provide channels 3, 4, 5, 6, 7, and 8 of the 8-channel setup. These units must input the SYNC and 10 MHz Reference signals from Unit 1 (Primary).

10 MHz Reference Distribution

A 10 MHz reference signal is used to synchronize the processing clocks in each of the TAS 4500s. A 10 MHz signal is output from the rear panel of Unit 1 and distributed to Unit 2, Unit 3, and Unit 4. The 10 MHz distribution includes the following cables and accessories:

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
4	BNC to BNC Cable (3 feet) cable between TAS 4500s
1	1-to-3 splitter for splitting the 10 MHz Reference signal

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	EXT REF I/O connector on the Unit 1 (Primary)	“S” port on the 1 to 3 splitter
BNC	Port 1 of the 1 to 3 splitter	EXT REF I/O connector on Unit 2
BNC	Port 2 of the 1 to 3 splitter	EXT REF I/O connector on Unit 3
BNC	Port 3 of the 1 to 3 splitter	EXT REF I/O connector on Unit 4

Synchronization Signal Distribution

System synchronization signals are output from the rear panel of Unit 1 (primary) and distributed to Unit 2, Unit 3, and Unit 4. These TTL digital signals are used to provide synchronization of the digital signal processing between the four 4500 units that are configured in an 8-channel test setup. The 4500 designated to be Unit 1 (primary) is the source of the hardware sync signals used by Unit 2, Unit 3, and Unit 4. To access the RJ-45 jacks required to make the connections outlined below, the cover plate on the rear panel of each unit over the SYNC IN and SYNC OUT ports will need to be removed. This can be accomplished by loosening the two thumb screws holding the cover plate in place using a regular screw driver. See Section 1.2.2 to locate the SYNC IN/SYNC OUT connectors on the rear panel.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
3	RJ-45 to RJ-45 Cable (3 feet) Cable between TAS 4500s for synchronization

The following connections are required.

CABLE TYPE	CONNECT FROM	CONNECT TO
RJ-45 (4 foot)	SYNC OUT connector on Unit 1	SYNC IN connector on Unit 2
RJ-45 (4 foot)	SYNC OUT connector on Unit 2	SYNC IN connector on Unit 3
RJ-45 (4 foot)	SYNC OUT connector on Unit 3	SYNC IN connector on Unit 4

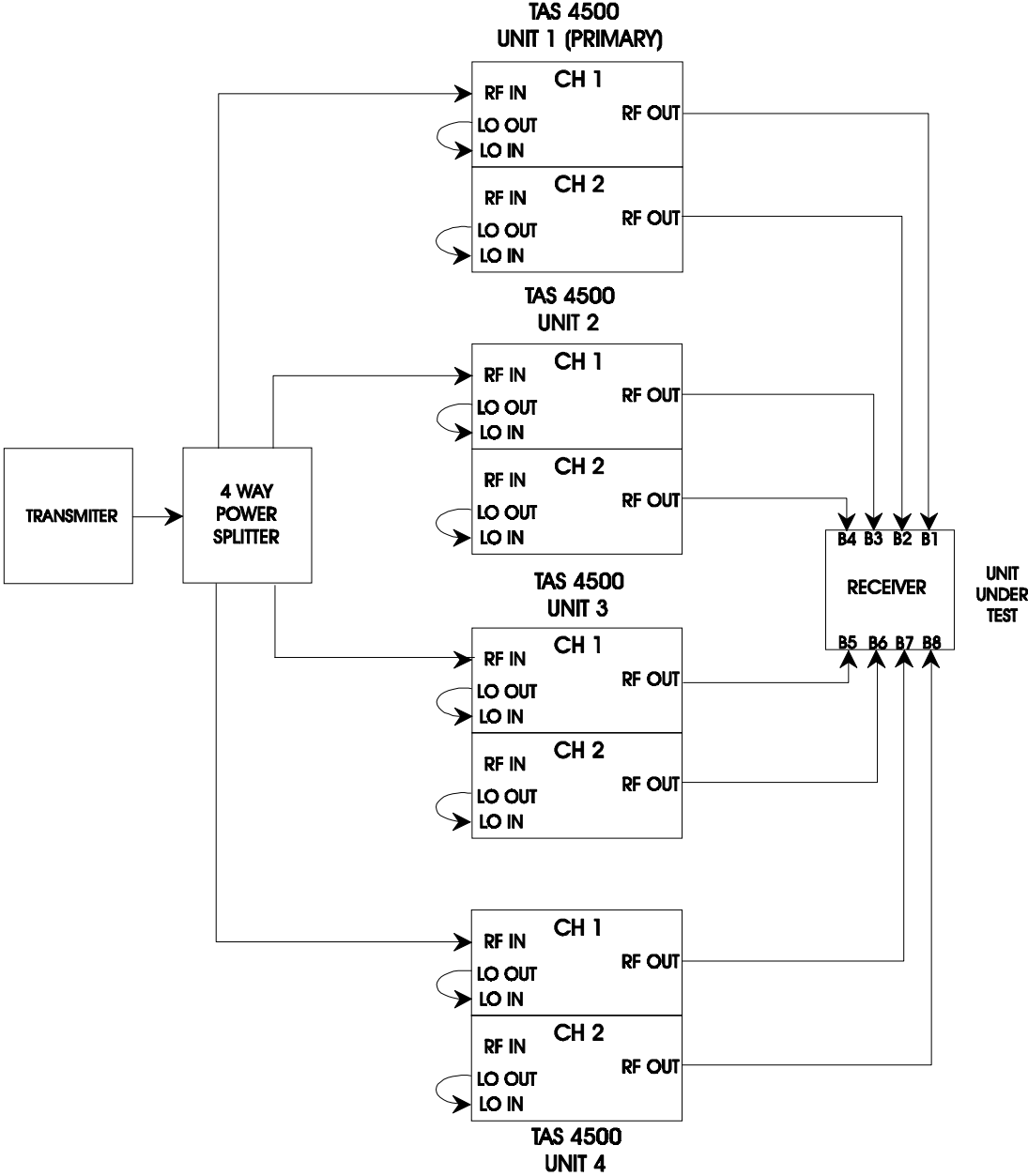


Figure 1-10. 8-channel RF Signal Distribution

Configuration of the Local Oscillator (LO)

NOTE: The configuration of the LOs described below is a simple and cost effective approach for providing each channel of the 4500 with its required LO. However there are also several other LO configurations that may be suitable for your test setup.

An LO (Local Oscillator) signal must be present at the LO IN for that channel to operate. The LO is used by the channel's down converter to translate the RF input signal to an internal IF signal, and by the channel's up converter to translate the IF signal back to an RF output signal. Refer to Section 8.0 "Technical Specifications" for the required LO frequency and level.

1. For each 4500, install a short cable from the N type connector labeled "CHANNEL 1 LO OUT" to the "CHANNEL 1 LO IN" connector on the front panel of the TAS 4500 shown in Figure 1-10.
2. For each 4500, install a short cable from the N type connector labeled "CHANNEL 2 LO OUT" to the "CHANNEL 2 LO IN" connector on the front panel of the 4500.

Interconnect of the RF Transmit and Receive Signals

NOTE: An attenuator is required if the transmit power is greater than the specified input signal level range of the 4500 (-10 dBm is the nominal, see technical specifications for limits). The loss required by the RF attenuator depends on the transmitter's output power. A 6 watt (38 dBm) transmitter with a 50 dB attenuator would present the power splitter with -12 dBm (38 dBm-50 dB).

1. Install a cable from the antenna jack of the RF transmitter to the input of a 50 Ω 1 to 4 power splitter. The power splitter is needed to split the transmit signal to drive the channel inputs of this multiple TAS 4500 setup. In this case, the Channel Configuration parameter should be set to "diversity" mode to allow the Channel 1 RF Input to be shared by both Channel 1 and Channel 2. See Section 2.4.10 for additional details on setting the Channel Configuration parameter.
2. Install a cable from each of the four splitter outputs to the "CHANNEL 1 RF IN" N type connectors on the front panel of each of the four units in the test setup.
3. Install a cable from the "CHANNEL 1 RF OUT" and "CHANNEL 2 RF OUT" N type connectors on the four units to each of the eight inputs of the receiver.

Configuration of the Test System Control Interfaces

The TAS 4500 8-channel test system is controlled by TASKIT/4500 software that executes on an IBM compatible PC. The required method for communication with the TAS 4500 units is via direct GPIB control. This setup is shown in the diagram below.

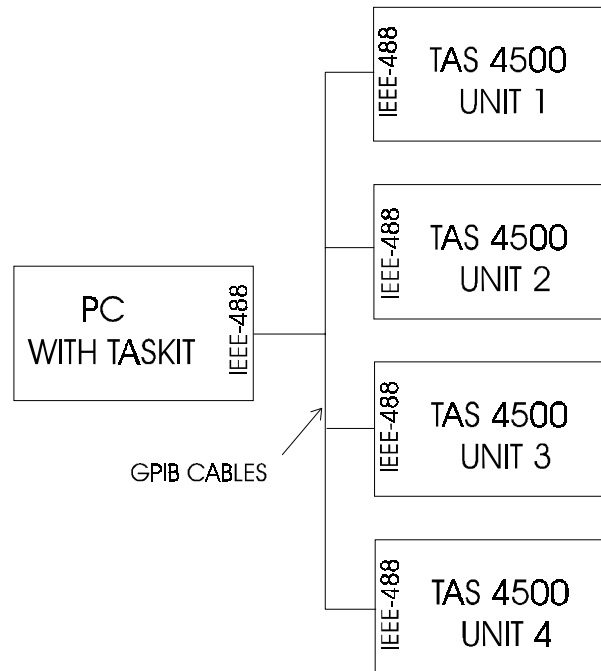


Figure 1-11. 8-channel Test Setup

The following is a list of helpful tips that should be considered when using TASKIT/4500 to control the TAS 4500 8-channel test system.

1. The remote protocol configuration for all 4500 units must be setup to match the selections in the COMMUNICATIONS OPTIONS menu of TASKIT. The remote protocol is configured from the CONFIG menu on the front panel of the 4500. Typical selections are as follows:

INSTRUMENT	PROTOCOL	GPIB ADDRESS
Unit 1 (Primary)	GPIB	01
Unit 2	GPIB	02
Unit 3	GPIB	03
Unit 4	GPIB	04

2. Each instrument will be placed in remote control mode when TASKIT connects to the units. Do not take the TAS 4500 units out of remote control mode once communication has been established with the test system. If the 4500 is put into local mode then back to remote mode it will be placed into a state that is not compatible with the control requirements of the TASKIT software. This will result in improper operation of the test system.
3. Additional information on the diversity and smart antenna applications can be found in Section 3.3. Details on the Dynamic Environment Emulation application can be found in Section 3.2.

Connection of an Optional External Trigger

NOTE: The external trigger is not a required input and does not need to be provided unless external synchronization is necessary for the test application.

If you wish to use an external trigger input to control the state changes in either Dynamic Environment Emulation or the Random Angle of Arrival Test, you must add the following cable connection.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (6 feet) Cable from external trigger source to Unit 1(Primary)

The following connections are required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	External trigger source	TRIG IN connector on Unit 1 (Primary)

NOTE: The external trigger source is only provided to Unit 1 (Primary). The remaining units in the test system receive synchronization information from Unit 1 (Primary) through the SYNC IN/ SYNC OUT interconnection outlined above.

Additional information on the signaling requirements for the external trigger can be found in Section 8.0 “Technical Specifications.”

Details on how to apply the external trigger in the RAOA test can found in Section 3.3. Details on the application of the external trigger in Dynamic Environment Emulation Mode can be found in Section 3.2.

1.4. Feature Release History

The following information provides a summary of the feature releases of the 4500 that have occurred since the initial Version 1.00 release.

Version 5.31

- Performance enhancements have been made to the FLEX5-EFX option.

Version 5.30

- Added a new mode of AOA Variation to the Angle of Arrival Test available as part of the Smart Antenna feature. The AOA Test now supports Linear variation of the Angle of Arrival in addition to the original Uniform Random AOA variation.

Version 5.23, 5.24, and 5.25

- An isolated issue involving the storage of calibration data in the system was discovered. This required some System Operating Firmware modifications to assure the integrity of the data during operation.

Version 5.22

- Updates were made to support Interference Mode (MODE4) of the Channel Configuration (PATHSW) parameter. This change permits Channel 1 and Channel 2 to have independent Input Reference Level values when the unit is operating in this Mode.

Version 5.21

- Updates were made to support the operation of the Overload LEDs for units configured for the factory installed Diversity Interference application.

Version 5.20

- Added both remote command support and TASKIT support for the new 3GPDP dynamic test capability. The complete operation of 3GPDP has now been incorporated in this manual
- Added support within Dynamic Environment Emulation (DEE) for pausing a test in progress and defining start and stop state numbers within a large file. A Time Stamp column has also been added to the Excel template to permit easy conversion of active state number to total elapsed test time.
- Added limited DEE support for Accelerated State Duration permitting 5 to 9msec state durations to be utilized.
- A new mode (MODE4) has been added to the PATHSW command to permit the Channel Configuration to be set to Interference Mode.

Version 5.11

- A modification was made to the System Operating Firmware to improve the performance of the internal system memory restoration during the power up sequence of the instrument.

Version 5.10

- Optional RF Operation to 4 GHz has been added to the system.
- The ATT3 RF Attenuator option has been added. Please see Section 8.0 “Technical Specifications” for the capabilities of this new module.
- The Channel Configuration parameter has been added to allow the user to dynamically combine the RF Channels within the unit to provide single channel 6 or 12 path test setups with no external hardware required.
- The optional IF Breakout (IFBO) capability has been added to allow the user to access the 140 MHz point in the RF Up Convert path. The user may now add impairments including AWGN to the signal at 140 MHz prior to the final RF Up Conversion step.
- A new Channel/Path command (CHx_Py:FS_DOPP) has been added to increase the resolution of the frequency shift parameter to 0.01 Hz steps.
- Several enhancements have been made to the Dynamic Environment Emulation Mode. These include support for state durations as short as 10 ms, external state trigger input capability, and support for control of the TASKIT software from a remote PC.
- A new selection has been added to the I/O Frequency Tracking Mode (CNFG:IOFTM) parameter. The addition of the “Ext BC (4-6 GHz)” option supports integration of the TAS 4500 with the TAS 5046 Block Converter to provide RF operation in the 4-6 GHz range.

Version 5.00

- The minimum delay resolution was changed from 1.0 ns to 0.5 ns. This change will impact the supported range and resolution of the path delay command (/CHy_Px:DELAY/) in a Version 5.0 or later system. See section 6.0 for details.
- The IF signal processing hardware has been upgraded to provide improved system performance.
- The dynamic test capability of the TAS 4500 has been upgraded with the introduction of the Dynamic Environment Emulation feature. This provides faster download of state data to provide better real-time emulation capability. The Dynamic Environment Emulation feature is available through TASKIT/4500.

- Support was added to allow programmable correlation options for both 6 Branch and 8 Branch Diversity Testing.
- Additional features to support smart antenna test applications have been added including the Random Angle of Arrival test capability. This feature is available through TASKIT/4500.
- The available Doppler Frequency range has been increased from (–740.0 to –1.0, 1.0 to 740.0 Hz) to the new ranges of (–1000.0 to –1.0, 1.0 to 1000 Hz) for Fading Emulation Method Type 1 and (–1000.0 to –0.1, 0.1 to 1000 Hz) for Fading Emulation Method Type 2.
- The dominant parameter used to determine the Doppler Shift on any path in the TAS 4500 will now be the Velocity setting. Any change to the carrier frequency associated with a particular path will maintain the same velocity while updating the associated Doppler Shift.
- A new Configuration parameter, Fading Doppler Tracking Mode (CNFG:FDTM), has been introduced to allow the user to determine how the Doppler Shift is controlled within the unit. The parameter options include System (SYS), Channel (CHAN), and Path (PATH) modes.
- A new Configuration parameter, I/O Frequency Tracking Mode (CNFG:IOFTM), will allow the user to independently set the RF Carrier Frequency and the Emulation Carrier Frequency of the TAS 4500.
- Support for two new fading types, Frequency Shift Rayleigh and Frequency Shift Rician, have been added.

Version 4.51/Version 4.61

- Support for calibration of the RF Attenuators added (ATT1 option) to improve attenuator accuracy across the RF Frequency range of operation.
- Updates made in Dynamic Parameter Emulation mode (MODE2) to fix performance issues with the path delay parameter.

Version 4.60

- A new front panel with new keys and a larger display was added.
- The Channel Bypass feature was incorporated with front panel buttons.

Version 4.50

- Support was added for a custom system option that extended the maximum carrier frequency from 3.0 GHz to 3.6 GHz.
- Support was added for a custom system option with an IF bandwidth of 8 MHz. All features of this system are the same as a 15 MHz bandwidth system.

- Support was added for a custom “one path delay mode” of operation. This new mode is only available via the remote interface.
- When in Dynamic Parameter Emulation mode the current state number and GPIB address will be transmitted out the AUX port of the TAS 4500 at every state transition.

Version 4.42

- Signal processing improvements were made in the performance of the relative path delay when the system is equipped with the extended delay option. No menus or remote commands were added or changed.

Version 4.41

- Signal processing improvements were made in the performance of the filtered noise emulation method. No menus or remote commands were added or changed.
- To optimize spurious performance, the 4-branch diversity test configuration was changed. The secondary unit (Channels 3 and 4) is now required to input the 10 MHz reference signal from the primary unit (Channels 1 and 2).

Version 4.40

- An attenuator Type 4 option was added to support the carrier frequency range of 800 to 2700 MHz. This attenuator has a range of 0 to 80 dB and a 0.1 dB resolution.
- The recallable ROM based configuration files that setup the factory default parameters and the industry standard test procedures were changed to use the filtered noise emulation method for multipath fading.
- The configuration files that setup the industry standard test files were changed to have both channel 1 and channel 2 share the same carrier frequency. This configures the test setup to operate as the forward channel (base station to mobile link).

Version 4.31

- The synchronization method that is used between internal DSPs was improved. This eliminates the potential for the improper generation of path modulation. No menus or remote commands were added or changed.

Version 4.30

- An RF Channel Bypass(FLEX4-CBP) option was added. This permits the bypass of both the RF Front End and the IF signal processing circuitry of the TAS 4500. When used in this mode, the unit will pass RF IN directly to RF OUT with minimal insertion loss.

- Added the ability to put the TAS 4500 into REMOTE operation over the GPIB control interface.

Version 4.20

- A 26 MHz IF bandwidth option was added. This includes support for a 26 MHz RF module and an EFX-26 enhanced RF front end option.

Version 4.10

- Nakagami Fading, with programmable M value and angle of arrival, and Rician Fading, with programmable K factor and LOS arrival angle, were added to the available selections for modulation type. This is only available on TAS 4500 units that are equipped with a Type 5 or later DSP module.
- The RF Carrier Range was expanded to cover carrier frequencies ranging from 25 MHz to 3.0 GHz while providing more consistent RF output levels and insertion loss through the TAS 4500.
- A 940 to 2860 MHz LO option was added to support the carrier frequency range of 800 MHz to 3.0 GHz. This option supersedes the LO1 and LO2 options.
- A Type 3 Output Attenuator will support 0 to 95.5 dB of attenuation in 0.5 dB steps while covering the entire RF Carrier Range of 25 MHz to 3.0 GHz.
- The resolution of the programmable correlation for 2, 4, and 8 Branch Diversity applications has increased from 1 digit to 2 digits. This requires the use of the new ECORR command.
- New calibration capability has been added to improve the performance of the Input Reference Level and Peak Measurement functions across the entire RF Carrier Range. The range of the Input Reference Level for both 15 MHz and 6 MHz systems has been adjusted to a standard +5 to -30 dB range
- A new option has been added to the system configuration menu (CONFIG\SYSTEM) and remote command set (CNFG:REF) to allow user selection of either an internal or external 10 MHz reference for the signal processing modules in the TAS 4500.
- Dynamic Parameter Emulation Mode (MODE2) and the associated PATHS: D, RANGE, S and CHi_Pj:D remote commands were amended to provide up to 512 programmable states through the associated TASKIT control interface and to allow the use of Nakagami and Rician Fading within MODE2.
- An Insertion Loss Estimation Feature is added and is only available through the TASKIT control interface.
- A Filter Bypass (FLEX4-FBP) option was added. This extends the frequency range of operation to 25-3000 MHz when purchasing the Enhanced Front End option. Below 800 MHz the enhanced feed-through suppression is automatically bypassed.

Version 4.00

- The Emulation Mode parameter was added to the remote command set (CNFG:EMULM). MODE1 is the static mode, while MODE2 is a dynamic mode. MODE2 allows the Dynamic Parameter Emulation Mode to be available through TASKIT.
- To support the dynamic parameter emulation mode the PATHS remote command group was added. This command group supports changes that effect all paths within one TAS 4500.
- The following remote commands were created to support dynamic parameter emulation mode: PATHS:D, HALT, LOOP, RANGE, RUN, STEP, S and CHi_Pj:D.
- A user selectable Fading Repetition Rate was added to the system configuration menu (CONFIG\SYSTEM) and remote command set (PATHS:FADREP). Three nominal rates are available, 20 minutes, 27 seconds and 24 hours.
- A user selectable Fading Emulation Method was added to the system configuration menu (CONFIG\SYSTEM) and remote command set (CONFIG:FADEM). Two fading emulation methods are available; Jakes and filtered noise.
- A user selectable Fading Power Spectrum was added to the channel\path\modulation menu. Four spectrums are available with the filtered noise emulation method: classical 6 dB, flat, classical 3 dB and rounded. Two spectrums are available with the Jakes emulation method: classical 6 dB and flat.
- An optional Extended Relative Path Delay feature is now available. The maximum delay range is now 1.6 ms for a 6 MHz bandwidth system and 0.8 ms for a 15 MHz bandwidth system.
- A new LO control mode selection was added. The mode is “external from 4500” and is used when an LO signal from another 4500 channel is being used to drive the selected channel.

Version 3.11

- The method used to decorrelate Channel 1 Path 1 and Channel 2 Path 1 from each other was modified. The new method corresponds to that used to decorrelate all other paths.

Version 3.10

- The 4-branch Diversity and 8 Branch Diversity test setups can now support 6 paths per branch.
- A 200 to 400 MHz LO option was added to support carrier frequencies of 60 to 260 MHz and 340 to 540 MHz.

- Type 2 Output Attenuator was made available. The Type 2 output attenuator supports a 0 to 80.0 dB attenuation range in 0.5 dB step size over a frequency range of 25 MHz to 2500 MHz.
- Rayleigh Fading with Frequency Shift was added to the available selections for modulation type on TAS 4500 units that are equipped with a Type 3 or later DSP module.
- The Correlation Algorithm parameter was added in the system configuration menu (CONFIG\SYSTEM) and remote command set (CNFG:CORRAL). The path correlation can now be programmed as Envelope or as Component. Envelope correlation is between the envelope of the Rayleigh faded signals at the output of the associated channels. While Component defines the correlation between the In-Phase components of the associated Rayleigh faded signals in addition to the correlation between the Quadrature components.

Version 3.00

- The capability to accommodate up to 12 independent transmission paths in a single TAS 4500 was added.
- A wideband 15 MHz channel option was made available with 1 nsec relative delay resolution over a range of 100 μ s.
- A PCMCIA System Software Interface was added to facilitate firmware upgrades to the TAS 4500 while in the field.
- The ability to select between two different Rayleigh power spectrum shapes was added.
- The syntax of the remote commands pertaining to the Path parameters was modified.
- The Channel Paths Correlation (CNFG:CPCORR) parameter was eliminated from the menus and remote command set. Paths within a channel will always be uncorrelated.
- The Configuration Options (CNFG:OPT) parameter was eliminated from the remote command set. It has been superseded by the Configuration System (CNFG:SYS) parameter which offers a superset of the information previously reported by the Configuration Options parameter.
- The Delay Units Parameter (CNFG:DLYU) was eliminated from the front panel menus. The units will always be μ sec.
- The Path Model parameter (MODEL) was replaced in the menus and remote commands set (CNFG:PMODL) with the Channel Correlation parameter (CHANNEL CORR) and remote command (CNFG:CHCORR).

Version 2.00

- Support of the 4500 FLEX was added including a new, more flexible RF front end, additional internal local oscillators, and 6 MHz bandwidth.
- GSM Rician fading was added to the available selections for modulation type on path 1 only.
- The capability to edit the modulation parameters (including the effective velocity) without causing the path to be momentarily disabled was added.

Version 1.11

- Implementation of path delay was changed to correct the intermittent improper operation at a delay setting of 70 nsec. No menus or remote commands were added or changed.

Version 1.10

- Implementation of the “Path Model” parameter was changed to eliminate the requirement for the primary and secondary 4500 units, that form a 4-channel 12 path configuration, to directly communicate with each other. As a result the rear panel AUX port (9 pin D-sub connector) is no longer used. No menus or remote commands were added or changed.

2.0. LOCAL OPERATION

2.1. Overview

The TAS 4500 RF Channel Emulator can be operated either locally from the instrument's front panel, or remotely using either the instrument's RS-232 or GPIB control interfaces. For remote control, a computer or terminal is required to pass commands to the TAS 4500. Remote operation proves to be most effective when you need to perform automatic or repeated test scripts.

This section of the manual will describe the local operation of the TAS 4500. Section 6.0. "Remote Operation" describes the TAS 4500's remote command protocols and commands.

The TAS 4500 must either be in Remote Operation Mode or Local Operation Mode. It can never be in both modes at once. To toggle to Remote Operation Mode, simply set the unit to the desired remote protocol and begin sending commands. The letter 'R' will appear in the upper right corner of the LCD to indicate that the 4500 is in Remote Operation Mode. When in this mode, no parameters may be changed using the front panel keys, but browsing menus and viewing settings is still possible. To enter Local Operation Mode, press the **LOCAL** key. The 'R' indicator will disappear, signifying that the 4500 is no longer in Remote Operation Mode. Parameters can be adjusted via the front panel keys in Local Operation Mode.

2.2. Getting Started

This section explains step by step how to perform local control of some of the basic features of the TAS 4500. It is intended to familiarize the user with the local control through two examples. For more information on each menu and control key, refer to Section 2.3. "Menu Overview".

The first example guides the user through a series of simple local control operations to perform a parameter file recall. The second example shows the user how to change certain system parameters and then how to save the parameter configuration as a user defined file for later use.

2.2.1. Recalling Predefined Test Configurations

The TAS 4500 provides a set of predefined test configurations for many industry standards such as IS-54/136 (TDMA), IS-95 (CDMA), and GSM. These configurations are stored in ROM and can be recalled as often as needed. For detailed information on these files see Section 9.1 "Standard Test Profiles".

A predefined factory default file can be recalled. The default file sets the following parameters:

Default Values												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System I/O Frequency Tracking Mode – Carrier Line of Site Reference – PD (Path Doppler) Channel Configuration – Dual Channel											
Channel	1						2					
Input Reference Level	-10.0 dBm						-10.0 dBm					
Output Attenuator	0 dBm						0 dBm					
LO Mode	external						external					
Carrier Freq. (MHz)	900.00						900.00					
Alternate I/O Freq. (MHz)	900.00						900.00					
RF Channel	enabled						enabled					
Channel Max Doppler(Hz)	41.7						41.7					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	off	off	off	off	off	on	off	off	off	off	off
Relative Delay (µs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Modulation Type	none	none	none	none	none	none	none	none	none	none	none	none
Fading Doppler Freq. (Hz)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
LOS Doppler Freq. (Hz)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (Deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

By recalling any one of the predefined parameter configurations, the TAS 4500 can be configured for testing within seconds. Wireless communication devices can then be tested according to these specified standards. These predefined configurations can be easily recalled from the front panel by following the steps described below:

1. Select the File Recall menu by first pressing the **File** key on the front panel. The Recall File selection will appear on the third line of the front panel display as shown below:

```
FILE (PRESS ENTER TO PROCEED)
SAVE FILE : file0┘
RECALL FILE: default┘
```

2. Move the blinking cursor to the File Recall submenu selection by pressing the **Menu Navigation Down Arrow** key.
3. Change the configuration file parameter to the desired selection ("IS55-56_1" in this example) using the **Value +** or **Value -** key. You can experiment with changing the parameter value using these keys before proceeding to the next step. Here "IS55-56_1" is chosen as the desired parameter configuration file.

```
FILE (PRESS ENTER TO PROCEED)
SAVE FILE : file0┘
RECALL FILE: IS55-56_1┘
```

4. Execute the recall by pressing the **Enter** key. The front panel will display:

```
Recalling setup...
```

Then:

```
Setup recalled - Esc to continue
```

Indicating a successful configuration recall from the IS55-56_1 file.

If the TAS 4500 had not been equipped with the necessary hardware required for the desired configuration the following message would have been displayed:

```
Insufficient hardware configuration[ESC]
```

5. Press the **Escape** key to return to the File menu:

```
FILE (PRESS ENTER TO PROCEED)
SAVE FILE : file0↵
RECALL FILE: IS55-56_1↵
```

The TAS 4500 is now configured with the TAS defined IS55-56_1 parameter values.

2.2.2. Defining and Saving Custom Test Configurations

In addition to predefined parameter configuration files, the TAS 4500 can save up to five (file 0 to file 4) user defined configurations. These user defined configuration files can also be recalled in the same manner as described in Section 2.2.1, "Recalling Predefined Test Setups".

Defining a custom test setup can easily be done by first recalling the predefined configuration that is most similar to the desired setup, and then modifying those parameters that are different from the desired configuration.

After all the modifications have been made, the existing setup can be saved to one of the user files: file0, file1, file2, file3, or file4. This modified setup can then be recalled as described in Section 2.2.1.

WARNING: Any previous configuration in the user-defined file will be overwritten by the existing setup upon a save operation to the file. The following is an example of defining and saving a user defined parameter configuration that is based on the factory default configuration:

1. Recall the "**default**" configuration using the method described in section 2.2.1, "Recalling Predefined Test Configurations".
2. Select the Channel 1 Path Status Menu by first pressing the **Channel 1 Menu Tree** key and then using **Menu Navigation Down Arrow** key to arrive at the menu shown below. Once this menu is displayed, use the **Menu Navigation Right** and **Left Arrow** keys to position the blinking cursor on the Path 2 status field.

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	:on	:off	:off	
DELAY (μ s)	: 0.0000	:---	:---	
LOSS (dB)	: 0.0	:---	:---	

3. Change the Path 2 status parameter to **on** by pressing the **Value +** key:

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	:on	: <u>o</u> n	:off	
DELAY (μ s)	: 0.0000	: 0.0000	:---	
LOSS (dB)	: 0.0	: 0.0	:---	

4. Once the status parameter is changed to on, the Path 2 Characteristics can be accessed.

- Change the value of the Path 2 Delay from 0.000 μsec to 10.000 μsec as follows:

First, using the **Cursor Navigation Down and Right Arrow** keys position the blinking cursor on the Path 2 Delay parameter's tens digit as shown below. Then use the **Value +** key to change the value of this digit from a 0 to a 1. The Path 2 Delay will now be set to 10.000 μsec as shown in the following display:

CHANNEL1		PATH1		PATH2		PATH3	⇕⇔
STATUS	:	on	:	on	:	off	
DELAY (μs)	:	0.0000	:	<u>1</u> 0.0000	:	---	
LOSS (dB)	:	0.0	:	0.0	:	---	

Practice changing the Path 2 Delay parameter to other values using the Cursor Navigation keys and the Value keys before moving on to the next step.

- To save this new custom configuration to a user file, first begin by pressing the **FILE Menu Tree** key. The Save File menu selection will appear on the second line of the display as shown below:

FILE	(PRESS ENTER TO PROCEED)
SAVE FILE	: file0 <u>↓</u>
RECALL FILE:	default <u>↓</u>

- If this field is not already selected, move the blinking cursor to the Save File menu using the **Menu Navigation Up Arrow** key.
- Select the user file that you want to save the current configuration to by using the **Value +** or **Value -** key. Remember that the previous configuration of the file will be overwritten. For this example, this configuration will be saved to file 1:

FILE	(PRESS ENTER TO PROCEED)
SAVE FILE	: file1 <u>↓</u>
RECALL FILE:	default <u>↓</u>

- Execute the save operation by pressing the **Enter** key. The front panel will now display:

Setup saved - Esc to continue

10. Press the **Escape** key to return to the File menu:

```
FILE (PRESS ENTER TO PROCEED)
SAVE FILE : file1↓
RECALL FILE: default↓
```

This custom parameter configuration is now saved to file 1 and can be recalled in the same manner as any other predefined configuration. The parameters saved to a user-defined file, and which can subsequently be recalled are listed below:

Systems Configuration:

Velocity Units	Correlation Algorithm
Emulation Method	10 MHz Reference
Nominal Fading Repetition	Fading Doppler Tracking Mode
I/O Frequency Tracking Mode	Line of Site Reference
Channel Configuration	

Channel 1 & 2:

Carrier Frequency	Input Reference Level
LO Status	Output Attenuator
LO Frequency	RF Channel Status
Channel Maximum Doppler	Vehicle Speed
Alternate I/O Frequency	

Channel 1 & 2 Paths 1-6:

Status	Phase Shift
Delay	Shift Frequency
Loss	Log-Normal Status
Modulation	Log-Normal Standard Deviation
Fading Doppler Frequency	LOS Doppler Frequency
Log-Normal Rate	Velocity
Path Correlation (Channel 2 only)	Fading Power Spectrum

WARNING: The following parameters are not saved as part of a user-defined file:

```
Remote Protocol Parameters
Channel Correlation Type
```

2.3. Menu Overview

The TAS 4500 provides a convenient and easy to use hierarchical menu structure that gives easy access to all of its functions. This section will give you instructions on navigating through the TAS 4500 menu structure using the keys on the front panel. You will also find specific information about the different menus which appear in the TAS 4500 LCD display.

2.3.1. Menu Summary

There are four menu tree groups in the TAS 4500: CHANNEL 1, CHANNEL 2, CONFIG, and FILE. Each of these menus is represented by a key on the instrument's front panel. For example, to access the CONFIG menu tree, press the CONFIG key. These menu trees organize the TAS 4500's functionality so that you can find the instrument's features easily. Once you become familiar with the TAS 4500's menu structure, you will find it easy to use.

CHANNEL 1 Main Menu

The **CHANNEL 1** menu group controls the simulated unidirectional RF channel that consists of three, six, or twelve independently programmable transmission paths. This menu group allows I/O parameters such as carrier frequency, LO frequency, and input reference level, as well as RF channel parameters such as the number of paths in the channel model, relative path delay, fast and slow fading, frequency shift, phase shift, and relative path attenuation to be viewed and controlled.

The 12-path model can only be obtained by setting the Channel Configuration Parameter to single channel mode. Details on this parameter can be found in Section 2.4.10 "Setting the Channel Configuration." The menus for paths 7-12 are exactly the same as those shown below for paths 1-6 below.

The menu screens contained in the Channel 1 menu group are shown below.

With I/O Frequency Tracking Mode = Carrier (MODE1)

```

CHANNEL1                               ↓
CARRIER: 900.000MHz↓ LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm
OUTPUT ATTENUATOR:  0.0 dB

```

**With I/O Frequency Tracking Mode = I/O_Carrier (MODE2)
or Ext. BC(4-6 GHz) (MODE3).**

```
CHANNEL1      [I/O FREQ: 245.000MHZ]      ↓
CARRIER: 900.000MHz LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm
OUTPUT ATTENUATOR: 0.0 dB
```

```
CHANNEL1 | PATH1      | PATH2      | PATH3      ↕⇔
STATUS   :on        :on        :on
DELAY (μs): 200.0000: 300.0000: 400.0000
LOSS (dB) : 5.0     : 10.0     : 15.0
```

```
CHANNEL1 | PATH4      | PATH5      | PATH6      ⇐⇓
STATUS   :on        :on        :on
DELAY (μs): 100.0000: 0.0000: 0.0000
LOSS (dB) : 5.0     : 0.0     : 0.0
```

```
CHANNEL1 | PATH1      | PATH2      | PATH3      ↕⇔
MODULATN :rayl↓     :f_shift    :nakag↓
VEL (ft/s): 60.0   : 60.0     : 60.0
DOPP (Hz) : 54.9    : 54.90    : 54.9
```

```
CHANNEL1 | PATH4      | PATH5      | PATH6      ⇐⇓
MODULATN :rician↓    :phase↓     :fs+rayl↓
VEL (ft/s): 60.0   : ---      : 60.0
DOPP (Hz) : 54.9    : ---      : 54.9
```

```
CHANNEL1 | PATH1      | PATH2      | PATH3      ↑⇔
LOGNORMAL:on↓    :off        :on↓
```

```
CHANNEL1 | PATH4      | PATH5      | PATH6      ⇐⇓
LOGNORMAL:off    :off        :off
```

CHANNEL 1 CARRIER Submenu

```
CHANNEL1 SUBMENU      ↑
CARRIER FREQUENCY: 900.000MHz
(+/- TO EDIT, ESCAPE TO SET/EXIT)
```

CHANNEL 1 LO Submenu

```
CHANNEL1 SUBMENU (ESC TO EXIT)
LO FREQUENCY: 1040.0 MHz
```

CHANNEL 1 RAYLEIGH Submenu

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↗
RAYLEIGH | PATH1      | PATH2      | PATH3
SPECTRUM :classic6 :---          :---
```

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↖
RAYLEIGH | PATH4      | PATH5      | PATH6
SPECTRUM :---          :---          :---
```

CHANNEL 1 RICIAN Submenu

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↘↗
RICIAN   | PATH1      | PATH2      | PATH3
AOA (DEG) :---          :---          :---
AOA (Hz)  : [---      ] : [---      ] : [---      ]
```

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↗↖
RICIAN   | PATH1      | PATH2      | PATH3
K (dB)   :---          :---          :---
SPECTRUM :---          :---          :---
```

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↖↘
RICIAN   | PATH4      | PATH5      | PATH6
AOA (DEG) :   45.0 :---          :---
AOA (Hz)  : [ 100.00] : [---      ] : [---      ]
```

```
CHANNEL1 SUBMENU (ESC TO EXIT)      ↖↗
RICIAN   | PATH4      | PATH5      | PATH6
K (dB)   :   12.0 :---          :---
SPECTRUM :flat      :---          :---
```

CHANNEL 1 NAKAGAMI Submenu

CHANNEL1 SUBMENU (ESC TO EXIT)				↓⇒
NAKAGAMI	PATH1	PATH2	PATH3	
AOA (DEG)	:---	:---	: 45.0	
AOA (Hz)	: [---] : [---] : [100.00]	

CHANNEL1 SUBMENU (ESC TO EXIT)				↑⇒
NAKAGAMI	PATH1	PATH2	PATH3	
M	:---	:---	: 25	
SPECTRUM	:---	:---	: classic3	

CHANNEL1 SUBMENU (ESC TO EXIT)				⇐↓
NAKAGAMI	PATH4	PATH5	PATH6	
AOA (DEG)	:---	:---	:---	
AOA (Hz)	: [---] : [---] : [---] :

CHANNEL1 SUBMENU (ESC TO EXIT)				⇐↑
NAKAGAMI	PATH4	PATH5	PATH6	
M	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL 1 PHASE Submenu

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
PHASE	PATH1	PATH2	PATH3	
ANGL (DEG)	:---	:---	:---	

CHANNEL1 SUBMENU (ESC TO EXIT)				⇐
PHASE	PATH4	PATH5	PATH6	
ANGL (DEG)	:---	: 25.0	:---	

CHANNEL 1 FREQUENCY SHIFT+RAYLEIGH Submenu

NOTE: Selection available only when Fading Doppler Tracking Mode = Path
--

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
FS+RAYL	PATH1	PATH2	PATH3	
SHIFT (Hz)	:---	:---	: 0.0	
SPECTRUM	:---	:---	: classic6	

CHANNEL1 SUBMENU (ESC TO EXIT)				↩
FS+RAYL	PATH4	PATH5	PATH6	
SHIFT (Hz)	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL 1 FREQUENCY SHIFT+RICIAN Submenu

NOTE: Selection available only when Fading Doppler Tracking Mode = Path

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↔
FS+RICE	PATH1	PATH2	PATH3	
AOA (DEG)	:---	:---	: 0.0	
AOA (Hz)	:---	:---	: [41.7]	

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↩
FS+RICE	PATH4	PATH5	PATH6	
AOA (DEG)	:---	:---	:---	
AOA (Hz)	:---	:---	:---	

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↔
FS+RICE	PATH1	PATH2	PATH3	
K (dB)	:---	:---	: 0.0	
SPECTRUM	:---	:---	: classic6	

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↩
FS+RICE	PATH4	PATH5	PATH6	
K (dB)	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↔
FS+RICE	PATH1	PATH2	PATH3	
SHIFT (Hz)	:---	:---	: 0.0	

CHANNEL1 SUBMENU (ESC TO EXIT)				↕↩
FS+RICE	PATH4	PATH5	PATH6	
SHIFT (Hz)	:---	:---	:---	

CHANNEL 1 LOGNORMAL Submenu

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
LOGNORMAL	PATH1	PATH2	PATH3	
RATE (Hz)	: 10.275	:---	: 1.275	
STD (dB)	: 2.0	:---	: 6.0	

CHANNEL1 SUBMENU (ESC TO EXIT)				⇐
LOGNORMAL	PATH4	PATH5	PATH6	
RATE (Hz)	:---	:---	:---	
STD (dB)	:---	:---	:---	

CHANNEL 2 Main Menu

The **CHANNEL 2** menu group controls the simulated unidirectional RF channel that consists of either three or six independently programmable transmission paths for TAS 4500's equipped with two RF channels. This menu group allows I/O parameters such as carrier frequency, LO frequency, and input reference level, as well as RF channel parameters such as the number of paths in the channel model, relative path delay, fast and slow fading, frequency shift, phase shift, and relative path attenuation to be viewed and controlled.

The Channel 2 menu group is not available when the Channel Configuration is set to single channel mode. Details on this parameter can be found in Section 2.4.10 "Setting the Channel Configuration."

The menu screens contained in the Channel 2 menu group are shown below.

With I/O Frequency Tracking Mode = Carrier (MODE1)

```
CHANNEL2                               ↓
CARRIER: 900.000MHz↓ LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm
OUTPUT ATTENUATOR: 0.0 dB
```

With I/O Frequency Tracking Mode = I/O_Carrier (MODE2) or Ext. BC(4-6 GHz) (MODE3).

```
CHANNEL2      [I/O FREQ: 245.000MHZ]   ↓
CARRIER: 900.000MHz LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm
OUTPUT ATTENUATOR: 0.0 dB
```

```
CHANNEL2 | PATH1      | PATH2      | PATH3      ↕⇔
STATUS   :on        :on        :on
DELAY (μs): 200.0000: 300.0000: 400.0000
LOSS (dB) : 5.0     : 10.0     : 15.0
```

```
CHANNEL2 | PATH4      | PATH5      | PATH6      ⇔↕
STATUS   :on        :on        :on
DELAY (μs): 100.0000: 200.0000: 0.0000
LOSS (dB) : 5.0     : 10.0     : 0.0
```

```
CHANNEL2 | PATH1      | PATH2      | PATH3      ↕⇔
MODULATN :rayl↓    :f_shift    :nakag↓
VEL (ft/s): 60.0   : 60.0     : 60.0
DOPP (Hz) : 54.9   : 54.90    : 54.9
```

CHANNEL2	PATH4	PATH5	PATH6	↔↕
MODULATN	:rician↵	:phase↵	:fs+rayl↵	
VEL(ft/s)	: 60.0	:---	: 60.0	
DOPP(Hz)	: 54.9	:---	: 54.9	

CHANNEL2	PATH1	PATH2	PATH3	↑↔
LOGNORMAL	:on↵	:off	:on↵	

CHANNEL2	PATH4	PATH5	PATH6	↔↑
LOGNORMAL	:off	:off	:off	

CHANNEL 2 CARRIER Submenu

CHANNEL2 SUBMENU
CARRIER FREQUENCY: 900.000MHz
(+/- TO EDIT, ESCAPE TO SET/EXIT)

CHANNEL 2 LO Submenu

CHANNEL2 SUBMENU (ESC TO EXIT)
LO FREQUENCY: 1040.0 MHz

CHANNEL 2 RAYLEIGH Submenu

CHANNEL2 SUBMENU (ESC TO EXIT)	↔		
RAYLEIGH	PATH1	PATH2	PATH3
SPECTRUM	:classic6	:---	:---
CORR COEF:	0.62	:---	:---

CHANNEL2 SUBMENU (ESC TO EXIT)	↔		
RAYLEIGH	PATH4	PATH5	PATH6
SPECTRUM	:---	:---	:---
CORR COEF:	:---	:---	:---

CHANNEL 2 RICIAN Submenu

CHANNEL2 SUBMENU (ESC TO EXIT)				↓⇨
RICIAN	PATH1	PATH2	PATH3	
AOA (DEG)	:---	:---	:---	
AOA (Hz)	: [---]	: [---]	: [---]	

CHANNEL2 SUBMENU (ESC TO EXIT)				↑⇨
RICIAN	PATH1	PATH2	PATH3	
K (dB)	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨↓
RICIAN	PATH4	PATH5	PATH6	
AOA (DEG)	: 45.0	:---	:---	
AOA (Hz)	: [100.00]	: [---]	: [---]	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨↑
RICIAN	PATH4	PATH5	PATH6	
K (dB)	: 12.0	:---	:---	
SPECTRUM	: flat	:---	:---	

CHANNEL 2 NAKAGAMI Submenu

CHANNEL2 SUBMENU (ESC TO EXIT)				↓⇨
NAKAGAMI	PATH1	PATH2	PATH3	
AOA (DEG)	:---	:---	: 45.0	
AOA (Hz)	: [---]	: [---]	: [100.00]	

CHANNEL2 SUBMENU (ESC TO EXIT)				↑⇨
NAKAGAMI	PATH1	PATH2	PATH3	
M	:---	:---	: 25	
SPECTRUM	:---	:---	: classic3	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨↓
NAKAGAMI	PATH4	PATH5	PATH6	
AOA (DEG)	:---	:---	:---	
AOA (Hz)	: [---]	: [---]	: [---]	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨↑
NAKAGAMI	PATH4	PATH5	PATH6	
M	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL 2 PHASE Submenu

CHANNEL2 SUBMENU (ESC TO EXIT) ↗			
PHASE	PATH1	PATH2	PATH3
ANGL (DEG) :	----	:----	:----

CHANNEL2 SUBMENU (ESC TO EXIT) ↖			
PHASE	PATH4	PATH5	PATH6
ANGL (DEG) :	----	: 25.0	:----

CHANNEL 2 FREQUENCY SHIFT+RAYLEIGH Submenu

NOTE: Selection available only when Fading Doppler Tracking Mode = Path

CHANNEL2 SUBMENU (ESC TO EXIT) ↗			
FS+RAYL	PATH1	PATH2	PATH3
SHIFT (Hz) :	----	:----	: 0.0
SPECTRUM :	----	:----	:classic6

CHANNEL2 SUBMENU (ESC TO EXIT) ↖			
FS+RAYL	PATH4	PATH5	PATH6
SHIFT (Hz) :	----	:----	:----
SPECTRUM :	----	:----	:----

CHANNEL 2 FREQUENCY SHIFT+RICIAN Submenu

NOTE: Selection available only when Fading Doppler Tracking Mode = Path

CHANNEL2 SUBMENU (ESC TO EXIT) ↕↗			
FS+RICE	PATH1	PATH2	PATH3
AOA (DEG) :	----	:----	: 0.0
AOA (Hz) :	----	:----	: [41.7]

CHANNEL2 SUBMENU (ESC TO EXIT) ↕↖			
FS+RICE	PATH4	PATH5	PATH6
AOA (DEG) :	----	:----	:----
AOA (Hz) :	----	:----	:----

CHANNEL2 SUBMENU (ESC TO EXIT)				⇅⇨
FS+RICE	PATH1	PATH2	PATH3	
K (dB)	:---	:---	: 0.0	
SPECTRUM	:---	:---	: classic6	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇅⇨
FS+RICE	PATH4	PATH5	PATH6	
K (dB)	:---	:---	:---	
SPECTRUM	:---	:---	:---	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇅⇨
FS+RICE	PATH1	PATH2	PATH3	
SHIFT (Hz)	:---	:---	: 0.0	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇅⇨
FS+RICE	PATH4	PATH5	PATH6	
SHIFT (Hz)	:---	:---	:---	

CHANNEL 2 LOGNORMAL Submenu

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨
LOGNORMAL	PATH1	PATH2	PATH3	
RATE (Hz)	: 10.275	:---	: 1.275	
STD (dB)	: 2.0	:---	: 3.0	

CHANNEL2 SUBMENU (ESC TO EXIT)				⇨
LOGNORMAL	PATH4	PATH5	PATH6	
RATE (Hz)	:---	:---	:---	
STD (dB)	:---	:---	:---	

CONFIG Main Menu

The **CONFIG** menu group allows the configuration of the remote control interface, displays the instrument's software version and diagnostic status, and selects the unit's that the characteristics will be displayed in the path submenus. The CONFIG menu group arrangement is as follows:

```

CONFIG                               ↓
RF CONFIG: dual channel↓
10MHz REFERENCE: internal
REMOTE PROTOCOL: crlf↓             SUMMARY↓
    
```

```

CONFIG                               ⇅
EMULATION METHOD: jakes
VELOCITY UNITS: km/h      LCD CONTRAST: 3
CORRELATION ALGORITHM: envelope
    
```

```

CONFIG                               [ TYPE1 ] ↑
CHANNEL CORR: type1↓      (ENTER TO SELECT)
FADING DOPPLER TRACKING MODE: system
I/O FREQ TRACKING MODE: carrier
    
```

CONFIG CHANNEL CONFIGURATION Submenu

```

CONFIG SUBMENU (ESC TO EXIT)
CHANNEL CONFIGURATION
MODE: dual channel↓
(+/- TO EDIT, ENTER TO SET)
    
```

CONFIG CRLF REMOTE PROTOCOL Submenu

```

CONFIG SUBMENU (ESC TO EXIT)
CRLF REMOTE PROTOCOL
BIT RATE: 1200
DATA: 7          PARITY: odd          STOP: 1
    
```

CONFIG ACKNAK REMOTE PROTOCOL Submenu

```

CONFIG SUBMENU (ESC TO EXIT)
ACKNAK REMOTE PROTOCOL
BIT RATE: 4800      ADDRESS: 11
DATA: 7          PARITY: odd          STOP: 1
    
```


CONFIG GPIB REMOTE PROTOCOL Submenu

```

CONFIG SUBMENU (ESC TO EXIT)
GPIB REMOTE PROTOCOL
ADDRESS: 30

```

CONFIG FILTERED NOISE Submenu

```

CONFIG SUBMENU (ESC TO EXIT)
FILTERED NOISE EMULATION METHOD
NOMINAL FADING REPETITION RATE:20 min_

```

CONFIG SUMMARY Submenu

```

CONFIG SUBMENU (ESC TO EXIT) ↓
SYSTEM SUMMARY
STATUS:ok    FW VER:5.10    DSP VER:5.10
RF RANGE CH1: 25-4000  CH2: 25-4000 MHz_

```

```

CONFIG SUBMENU (ESC TO EXIT) ⇅
SYSTEM SUMMARY
RF ATTEN CH1: 90.0/0.1dB  CH2: 90/0.1dB
RF FILTER CH1:INSTALLED  CH2:INSTALLED_

```

```

CONFIG SUBMENU (ESC TO EXIT) ⇅
SYSTEM SUMMARY
FILTER BP CH1:NONE        CH2:NONE
CHANNEL BP CH1:INSTALLED  CH2:INSTALLED_

```

```

CONFIG SUBMENU (ESC TO EXIT) ⇅
SYSTEM SUMMARY
LO CH1: 940-2860MHz  CH2:940-2860MHz
DELAY: 125μsec/.5nsec_

```

```

CONFIG SUBMENU (ESC TO EXIT) ⇅
SYSTEM SUMMARY
DYNAMIC EMULATION MODE: INSTALLED
CHANNEL CONFIGURATION: INSTALLED

```

```

CONFIG SUBMENU (ESC TO EXIT) ↑
SYSTEM SUMMARY
ESYS:00000111114112313767332451663255

```

CONFIG I/O FREQ TRACKING MODE Submenu

```
CONFIG SUBMENU (ESC TO EXIT)           ↑  
I/O FREQ TRACKING MODE  
CH1 ALT I/O FREQ: 245.000MHz  
CH2 ALT I/O FREQ: 245.000MHz
```

FILE Main Menu

The **FILE** menu group allows you to load both user and TAS defined parameter profiles and to save user define parameter configurations. The FILE menu group is as follows.

```
FILE (PRESS ENTER TO PROCEED)  
SAVE FILE : file1↓  
RECALL FILE: IS55-561↓
```

2.3.2. Control Key Summary

This section describes the set of keys used to navigate through the TAS 4500 menus.

Menu Group Select Keys

The menu tree select keys are: CHANNEL 1, CHANNEL 2, FILE and CONFIG. Pressing any one of these keys will select that menu group and return to the menu screen previously displayed the last time this menu tree was active. By pressing a menu tree key for the currently selected submenu group, you can return back to the top of the menu tree.

To illustrate this function, when the CHANNEL 1 key is pressed while in one of the submenus, as in the example below, you will exit the submenu and the front panel will display the path modulation screen:

Current screen...

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
PHASE	PATH1	PATH2	PATH3	
ANGL (DEG) :	10.0	:---	:---	

Press CHANNEL1 key...

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
MODULATN :	phase↵	:f_shift	:nakag↵	
VEL (ft/s) :	---	: 60.0	: 60.0	
DOPP (Hz) :	---	: 54.90	: 54.9	

Menu trees are configured in a hierarchical nature, each with associated levels of submenus. To indicate a submenu is present, a carriage return symbol is displayed at the right side of a menu parameter. The first (and sometimes second) line of the LCD displays a heading indicating what part of the menu tree is being shown.

A screen above/below prompt is also used to indicate the presence of additional screens above and/or below the current screen in the selected menu. A screen left/right prompt is also used to indicate the presence of an additional screen to the right or left of the current screen in the selected menu. These directional arrow characters are displayed in the last positions on the top line of the LCD.

Menu Navigation Up & Down Arrow Keys

To move among lines on a screen and to move between screens of the same menu, the Menu Navigation Up and Down Arrow keys are used. They are located together with the Menu Navigation Left and Right Arrow keys as a group within the SELECT/EDIT block on the front panel.

As an example, suppose the user is on the REMOTE PROTOCOL field of the CONFIG menu. If the Menu Navigation Down Arrow key is pressed, the cursor will move to the EMULATION METHOD field. Pressing that key two more times changes the screen to the second CONFIG screen, showing the options for units. In the example below, note how the screen above/below prompt changes to indicate that there are screens in different locations relative to the current screen.

Current screen...

```

CONFIG                                     ↓
RF CONFIG: dual channel↓
10MHz REFERENCE: internal
REMOTE PROTOCOL: crlf↓                SUMMARY↓
    
```

Press **Menu Navigation Down Arrow** key...

```

CONFIG                                     ⇅
EMULATION METHOD: jakes
VELOCITY UNITS: km/h    LCD CONTRAST: 3
CORRELATION ALGORITHM: envelope
    
```

Press **Menu Navigation Down Arrow** key twice more...

```

CONFIG                                     [ TYPE1 ] ↑
CHANNEL CORR: type1↓    (ENTER TO SELECT)
FADING DOPPLER TRACKING MODE: system
I/O FREQ TRACKING MODE: carrier
    
```

Menu Navigation Left & Right Arrow Keys

The Menu Navigation Left and Right Arrow Keys move the cursor between parameter fields of the same menu screen and to move between screens of the same menu. They are located together with the Menu Navigation Up and Down Arrow keys within the SELECT/EDIT block the front panel display.

As an example, suppose the user is on the STATUS field of Path 2 in the CHANNEL 1 menu. If the Menu Navigation Right Arrow key is pressed, the cursor will move to the Path 3 STATUS field. Pressing that key one more time changes the screen to the STATUS screen showing the paths 4 through 6. In the example below, note how the screen right/left prompt changes to indicate that there are screens in different locations relative to the current screen.

Current screen...

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	:on	: <u>o</u> n	:on	
DELAY (μ s)	: 200.0000	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

Press **Menu Navigation Right Arrow** key...

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	:on	:on	: <u>o</u> n	
DELAY (μ s)	: 200.0000	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

Press **Menu Navigation Right Arrow** key once more...

CHANNEL1	PATH4	PATH5	PATH6	⇐⇓
STATUS	: <u>o</u> n	:on	:off	
DELAY (μ s)	: 100.0000	: 200.0000	:---	
LOSS (dB)	: 5.0	: 10.0	:---	

Enter & Escape Keys

The Enter and Escape keys have two main functions. Their first function is to allow entry and exit from submenus. When the blinking cursor is positioned under this carriage return symbol ↵, the associated submenu can be accessed by pressing the Enter key as in the example shown below:

Current screen...

```

CHANNEL1 | PATH1      | PATH2      | PATH3      ↕⇒
MODULATN :rayl↵   :f_shift   :nakag↵
VEL(ft/s) :   60.0   :   60.0   :   60.0
DOPP(Hz)  :   54.9   :   54.90  :   54.9
    
```

Press Enter key...

```

CHANNEL1 SUBMENU (ESC TO EXIT)      ⇐
RAYLEIGH | PATH1      | PATH2      | PATH3
SPECTRUM :classic6 :---          :---
    
```

Pressing the Escape key exits the submenu. An example is shown below.

Current screen...

```

CHANNEL1 SUBMENU (ESC TO EXIT)      ⇐
PHASE    | PATH4      | PATH5      | PATH6
ANGL(DEG) :---          :   25.0   :---
    
```

Press Escape key...

```

CHANNEL1 | PATH4      | PATH5      | PATH6      ⇐⇕
MODULATN :rician↵ :phase↵     :fs+rayl↵
VEL(ft/s) :   60.0   :---         :---
DOPP(Hz)  :   54.9   :---         :---
    
```

The secondary function of the Enter and Escape keys is to execute instrument functions and clear errors. In screens that allow the user to execute a particular action, the display indicates the instrument function performed by pressing the Enter key as shown in the example below:

```
FILE (PRESS ENTER TO PROCEED)
SAVE FILE : file1↓
RECALL FILE: IS55-561↓
```

If an error occurs after executing an instrument function, the Escape key will clear the error screen. After being prompted of the error shown in the screen below, pressing the Escape key clears the error condition and returns control to the previous screen.

```
Input Signal Out of Range
```

Cursor Left & Right Arrow Keys

The Cursor Left and Right Arrow Keys move the cursor between digits within a parameter field. The following example shows how to move from the hundred's to the ten's of nanoseconds digit:

Current digit...

CHANNEL1	PATH1	PATH2	PATH3	↕⇒
STATUS	:on	:on	:on	
DELAY (μ s)	100. <u>1</u> 200	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

Press Cursor Right Arrow key...

CHANNEL1	PATH1	PATH2	PATH3	↕⇒
STATUS	:on	:on	:on	
DELAY (μ s)	100.1 <u>2</u> 00	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

Value + & - Keys

The Value + and - keys are used to modify the value of the parameter field that is currently active. The Value + key increments the value of the field while the Value - key decrements the value of the field. An example is shown below:

Current value...

CHANNEL1	PATH1	PATH2	PATH3	↕⇒
STATUS	:on	:on	:on	
DELAY (μ s)	100.1 <u>2</u> 00	300.0000	400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

Press Value + key...

CHANNEL1	PATH1	PATH2	PATH3	↕⇒
STATUS	:on	:on	:on	
DELAY (μ s)	100.1 <u>3</u> 00	300.0000	400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

2.4. Setting System Configuration Parameters

This section contains information on system configuration parameters. It is assumed that the user is familiar with the basic local operations of the TAS 4500. If you are not familiar with the local control of the TAS 4500, please read Sections 2.2. "Getting Started" and 2.3. "Menu Overview" before referring to this section.

The menu location, definition and range of the system configuration parameters are listed in the following sections.

2.4.1. Selecting the Fading Emulation Method

The user can select the method used to emulate multipath fading. In the Jakes method the I/Q modulation signals consist of a summation of individual tones. In the filtered noise method the I/Q modulation signals consist of a filtered noise spectrum. See Section 4 "Reference" for a detailed description of these methods.

CONFIG	↕
EMULATION METHOD: jakes	
VELOCITY UNITS: km/h	LCD CONTRAST: 3
CORRELATION ALGORITHM: envelope	

EMULATION METHOD

Definition

Selects the emulation method for multipath fading

Value Range

jakes, filtered noise

2.4.2. Selecting the Nominal Fading Repetition Rate

When the Emulation Method is set to filtered noise, the user can select between three rates at which the fading repeats. The fading repetition rate is fixed for the Jakes Emulation Method. The nominal time of the rates are 20 minutes, 27 seconds and 24 hours. The exact duration of the fading sequence depends on the specific Doppler frequency and can be calculated using the equations stated in Section 4 “Reference”.

```
CONFIG SUBMENU (ESC TO EXIT)
FILTERED NOISE EMULATION METHOD
NOMINAL FADING REPETITION RATE:20 min
```

NOMINAL FADING REPETITION RATE

Definition

Selects the nominal fading repetition rate for filtered noise multipath fading

Value Range

27 sec, 20 min, 24 hrs

2.4.3. Selecting the Correlation Algorithm

The user can select the correlation algorithm used to specify the correlation between Rayleigh faded paths. Envelope correlation is between the Rayleigh faded signals at the output of the associated channels. While component correlation defines the correlation between the In-Phase components of the associated Rayleigh faded signals in addition to the correlation between the Quadrature components.

```
CONFIG [ TYPE1 ] ↑
CHANNEL CORR:type1 ↓ (ENTER TO SELECT)
FADING DOPPLER TRACKING MODE: system
I/O FREQ TRACKING MODE: carrier
```

CORRELATION ALGORITHM

Definition

Selects the correlation algorithm used for path correlation.

Value Range

envelope, component

2.4.4. Viewing the System Summary

The TAS 4500 Summary submenu in the CONFIG Menu Tree contains system status information such as the control processor and DSP processor firmware version, and current operating status. Information pertaining to which RF, LO and IF modules are present in the system is also given. The RF ATTEN submenu gives the RF attenuator range and resolution. The IF DELAY submenu gives the delay range and resolution. The ESYS command string is also reported. The ESYS command is described in Section 6.0 "Command Reference." The screens found in the System Summary submenu are "read-only" and do not contain any user programmable parameters.

CONFIG SUMMARY Submenu

```
CONFIG SUBMENU (ESC TO EXIT)      ↓
SYSTEM SUMMARY
STATUS:ok    FW VER:5.10    DSP VER:5.10
RF RANGE CH1: 25-4000  CH2: 25-4000 MHz_
```

```
CONFIG SUBMENU (ESC TO EXIT)      ⇅
SYSTEM SUMMARY
RF ATTEN CH1: 90.0/0.1dB  CH2: 90.0/0.1dB
RF FILTER CH1:INSTALLED  CH2:INSTALLED_
```

```
CONFIG SUBMENU (ESC TO EXIT)      ⇅
SYSTEM SUMMARY
FILTER BP CH1:NONE        CH2:NONE
CHANNEL BP CH1:INSTALLED  CH2:INSTALLED_
```

```
CONFIG SUBMENU (ESC TO EXIT)      ⇅
SYSTEM SUMMARY
LO CH1: 940-2860MHz    CH2:940-2860MHz
DELAY: 125μsec/.5nsec_
```

```
CONFIG SUBMENU (ESC TO EXIT)      ⇅
SYSTEM SUMMARY
DYNAMIC EMULATION MODE: INSTALLED
CHANNEL CONFIGURATION: INSTALLED
```

```
CONFIG SUBMENU (ESC TO EXIT)      ↑
SYSTEM SUMMARY
ESYS:00000111114112313767332451663255
```

2.4.5. Setting the Display Format for Vehicle Velocity Parameters

The user can specify the units for the vehicle velocity parameter by configuring the Velocity Unit's parameter found in the CONFIG Menu Tree.

NOTE: The Velocity Units parameter cannot be configured using remote commands.

The Velocity Units parameter indicates the format for the vehicle velocity parameter found in the Path submenus. The vehicle velocity parameter combined with the carrier frequency parameter sets the Doppler frequency for path characteristics such as Rayleigh fading.

```
CONFIG ⇅
EMULATION METHOD: jakes
VELOCITY UNITS: km/h    LCD CONTRAST: 3
CORRELATION ALGORITHM: envelope
```

VELOCITY UNITS

Definition

Sets the format for displaying the vehicle velocity parameter.

Value Range

ft/s, mi/h, m/s, km/h

2.4.6. Setting the Contrast Parameter for the LCD Display

The user can vary the contrast of the LCD on the front panel of the TAS 4500 by adjusting the LCD CONTRAST parameter in the CONFIG Menu Tree. Increasing the index for this parameter increases the amount of contrast.

```
CONFIG ⇅
EMULATION METHOD: jakes
VELOCITY UNITS: km/h    LCD CONTRAST: 3
CORRELATION ALGORITHM: envelope
```

LCD CONTRAST

Definition

Adjusts the amount of contrast for the LCD on the front panel of the TAS 4500.

Value Range

0-10

2.4.7. Selecting the 10 MHz Reference Source

The TAS 4500 requires a 10 MHz sinusoidal reference signal to synchronize the internal signal processing functions of the unit. The user can elect to use either the internally generated 10 MHz reference or to provide their own external source via the BNC connector labeled EXT REF I/O available on the rear panel. See Section 1.2.2 Rear Panel Description to locate BNC connector. This parameter must be set to match the chosen mode of operation. Refer to Section 8.0 “Technical Specifications” for the requirements on the external source.

```

CONFIG                               ↓
RF CONFIG: dual channel↓
10MHz REFERENCE: internal
REMOTE PROTOCOL: crlf↓             SUMMARY↓

```

10MHz REFERENCE

Definition

Selects either internal or external 10 MHz reference source.

Value Range

internal, external

It is important to note that the external signal source must be connected to the TAS 4500 and must have the proper frequency and power settings prior to toggling this parameter. If the signal is not present or is detected to be out of the specified power or frequency range, the TAS 4500 will respond with the following message on the front panel:

```

E064 - External reference not detected
Returning to internal mode           [ESC]

```

Only when the signal present is determined to meet the specification will the unit proceed and allow for an external source to be used.

NOTE: The TAS 4500 generates a very high quality internal source, and it is not recommended that an external source be used unless the user has a specific reason for doing so.

2.4.8. Setting the Fading Doppler Tracking Mode

With both the Jakes and filtered noise fading emulation methods, the user has the ability to choose the way in which the fading Doppler on each path in the 4500 is controlled. There are three possible tracking modes to choose from.

System mode designates that all paths in both channels of the 4500 must have the same Doppler frequency. Paths set to Rayleigh, Rician, Nakagami, or GSM_Rician must have a Doppler frequency equal to the Channel Maximum Doppler (CMD) Frequency. All Frequency Shifted paths must have a Doppler frequency set less than or equal to the CMD frequency. This mode forces both the carrier frequency and the CMD in both channels to be the same. If the Doppler frequency or path velocity is changed on any path in the system, then all other paths will be updated with the new matching rate.

Channel mode forces all paths within a particular channel of the 4500 to have the same fading Doppler frequency. Different carrier frequencies may be maintained on the two channels of the TAS 4500. Doppler frequency changes in Channel 1 will force only the paths present in Channel 1 to be updated.

Path mode allows each path to maintain an independent Doppler frequency. Changes to any particular path will have no effect on the other paths in the system. It should be noted that the two modulation types, Rayleigh with Frequency Shift and Rician with Frequency Shift, are only available when the Fading Doppler Tracking Mode is set to Path mode.

```

CONFIG                                     [ TYPE1 ] ↑
CHANNEL CORR: type1 ↓      (ENTER TO SELECT)
FADING DOPPLER TRACKING MODE: system
I/O FREQ TRACKING MODE: carrier

```

FADING DOPPLER TRACKING MODE

Definition

Sets the control mechanism for the fading Doppler frequency in the 4500.

Value Range

system, channel, path

2.4.9. Setting the I/O Frequency Tracking Mode

The TAS 4500 allows the user to independently set the RF carrier frequency and the emulation carrier frequency using the I/O Frequency Tracking Mode parameter. The RF carrier frequency represents the actual RF input frequency of the signal a user will put into the 4500. The emulation carrier frequency is used to determine the proper fading Doppler frequency based on the velocity setting for a path.

In the Carrier mode option, both the RF carrier frequency and the emulation frequency will be the same. The two parameters do not need to be independently set in this mode. Both are controlled via the carrier parameter in the Channel menu.

In the I/O_carrier mode, the emulation carrier frequency is still set via the carrier parameter in the Channel menu. This setting is used only to determine the appropriate Doppler frequency. However, the actual RF carrier frequency (I/O CARRIER FREQ) will be set in the Frequency Tracking Mode submenu.

The Ext BC (4-6 GHz) mode is available when the 4500 is paired with the TAS5046 External Block Converter. The TAS5046 permits RF Operation of the 4500 in the 4-6 GHz range. When the 4500 is placed in this mode, the Carrier frequency and the emulation frequency are automatically controlled to permit proper mapping of the 4-6 GHz input of the TAS5046 into the 800-2800 MHz input range of the 4500. Note that when you enter this mode the carrier frequency setting will be limited to the 4-6 GHz range.

```

CONFIG                                     [ TYPE1 ] ↑
CHANNEL CORR:type1↓      (ENTER TO SELECT)
FADING DOPPLER TRACKING MODE: system
I/O FREQ TRACKING MODE: carrier

```

When the unit is placed in I/O_carrier mode or Ext. BC (4-6 GHz) mode, the submenu below indicates the I/O carrier frequency for each channel.

```
CONFIG SUBMENU (ESC TO EXIT)           ↑
I/O FREQ TRACKING MODE
CH1 I/O CARRIER: 245.000MHZ
CH2 I/O CARRIER: 245.000MHZ
```

I/O FREQ TRACKING MODE

Definition

Sets the tracking mode for the RF carrier I/O frequency and the emulation frequency.

Value Range

carrier, I/O carrier, Ext BC (4-6 GHz)

2.4.10. Setting the Channel Configuration

The TAS 4500 allows the user to change the channel/path configuration of the unit through the use of the Channel Configuration parameter. The default configuration provides the factory installed option of 1 or 2 RF Channels with 3 or 6 independent emulation paths per channel.

With a factory installed 1 Channel (3 or 6 path) system, The Channel Configuration parameter is not available. All paths are installed and available in Channel 1.

The default Dual Channel Mode setting provides the user with two independent RF emulation channels with a total of 3 or 6 paths per channel. This was the only mode available in 4500 systems prior to Version 5.10.

Single Channel Mode permits the emulation paths in 2 Channel units to be reconfigured in one of two ways. In each case, the available paths from Channel 2 are added to Channel 1. In a factory installed 2 Channel 6 Path configuration, Channel 1 will consist of six total paths. In a factory installed 2 Channel 12 Path configuration, Channel 1 will contain 12 total paths. In either case, the Channel 1 RF IN/RF OUT and LO IN/LO OUT signals provide the external interface to the new single channel configuration. The Channel 2 front panel connections are not needed.

The front panel menus are remapped to provide access to all paths from within the Channel 1 submenu. The Channel 2 submenu is unavailable in this case. The Channel 2 Channel Bypass function is also inactive while in Single Channel Mode. The Channel 1 AutoRange button and Input Reference Level value are used to provide input level control for all paths.

When operating the unit in Single Channel Mode, the Dynamic Environment Emulation feature and the Smart Antenna feature are not currently supported.

The Diversity Mode setting can be used to simplify the external cabling requirements when multiple system test setups are used. This mode splits the Channel 1 RF Input signal and provides this signal to both Channel 1 and Channel 2 of the unit. However, the internal signal processing and the RF Outputs are maintained as two separate Channels that can then be used as two inputs to a diversity receiver.

The Interference Mode setting can be used to combine a desired signal with an interference signal inside of a single TAS 4500. Interference mode can only be applied when both signals are present at the same RF Carrier frequency.

Additional information on the Channel Configuration parameter can be found in Section 4.3.9 of the manual. The menus associated with changing the Channel Configuration are displayed below.

```

CONFIG                                     ↓
CHANNEL CONFIG: dual channel↓
10MHz REFERENCE: internal
REMOTE PROTOCOL: crlf↓                SUMMARY↓

```

When the Enter key is pressed, the following submenu appears to allow the user to change the current Channel Configuration.

```

CONFIG SUBMENU (ESC TO EXIT)
CHANNEL CONFIGURATION
MODE: dual channel↓
(+/- TO EDIT, ENTER TO SET)

```

When the Enter key is pressed to change the configuration the following warning is displayed to remind the user that changing the Channel Configuration will reset all parameters to the system default.

```

This will reset all the parameters
to factory default. Press Enter to continue
or ESC to cancel.

```

CHANNEL CONFIGURATION

Definition

Sets the Channel/Path configuration of 2 Channel systems.

Value Range

dual channel, single channel, diversity, interference

2.5. Setting Channel I/O

This section contains information on setting channel I/O parameters. It is assumed that the user is familiar with the basic local operations of the TAS 4500. If you are not familiar with the local control of the TAS 4500, please read Sections 2.2. "Getting Started" and 2.3. "Menu Overview" before referring to this section.

The menu location, definition and range of the channel I/O parameters are listed in the following sections.

2.5.1. Manually Setting the Input Reference Level

The user can manually adjust the gain applied to the RF signal present at the input of each RF channel by setting the Input Reference Level parameter found in the Channel 1 and Channel 2 Menu Trees. The input reference level is calibrated to the power level of a sine wave. The actual input reference level set will depend upon the RF frequency and signal waveform. The input reference level for each channel is configured independently and overrides any automatic range operation that had been previously performed.

A red OVERLOAD LED is associated with each RF channel and is located under INPUT key group. These two LEDs should be monitored to be sure the signal applied at the RF Channel input is within the specified range. When lit, the LED indicates the RF input signal has peak levels above the permitted range and will be clipped by the instruments input circuitry. If an overload condition occurs, the input reference level parameter should be increased and/or the input signal level should be reduced.

The Input Reference Level is handled differently when the Channel Configuration is set to single channel mode or diversity mode. In single channel mode, only the Channel 1 Input Reference Level setting is used to control the gain on the input signal. In diversity mode, the same Input Reference Level setting is maintained on both Channel 1 and Channel 2 since the input signal for both channels originates from the Channel 1 RF Input. For more details on setting the Channel Configuration see Section 2.4.10.

Although only the Channel 1 menu screen is shown below, there is a similar screen for Channel 2.

CHANNEL1	↓
CARRIER: 900.000MHz	LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm	
OUTPUT ATTENUATOR: 0.0 dB	

INPUT REFERENCE LEVEL

Definition

Sets the gain applied to the input of the selected RF Channel.

Value Range

Depends on the specific RF and IF modules installed. See Section 8.0 “Technical Specifications” for details.

Manual configuration of the Input Reference Level is recommended for applications with wideband or noise-like transmit signals. This will provide the most accurate and repeatable setting for the Input Reference Level parameter. The following procedure illustrates how to manually set the Input Reference Level parameter for the transmit signal present at either RF input of the TAS 4500.

1. Begin by setting the desired channel’s Input Reference Level to its maximum value.
2. Check the overload LED for the RF channel being configured. If the overload LED is already illuminated, the input level to the TAS 4500 is too high and must be lowered using an appropriate external attenuator.
3. Otherwise, monitor the overload LED and step the Input Reference Level down in 1 dB steps until the LED is illuminated.
4. If the minimum Input Reference Level of -30.0 dBm is reached before the LED becomes illuminated, the transmit signal level may be too low to optimize the dynamic range of the input level circuitry.

<p>NOTE: Under many circumstances the TAS 4500 will continue to provide accurate emulation characteristics for signals less than the minimum Input Reference Level. However, it should be noted that for each dB that the input signal is less than the minimum Input Reference Level the optimal dynamic range of the transmission channel will be reduced by an equal amount. To achieve the maximum dynamic range with very low transmit levels an external amplifier may be required.</p>
--

5. After reaching the overload condition, step the Input Reference Level up by 3 dB. This creates approximately 3 dB headroom for the input circuitry of the TAS 4500 and helps to insure that the peaks of the transmit signal will not be clipped.

2.5.2. Performing Automatic Input Level Range

Two front panel AUTORANGE keys, one for each RF channel, are dedicated to the automatic input level range function. They are located in the INPUT key area and each key has an associated red LED. When the TAS 4500 performs an automatic level range it adjusts the input signal peak level to maximize the dynamic range of the instrument. To perform an input level range, press the AUTORANGE key that corresponds to the desired channel.

For example, if the Channel 1 AUTORANGE key is pressed, the following message is displayed on the instrument's front panel.

```
Performing Channel 1 Auto Range...
```

If the autorange is successful, the corresponding Input Reference Level parameter is changed to reflect the amount of gain applied by the range algorithm. If the RF signal is out of range, the user is prompted with the following message.

```
Input Signal Out of Range
```

The Input Reference Level and corresponding AutoRange function is handled differently when the Channel Configuration is set to single channel mode or diversity mode. In single channel mode, only the Channel 1 Input Reference Level and AutoRange key are used to control the gain on the input signal. In diversity mode, the same Input Reference Level setting and is maintained on both Channel 1 and Channel 2 since the RF Input signal for both channels originates from the Channel 1 RF Input. An AutoRange action while in this mode will automatically adjust the Input Reference Level in both channels. For more details on setting the Channel Configuration see Section 2.4.10.

2.5.3. Setting the Output Attenuator

The 4500 FLEX can be equipped with an optional RF output attenuator. This programmable attenuator can be used to precisely set the RF OUT level of the transmission channel. When this feature is present in the instrument, the menu shown below will be displayed.

Although only the Channel 1 menu screen is shown below, there is a similar screen for Channel 2.

```

CHANNEL1                               ↓
CARRIER: 900.000MHz  LO:internal manual ↓
INPUT REFERENCE LEVEL: -10.0 dBm
OUTPUT ATTENUATOR:  0.0 dB

```

OUTPUT ATTENUATOR (OPTIONAL)

Definition

Sets the amount of loss provided by an RF attenuator for the selected RF channel.

Value Range

Depends on the specific RF option installed. See Section 8.0 “Technical Specifications” for details.

2.5.4. Setting the RF Channel Bypass

The 4500 FLEX can be equipped with optional RF switches. These switches can be used to bypass the TAS 4500 RF Front End and IF Signal Processing components. When in bypass mode, the TAS 4500 passes RF IN directly to RF OUT avoiding the insertion loss inherent in the RF channel emulation path of the unit.

Within the BYPASS group on the front panel are two keys and two LEDs. To activate the bypass for Channel 1 or Channel 2, press the Channel 1 or Channel 2 key within the BYPASS group. When a particular channel is bypassed, the Bypass LED for that channel will be illuminated. Pressing the bypass key a second time will cancel the bypass and the LED will be turned off.

While a channel is being bypassed, all parameters for that channel can be viewed and set as necessary.

When the Channel Configuration is set to diversity mode, the RF Channel Bypass capability is disabled due to the sharing of the RF Input/Output signals between the two channels. For additional information of setting the Channel Configuration see Section 2.4.10.

2.5.5. Setting the Carrier Frequency

The user must set the carrier frequency of the RF input signal for Channel 1 and Channel 2. The CARRIER parameter is used by the TAS 4500 in determining the Doppler frequency for path characteristics, and for setting the internal local oscillator frequency when the LO mode is set to "internal auto". See Section 2.4.9 "Setting the I/O FREQ TRACKING MODE" for more details on independently setting the RF carrier frequency and the emulation carrier frequency. Refer to Section 2.5.6. "Setting the Local Oscillator Mode" for more details on the interdependence of the carrier frequency parameter and the local oscillator mode.

Although only the Channel 1 menu screen is shown below, there is a similar screen for Channel 2.

```

CHANNEL1                                     ↓
CARRIER: 900.000MHz↓ LO:internal manual↓
INPUT REFERENCE LEVEL:-10.0 dBm
OUTPUT ATTENUATOR: 0.0 dB
  
```

To update the carrier frequency, the user must use the Enter key to get into the submenu shown below.

```

CHANNEL1 SUBMENU
CARRIER FREQUENCY: 900.000MHz
(+/- TO EDIT, ESCAPE TO SET/EXIT)
  
```

The carrier frequency can then be updated using the +/- keys as indicated above. When the proper frequency is displayed the ESC key should be pressed to update the carrier frequency and return to the Main menu for the channel.

CARRIER

Definition

Sets the carrier frequency for the selected RF channel.

Value Range

Depends on the specific RF options installed. See Section 8.0 "Technical Specifications" for details.

2.5.6. Setting the Local Oscillator Mode

The TAS 4500 requires a local oscillator (LO) to down convert the user's RF input signal to an IF signal. An LO input is provided for each channel on the front panel via N-type connectors. The LO source can be supplied by an optional internal LO or a user-supplied external RF synthesizer.

When equipped with an optional internal LO, the user must choose the applicable Local Oscillator Mode for Channel 1 and Channel 2. The LO Mode determines how the frequency of the LO will be configured. In "internal auto" mode, the LO will automatically configure itself to optimally track the CARRIER frequency parameter. Please note that setting the LO Mode to "internal auto" will restrict the available range of the carrier frequency to those supported by the internal LOs.

In "internal manual" mode, the LO frequency will be manually set in the LO submenu. Refer to Section 2.5.6 "Setting the Local Oscillator Frequency" for explicit details on manually setting the LO frequency.

If the LO mode is set to "external", the internal LO is switched off, and the TAS 4500 expects an external signal generator to be the source of the LO signal to allow the necessary down conversion of the RF signal. Refer to Section 8.0 "Technical Specifications" for the required LO frequency and level.

If the LO mode is set to "ext. from 4500", the internal LO is switched off. The TAS 4500 expects an external LO signal from another 4500 channel to be the source of the LO signal to allow the necessary down conversion of the RF signal. This setting is designed for applications where a single internal LO signal from the TAS 4500 is used to supply the LO signal for several channels. Verify, in Section 8.0 "Technical Specifications", that the required LO level for each channel is being met.

Although only the Channel 1 menu screen is shown below, there is a similar screen for Channel 2.

CHANNEL1	↓
CARRIER: 900.000MHz	LO:internal manual ↵
INPUT REFERENCE LEVEL: -10.0 dBm	
OUTPUT ATTENUATOR: 0.0 dB	

LO

Definition

Sets the local oscillator mode.

Value Range

internal auto, internal manual, external, ext. from 4500

2.5.7. Setting the Local Oscillator Frequency

For most applications, the LO Mode is set to “internal auto” and the internal synthesizers are automatically programmed to provide the correct frequency required for the TAS 4500’s up/down conversion of the RF input signal. But when the LO mode is set to "internal manual", the user must set the frequency of the on-board synthesizer using the LO FREQUENCY parameter located in the LO submenu of the Channel 1 and Channel 2 Menu Trees. The capability to manually set the LO frequency proves most useful when the internal synthesizers are being used for a testing application other than supplying the signal required for the 4500’s up/down conversion.

Although only the Channel 1 LO submenu screen is shown below, there is a similar screen for Channel 2.

```
CHANNEL1 SUBMENU (ESC TO EXIT)
LO FREQUENCY: 1040.0 MHz
```

LO FREQ

Definition

Sets the local oscillator frequency in internal manual mode.

Value Range

Valid range of internal synthesizer

2.6. Setting Path Characteristics

This section contains information on setting parameters to define the path characteristics. It is assumed that the user is familiar with the basic local operations of the TAS 4500. If you are not familiar with the local control of the TAS 4500, please read Sections 2.2. "Getting Started" and 2.3. "Menu Overview" before referring to this section.

The menu location, definition and range of the parameters for the path characteristics are listed in the following sections.

2.6.1. Setting Path On/Off Status

Each RF channel of the TAS 4500 models up to six independent transmission paths. The two channels can also be used in a single channel mode to combine the paths from the two original channels to provide up to twelve transmission paths in a single RF channel.

The paths can be turned on or off on an individual basis in the Path Status menu located in the Channel 1 and Channel 2 Menu Trees. When enabled, the user is permitted set the path specific propagation characteristics.

Although only the Channel 1 menu screen is shown below, there is a similar screen for Channel 2.

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	: on	: on	: on	
DELAY (μ s)	: 200.0000	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

CHANNEL1	PATH4	PATH5	PATH6	⇐⇓
STATUS	: on	: on	: off	
DELAY (μ s)	: 100.0000	: 200.0000	: ---	
LOSS (dB)	: 5.0	: 10.0	: ---	

STATUS (Channel 1&2Paths 1-6)

Definition

Sets status of the path selected for the selected RF channel.

Value Range

on, off

2.6.2. Setting Relative Path Delay

The user can independently program the relative path delay on each of the instrument's transmission paths. Note that the DELAY parameter does not represent an absolute time delay through the path.

Although only the Channel 1 Path 1 to 3 Delay parameter menu screen is shown below, there is a distinct DELAY parameter for each of the available transmission paths.

CHANNEL1	PATH1	PATH2	PATH3	↕⇒
STATUS	: on	: on	: on	
DELAY (μ s)	: 200.0000	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

DELAY (Channel 1&2 Paths 1-6)

Definition

Sets value of relative delay parameter for the selected path.

Value Range

Depends on the options installed. See Section 8.0 "Technical Specifications" for details.

2.6.3. Setting Path Modulation

The user can independently program the path modulation on each of the instrument's transmission paths.

If "Rayleigh", "Rician", "Nakagami", "Rayleigh with Frequency Shift", or "Rician with Frequency Shift" modulation is selected, a submenu can be accessed to set the fading power spectrum. Refer to Section 2.6.5. "Setting Fading Power Spectrum Shape" for additional details.

If "Phase" modulation is selected, a submenu can be accessed to set the amount of phase shift desired. Refer to Section 2.6.7 "Setting Relative Phase Modulation Angle" for additional details on this type of modulation.

If "Rayleigh with Frequency Shift" or "Rician with Frequency Shift" modulation is selected, a submenu can be accessed to set the "Shift Frequency". Refer to Section 2.6.8 "Setting Shift Frequency for Rayleigh/Rician with Frequency Shift" for additional details on this type of modulation.

If "Rician" or "Rician with Frequency Shift" modulation is selected, a submenu is available for setting the Line Of Site Arrival Angle and the K factor. Refer to Section 2.6.9 "Setting LOS Arrival Angle and Rician K Factor" for additional details on this type of modulation.

If "Nakagami" modulation is selected, a submenu is available for setting the Angle of Arrival and the M value. Refer to Section 2.6.10 "Setting Angle of Arrival and Nakagami M value" for additional details on this type of modulation.

Although only the Channel 1 Path 1 to 3 Modulation parameter menu screen is shown below, there is a distinct MODULATN parameter for each of the available transmission paths.

CHANNEL1	PATH1	PATH2	PATH3	⇕⇔
MODULATN	:rayl	:f_shift	:nakag	
VEL (ft/s) :	60.0	60.0	60.0	
DOPP (Hz) :	54.9	54.9	54.9	

MODULATION (Channel 1&2 Paths 1-6)

Definition

Sets the modulation type for the selected path.

Value Range

none, rayl(rayleigh), rician, nakag(nakagami), f_shift(frequency shift), phase, fs+rayl(frequency shift rayleigh), fs+rice(frequency shift rician)

2.6.4. Setting Vehicle Velocity and Doppler Frequency

The user can program either the desired vehicle velocity or Doppler frequency on each of the instrument's transmission paths. Note that the vehicle velocity and Doppler frequency are *dependent* parameters, and modifying one affects the other. This parameter pair is used to define characteristics of Rayleigh, Rician, Nakagami, Frequency Shift, Rayleigh with Frequency Shift, and Rician with Frequency Shift modulation. See Section 2.4.8 on "Setting the Fading Doppler Tracking Mode" for details on how the Doppler frequency for each path in the unit is controlled.

The dominant parameter in the TAS 4500 will be the vehicle velocity. This means that any change in the carrier frequency will result in a corresponding change only in the Doppler Frequency. The vehicle velocity will remain unchanged when this occurs.

The resolution of the Fading Doppler frequency is limited to 0.1 Hz, but the frequency shift Doppler frequency can be set with 0.01 Hz step size. Notice that the resolution of the displayed Doppler value changes based on the modulation type selected. In either case, the resolution of the velocity is limited to 0.1 km/hr.

Although only the Channel 1 Path 1 to 3 Vehicle Velocity and Doppler Frequency menu screens are shown below, there is a distinct VELOCITY and DOPPLER parameter pair for each of the available transmission paths.

CHANNEL1	PATH1	PATH2	PATH3	⇕⇔
MODULATN	:rayl	:f_shift	:nakag	
VEL (ft/s)	: 60.0	: 60.0	: 60.0	
DOPP (Hz)	: 54.9	: 54.90	: 54.9	

DOPPLER (Channel 1&2 Paths 1-6)

Definition

Sets the Doppler frequency, and along with the programmed carrier frequency, determines the velocity of the mobile terminal for the selected path.

Value Range

Two factors limit the possible range of values of the Doppler frequency. When the modulation type is set to frequency shift, the minimum value will always be ± 0.01 Hz. When the modulation type is set to any other choice, the minimum value will be ± 1.0 Hz in Jakes emulation method and ± 0.1 Hz in filtered noise (MODE2). The maximum value is 1000.00 Hz in all cases

VELOCITY (Channel 1&2 Paths 1-6)

Definition

Sets the velocity of the mobile terminal, and along with the programmed carrier frequency, determines the Doppler frequency for the selected path.

Value Range

The Doppler values outlined above in combination with the carrier frequency limit the obtainable velocity according to the following equation:

$$\text{Freq}_{\text{Doppler}} = \frac{\text{Velocity}_{\text{mobile}} \times \text{Freq}_{\text{carrier}}}{C}$$

where C = Speed of Light (3 x 10⁸ m/s)

2.6.5. Selecting the Fading Power Spectrum Shape

The user can select the shape of the fading power spectrum when the Modulation is set to Rayleigh, Rician, Nakagami, Rayleigh with Frequency Shift, or Rician with Frequency Shift. The classical (6 dB) power spectrum is the common Rayleigh definition which adheres to the specifications outlined in industry test standards. The flat power spectrum has been determined to be representative of the multipath propagation effects experienced in some indoor applications. The classical (3 dB) and rounded power spectrums are additional spectrum shapes available in the TAS 4500.

Although only the Channel 1 Rayleigh submenu screen is shown below, there is a distinct Fading Power Spectrum parameter for each of the available transmission paths.

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
RAYLEIGH	PATH1	PATH2	PATH3	
SPECTRUM	:classic6	:flat	:classic3	

FADING POWER SPECTRUM

Definition

Selects the shape of the fading power spectrum

Value Range

classical6 (classical 6 dB), classical3 (classical 3 dB), flat, rounded

2.6.6. Setting Rayleigh Fading Correlation

The user can independently program the path correlation coefficient between each of the pairs of like-numbered paths in Channel 1 and Channel 2. The Rayleigh fading correlation coefficients are accessed in the Rayleigh modulation submenu in the Channel 2 Paths 1-6 submenus.

Although only the Channel 2 Path 1 to 3 Rayleigh submenu screen is shown below, there is a distinct CORRelation COEFFicient parameter for Channel 2 Paths 4-6 as well.

CHANNEL2 SUBMENU (ESC TO EXIT)				⇒
RAYLEIGH	PATH1	PATH2	PATH3	
SPECTRUM	:classic6	:---	:classic3	
CORR COEF:	0.62	:---	:---	

CORRELATION (Channel 2 Paths 1-6)

Definition

Sets the correlation coefficient of selected path pair. This parameter is only valid when Rayleigh modulation is selected on each of the paths that make up the pair.

Value Range

0.00 to 1.00, in 0.01 steps

2.6.7. Setting Relative Phase Modulation Angle

When Phase is the selected modulation type, the user can independently program the relative phase modulation angle for each of the instrument's transmission paths using the ANGLE parameter. It is important to note that the phase modulation angle parameter only applies when phase modulation is selected on the selected path.

Although only the Channel 1 Path 4 to 6 Phase submenu screen is shown below, there is a distinct ANGLE parameter for each of the available transmission paths.

CHANNEL1 SUBMENU (ESC TO EXIT)				↩
PHASE	PATH4	PATH5	PATH6	
ANGL (DEG) : ---	:	25.0	:	---

ANGLE (Channel 1&2 Paths 1-6)

Definition

Sets the relative phase shift of the selected path. This parameter is only valid when the desired path has phase modulation selected.

Value Range

0.0 to 360.0, in 0.1 degree steps

2.6.8. Setting Shift Frequency for Rayleigh/Rician with Frequency Shift

When Rayleigh with Frequency Shift or Rician with Frequency Shift is the selected modulation type, the user can independently program the Shift Frequency for each of the Rayleigh/Rician faded transmission paths using the Shift Frequency parameter. The Shift Frequency parameter only applies when one of these modulation types is selected on a path.

The Rayleigh and Rician with Frequency Shift modulation types are only available when the Fading Doppler Tracking Mode is set to Path mode. Refer to Section 2.4.8 on "Setting the Fading Doppler Tracking Mode" for more details.

When setting the Shift Frequency, note that the sum of the Doppler Frequency and the Shift Frequency settings for the path cannot exceed +/-1000 Hz. Increasing one of these parameter settings beyond this range will force the unit to decrease the unmodified parameter to maintain the maximum limit.

Although only the Channel 1 Path 4 to 6 Frequency Shift plus Rayleigh submenu screen is shown below, there is a distinct SHIFT frequency parameter for each of the available transmission paths for both Rayleigh and Rician with Frequency Shift.

CHANNEL1 SUBMENU (ESC TO EXIT) ⇐			
FS+RAYL	PATH4	PATH5	PATH6
SHIFT (Hz) :---	:---	:	30.0
SPECTRUM :flat	:---	:	classic6

SHIFT FREQ (Channel 1&2 Paths 1-6)

Definition

Sets the shift frequency of the selected Rayleigh or Rician faded path. This parameter is only valid when the desired path has Rayleigh with Frequency Shift or Rician with Frequency shift modulation selected.

Value Range

-999.0 Hz to +999.0 Hz, in 0.1 Hz steps

2.6.9. Setting LOS Angle of Arrival and Rician K Factor

When Rician or Rician with Frequency Shift is the selected modulation type, the user can independently program the LOS (line of site) angle of arrival (AOA) and the K factor for each of the instrument's Rician modulated transmission paths using the AOA and K factor parameters respectively. Note that the AOA is displayed in both degrees and Hz. These are *dependent* parameters and modifying one affects the other.

Although only the Channel 1 Path 1 to 3 Rician submenu screen is shown below, there are distinct LOS ARRIVAL ANGLE parameters for each of the available transmission paths.

CHANNEL1	SUBMENU (ESC TO EXIT)			↕⇔
RICIAN	PATH1	PATH2	PATH3	
AOA (DEG)	: ---	: ---	:	45.0
AOA (Hz)	[---] [---] [100.00]

LOS ARRIVAL ANGLE (Channel 1&2 Paths 1-6)

Definition

Sets the arrival angle of the direct line of site component for the selected Rician modulated path. Notice that both the LOS arrival angle and the corresponding Doppler frequency are displayed. However, the Doppler frequency cannot be modified directly. It will be updated appropriately when the AOA(DEG) parameter is set.

Value Range

0.0 to 360.0, in 0.1 degree steps

Although only the Channel 1 Path 1 to 3 Rician submenu screen is shown below, there are distinct K factor parameters for each of the available transmission paths.

CHANNEL1	SUBMENU (ESC TO EXIT)			↑⇔
RICIAN	PATH1	PATH2	PATH3	
K (dB)	: ---	: ---	: ---	
SPECTRUM	: classic6	: ---	: classic3	

K FACTOR (Channel 1&2 Paths 1-6)

Definition

Sets the power ratio between the direct line of site component and the faded component of the selected Rician modulated path.

Value Range

-30 to 30, in .1 dB steps

2.6.10. Setting Angle of Arrival and Nakagami M Value

When Nakagami is the selected modulation type, the user can independently program the angle of arrival (AOA) and the M value for each of the instrument's Nakagami modulated transmission paths using the AOA and M value parameters respectively. Note that the AOA is displayed in both degrees and Hz. These are *dependent* parameters and modifying one affects the other.

Although only the Channel 1 Path 1 to 3 Nakagami submenu screen is shown below, there are distinct AOA and M parameters for each of the available transmission paths.

CHANNEL1 SUBMENU (ESC TO EXIT)				↓⇒
NAKAGAMI	PATH1	PATH2	PATH3	
AOA (DEG)	:---	:---	:	45.0
AOA (Hz)	[---] [---] [100.00]

ANGLE OF ARRIVAL (Channel 1&2 Paths 1-6)

Definition

Sets the angle of arrival of the direct line of site component for the selected Nakagami modulated path. Notice that both the angle of arrival and the corresponding Doppler frequency are displayed. However, the Doppler frequency cannot be modified directly. It will be updated appropriately when the AOA(DEG) parameter is set.

Value Range

0.0 to 360.0, in 0.1 degree steps

Although only the Channel 1 Path 1 to 3 Nakagami submenu screen is shown below, there are distinct M value parameters for each of the available transmission paths.

CHANNEL1 SUBMENU (ESC TO EXIT)				↑⇒
NAKAGAMI	PATH1	PATH2	PATH3	
M	:---	:---	:	25
SPECTRUM	:classic6	:---	:	classic3

M VALUE (Channel 1&2 Paths 1-6)

Definition

Sets the ratio of direct signal components to multi-path faded signal components for the selected Nakagami modulated path.

Value Range

1, 3, 5, 10, 15, 25, and 100

2.6.11. Setting Relative Path Loss

The user can independently program the relative path loss on each of the instrument's transmission paths using the LOSS parameter found in each of the channel menus. Note that the LOSS parameter does not indicate an absolute level difference from input to output.

The Relative Path Loss and Log-Normal Standard Deviation parameters are *dependent* parameters. Please refer to Section 2.6.12 "Setting Log-Normal Parameters" for further details on the inter-relationship of the valid ranges for these two parameters. When an invalid combination of path loss and log-normal standard deviation is set a [LN-UNCAL] prompt is displayed in the upper right-hand corner of the screen shown below. This indicates the current log-normal settings are un-calibrated, resulting in less than a two sigma variation of the path power level.

Although only the Channel 1 Path 1 to 3 menu screen is shown below, there is a distinct LOSS parameter for each of the available transmission paths.

CHANNEL1	PATH1	PATH2	PATH3	⇕⇒
STATUS	:on	:on	:on	
DELAY (μ s)	: 200.0000	: 300.0000	: 400.0000	
LOSS (dB)	: 5.0	: 10.0	: 15.0	

LOSS (Channel 1&2 Paths 1-6)

Definition

Sets the relative path loss of the selected path.

Value Range

Depends on the specific options installed. See Section 8.0 "Technical Specifications" for details.

2.6.12. Setting Log-Normal Parameters

When log-normal fading is enabled, the user can independently program the log-normal standard deviation (sigma) and log-normal rate for each of the instrument's transmission paths.

Before programming the log-normal parameters, it is important to understand the interrelationship of the path LOSS and LOG NORMAL STD parameters. To attain a minimum of two sigma amplitude variation for the log-normal standard deviation parameter on the desired path the following upper and lower bound requirements must be met:

1. Two times the LOG NORMAL STD value plus the path LOSS value is upper bounded by a total of 50 dB.
2. The path LOSS value minus two times the LOG NORMAL STD value is lower bounded by 0 dB.

As an example with LOG NORMAL STD set to 12 dB, a two sigma amplitude variation can be achieved with path LOSS set to 25 dB.

If the path loss and the standard deviation parameters are programmed in such a way that a 2 sigma variation cannot be met, the amplitude variation, induced by log-normal fading, will remain symmetrical around the mean power level but will be limited by the minimum distance of the current loss setting to either 0 or 50 dB.

For example, with the log-normal standard deviation set to 10 dB and the path loss set to 16 dB, the maximum amplitude variations will be constrained by ± 16 dB. Since $16 \text{ dB} < 20 \text{ dB}$ ($2 \times 10 \text{ dB}$), a two sigma amplitude variation cannot be achieved.

Although only the Channel 1 Path 1 to 3 menu screen is shown below, there is a distinct LOG NORMAL STATUS parameter for each of the available transmission paths.

CHANNEL1	PATH1	PATH2	PATH3	↑⇔
LOGNORMAL:	on↵	:off	:on↵	

LOG NORMAL STATUS (Channel 1&2 Paths 1-6)
Definition

Toggles log-normal fading either on or off for the selected path.

Value Range

on, off

Although only the Channel 1 Path 1 to 3 log-normal submenu screen is shown below, there is a distinct log normal RATE and STD parameter for each of the available transmission paths.

CHANNEL1 SUBMENU (ESC TO EXIT)				⇒
LOGNORMAL	PATH1	PATH2	PATH3	
RATE (Hz)	: 10.275	:---	: 10.275	
STD (dB)	: 4.0	:---	: 12.0	

RATE (Channel 1&2 Paths 1-6)
Definition

Sets the log-normal fading rate for the selected path.

Value Range

0.000 to 20.000 Hz, in 0.001 Hz steps

STD (Channel 1&2 Paths 1-6)
Definition

Sets the standard deviation for log-normal fading for the selected path.

Value Range

0 to 12 dB, in 1 dB steps

2.7. Dynamic Environment Emulation (DEE) Mode

Dynamic Environment Emulation Mode allows the user to dynamically simulate changing transmission mediums. This feature is only available through TASKIT/4500 with the TAS 4500 in REMOTE mode. The TAS 4500 will not respond to any key press except the LOCAL button. When the TAS 4500 is in the Dynamic Environmental Emulation Mode the following screen is displayed:

```
-- DYNAMIC ENVIRONMENT EMULATION SELECTED -  
-
```

When TASKIT/4500 switches out of Dynamic Environment Emulation mode or if the TAS 4500 is taken out of REMOTE the following screen is displayed

```
STOPPING DYNAMIC ENVIRONMENT EMULATION. .  
.
```

Additional information on Dynamic Environment Emulation can be found in Section 3.2 of the manual.

2.8. 3GPDP Emulation Mode

Similar to Dynamic Environment Emulation mode (DEE), the 3GPDP Emulation Mode allows the user to dynamically simulate changing transmission mediums. In particular, the 3GPDP feature provides an easy to use interface to the capabilities in DEE that are required to produce dynamic channel models called for in the 3G conformance test specifications (W-CDMA). In addition, 3GPDP provides direct remote control of the modeling parameters and test execution to allow easy integration into automatic test environments. While running a 3GPDP test, the TAS 4500 will not respond to any key press except the LOCAL button. When the 4500 is executing either the Moving Propagation or Birth-Death tests, one of the following screens will be displayed:

```
-- MOVING PROPAGATION TEST SELECTED --
```

```
-- BIRTH-DEATH TEST SELECTED --
```

When either of these tests is stopped or the TAS 4500 is taken out of REMOTE, one of the following screens will be displayed while the unit returns to static operation.

```
STOPPING MOVING PROPAGATION TEST. . .
```

```
STOPPING BIRTH-DEATH TEST. . .
```

Additional information on 3GPDP testing can be found in section 4.8 and 4.9 of this manual.

3.0. TASKIT[®]/4500 FOR WINDOWS

3.1. Introduction to TASKIT/4500 for Windows

TASKIT/4500 is a PC-based graphical user interface for the remote configuration and control of the TAS 4500 test instrument. TASKIT/4500 runs under the Microsoft Windows operating environment, delivering the same ease of use and graphical user interface features that Windows provides. TASKIT/4500 for Windows makes it easier than ever to use the TAS 4500 test system to perform sophisticated tests in a wide range of communication environments.

To run the TASKIT/4500 for Windows program, you will need a PC with the following:

- 486 or Pentium processor
- Minimum 8 Mb Ram
- Minimum 10 Mb available hard disk space
- VGA (color or monochrome) video adapter/monitor
- At least one available serial port (National Instruments GPIB interface recommended)
- Microsoft Windows '95, Windows '98 or Windows NT version 4.0 and higher.
- Keyboard
- Mouse or some type of pointing device

This section supports the basic operations of the TASKIT/4500 program and accessories. For more detailed information about the operation and configurations of the TASKIT/4500 program refer to the on-line help included in the program.

3.1.1. TASKIT/4500 Quick Start

This section of the manual will outline the steps required to begin using TASKIT/4500 with one or more TAS 4500 units. Each of these steps listed here is detailed further in this section of the manual.

1. Install TASKIT/System Files and TASKIT/4500 onto the PC as described in Section 3.1.2.
2. Setup the appropriate physical remote communication between the PC and the TAS 4500(s) as described in Section 3.1.3.
3. Review the basic operation of TASKIT/4500 as described in Section 3.1.4.

4. Configure TASKIT/4500 to the correct number of branches to be simulated and the correct remote communication for the TAS 4500 unit(s) as described in Section 3.1.4.
5. Establish remote communication to the TAS 4500(s) as described in Section 3.1.5.

The TAS 4500 unit(s) should now be under the control of the TASKIT/4500 interface.

3.1.2. TASKIT/4500 Installation

Below is a list of the programs contained on the TASKIT for Windows Wireless Test Applications CD.

TASKIT for Windows Wireless Test Applications

- TASKIT/4500
- TASKIT/4600

The TASKIT CD contains a set of related TASKIT products, each in its own directory on the CD. Table 3-1 below lists each TASKIT product and the directory on the CD that it resides in. Depending on the system or instrument that was ordered, the accompanying CD will contain a particular subset of the products listed below.

NOTE: The TASKIT System files are no longer required when installing TASKIT/4500.

TASKIT PRODUCT	CD DIRECTORY
TASKIT/System Files	D:\SYSTEM\
TASKIT/4500	D:\TSKT4500\
TASKIT/4600	D:\TSKT4600\

Table 3-1. TASKIT CD Directory Structure

The following steps are necessary to complete the TASKIT installation process.

1. Insert TASKIT CD into the CD ROM drive on your PC.
2. From the Windows Program Manager, select *Run* from the *File* Menu.
3. Type “*d:\tskt4500\setup*” to execute the TASKIT/4500 setup program.
4. The TASKIT/4500 setup program will guide you through the remainder of the program installation process.

Be sure to install the program in a directory that is different from the directory where any other TASKIT/4500 software programs are installed.

During installation, the setup program may display a window that reports “XXXX file is in use. Please close all applications and re-attempt setup.” To solve this problem, close all applications and run Setup again. If the problem persists, exit and restart Windows. Run Setup as the very first program you run. If the problem still persists, make a note of the filename and select “Ignore” in this window. If TASKIT/4500 runs without any problems then you can safely ignore this error message.

Replacing Earlier TASKIT/4500 Versions

If you have already installed an earlier version or demonstration version of the TASKIT/4500 program you are trying to setup, we recommend that you replace it with the new version. TASKIT/4500 is backward compatible, meaning files created using an earlier version can still be used.

To replace your existing TASKIT/4500 program with the current version, you must first erase the version you have previously installed. To do this, erase the files and the subdirectory in which the TASKIT/4500 program was previously installed. Be sure to copy or backup any files that you saved in this subdirectory before erasing it. After you have deleted the old subdirectory, you are ready to install the new version of the TASKIT/4500 program, as described above.

3.1.3. TASKIT/4500 Remote Connection

TASKIT/4500 allows you to control the TAS 4500 instrument using a National Instruments IEEE-488 interface, RS-232 CRLF interface or the IEEE-488 interface via another TAS product utilizing Serial to GPIB forwarding.

Direct GPIB Protocol Setup

TASKIT/4500 can control the unit via a National Instruments GPIB port. Connect your PC's GPIB port to the GPIB port on the rear panel of the TAS 4500(s) as shown in Figure 3-1. The TAS 4500 must also be configured for GPIB control from the front panel. Refer to the Section 5.3 for information on setting the unit for GPIB control. Multiple TAS 4500s may be controlled by a single PC by cabling the instruments together as shown in Figure 3-2.

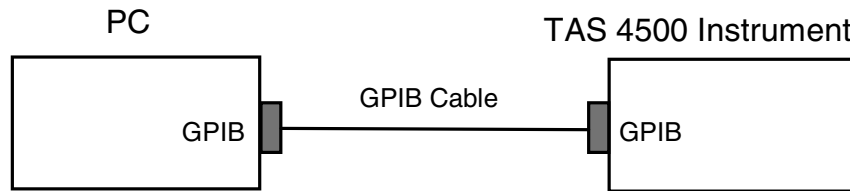


Figure 3-1. Connecting the PC to TAS 4500 with Direct GPIB Control

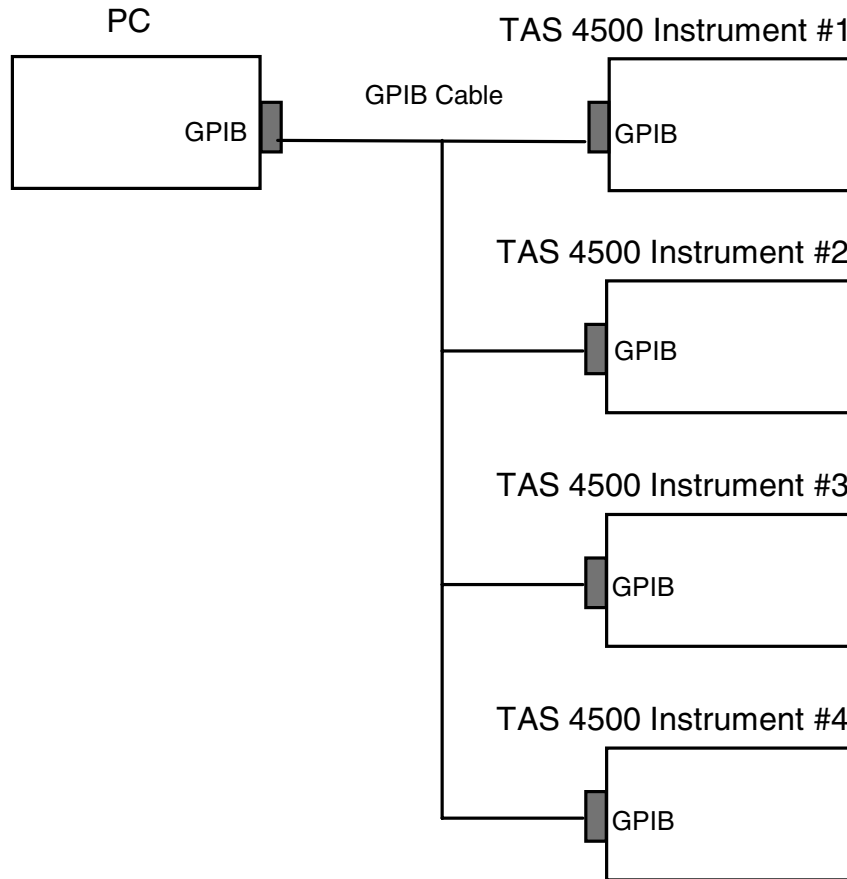


Figure 3-2. Connecting the PC to Multiple TAS 4500s with Direct GPIB Control

Serial Protocol Setup

TASKIT/4500 can control the unit via one of the PC's RS-232 serial ports. Connect the PC's RS-232 port to the RS-232 port on the rear panel of the TAS 4500(s) as shown in Figure 3-3. The TAS 4500 must be configured for RS-232 control from the front panel. Either the CR/LF or ACK/NAK serial protocol may be used. Refer to Section 5.3 for information on setting the unit up for RS-232 serial control. Multiple TAS 4500s may be controlled by a single PC using the serial protocol only if the PC has multiple RS-232 ports available.

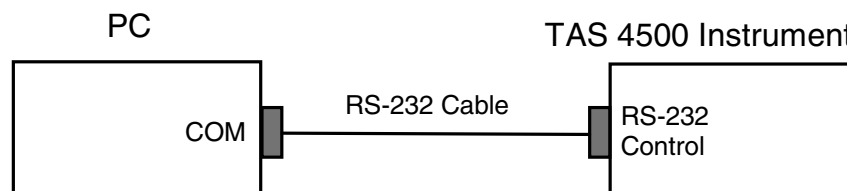


Figure 3-3. Connecting the PC to TAS 4500 Instrument

Serial/GPIB Protocol Setup

TASKIT/4500 also supports control of the TAS 4500(s) via any TAS product that supports Serial to GPIB forwarding. For example, the TAS 4500 itself may act as a Serial to GPIB forwarding device. Connect the forwarding TAS product to the both the PC (RS-232 connection) and the destination TAS 4500 unit (GPIB connection) as shown in Figure 3-4. The remote protocol setting for the forwarding device should be set to CR/LF or ACK/NAK, and the protocol for the destination TAS 4500 should be set to GPIB. The GPIB address setting defined in TASKIT for the destination TAS 4500 must match the address setting on the front panel of the unit. Refer to Section 5.3 for information on setting the unit up for RS-232 serial control.

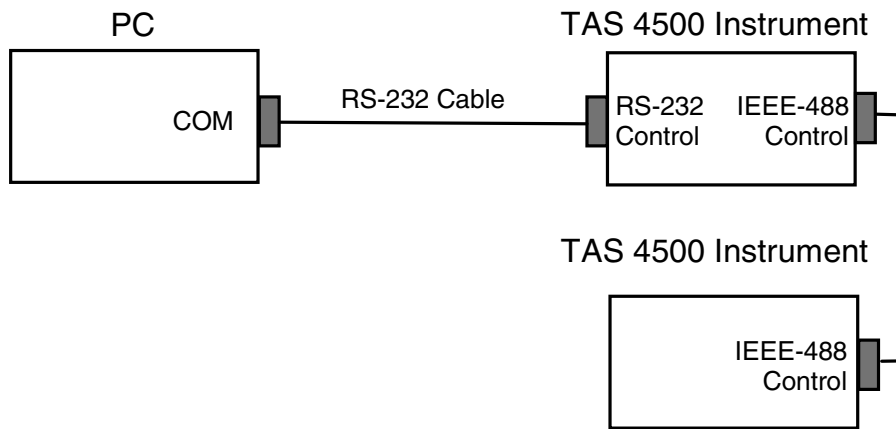


Figure 3-4. Connection for IEEE-488 Control with TAS 4500 in Serial to GPIB Forwarding Mode

3.1.4. Using TASKIT/4500

To start the TASKIT/4500 program, double-click on the corresponding icon, or select *Run* from the Windows Program Manager. TASKIT/4500 will display a main screen consisting of a Title Bar, a Menu Bar, a Command Ribbon, and Program Workspace.

Title Bar

The very top line on the screen is the Title Bar. The Title Bar contains the program name, the current device number, and the current settings file. Upon entry to the program, the current file is "[untitled]". The Control Box at the left side of the Title Bar gives access to the System Menu. This box allows you to close the application, or switch to a different application. The Resize buttons at the right side of the Title Bar minimize or resize the TASKIT/4500 Application Window.

Menu Bar

The Menu Bar is located immediately below the Title Bar. Each word on the menu bar is the title of a menu. To show the items in that menu, move the mouse pointer to that menu and click, or hold down the Alt key while pressing the underlined letter of the menu title. Each menu provides access to a certain type of function.

Command Ribbon

The Command Ribbon is located immediately beneath the Menu Bar. The Command Ribbon provides quick "point and click" access to commonly used functions. To execute a command ribbon function, position the mouse cursor over the appropriate icon and click.

Program Workspace

Directly beneath the Command Ribbon is the Program Workspace. The Program Workspace is where you view and/or modify the current settings.

Help Menu

TASKIT/4500 for Windows provides on-line help to assist the user whenever a question arises. The help function provides information about the characteristics of the TASKIT/4500 program, and the specifications that the program is designed to work within. When you have a question, go to the help menu and scroll through the contents or search for a specific topic. A topic should exist that will define the area that you are uncertain about. The help menu also includes information about the version of TASKIT/4500 you are using and the effective copyright dates.

3.1.5. Configuring TASKIT/4500 Program Options

NOTE: Prior to configuring each unit for TASKIT connection, you may need to configure the *Number of Branches* parameter from the *System Configuration* menu. If you have a test system that contains more than one TAS 4500, you should set the *Number of Branches* parameter to 4, 6, or 8 to match the number of 4500 channels present. This will then allow you to access the configuration information for each unit from the *Options* menu as outlined below.

Before communicating with the TAS 4500 unit, you must set the TASKIT/4500 program options to match the settings on the unit. This includes configuring the *Communications Options* and *Device Options* of each unit from the *Options* menu.

Communications Options

To set the *Communications Options*, selecting *Options* → *Unit #* from the TASKIT menu. If this is a multiple unit system configuration (i.e. an 8 branch diversity test system) the communications options must be set for each unit in the system by selecting *Unit 1 (primary)*, *Unit 2*, *Unit 3* and *Unit 4* in succession from the *Options* menu and clicking on the **Communications** button. The program will display the *Communications Options* dialog box similar to the one shown in Figure 3-5.

Select the remote control mode that you will use to communicate with the unit, as previously discussed in 3.1.3 on TASKIT/4500 Remote Connection. If selecting GPIB communications select the GPIB address the TAS 4500 is assigned. If selecting Serial communications select the RS-232 port that will be used to communicate with the instrument, as well as the port parameters. These default settings were chosen to provide the best performance:

- Rate = 19,200 bps
- Data Bits = 7
- Parity = odd
- Stop Bits = 1

However, these settings can be changed to fit individual testing needs. Be sure that the TAS 4500 instrument is using the same communication settings. If you select Serial/GPIB remote mode, then you must set the forwarding device RS-232 parameters and the destination unit(s) GPIB address appropriately.

Select **OK** to save any changes and exit the dialog box. TASKIT/4500 will save these settings when you exit the program. They are restored the next time the program is run. Select **Cancel** if you wish to abandon changes and exit the dialog box.

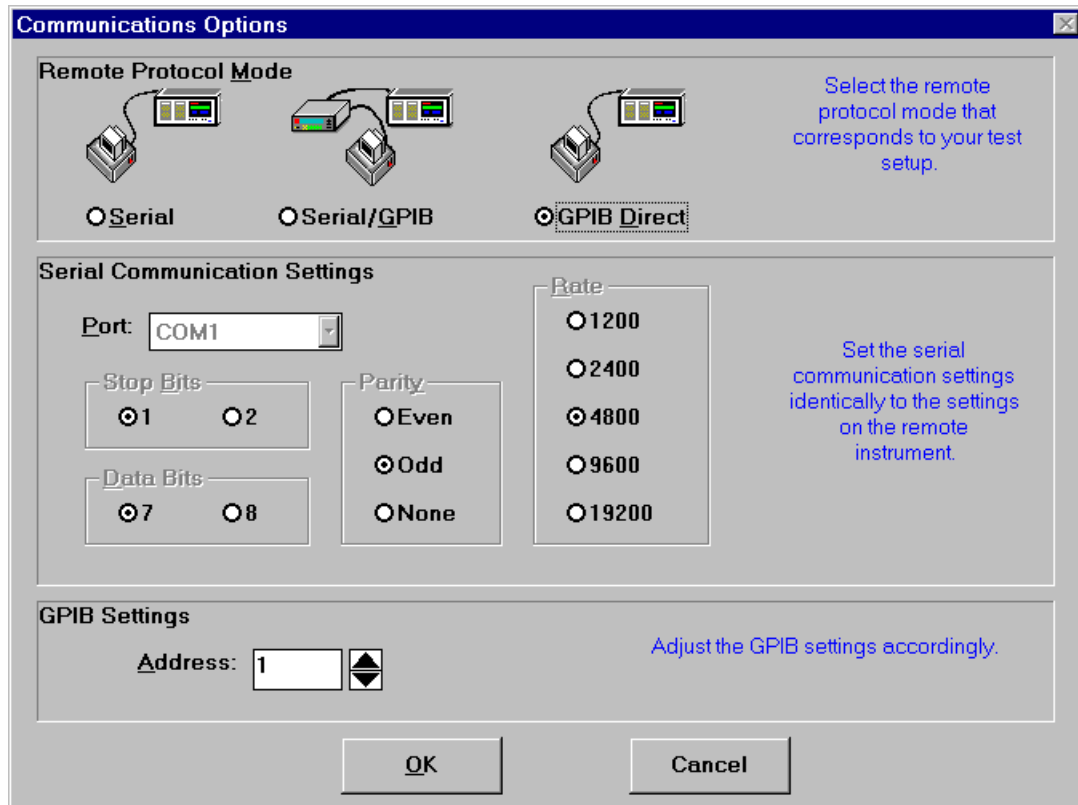


Figure 3-5. Communications Options Window

Device Options

Select *Options* → *Unit #* from the menu and click on the **Device Details** button to display the *Device Options* window similar to the one shown in Figure 3-6. Select the model number, firmware version, options and/or system configuration that correspond to the device you are using. Be aware that changing any of the device option settings will cause TASKIT/4500 to reset all parameter settings to the default values.

When remote communication is established, the TASKIT/4500 program compares the instrument settings with the settings from the Device Options window. If one or more settings do not match, TASKIT/4500 will display a dialog box indicating the incorrect settings. You have the option of canceling remote connection or matching the settings of the remote unit. Note that the latter will cause all parameter settings to reset to the default values. The device options settings are saved when you exit the program and restored the next time TASKIT/4500 is run.

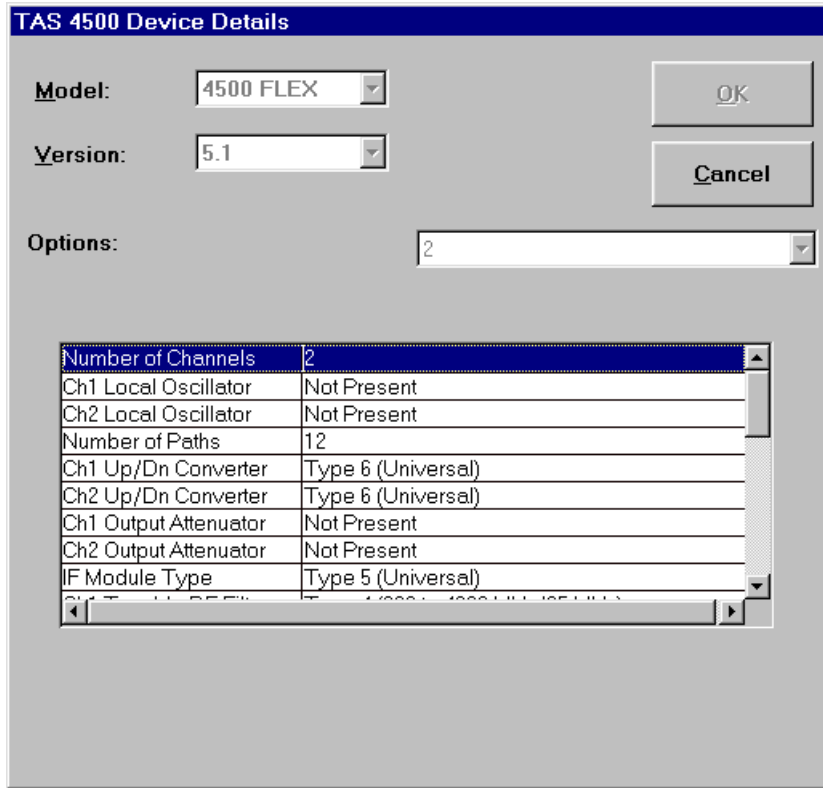


Figure 3-6. Device Options Window

Software Options

Select *Options* → *Software* from the menu to display the *Software Options* window shown in Figure 3-7. The *Operator Name* and *Operator Initials* settings are used in the file summary information and in printed reports. The *Default Path* setting allows you to specify the default path that will be used for file operations. Select **OK** to save any entries and exit the dialog box. Select **Cancel** if you wish to abandon changes and to exit the dialog box.

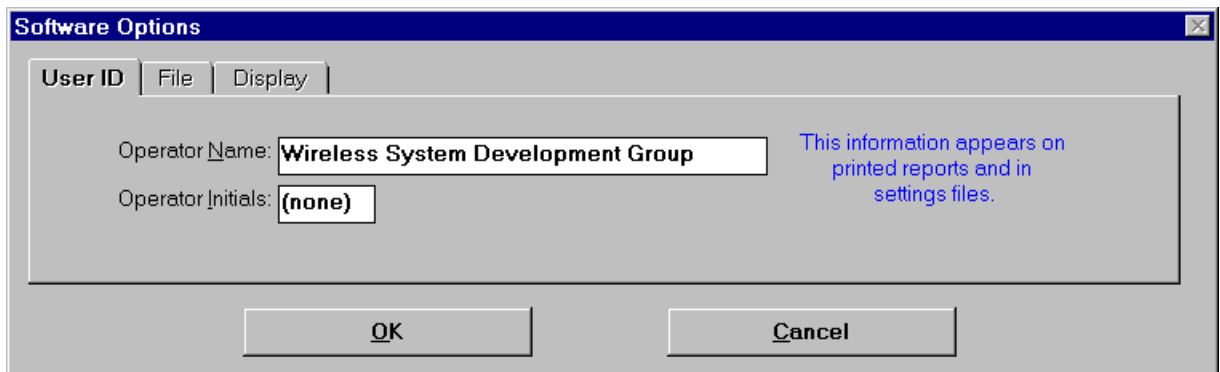




Figure 3-7. Customize Options Window

3.1.6. Establishing Communication

It is possible to load and execute TASKIT/4500 without connecting the PC to the TAS 4500 instrument. This allows you to see the menus and to create files. However, certain functions are available only when the PC is connected to an instrument.

TASKIT/4500 Instrument Communication

Now you should be able to establish communication with the TAS 4500 unit(s).

Click on the face icon, . The hourglass cursor should appear. After a few seconds, the face icon should smile.  After several more seconds, the hourglass cursor should revert to an arrow. You are now on-line with the test instrument(s).

When the face icon is clicked, TASKIT/4500 attempts to establish a connection with the 4500 device. TASKIT/4500 checks the interface to see if an instrument is connected. If an instrument is detected, TASKIT/4500 commands the instrument to report its model number, version, and system configuration. TASKIT/4500 compares these values with the settings from the Device Options window. If one or more settings do not match, TASKIT/4500 will display a dialog box indicating the incorrect settings.

Once a connection is established, TASKIT/4500 will download all the parameter settings in the program to the 4500 unit. From this point on, any changes in the settings entered on the PC will be immediately transmitted to the test instrument. This exchange causes the instrument settings to stay in-sync with the settings on the PC screen until the communication session with the 4500 unit has ended.

3.1.7. File Operations

Creating Device Files

TASKIT/4500 allows you to save all the settings in a file and restore them at a later time. This feature is very useful for developing test plans that include various configurations of your TAS 4500 test instrument.

To save the current settings in a file select *Save As* from the *File* menu. A dialog box will appear where you can specify the drive, path and filename. After the file is saved, the Title Bar will show the name of the current file name. To re-save or update the current settings file select *Save* from the *File* menu.

To open a settings file select *Open* from the *File* menu. A dialog box will appear where you can specify the drive, path and filename of the file you wish to open. If TASKIT/4500 is connected to the device all settings in the file will be downloaded to the device at this time. The Title Bar will be updated with the new file name. During a file open, if TASKIT/4500 detects differences between current options settings and options settings in the file, it will ask you to approve a file conversion.

Creating Commands Files

A Commands File is created by choosing *Make Commands File* under the *File* menu. The commands file contains all the specific remote commands, which are used to configure the TAS 4500 to the parameter settings that are currently displayed in the TASKIT menus. The data in this file can be used to program the TAS 4500 when it is controlled via a customer specific ATE application.

File Conversion

When a Device Settings File is being opened and the file has device options which differ from those currently set, the file must be converted. During a file conversion all parameters that are not contained in the file, but are available for the device will be set to default values. Values that are contained in the file, but are not valid for the current device, will be ignored. All non-valid parameters in the file will be listed below the file convert form and logged in the file conversion error file. The error log file is saved as the same root name as the opened file, but with the .ERR extension.

When a file is to be converted the File Conversion dialog box will appear. To convert the file, click on **Proceed with Conversion**. To cancel the file conversion click on **Cancel**. When the file is converted a box displaying any errors which have occurred will appear below the line on this window. After finishing viewing errors click on the **OK** button. The file conversion is now complete. If the file is saved, it will be saved as the new format.

3.2. Dynamic Environment Emulation (DEE) Mode

This section details the operation of the TAS 4500's Dynamic Environment Emulation (DEE) Mode. Dynamic Environment Emulation Mode is a standard feature available in TASKIT/4500. DEE Mode allows the user to emulate a dynamic propagation environment by cascading a series of parameter states in one or multiple TAS 4500s. Both an introduction and a detailed description of the steps required to use DEE mode are provided. A simple example is provided with all example files included with the installation of TASKIT/4500.

In DEE a group of parameters is defined as a state. A sequence of states creates a test scenario. Dynamic Environment Emulation Mode allows for a virtually unlimited number of states to be configured. In order to perform a DEE test, the state data must be collected or generated, formatted and compiled. This mode is only available through TASKIT/4500 with direct GPIB control of the 4500 unit(s).

NOTE: A National Instruments GPIB card is required to provide control of the unit(s) and allow for timely download of state parameters.

DEE Parameter Definition

One of the key programmable parameters available in DEE is the State Duration. This is the period of time for which a DEE test will emulate each state defined in the test scenario. Based on the required state duration, the user has access to certain parameters in the unit for modification on a state by state basis.

There are two acceptable State Duration ranges defined in DEE. The **Standard State Duration** of 10msec or greater permits all of the following parameters to be set in State 1 and modified in each successive state within a DEE test scenario.

- ⇒ Path Loss
- ⇒ RF Attenuation (ATT1 only)
- ⇒ Modulation Type
- ⇒ Velocity
- ⇒ LOS Component
- ⇒ Spectrum Offset
- ⇒ Rician K / Nakagami M
- ⇒ Phase Shift
- ⇒ Fading Power Spectrum

The **Accelerated State Duration** permits State 1 of the DEE test to also define any combination of the parameters listed above for Standard State Duration tests. However, once State 1 has been established, only the following subset of parameters can be modified in any subsequent state transitions within a DEE test

scenario. Notice that the user is not permitted to modify any modulation related parameters (i.e. modulation type, velocity, etc.) when attempting to use these shorter state durations. Attempting to do so will result in compiler warning messages and will prohibit use of a 5msec state duration.

- ⇒ Path Loss
- ⇒ RF Attenuation (ATT1 only)
- ⇒ Path Delay

DEE Additional Notes

The execution of a DEE test can also be controlled from a remote PC via an RS-232 connection using Remote Client Mode. See Section 3.2.11 for more details on this mode.

The DEE features are only available when the Channel Configuration is set to dual channel, diversity, or interference modes. This feature is not currently supported in single channel mode. The DEE menu options and tool bar icons will be disabled when single channel mode is selected.

3.2.1. Getting Started with DEE

The operation of the TAS 4500's Dynamic Environment Emulation (DEE) Mode requires a specific sequence of actions to be performed. The procedure for the operation of the DEE mode is as follows:

1. Install TASKIT/4500 and configure the TAS 4500 unit(s) and TASKIT software as detailed in Section 3.1.
2. Configure the TAS 4500 unit(s) hardware setup based on the number of channels used in the test. If more than one system will be used in the DEE test, refer to Section 1.3.5 "Setup Requirements for Multiple System Test Configurations" for additional information on the required system interconnections.
3. Collect the data *or* generate the data with the TAS supplied Microsoft Excel template.
4. Generate a State Source Code (.SSC) file from the state data using either a user supplied conversion utility or a Microsoft Excel file as detailed in Sections 3.2.3 and 3.2.4.
5. Establish a remote connection using the GPIB remote protocol with the TAS 4500(s) as described in Section 3.1.2.
6. Compile the .SSC file into a State Machine Code (.SMC) file using the TASKIT/4500 DEE Compiler as detailed in Section 3.2.6.

7. Preview the DEE test with the TASKIT/4500 DEE Preview feature as detailed in Section 3.2.7.
8. Use the .SMC file to execute a DEE test using the TASKIT/4500 Dynamic Environment Emulator as detailed in Section 3.2.8.

State data can be generated using either the Excel spreadsheet with macro support provided with TASKIT/4500 or user supplied playback data. The data collection process is based entirely on the user's source for the state data (i.e. channel sounding, terminal diagnostic monitor output, simulation, etc.). The only limitation on the total number of states for a particular DEE test is the storage capability of the PC that is the host of the TASKIT/4500 DEE application software.

The state source data, stored in the .SSC file must next be compiled into the compressed data format of the State Machine Code (.SMC) file. If multiple 4500s are controlled by one DEE test, multiple source data files and multiple compiled data files will be utilized. There is a one-to-one mapping between the number of 4500 units controlled and the number of source data files and compiled data files.

The .SMC file is a proprietary file format used by the TASKIT/4500 Dynamic Environment Emulator for the real time emulation process. TASKIT DEE downloads the .SMC file(s) to the test system in real time to "play" the dynamic propagation data that has been recorded into discrete states and saved in the corresponding .SMC file. The user has the ability to run through the states once, loop the states N times, or loop through the states indefinitely.

3.2.2. Dynamic Environment Emulation Mode Data Editor

The following section describes the use of the Dynamic Environment Emulation Mode MS Excel '97 template provided with TASKIT/4500. The DEE template shown in Figure 3-8 contains macros to assist data entry and .SSC file generation as well as the data column labels. This mode of .SSC file generation is the recommended method for a user who is creating the data independent of an automated acquisition method. If the DEE test will control multiple 4500 units, multiple DEE data and machine code files will be required. There is a one to one mapping between the 4500 units in the test system and the number of .SSC files required.

Each row in the Excel spreadsheet contains the definition of a state. The first row of the spreadsheet is the only exception. This row contains the column headers to label the column parameters. The columns in the Excel spreadsheet contain the parameters necessary to define each state.

The screenshot shows a Microsoft Excel '97 window titled "Dee_man.xls". The spreadsheet contains a table with the following data:

1	Comment	Time Stamp	State Duration (s)	Ch1 P1 Status / Modulation	Ch1 P1 Delay (us)	Ch1 P2 Status / Modulation	Ch1 P2 Delay (us)	Ch1 P3 Status / Modulation	Ch1 P3 Delay (us)	Ch1 P4 Status / Modulation	Ch1 P4 Delay (us)	Ch1 P5 Status / Modulation
2		0:0:0.1	0.100	1	1.000	1	3.000	1	5.000	1	7.000	1
3		0:0:0.2			2.000		4.000		6.000		8.000	
4		0:0:0.3			3.000		5.000		7.000		9.000	
5		0:0:0.4			4.000		6.000		8.000		10.000	
6		0:0:0.5			5.000		7.000		9.000		11.000	
7		0:0:0.6			6.000		8.000		10.000		12.000	
8		0:0:0.7			7.000		9.000		11.000		13.000	
9		0:0:0.8			8.000		10.000		12.000		14.000	
10		0:0:0.9			9.000		11.000		13.000		15.000	
11		00:00:01			10.000		12.000		14.000		16.000	
12		0:0:1.1			11.000		13.000		15.000		17.000	
13		0:0:1.2			12.000		14.000		16.000		18.000	
14		0:0:1.3			13.000		15.000		17.000		19.000	
15		0:0:1.4			14.000		16.000		18.000		20.000	
16		0:0:1.5			15.000		17.000		19.000		21.000	
17		0:0:1.6			16.000		18.000		20.000		22.000	
18		0:0:1.7			17.000		19.000		21.000		23.000	
19		0:0:1.8			18.000		20.000		22.000		24.000	
20		0:0:1.9			19.000		21.000		23.000		25.000	
21		00:00:02			20.000		22.000		24.000		26.000	
22		0:0:2.1			21.000		23.000		25.000		27.000	
23		0:0:2.2			22.000		24.000		26.000		28.000	
24		0:0:2.3			23.000		25.000		27.000		29.000	
25		0:0:2.4			24.000		26.000		28.000		30.000	
26		0:0:2.5			25.000		27.000		29.000		31.000	
27		0:0:2.6			26.000		28.000		30.000		32.000	
28		0:0:2.7			27.000		29.000		31.000		33.000	
29		0:0:2.8			28.000		30.000		32.000		34.000	
30		0:0:2.9			29.000		31.000		33.000		35.000	

Figure 3-8. Excel '97 Data Entry Table

In order to create a new DEE state source code file via the MS Excel '97 interface follow this basic procedure:

1. Run MS Excel '97 on a PC. (Preferably the PC which has TASKIT/4500 installed).
2. Select *File* → *New* and then select the supplied “*DEE_TEMPLATE.XLT*” file and click **OK**.

NOTE: An attempt is made when TASKIT/4500 is installed to place a copy of the supplied template in the destination directory for Excel templates. If TASKIT is unable to locate this directory or install the necessary file, a copy of the “*DEE_TEMPLATE.XLT*” files is also available in the “*TAS4500.WIN*” directory where the TASKIT/4500 program files were originally installed. The user may choose to map the Excel template destination directory to point to the “*TAS4500.WIN*” directory.

3. You must completely specify the first state along row 2 in the spreadsheet for all of the columns.
4. Click on the **Hide/Unhide** button from spreadsheet cell A1 to pop up the View Selection form.
5. Select which paths you would like to modify on a state by state basis from the left portion of the View Selection form.
6. Select which path parameters you would like to modify on a state by state basis from the right portion of the View Selection form.
7. Click **OK** on the View Selection form and the columns you have specified will be displayed on the Excel spreadsheet (all others will simply be hidden from view).
8. Specify the remaining state parameters on a row by row basis to define the successive states for your DEE test.
9. Select *File* → *Save As* and save your .XLS file for future Excel interface edits to your DEE source code data.

NOTE: Any future edits to the state data should be made to the .XLS file. The .SSC file should not be recalled within Excel.

10. Click on the **Save as SSC** button from spreadsheet cell A1 to save your spreadsheet into the .SSC file for use by TASKIT/4500 DEE.
11. Now that your data is saved you may exit the MS Excel program, start TASKIT/4500 and continue on to Section 3.2.6 to compile the state source code data

The second row containing the first state information may be modified to the desired values for the test. It is important that the first state (the second row in the Excel spreadsheet) be completely filled in. Do not delete any values without replacing them with the desired values.

Once the first state is defined the user should click on the **Hide/Unhide** button in cell A1 (in the top left corner of the spreadsheet). The macro dialog box shown in Figure 3-9 will allow the user to specify the paths and state parameters the user desires to edit. The macro simply hides and reveals columns based on the selections made by the user. The data hidden is still in the .XLS file and may be unhidden at any time. For example, if the DEE test will only change path loss and delay for all paths from one state to the next, the user should check all paths in the Paths to View box and check Path Loss and Relative Delay in the Parameters to View box. Once the selections are made from the **Hide/Unhide** macro click on

OK to update the spreadsheet view or click on **Cancel** to leave the spreadsheet view unchanged.

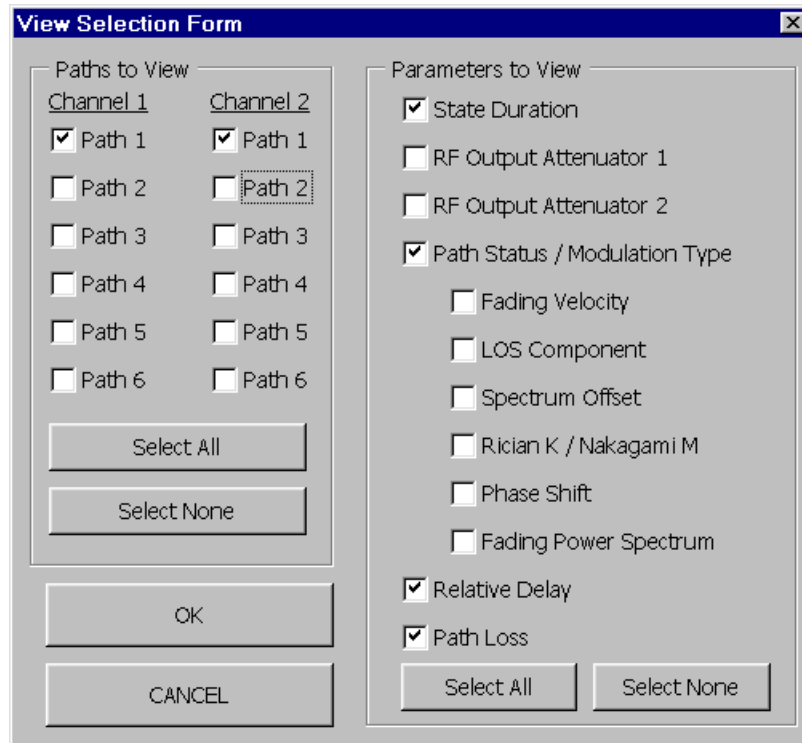


Figure 3-9. Excel 97 Hide/Unhide Macro

Once the desired columns are displayed on the spreadsheet the user may enter the DEE data for the remainder of the states. Each row of the spreadsheet holds the data for a state. Row N contains the state information for state N-1. It is important to note that if a value is to be unchanged from one state to the next, the cell may be left empty. This will allow a user to only enter values that change from one state to the next. This should minimize the data entry requirements.

After all of the state data is entered the user should save the MS Excel file (as an .XLS file) for future state data editing. It is important to note that future edits are to be completed on the saved .XLS file and not on the formatted SSC file.

Next the **Save as SSC** button should be clicked to save the spreadsheet as a comma delimited text file for the DEE Compiler.

If the DEE test is controlling multiple 4500 units then the multiple sheets included in the editor template should be used. All four sheets of the MS Excel spreadsheet will be saved with the .XLS file but each .SSC file must be generated separately from its respective sheet.

It should be noted that when defining a DEE test scenario, the user must define a minimum of 3 states. Failing to do so will result in an error from the DEE Compiler.

DEE Mode Data Editor Example

The following MS Excel '97 screen capture shows the "PATHLOSS.XLS" Excel file loaded. This file is installed into the "TAS4500.WIN\EXAMPLES" subdirectory.

The first state in the PATHLOSS test is defined as follows:

- State duration set to 0.100 seconds
- Path 1 On in each channel set to modulation type None
- Path 1 delay set to 0 nsec in each channel
- Paths 2 through 6 are disabled in each channel
- Channel 1 Path 1 set to 0.0 dB of path loss, Channel 2 Path 1 set to 30.0 dB of path loss

The only parameter that changes from one state to the next is path loss. Channel 1 Path 1 path loss is incremented by 0.1 dB for each state. Channel 2 Path 1 path loss is decremented by 0.1 dB for each state.

There are a total of 300 states defined in the "PATHLOSS.XLS" file. In order to view the example file with the MS Excel '97 interface as shown in figure 3-10 follow this basic procedure:

1. Run MS Excel '97 on a PC. (Preferably the PC which has TASKIT/4500 installed).
2. Select *File* → *Open* and then select the supplied file "PATHLOSS.XLS" from the "TAS4500.WIN\EXAMPLES" subdirectory and click **OK**.
3. Click on the **Hide/Unhide** button from spreadsheet cell A1 to pop up the View Selection form.
4. Check the Channel 1 Path 1 and Channel 2 path 1 entries from the Paths to View box of the View Selection form.
5. Check the parameters Modulation Type and Path Loss from the Parameters to View box of the View Selection form.
6. Click **OK** on the View Selection form and the columns you have specified will be displayed on the Excel spreadsheet (all others will simply be hidden from view).

Comment	Time Stamp	State Duration (s)	Ch1 P1 Status / Modulation	Ch1 P1 Delay (us)	Ch1 P1 Loss (dB)	Ch2 P1 Status / Modulation	Ch2 P1 Delay (us)	Ch2 P1 Loss (dB)
	0:0:0.1	0.100	1	0.000	0.0	1	0.000	30.0
	0:0:0.2				0.1			29.9
	0:0:0.3				0.2			29.8
	0:0:0.4				0.3			29.7
	0:0:0.5				0.4			29.6
	0:0:0.6				0.5			29.5
	0:0:0.7				0.6			29.4
	0:0:0.8				0.7			29.3
	0:0:0.9				0.8			29.2
	00:00:01				0.9			29.1
	0:0:1.1				1.0			29.0
	0:0:1.2				1.1			28.9
	0:0:1.3				1.2			28.8
	0:0:1.4				1.3			28.7
	0:0:1.5				1.4			28.6
	0:0:1.6				1.5			28.5
	0:0:1.7				1.6			28.4
	0:0:1.8				1.7			28.3
	0:0:1.9				1.8			28.2
	00:00:02				1.9			28.1
	0:0:2.1				2.0			28.0
	0:0:2.2				2.1			27.9
	0:0:2.3				2.2			27.8
	0:0:2.4				2.3			27.7
	0:0:2.5				2.4			27.6
	0:0:2.6				2.5			27.5
	0:0:2.7				2.6			27.4
	0:0:2.8				2.7			27.3
	0:0:2.9				2.8			27.2

Figure 3-10. Excel '97 PATHLOSS.XLS Sample File Screen Capture

3.2.3. DEE Mode State Source Code File Format

If the Dynamic Environment Emulation Mode state data is generated from the MS Excel template, the file format of the State Source Code (.SSC) file will be handled automatically. If the DEE state data is to be converted from some other source such as a mobile station diagnostic monitor, then the .SSC file will need to be translated from this source data format to the appropriate .SSC file format. It is for these DEE users that the .SSC file format is described in this section.

The .SSC file is a readable text format with comma delimiters between data elements in a 'row' and a CR/LF character marking the end of a row. The file format is very similar to the MS Excel Template spreadsheet format described in Section 3.2.3. The first row contains the column labels, the second row contains the state 1 data and the following rows contain the remaining state information as a sparse matrix (i.e. not all 'cells' have data). It is important that the first row precisely match the following format in order for the DEE Compiler to properly recognize the columns extracted from the .SSC file.

The .SSC file has the following labels as the first row column header separated by commas.

NOTE: The column header text should exactly match the listing below. However, the DEE compiler is **not** case sensitive and will treat upper and lower case labels identically.

- State Duration (s)
- CH1 RF Attenuation (dB)
- CH2 RF Attenuation (dB)
- Ch1 P1 Status / Modulation
- Ch1 P1 Fading Velocity (km/hr)
- Ch1 P1 LOS Comp (Hz)
- Ch1 P1 Spectrum Offset (Hz)
- Ch1 P1 Rician K (dB) / Nakagami M
- Ch1 P1 Phase Shift (deg)
- Ch1 P1 Fading Power Spectrum
- Ch1 P1 Delay (μ s)
- Ch1 P1 Loss (dB)
- Ch1 P2 Status / Modulation
- Ch1 P2 Fading Velocity (km/hr)
- Ch1 P2 LOS Comp (Hz)
- Ch1 P2 Spectrum Offset (Hz)
- Ch1 P2 Rician K (dB) / Nakagami M
- Ch1 P2 Phase Shift (deg)
- Ch1 P2 Fading Power Spectrum
- Ch1 P2 Delay (μ s)
- Ch1 P2 Loss (dB)
- ...

The nine columns for each path are repeated for every path from Ch1 P1 (Channel 1 Path 1) to Ch1 P6 (Channel 1 Path 6) followed by Ch2 P1 (Channel 2 Path 1) to Ch2 P6 (Channel 2 Path 6). There are a total of 111 columns of information in the file for a 2 channel 12 path 4500 unit. A 4500 unit without paths 4 through 6 would not be required to specify these paths in the State Source Code file resulting in a total of 57 columns of data. A 4500 unit with only 1 channel and 3 paths would have a total of 30 columns of data in the State Source Code file.

The second row of data specifies the first state of the unit for the DEE test. It is required that every parameter be present for the first state to be fully defined. All

of the data specified for the DEE test in the State Source Code file are comma delimited (as is the column label row). Each state is one line of the .SSC file. An example of a simple .SSC file is as follows:

```

example.ssc - WordPad
File Edit View Insert Format Help
State Duration (s),CH1 RF Attenuation (dB),CH2 RF Attenuation (dB),Ch1 P1 Status / Modulation;
0.10,0.0,0.0,50.0,0.0,0.0,0.0,0.0,0.0,0.0000,0.0,0,50.0,0.0,0.0,0.0,0.0,0.0000,0.0,0,50.0,0.0
,10,
,20,
For Help, press F1
NUM

```

Figure 3-11. Sample DEE .SSC File

The first four columns of this partial .SSC file specify the state duration, RF channel attenuation and the modulation status of Channel 1 path 1. The first state specifies the state duration of 0.10 seconds, the Channel 1 RF output attenuator set to 0 dB of loss, the Channel 2 RF output attenuator set to 0 dB of loss and the Channel 1 Path 1 modulation type set to NONE. The third row specifies the second state. The second state is defined the same as the first state except that the Channel 1 RF output attenuator is set to 10 dB of loss. The fourth row specifies the third state. The third state is defined the same as the second state except that the Channel 1 RF output attenuator is set to 20 dB of loss.

For this partial .SSC file there are only three states. These three states may be executed once progressing from state 1 to state 3. After state 3 is complete the TAS 4500 unit(s) will return to the static mode of operation they were in before the DEE test was started. Note that this short test would only last a total of 300 msec. Alternatively, the test may be executed in a loop mode in which the Channel 1 RF output attenuator will loop from 0 dB, 10 dB, 20 dB, 0 dB, until the test is stopped. Section 3.2.8 on the DEE Test Execution will describe the test execution in more detail.

It is possible to generate the required first line of the .SSC file by using the default Excel template. The template file should be opened and saved as an SSC file as outlined in Section 3.2.2. Prior to using the *Save as SSC* macro, the default data in row 2 (default data for state 1) of the template should be deleted. This default data defines all applicable system parameters for the first state of the DEE test as required for DEE test generation. The user supplied conversion mechanism will be required to provide this complete state 1 definition. The resulting SSC text file

containing the comma delimited column headers can be used as a starting point for appending the user's converted state data.

DEE Mode State Source Code File Example

The following text editor screen capture shows a portion of the "PATHLOSS.SSC" file. The "PATHLOSS.SSC" file was generated from the "PATHLOSS.XLS" file example from the previous section of this manual. This file is installed into the "TAS4500.WIMEXAMPLES" subdirectory. It is recommended that this file be viewed electronically to see row 1 and row 2 in total.

```

State Duration (s),CH1 RF Attenuation (dB),CH2 RF Attenuation (dB),Ch1 P1 Status / Modulation,Ch
0.100,0.0,0.0,1,50.0,0.0,0.0,0.0,0.0,0.000,0.0,0,50.0,0.0,0.0,0.0,0.0,0.000,,0,50.0,0.0,0.0,
//.....0.1,.....29.9
//.....0.2,.....29.8
//.....0.3,.....29.7
//.....0.4,.....29.6
//.....0.5,.....29.5
//.....0.6,.....29.4
//.....0.7,.....29.3
//.....0.8,.....29.2
//.....0.9,.....29.1
//.....1.0,.....29.0
//.....1.1,.....28.9
//.....1.2,.....28.8
//.....1.3,.....28.7
//.....1.4,.....28.6
//.....1.5,.....28.5
//.....1.6,.....28.4
//.....1.7,.....28.3
//.....1.8,.....28.2
//.....1.9,.....28.1
//.....2.0,.....28.0
//.....2.1,.....27.9
//.....2.2,.....27.8
//.....2.3,.....27.7
//.....2.4,.....27.6
//.....2.5,.....27.5
//.....2.6,.....27.4

```

For Help, press F1

Figure 3-12. Text Editor PATHLOSS.SSC Sample File Screen Capture

3.2.4. DEE Mode State Source Code Field Descriptions

The table below identifies the valid data fields that can be used in the .SSC file to define any particular state for the test system. The valid data range for each parameter is also outlined in the table.

Name	Description	Data Range
State Duration (s)	Duration of current state	.005 to 16777 sec ¹
CH1 RF Attenuation (dB)	Additional CH1 insertion loss for RF Attenuator (if present)	0.0 to 80.0 dB ²
CH2 RF Attenuation (dB)	Additional CH2 insertion loss for RF Attenuator (if present)	0.0 to 80.0 dB ³
Chx Py Status / Modulation	Modulation type for Channel x, Path y	0 – Off 1 – None 2 – Rayleigh 3 – Frequency Shift 4 – Phase Shift 5 – Rician 6 – Nakagami 7 – Rayleigh w/ Fshift 8 – Rician w/ Fshift
Chx Py Fading Velocity	Fading velocity for Chx Py (Used in Rayleigh, Rician, Nakagami, Rayleigh w/ Fshift, Rician w/ Fshift.)	Units of km/hr Limited by Doppler range of -1000.0 to -0.1, 0.1 to 1000.0 Hz
Chx Py LOS Comp (Hz)	Line of Sight Component for Chx Py (Used in Frequency Shift, Rician, Nakagami, Rician w/FShift)	-1000.00 to -0.01, 0.01 to 1000.00 Hz (0.01 Hz resolution)
Chx Py Spectrum Offset (Hz)	Frequency shift for Chx Py (Used in Rayleigh w/FShift, Rician w/Fshift)	-1000.0 to -0.1, 0.1 to 1000.0 Hz
Chx Py Rician K (dB)/ Nakagami M	Sets the Rician K factor (Used in Rician and Rician w/Fshift) Sets the Nakagami M value (Used in Nakagami)	Rician K factor: -30.0 to +30.0 Nakagami M values: 1,3,5,10,15,25,100
Chx Py Phase Shift (deg)	Sets the phase shift for Chx Py (Used in Phase Shift)	-360.0 to 360.0
Chx Py Fading Power Spectrum	Sets the shape of fading spectrum (Used in Rayleigh, Rician, Nakagami, Rayleigh w/FShift, Rician w/FShift)	0 – Classic 6dB 1 – Flat 2 – Classic 3dB 3 – Rounded
Chx Py Delay (us)	Sets the relative path delay for Chx Py	Standard: 0.000 to 125.000µsec Extended: 0.000 to 2000.000µsec
Chx Py Loss (dB)	Sets the relative path loss for Chx Py	0.0 to 50.0 dB

¹ 5msec State Duration available only when rules for Accelerated State Duration are followed.

² CHx RF Attenuation (dB) settings available only when ATT1 option installed.

Table 3-2. Parameter Definition and Data Ranges

As indicated in the table above, some of the parameters in the .SSC file have slightly different uses depending on what modulation type has been selected. The table below details the use of each parameter for each of the available modulation selections.



Chx Py Status / Modulation	Chx Py Fading Velocity (km/hr)	Chx Py LOS Comp (Hz)	Chx Py Spectrum Offset (Hz)	Chx Py Rician K / Nakagami M	Chx Py Phase Shift (deg)	Chx Py Fading Power Spectrum
Off (0)	UNUSED	UNUSED	UNUSED	UNUSED	UNUSED	UNUSED
None(1)	UNUSED	UNUSED	UNUSED	UNUSED	UNUSED	UNUSED
Rayleigh(2)	Specifies the fading velocity in units of km/hr.	UNUSED	UNUSED	UNUSED	UNUSED	Specifies the shape of the fading spectrum.
Frequency Shift(3)	UNUSED	Specifies the frequency shift of the path in units of Hz.	UNUSED	UNUSED	UNUSED	UNUSED
Phase Shift (4)	UNUSED	UNUSED	UNUSED	UNUSED	Specifies the phase shift of the path in units of degrees.	UNUSED
Rician(5)	Specifies the fading velocity in units of km/hr.	Specifies frequency of the line of sight component in units of Hz.	UNUSED	Specifies the Rician K factor in units of dB.	UNUSED	Specifies the shape of the fading spectrum.
Nakagami (6)	Specifies the fading velocity in units of km/hr.	Specifies frequency of the line of sight component in units of Hz.	UNUSED	Specifies the Nakagami M factor.	UNUSED	Specifies the shape of the fading spectrum.
Frequency Shifted Rayleigh (7)	Specifies the fading velocity in units of km/hr	UNUSED	Specifies the frequency shift of the fading spectrum in units of Hz.	UNUSED	UNUSED	Specifies the shape of the fading spectrum.
Frequency Shifted Rician (8)	Specifies the fading velocity in units of km/hr	Specifies frequency of the line of sight component in units of Hz.	Specifies the frequency shift of the fading spectrum in units of Hz.	Specifies the Rician K factor in units of dB.	UNUSED	Specifies the shape of the fading spectrum.

Table 3-3. SCC File Fields

3.2.5. DEE Data Compiler

After the State Source Code file has been generated the file must be compiled into a State Machine Code file. This compilation process is required to reduce the amount of redundant data found in the State Source Code file to minimize the amount of data downloaded in real time to the TAS 4500(s) during the DEE test. The State Source Code file is read into the TASKIT/4500 DEE Compiler utility and the output of the compiler is the State Machine Code file.

The following procedure summarizes the DEE compilation process:

1. Start TASKIT/4500 and configure the TAS 4500 unit(s) under the *Options* menu.
2. Click on the  icon to connect to the TAS 4500 unit(s).
3. Click on the  icon to access the DEE compiler screen.
4. Enter the State Source Code input file name into the *State File (*.SSC)* text box.
5. Enter the State Machine Code output file name into the *Output File (*.SMC)* text box.
6. Enter the log file name into the *Log File (*.LOG)* text box.
7. Enter any desired comments into the *User Comment* text box.
8. At this point, there are two possible compile options. The **Full Compile** button will provide a compiled .SMC file that contains all states defined in the original .SSC source. The **Custom Compile** button allows the user to select a subset of the total states defined in the .SSC file for compilation. In this case, all states that fall outside of the defined range will be ignored by the compiler.
9. If the compile is completed with “0 Errors” and “0 Warnings”, the progress bar will indicate “Compile Successful”. If the compilation is successful you may continue on to the DEE Preview and/or DEE Execution screens.

If the compile is interrupted by errors or warnings, you should use a text editor to view the Log file. Hints on how to resolve the errors or warnings are provided in the Log file. Resolve the problems and repeat the above procedure.

The compiler shown in Figure 3-13 may be invoked by either clicking on the



icon at the top of the TASKIT/4500 screen or by selecting *View* → *Dynamic Compiler*.

The compilation process and the output .SMC file are dependent on both the 4500 unit hardware configuration and the configuration of the RF parameters. For this reason the .SMC file has the TAS 4500 system configuration embedded in the file's header to ensure the .SMC file is only downloaded to a compatible system with compatible RF settings. The RF settings compared include RF Carrier frequency, RF I/O Frequency, LO mode, LO frequency and RF Frequency Tracking Mode. Before compiling the .SSC file, the system configuration information provided at the top left corner of the TASKIT/4500 DEE Compiler screen should be verified. This information is extracted directly from the *Options* → *unit #* → *Device Options* screen.

The .SSC file must be specified in the box labeled *State Definition File* for the input to the compiler. The box labeled *Output File* must specify the file name of the target .SMC file for the output of the compiler. The box labeled *Log File* must specify the file name the compiler will use to store any warning messages or error messages generated during the compilation process. The box labeled *User Comment* may contain user entered text to which will add a readable message to the unreadable .SMC file. The *User Comment* will be available in the Preview function located on the DEE Execution screen described in Section 3.2.6.

After the above information has been entered into the compiler the Compile button may be selected. Once the compilation process starts, the progress bar will indicate the status of the compile. At the completion of the compilation process, the .SMC file is stored for use by the Dynamic Environment Emulator that is described in 3.2.7 of the manual.

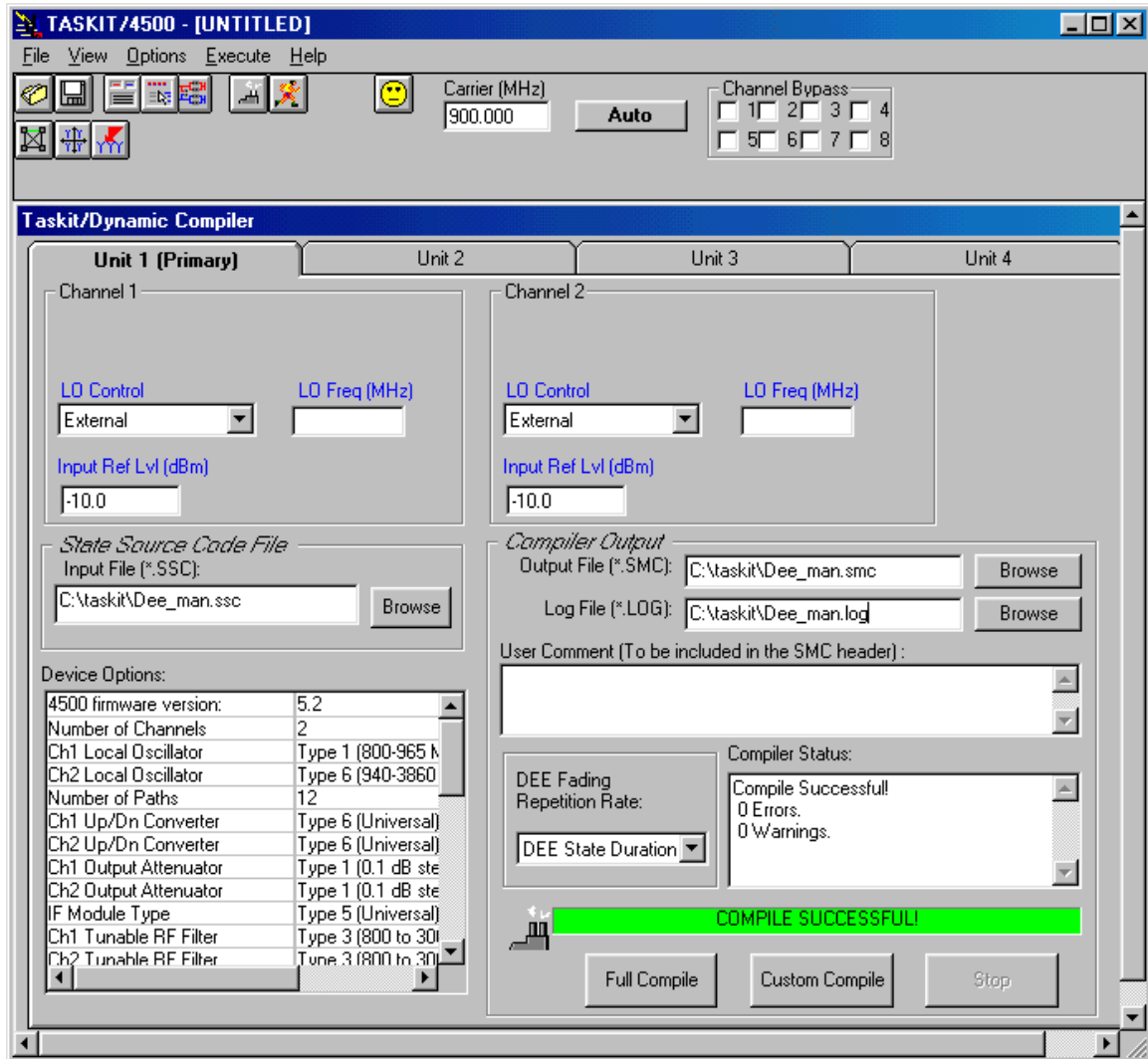


Figure 3-13. TASKIT DEE Compiler

After the compilation of an .SSC file into an .SMC file the Log file should always be reviewed for any warnings generated by the compiler. One of the things that can generate a warning is an out of range parameter. In this case, the compiler will automatically choose a value for the parameter that is within the valid range to allow the compile to complete. An error would be generated if the file header row was not specified properly. In this case the compiler would abort and display an unsuccessful compile message.

DEE Repetition Rate Defined

The *DEE Fading Repetition Rate* parameter can be defined on the DEE Compiler screen. The fading repetition rate is used in the TAS 4500 to define the length or duration of the unique sequence used to generate fading. This parameter provides added flexibility to a dynamic test scenario that requires a Rayleigh faded channel.

When using the unit in a static fading environment, the length of the fading sequence is determined by the Configuration parameter referred to as the Fading Repetition Rate (FADEREP). Setting this parameter defines the time duration of the unique fading sequence. When the defined sequence reaches completion, it is repeated. There are three possible settings: 27seconds, 20 minutes, and 24 hours.

By default DEE allows any path parameter on any path to be modified in each state. This implementation requires the fading sequence length in DEE to be determined by the state duration. Each state transition results in a reset of the fading sequence. This can present a problem if the user applies a small state duration to a Dynamic Test scenario that also contains Rayleigh Faded paths. The statistical properties of the fading will be invalid in this case.

Support has been added to address these applications by allowing the user to set the *DEE Fading Repetition Rate* at the time a .SSC file is compiled. The default DEE operation resets the fading sequence with every state change (*DEE Fading Repetition Rate* set to *DEE State Duration*). It is important to note that selecting any other *DEE Repetition Rate* (27 seconds, 20 minutes, or 24 hours) reduces the list of parameters that can be modified on a state by state basis to the following.



- ⇒ Path Loss
- ⇒ RF Attenuation (ATT1 only)
- ⇒ Path Delay
- ⇒ Velocity*

***NOTE:** The Velocity parameter must be set and modified on a channel wide basis. This means that the Velocity setting defined in State 1 must be the same for all paths in a Channel. Any subsequent changes to the Velocity in any state of the DEE test must be also be applied to all paths in a Channel. Failure to obey this rule will prevent the .SSC file from being successfully compiled. No other modulation related parameters can be modified in a DEE test that does not use the *DEE State Duration* parameter selection.

DEE Mode Compiler Example

Figure 3-14 shows the DEE Compiler screen results from the generation of the “*PATHLOSS.SMC*” file. The “*PATHLOSS.SSC*” file that comes with TASKIT/4500 was used to compile the “*PATHLOSS.SMC*” file. The compiler Log file in this case is stored in “*PATHLOSS.LOG*”. The “*PATHLOSS.SSC*” and “*PATHLOSS.SMC*” files are installed into the “*TAS4500.WIN\EXAMPLES*” subdirectory.

The following procedure summarizes the DEE compilation process for this DEE example:

1. Start TASKIT/4500 and configure the TAS 4500 unit(s) under the *Option* menu.
2. Click on the  icon to connect to the TAS 4500 unit(s).
3. Click on the  icon to access the DEE compiler screen.
4. Enter the State Source Code input file “*PATHLOSS.SSC*” into the *State File (*.SSC)* text box.
5. Enter the State Machine Code output file “*PATHLOSS.SMC*” into the *Output File (*.SMC)* text box.
6. Enter the log file “*PATHLOSS.LOG*” into the *Log File (*.LOG)* text box.
7. Enter any desired comments into the *User Comment* text box.
8. Click on the **Full Compile** button to begin the compilation process for the entire source file. A successful compilation should result in “0 Errors” and “0 Warnings” as shown in Figure 3-14.

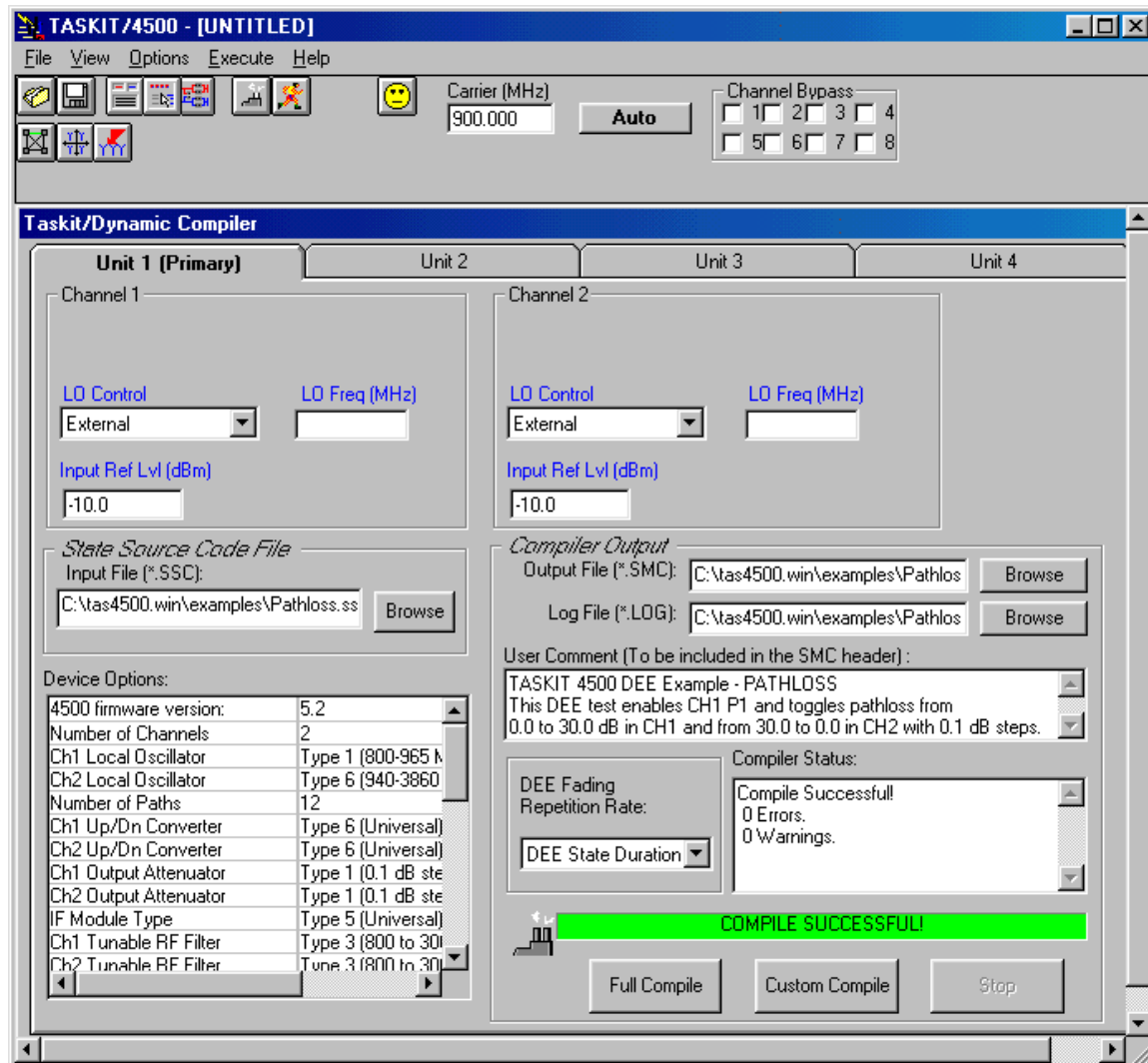


Figure 3-14. TASKIT DEE Compiler Example

DEE Data Compiler Troubleshooting

Error Messages:

Compile errors are always fatal to the compilation process. They occur only when the format of the input file is corrupt. Parameters that are set to improper values cause warnings rather than error messages. The listing of warning messages follows the error section. All error and warning messages are written to the specified log file.

- *Failed to open LOG File.*
TASKIT was unable to open the specified *Log File*. This error could occur if the path or filename is invalid. It could also occur if the specified *Log File* is already in use by another program.
- *Failed to open State Definition (.SSC) File.*
TASKIT was unable to open the specified *State File*. This error could occur if the path or filename is invalid. It could also occur if the specified file is already in use by another program.
- *Failed to open Output (.SMC) File.*
TASKIT was unable to open the specified *Output File*. This error could occur if the path or filename is invalid. It could also occur if the specified file is already in use by another program.
- *Field Header is missing.*
One of the field (column) headers is missing. This error occurs if a necessary field is omitted from the .SSC file. For example, if the column for fading velocity on channel 1 path 6 is missing in a .SSC file targeted for a 12 path system, the compiler will generate this error. For a 3 path system, this column would not need to be present in the source file.
- *Duplicate Field Header.*
Two fields (columns) have the same or similar names. This error occurs when two fields have names that are indistinguishable by the compiler. An example of this would be if one field was called “CH1 RF Attenuation (dB)” and another was called “CH1 RF Attenuation”. The compiler is only looking for “CH1 RF Attenuation” which is a substring of both of the above. It does not know which field contains valid data for the channel 1 RF attenuator.
- *Unrecognized Field Header.*
The compiler does not recognize one of the field headers. This may be because the field is misspelled or simply invalid. The compiler interpretation of field headers is case insensitive. However, white space is not ignored and could cause this error message. For example, the CH1 RF Attenuation (dB) parameter could generate this error message if either “CH1 RF Att” or “CH1RFAttenuation” were present in the .SSC file.

- *State 1 not completely specified.*
The compiler generates this error if any of the parameters for state 1 are missing. For all other states, parameters that do not change may be left blank, and they will retain the value of the previous state. However, if the first state of a parameter is not specified the compiler can not determine what the initial value of the parameter should be.
- *Unexpected end of file*
There are two ways in which this error can occur. The first possible cause of this error is that the first state does not exist at all (i.e. the field header line exists, but no data is present). The second possible cause is that the end of the file is reached before the *Line Feed* for the last state. A state is defined as comma delimited data followed by a *Line Feed*. If the end of the file is reached before this *Line Feed*, it is assumed that the file is corrupt. Note that this could occur if the .SSC file is edited in a text editor and the last *Line Feed* is deleted. To avoid this error, add a few *Line Feeds* to the end of the file (The extras will be ignored).
- *Invalid DEE Fading Repetition Rate*
This error message indicates that the user has defined a *DEE Fading Repetition Rate* that is not compatible with the parameter modifications defined in the .SSC file. These requirements are outlined in Section 3.2.5.

Warning Messages

Warnings are non-fatal errors that occur during a compile. The compiler does not stop when a warning condition occurs. Each warning is written to the log file, and a count of the number of warnings is maintained during the compile. This count is displayed in TASKIT and also appears at the end of the log file.

- *Bounds check warning.*

The form of this type of warning follows:

"The possible values for [SOME PARAMETER] are [MIN]->[MAX] dB. Value has been set to [MIN or MAX] dB"

If the value of a parameter is set to a value greater than the maximum, the value is set to the maximum and this warning occurs. If the value is set to less than the minimum, the value is set to the minimum and this warning occurs.

Example1:

If path loss is set to 60 dB for a state, the following warning will be added to the log file:

"The possible values for path loss are 0->50 dB. Value has been set to 50 dB"

Example2:

If the system does not contain an output attenuator and the input file specifies an output attenuation value other than 0 dB the following warning will be output to the log file:

"The loss value for RF Attenuator 1 must be between 0 dB and 0 dB. Value has been set to 0 dB."

NOTE: If the warning range is 0 → 0 this means that the system does not support this option.

- *Extra Comma Warning*

The form of this type of warning follows:

"Warning: Line [CURRENT LINE NUMBER] contains extra comma delimiters. Extra delimiters have been ignored."

This warning is generated when a line in the .SSC file has more commas than it should. If a comma was inadvertently added to the beginning of a line it would cause the compiler to interpret incorrect data for all parameters following the extra comma.

- *No new state data warning*

The form of this type of warning follows:

"Warning: Line [CURRENT LINE NUMBER] contains no new state data. Line [CURRENT LINE NUMBER - 1] is considered to contain last state."

This warning is generated when a state is reached which contains no new data (all commas, no data). It is assumed that this is the last line in the file. This is done because many programs will pad extra commas to the end of a file when saving it as comma delimited text. This could cause a problem if a state in the middle of the .SSC file contains no new data.

Example:

[SSC File]

1,2,,,1,,,,,,,,,

1,0,0,0,1,,,,,,,,, ← This is assumed to be the last state.

,,,,,,,,,


1,2,1,1,1,,,,,,,,, ← This state and those following it are ignored.

- *Invalid State Definition for 0.005000 second minimum state duration.*
This warning is generated when a state duration less than 10msec has been defined, but an invalid parameter modification has been requested. In this case, the state duration of all states that violate the established rules for Accelerated State Duration operation will be modified to a value of 10msec. Further details on the State Duration definition can be found in Section 3.2.

3.2.6. DEE Mode Data Preview Function

The State Machine Code file is stored in an unreadable compressed binary format. The Dynamic Environment Emulator has a .SMC file preview function used to determine the target 4500 configuration of the .SMC file and to view user comments embedded in the .SMC file. The DEE Preview utility also displays the total Dynamic test duration and the Power Delay Profile (PDP) for a given state as defined by the source data file.

To preview a DEE test perform the following procedure:

1. To access the TASKIT/4500 DEE Preview utility shown in Figure 3-14, click on the  icon at the top of the TASKIT/4500 screen or select *View* → *Dynamic Environment Emulator*.
2. From the TASKIT/4500 Dynamic Environment Emulator screen enter the name of the .SMC file in the *Select State Machine File* text box.
3. With the file selected, click on the *Preview>>* button to display the *DEE Preview* screen. Note that if this is a multiple 4500 unit test system, only one

.SMC file may be previewed at a time by clicking on the corresponding *Preview>>* button.

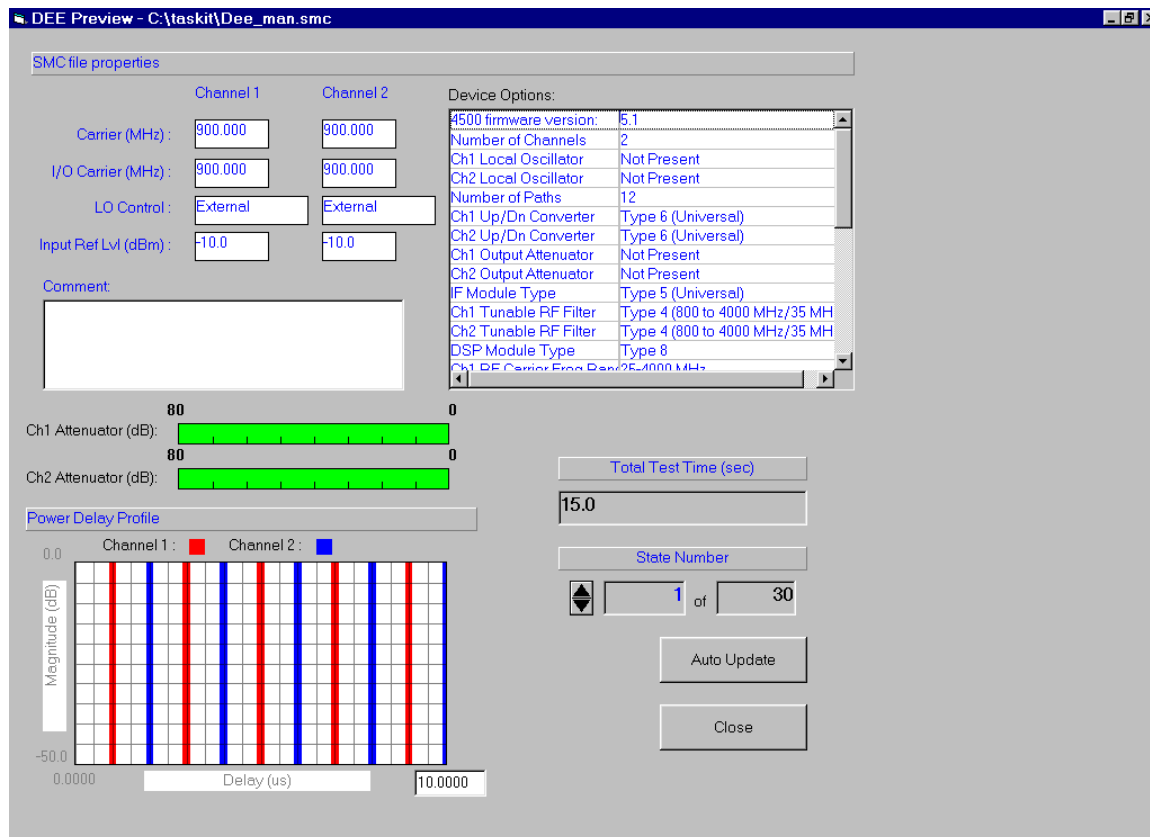


Figure 3-15. TASKIT DEE Preview Screen

For each state, a *Power Delay Profile* will be displayed. Power delay profiles are often used to characterize received signals for adaptive antenna array systems and Rake receiver systems. This graphical representation shows the nominal path signal strength in dB versus the relative path delay setting. In TASKIT/4500, both channels are displayed on a single graph and differentiated by color. When viewing the *Power Delay Profile*, the \uparrow and \downarrow buttons can be used to cycle through the states defined for the Dynamic test.

A second method of viewing the *Power Delay Profile* of a DEE test is to click on the **Auto Update** button, which will proceed sequentially through each state of the test. The **Auto Update** feature starts by displaying the *Power Delay Profile* for state 1 and pauses to display each subsequent state for approximately one second. To stop the **Auto Update** feature, click on the **Stop** button, which appears once the automatic cycle begins.

The following is an example of a power delay profile plot that approximates a hilly urban area with 6 paths.

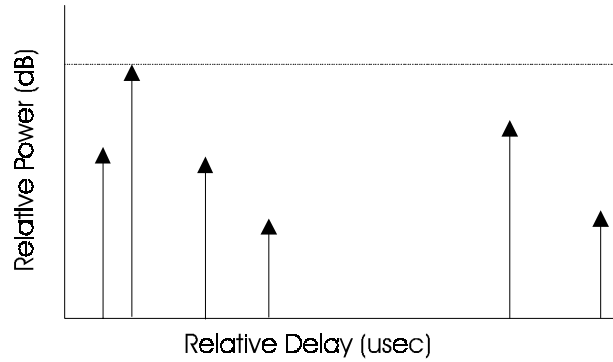


Figure 3-16. Power Delay Profile Example


To exit the TASKIT/4500 DEE Preview function click on the **Close** button at the bottom right of the screen to return to the previous Dynamic Environment Emulator screen.

It is important to note that the **Preview>>** utility accesses information from both the original .SSC file and the compiled .SMC file. Both the .SSC source filename and path are embedded within the .SMC file. If the .SSC file is not found by TASKIT based on the path specified in the .SMC file, a *File → Open* window will pop up prompting the user to locate the appropriate .SSC file. If the .SSC file is not available, the **Preview>>** utility cannot be used.

3.2.7. DEE Mode Test Execution

After the State Source Code file has been compiled into the State Machine Code file the DEE test may be started. The Dynamic Environment Emulator provides the test execution control and status feedback from the unit(s).

To execute a DEE test perform the following procedure:

1. Access the DEE execution screen by either clicking on the  icon at the top of the TASKIT/4500 screen or select *View* → *Dynamic Environment Emulator*.
2. This will open the Dynamic Environment Emulator screen from which the .SMC file may either be previewed or executed.
3. The .SMC file to be executed must be specified in the *Select State Machine File* text box. If there is more than one 4500 unit in the test system (4, 6 or 8 channel system configurations) multiple .SMC files must be selected, one file for each unit.
4. The start of the DEE test is handled by a two step process. First, the **Arm** button should be pressed to place the unit(s) into DEE mode and download state 1 of the .SMC file(s). This initialization process could result in signal path discontinuities while the units are placed in DEE mode. It is important to remember that state 1 of a DEE test must completely define all possible parameters and all parameters will therefore be downloaded at this time. The **Arm** capability is provided to assure that when the test actually starts with a click of the **Run** button, all state transitions (including the initial transition) will be uniform and no signal discontinuities will result.
5. As indicated above, the second step in the execution of a DEE test includes clicking on the **Run** button. The test execution begins immediately with the time elapse of state 1 followed by the transition to state 2. Note that there will be no signal path disruptions when the **Run** button is pressed.

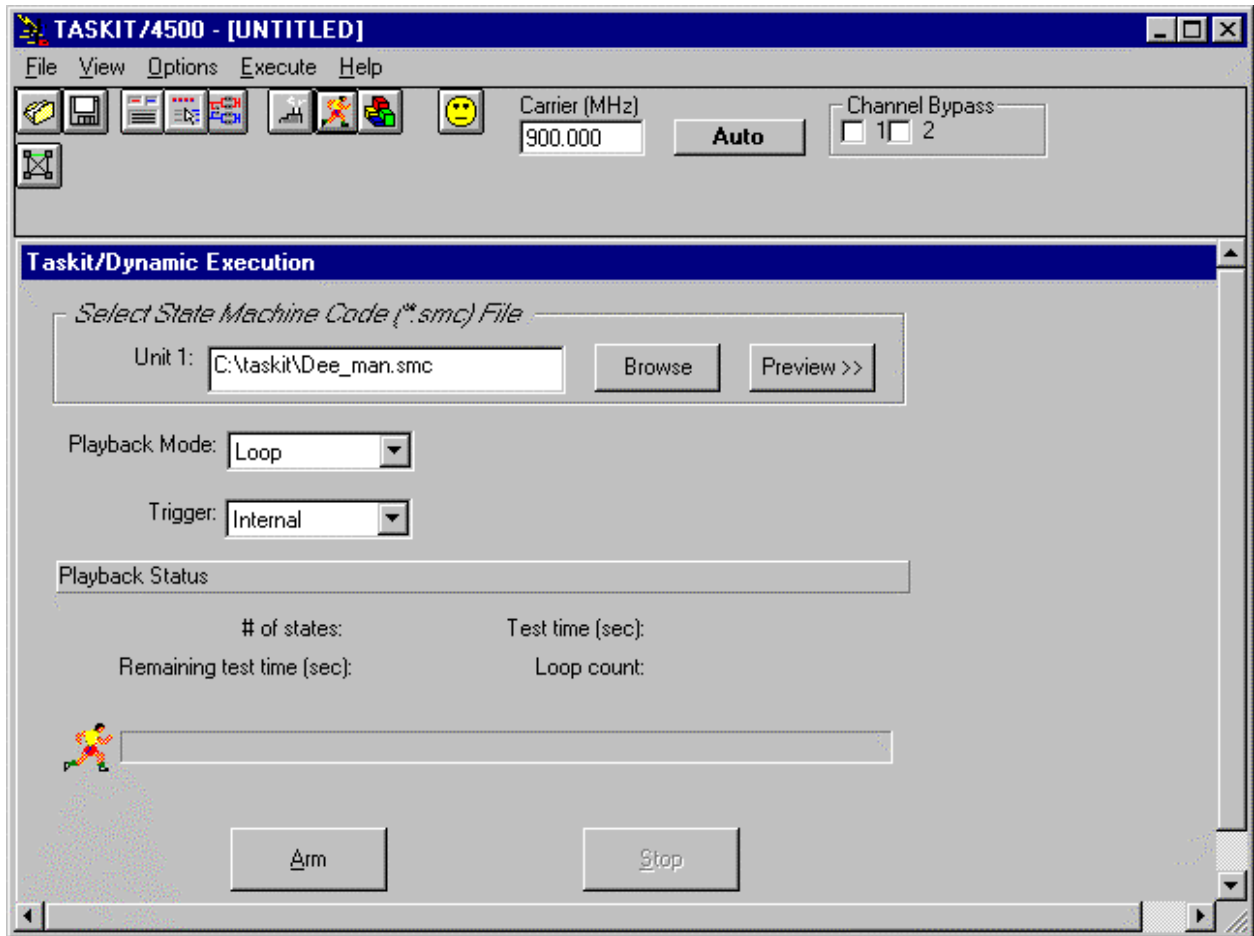


Figure 3-17. TASKIT DEE Execution

Prior to the start of the DEE test execution, the parameter settings on the TAS 4500 unit(s) will match the settings originally configured in TASKIT/4500 when a remote connection was established. When the **Arm** button is pressed, TASKIT will spend approximately 30 seconds placing the unit(s) into DEE mode. DEE test execution will begin immediately when the **Run** button is pressed. A test progress bar provides feedback to the user in the form of time remaining in the test in terms of the number of states executed with respect to the total number of states in the test. A **Pause** button will appear when the test execution begins. This allows the user to temporarily suspend test execution and begin again at the point where the test is left off.


If the selected DEE *Playback Mode* is **Once** the test will automatically stop when the first cycle through the state listing is complete. When the test completes, the TAS 4500 unit(s) is returned to the static mode of TASKIT operation with the same parameter settings in place that were used prior to the start of the DEE test. If the DEE *Playback Mode* setting is **Loop N times**, the test will loop a user

defined number (N) of times before returning the units to the static mode of operation. If the DEE *Playback Mode* setting is **Loop**, the test will run continuously until the **Stop** button is clicked to terminate the test. When the **Stop** button is clicked the 4500 unit(s) will return to the static mode of operation. The *Trigger Mode* selection allows the user to control the state transitions within a DEE test in one of three ways. The **Internal** selection allows the 4500 unit to control the transitions based on the user defined state duration parameter. The **Single Step** selection permits the user to change states by clicking on the **Step** button that appears after the unit has been armed. The **External** selection requires the user to provide an external TTL control signal input via the rear panel of the unit. The low to high transitions of this TTL signal can then initiate the state changes. For more information on the hardware setup and the trigger signal requirements see Section 3.2.8 “DEE External Trigger Setup and Timing Requirements.”

DEE Mode Test Execution Example

The TASKIT/4500 DEE Execution screen capture below shows the selection of the “*PATHLOSS.SMC*” file. The “*PATHLOSS.SMC*” file should be generated from the “*PATHLOSS.SSC*” file as shown in Section 3.2.7 to ensure the resulting .SMC file has the correct device options. The “*PATHLOSS.SSC*” file is installed in the “*TAS4500.WINEXAMPLES*” subdirectory.

To execute this example DEE test perform the following procedure:

1. To access the DEE execution screen, click on the  icon at the top of TASKIT/4500 screen or select *View* → *Dynamic Environment Emulator*.
2. This will open the Dynamic Environment Emulator screen from which the .SMC file may either be previewed or executed.
3. The “*PATHLOSS.SMC*” file must be specified in the *Select State Machine* text box. If there is more than one 4500 unit in the test system (for 4, 6 or 8 channel system configurations) multiple .SMC files must be selected.
4. To start the DEE test, click on the **Arm** button to enter DEE Execution mode. When the arming process is complete, click on the **Run** button to start the test.

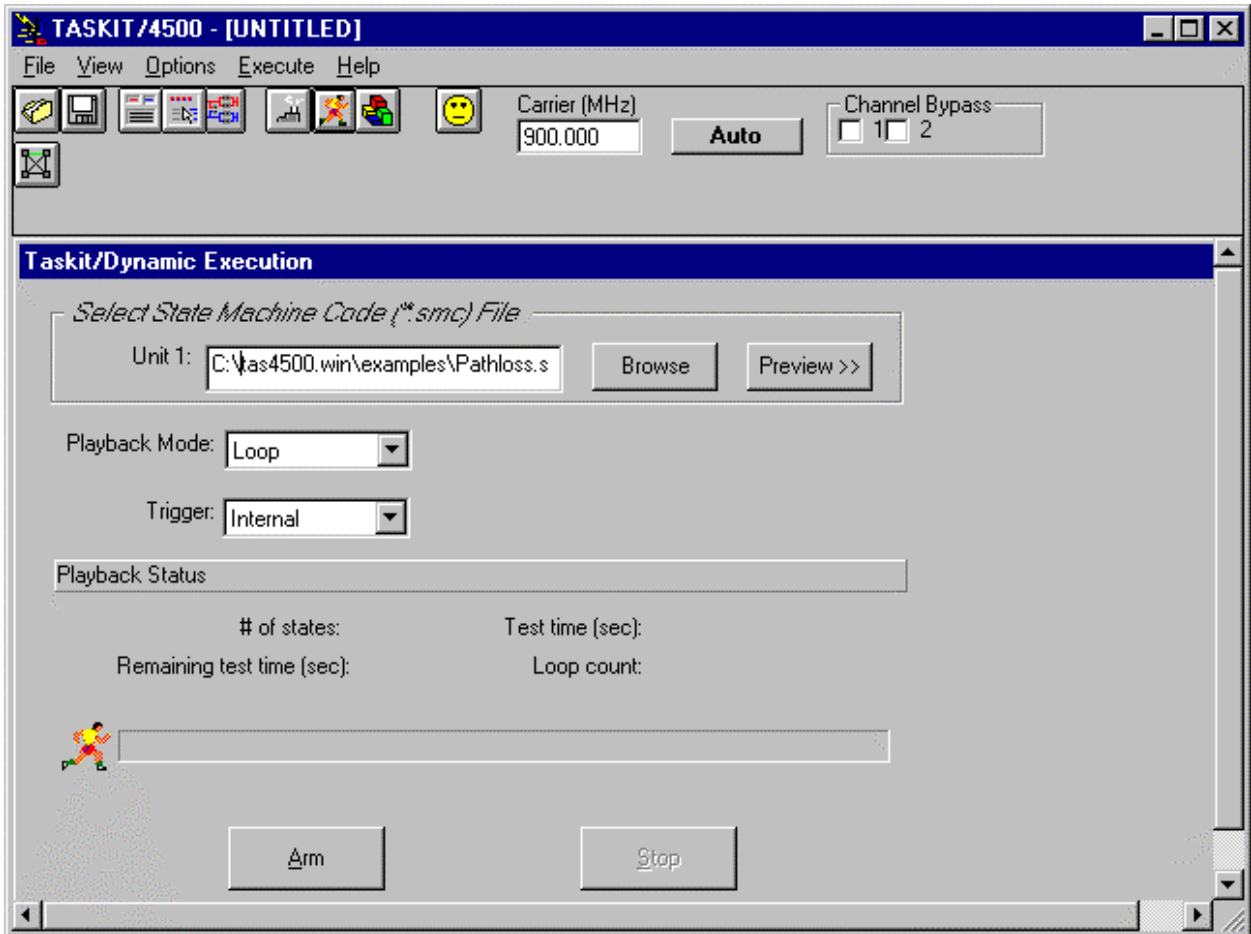


Figure 3-18. TASKIT DEE Execution Screen Example

3.2.8. DEE External Trigger Setup and Timing Requirements.

The Dynamic Environment Emulation state transitions can be driven by an externally generated TTL signal. This allows the user to synchronize the transitions to an external event. For example, unused time slots in a TDMA application could be used to trigger the DEE state changes.

DEE External Trigger Setup

The following cable should be used to provide an external trigger:

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (6 feet) Cable from external trigger source to Unit 1(Primary)

The following connection is required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	External trigger source	TRIG IN connector on Unit 1 (Primary)

NOTE: In a multiple system test setup, the external trigger source is only provided to Unit 1 (Primary). The remaining units in the test system receive synchronization information from Unit 1 (Primary) through the SYNC IN/ SYNC OUT interconnection outlined in Section 1.3.5

DEE External Trigger Timing Requirements

The timing constraints on the external trigger that is fed into the 4500 are as follows. The state transitions occur when the trigger signal has been raised from a logic “low” (between 0.0 V and 0.4 V) to a logic “high” (between 3.0 V and 5.0 V). The next state transition will occur between 2.9 ms and 4.3 ms after the trigger is asserted.

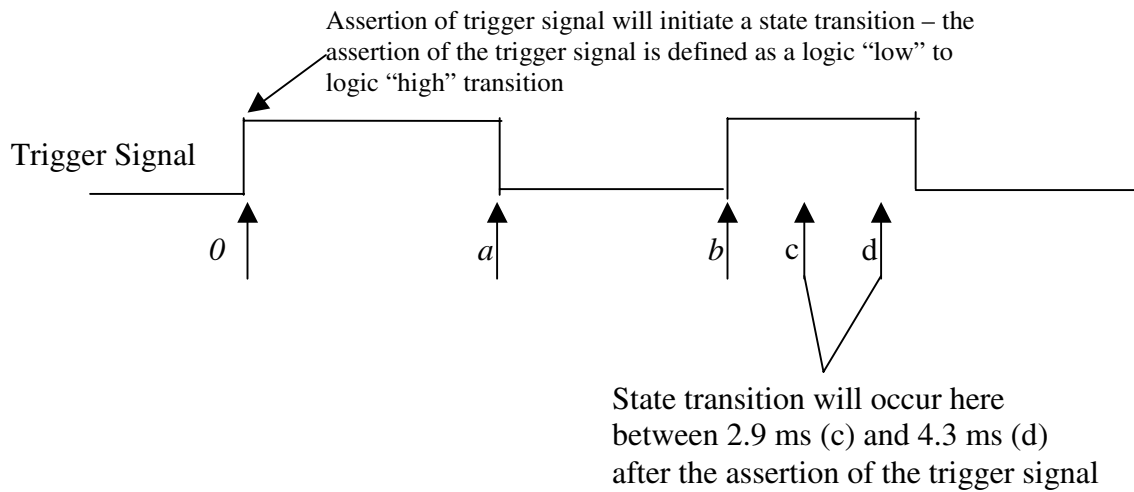


Figure 3-19. DEE External Trigger Timing Diagram

Timing Parameter Definition:

0 = time reference when the trigger signal is asserted (“low” to “high” transition) by the trigger device.

a = the trigger signal must be held in the logic “high” state (3.0 - 5.0 V) for a minimum of 1 μ s

b = the next assertion of the trigger signal may occur at $b \geq 2.4$ ms.

c = the minimum delay between the assertion of the trigger signal and the state transition = 2.9 ms

d = the maximum delay between the assertion of the trigger signal and the state transition = 4.3 ms

NOTE: Trigger assertion is defined as a logic “low” (0.0 - 0.4 V) to a logic “high” (3.0 - 5.0 V) transition on the trigger signal.

Parameter	Description	Minimum	Maximum
F_{CLK}	Trigger pulse frequency. (Triggering at a higher frequency will not harm the 4500. However, one state change will not occur for each trigger.)	-	100 Hz
T_{SST}	Time from trigger assertion to state transition	2.9 ms	4.3 ms

Table 3-4. DEE External Trigger Timing Constraints

After a trigger is received, the 4500 will be able to receive the next trigger after 2.4 ms has elapsed. However, with a minimum state duration of 5 ms, the state will not change until 5 ms after the previous state change. The 4500 can only queue up one trigger beyond the state currently being executed. Therefore any additional triggers received before a state change will be lost as shown in the example below.

Invalid External Trigger Example

Figure 3-20 shows what will occur when a trigger is applied to the 4500 with a 3 ms period. When the trigger to transition from state 1 to state 2 is received, the unit will begin processing the second state. It will not accept any additional triggers for 2.4 ms. The trigger for the state 3 transition is then received successfully since the minimum 2.4 ms time period has elapsed. However, since the 4500 can only queue one trigger at a time, the next two trigger attempts will not register with the 4500. When state 2 has expired and the transition to state 3 is complete, the unit is then able to again accept a trigger for state 4 as shown. The next two triggers applied are again ignored until state 3 has elapsed. To avoid faulty triggering, the external trigger frequency should be limited 200 Hz.

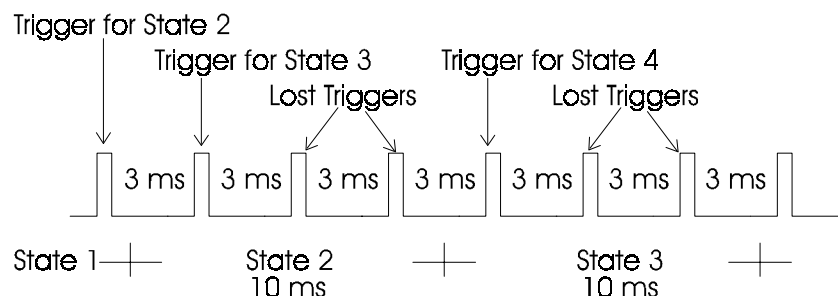


Figure 3-20 DEE External Trigger – Timing Violation Example (10msec)

3.2.9. DEE External State Monitor Setup and Timing Constraints

Due to the optimization of the download data stream to support small state durations, the Dynamic Environment Emulator is only able to provide an elapsed time estimate for the test being run at the TASKIT GUI level. The external state monitor actually allows direct access to the 4500 hardware that is performing the state changes. When a state transition occurs, the 4500 will output an active high pulse. This pulse indicates that the current state has been completed and the next state is beginning.

When TASKIT is in DEE mode and the **ARM** button has been pressed, the signal level on the TRIG OUT port will be set to a logic “low”. When the **RUN** button is pressed, a pulse will be generated for each state change. When the **STOP** button is pressed, the level on the trigger output becomes undefined.

By connecting a frequency counter to the TRIG OUT port and setting it up to count positive edges, the user can track exactly which state the unit is executing. This is illustrated in the figure below.

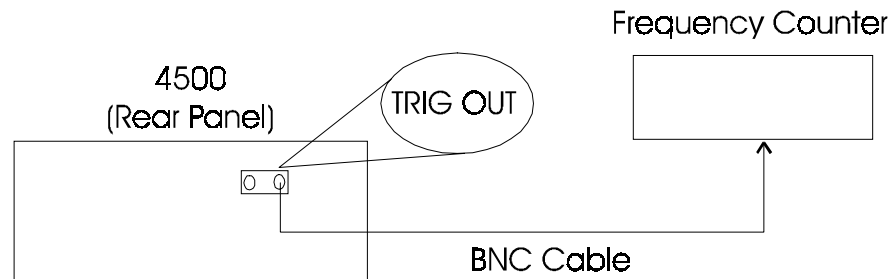


Figure 3-21 External State Monitor Setup

DEE External State Monitor Setup

The cable required to monitor this signal is as follows.

QUANTITY	CABLE AND ACCESSORY DESCRIPTION
1	BNC to BNC Cable (6 feet) Cable from Unit 1(Primary) to external counter device

The following connection is required:

CABLE TYPE	CONNECT FROM	CONNECT TO
BNC	TRIG OUT connector on Unit 1 (Primary)	External frequency counter

DEE External State Monitor Timing Constraints

Table 3-5 provides the specifications on the output signal available from the TRIG OUT port on the rear panel.

Parameter	Description	Minimum	Maximum
V _{OH}	Pulse output high voltage (I _{OH} = -0.5 mA)	2.4 V	5V
V _{OL}	Pulse output high voltage (I _{OL} = 12 mA)	-	.4V
T _H	Time trigger pulse is high	0.6 ms	1.4 ms

Table 3-5. DEE External Trigger output Timing

3.2.10. DEE General Notes***Delay changes in DEE mode:***

All modified parameters within DEE are changed immediately upon state transition with the exception of delay. When the path delay changes, the path must be turned off for an amount of time equal to the delay change. In order to avoid shutting off all of the paths in the system at once, the delay changes are staggered. When the state transition begins, Channel 1 Path 1 and Channel 1 Path 4 are turned off for the appropriate amount of time. When the delay change on these paths is completed, Channel 1 Path 2 and Channel 1 Path 5 are turned off. This process repeats in the order shown below until all paths are complete. The two delay update sequences A and B shown below do occur in parallel.

Sequence A: Ch 1 Path 1 → Ch 1 Path 2 → Ch 1 Path 3 → Ch 2 Path 1 → Ch 2 Path 2 → Ch 2 Path 3

Sequence B: Ch 1 Path 4 → Ch 1 Path 5 → Ch 1 Path 6 → Ch 2 Path 4 → Ch 2 Path 5 → Ch 2 Path 6

Note that Channel 1 Path 4 need not have the same delay change as Channel 1 Path 1. If channel 1 Path 1 has a larger delay change than Channel 1 Path 4, then Channel 1 path 5 will begin its change before Channel 1 Path 1 is finished.

It should also be noted that the total delay change for a state cannot be greater than the state duration. If the compiler detects that the total delay change is greater than the state duration, the state duration originally defined will be automatically increased. A corresponding warning will be placed in the .LOG file.

Similarly, if external triggering is used, the minimum state duration permitted will be changed from 10 ms to a value larger than the maximum total delay change for all states in the test. A warning will again be placed in the .LOG file indicating the minimum allowable state duration

The total delay change for a state is defined as the larger of the following two quantities:

Delay change for CH1 P1 + Delay change for CH1 P2 +
Delay change for CH1 P3 + Delay change for CH2 P1 +
Delay change for CH2 P2 + Delay change for CH2 P3 +
1 ms (overhead)

OR

Delay change for CH1 P4 + Delay change for CH1 P5 +
Delay change for CH1 P6 + Delay change for CH2 P4 +
Delay change for CH2 P5 + Delay change for CH2 P6 +
1 ms (overhead)

3.2.11. DEE Remote Client Mode

The Remote Client Mode provides the user with a basic set of commands that allows DEE tests to be setup, executed, and monitored from a remote PC using the RS-232 port. The host PC must be physically connected to the 4500 via the GPIB port and must also be running the TASKIT software. The remote PC can then be used to send commands via the serial port to the host

Remote Client Mode System Setup

The host PC, remote PC, and TAS 4500 unit(s) must be properly setup prior to using the Remote Client Mode. Figure 3-22 below shows the basic cable connections that are required to interconnect the devices. For multiple unit test systems involving more than one 4500, the complete system setup requirements are outlined in Section 1.3.5 of the manual.

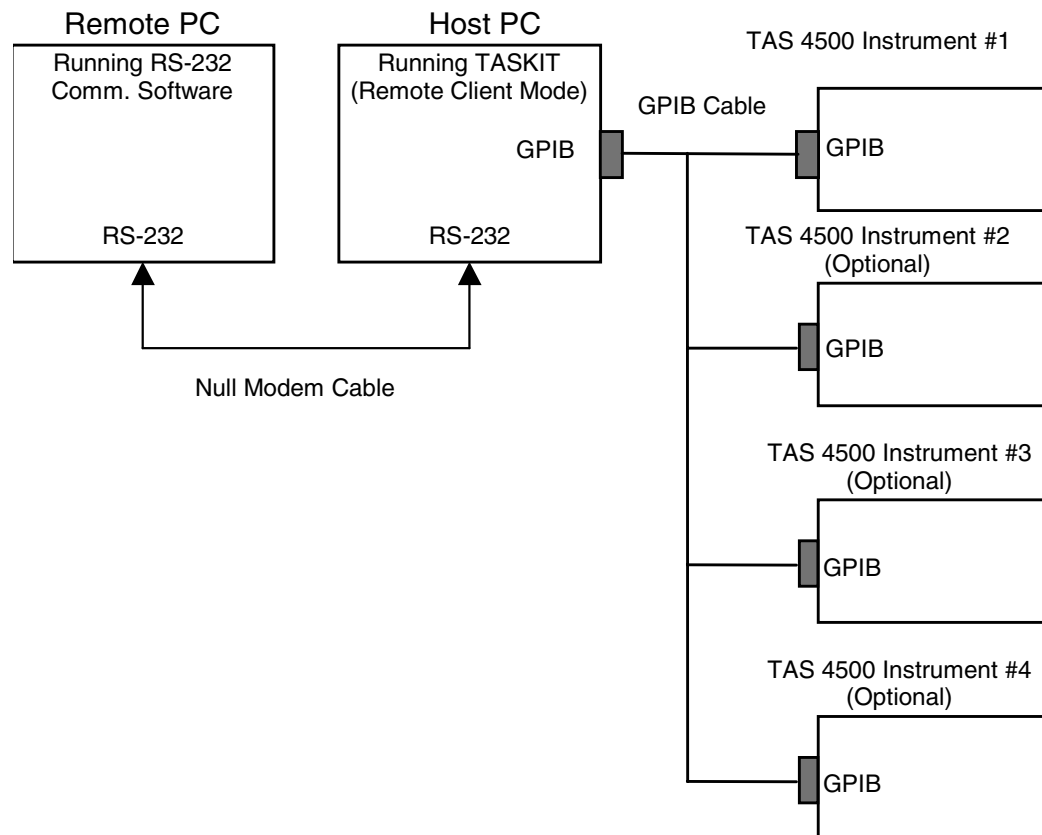


Figure 3-22. Remote Client Mode Setup

The TAS 4500 must be configured for GPIB communication with settings that match those found in the TASKIT software residing on the host PC.

The host PC must be configured to communicate with the 4500 using direct GPIB control. It will communicate with the remote PC via RS-232. The host PC must

have TASKIT/4500 running and must be placed in Remote Client Mode as described in the next section.

The remote PC must be configured to communicate with the host via RS-232. User produced software or a Terminal program should be used to send commands to the host PC via this connection. A Null Modem cable must be used to permit the two PCs to communicate with each other.

Getting Started with Remote Client Mode

The operation of Remote Client Mode requires a specific sequence of actions to be performed. The procedure for getting started with RCM is as follows:

1. Setup and configure the TAS 4500 and the two PCs as shown in Figure 3-22 above.
2. Run the TASKIT software on the host PC by clicking on the proper icon.
3. Make sure that the Host PC and the TAS 4500 are properly configured to communicate via direct GPIB and verify the communications settings in TASKIT are set to match.
4. Choose *Execute* → *Client Mode* from the main menu to access the Remote Client Mode window. Note that you do not need to connect to the TAS 4500 on the Host PC since the remote command set permits this action from the Remote PC.
5. Click on the **Communications** button in the TASKIT Remote Client Mode window to configure the PC to PC communication parameters.
6. Click on the **Execute** button to place the unit in Remote Client Mode. The TASKIT software will now process received commands from the Remote PC.
7. From the Remote PC, run the selected communications software or terminal program making certain that the RS-232 settings for the COM port in use match those set in Step 5 above within TASKIT on the Host PC.
8. See the next Section titled Remote Client Mode Command Set to view the available commands while in this mode.

Remote Client Mode Command Set

Table 3-6 contains a listing of the remote commands available from the Remote PC when communicating with the host PC.

The syntax of the commands is of the form *'/Command'*. Both the leading and trailing *'/'* are required. Following the execution of the command, the Host PC running TASKIT will respond with either a *'/C'* for successful execution or an

error code in the form of 'E xxx '. The error code listing can be found in the next section.

It should be noted that unlike the TAS 4500 remote command set, only one command can be sent at a time and the cascade of commands is not permitted.

Command set (Remote PC to Taskit/4500)

Command	Description
/VER/	Get TASKIT/4500 software version
/CONNECT/	Connect to 4500 unit(s). Note: If the selected device options do not match the actual hardware, TASKIT will try to match the actual configuration.
/DISCONNECT/	Disconnect from 4500 unit(s).
/FRECALL <i>filename</i> /	Recall static setup (.rce) file specified by <i>filename</i> ¹ . Note: If recalled parameters are not supported by the 4500, TASKIT will set those parameters to default.
/SEL_SMC1 <i>filename</i> /	Select SMC file specified by <i>filename</i> ¹ for 4500 unit 1.
/SEL_SMC2 <i>filename</i> /	Select SMC file specified by <i>filename</i> ¹ for 4500 unit 2.
/SEL_SMC3 <i>filename</i> /	Select SMC file specified by <i>filename</i> ¹ for 4500 unit 3.
/SEL_SMC4 <i>filename</i> /	Select SMC file specified by <i>filename</i> ¹ for 4500 unit 4.
/ARM_DEE/	Arm DEE with selected SMC file(s).
/RUN_DEE/	Execute DEE with selected SMC file(s).
/STOP_DEE/	Stop DEE execution and return to static operation. Note: This command can be sent either when the unit has been ARMed or while it is RUNning.
/DEE_MODE <i>mode</i> /	Select DEE execution mode where <i>mode</i> = <i>once</i> , <i>loop</i> or <i>loopn</i>
/LOOPNUM <i>n</i> /	Set number of loops to <i>n</i> when in loopn mode
/DEE_STATUS/	Poll DEE execution status. TASKIT will respond with the information shown in Figure 3-23.
/DEE_SETUP/	Display current DEE environment settings (file names, DEE mode) as shown in Figure 3-23.

¹ All filenames must include the full path of the files to be recalled.

Table 3-6. DEE Remote Client Mode Remote Commands

```

4500 - HyperTerminal
File Edit View Call Transfer Help

/dee_setup/
SMC1: C:\TAS4500.WIN\EXAMPLES\PATHLOSS.SMC
DEE MODE: LOOP
>>dee_status/
DEE RUNNING
/STOP_DEE/ to STOP DEE

Total States : 301
Time Remain : 2.5    Test Time: 30.1    Loop: 1
>

```

Connected 0:09:22 Auto detect 9600 7-0-1 SCROLL CAPS NUM Capt

Figure 3-23. DEE_SETUP and DEE_STATUS Feedback

Remote Client Error Code Definitions

Response / Error Code	Description
/E001/	Unrecognized command
/E002/	Command value error. (e.g. file not found for SEL_SMC1 command)
/E003-errcode/	Instrument command failure. TASKIT forwards any error returned from the unit using this error code. Refer to Section 7.0 of this manual for the definition of the error code accompanying this response.
/E004/	Command cannot be performed in the selected mode. (e.g. RUN_DEE command is sent before the ARM_DEE command has been sent or SEL_SMC1 command is sent while the unit is executing a DEE test.)
/E005-errcode/	Communication error has occurred between TASKIT on the Host PC and the 4500 unit(s).
/E006/	Unable to ARM DEE – may need to recompile the original SSC file with the current system settings.
/E007/	Failed to STOP DEE. 4500 is currently busy, please try to STOP the test again.

Table 3-7. DEE Remote Client Mode Error Codes

Remote Client Mode Execution Example

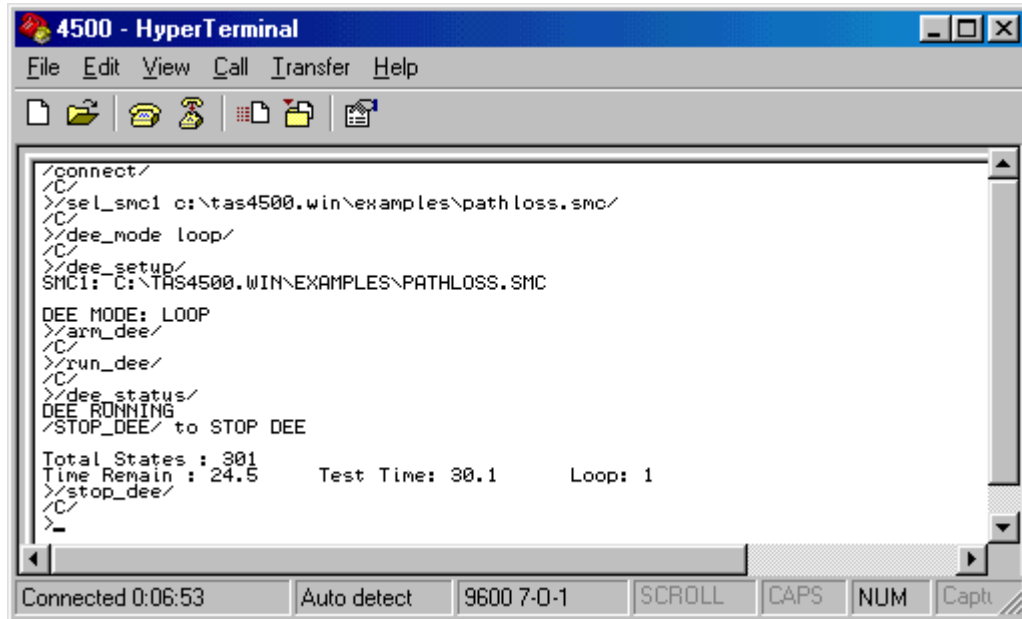
The following example demonstrates the use of the Remote Client Mode to execute the provided example file “*PATHLOSS.SMC*” from a remote PC using a Terminal program. Figure 3-22 below provides a screen capture of the successive commands sent from the Remote PC to the Host PC to setup and run this test. The step-by-step outline provided below shows the typical sequence of commands that would be necessary.

1. Follow the system setup instructions outlined above to properly configure the hardware/software on the two PCs and the 4500 unit(s) prior to proceeding.
2. Run the TASKIT software on the Host PC and place the software into Remote Client Mode by selecting *Execute* → *Remote Client Mode*.
3. Click on the **Communications** button to configure the RS-232 port parameters for the PC to PC communications.
4. Click on the **Execute** button to place the unit in Remote Client Mode. The TASKIT software will now process received commands from the Remote PC.

Using the RS-232 comm. capability on the Remote PC, perform the following:

5. Send */CONNECT/* to establish a remote connection to the 4500 unit(s).
6. Send */SEL_SMC1 C:\TAS4500.WINEXAMPLES\PATHLOSS.SMC/* to recall the SMC file that will be executed.
7. Send */DEE_MODE LOOP/* to set the test to loop through the SMC file repeatedly until stopped.
8. Send */DEE_SETUP/* to verify that the DEE environment has been setup properly.
9. Send */ARM_DEE/* to arm the unit(s) prior to executing the DEE test.
10. Send */RUN_DEE/* to begin the test execution.
11. Send */DEE_STATUS/* as needed to track the progress of the test.
12. To stop the test, send the */STOP_DEE/* command.
13. Return to the Host PC running TASKIT and click on the **Abort** button to return the Host PC to local operation.

This completes the DEE Remote Client Mode example. Figure 3-24 below shows a screen capture of the Terminal program that has been used to execute the example outlined above.



```
/connect/  
/C/  
>sel_smc1 c:\tas4500.win\examples\path loss.smc/  
/C/  
>dee_mode loop/  
/C/  
>dee_setup/  
SMC1: C:\TAS4500.WIN\EXAMPLES\PATHLOSS.SMC  
DEE MODE: LOOP  
>arm_dee/  
/C/  
>run_dee/  
/C/  
>dee_status/  
DEE RUNNING  
/STOP_DEE/ to STOP DEE  
Total States : 301  
Time Remain : 24.5    Test Time: 30.1    Loop: 1  
>stop_dee/  
/C/  
>-
```

Connected 0:06:53 Auto detect 9600 7-0-1 SCROLL CAPS NUM Capt

Figure 3-24. RCM Example - Terminal Screen Capture

While the Remote PC is executing a DEE test, the Host PC does maintain and display the status of the current test. The user cannot interact with TASKIT on the Host PC while it is in Remote Client Mode. A test that is initiated from a remote PC should also be terminated from the remote PC using the /DEE_STOP/ command. When the remote test has been stopped, the Abort button can be pressed to return TASKIT on the Host PC to local control. Figure 3-25 below shows the status window displayed by the Host PC running TASKIT as the DEE test is executed from the Remote PC.

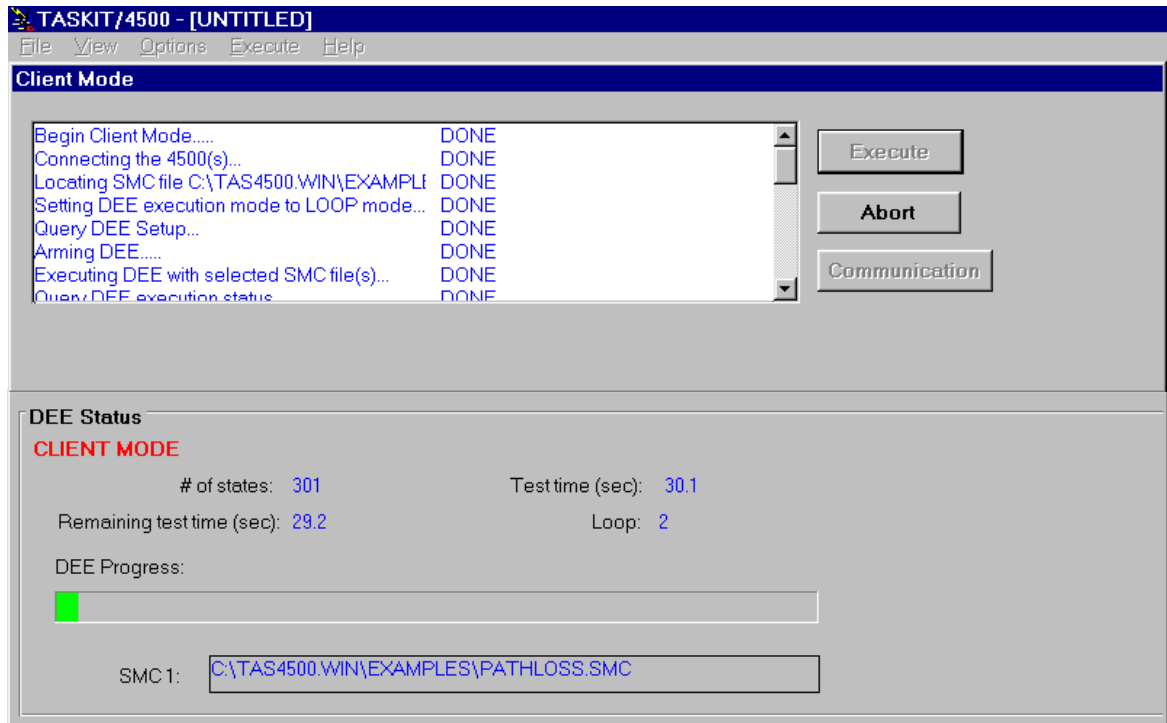


Figure 3-25. Host PC – Test Status Feedback

3.2.12. DEE Mode Test Capabilities

Refer to Section 8.0. “Technical Specifications” to find the ranges and resolutions for the active parameters in Dynamic Environment Emulation Mode.

3.3. Smart Antenna Option Reference Guide

The TAS Smart Antenna Option provides an integrated test bench for evaluating communication systems that employ adaptive antenna arrays. Antenna arrays using up to 8 branches may be tested with this system. By integrating up to four TAS 4500 RF Channel Emulators with the TASKIT control interface and the Smart Antenna Option, a complete test system is produced. The TASKIT software and Smart Antenna Option not only acts as the interface to control all the channel parameters but also controls the synchronization of the TAS 4500s. For details on the hardware setup requirements for this test, refer to Section 1.3.5 “Setup Requirements for Multiple System Test Configurations.” The TAS Smart Antenna Option contains the following key features useful when evaluating an adaptive antenna array system:

- 4, 6, or 8 branch user programmable correlation
- User programmable antenna array geometry
- User programmable angle of arrival for each path in the system
- Phase and Delay offset entry for each path in the system
- Angle of Arrival test feature

It is important to note that these features are not available with the standard TASKIT/4500 product. These features are only available with the Smart Antenna Option.

Also notice that the Channel Configuration setting of single channel mode does not support programmable correlation or any of the Smart Antenna features.

3.3.1. Product Highlights

Eight Branch User Programmable Correlation

The TAS Smart Antenna Diversity System has programmable channel correlation. The data entry of correlation coefficients is implemented with a single table within TASKIT. The user is provided with a range of valid values for each entry based on the previously entered correlation coefficients.

User Programmable Antenna Array Geometry

The data entry of antenna geometry is implemented with a single table within TASKIT. The X position and Y position of each antenna is entered in units of wavelengths. From the antenna geometry and angle of arrival, phase offset values are calculated and automatically applied to each path.

User Programmable Angle of Arrival for Each Path in the System

Each path in the system may have a user programmable angle of arrival entered in units of degrees. From the antenna geometry and angle of arrival, phase offset values are calculated and automatically applied to each path.

User Programmable Phase and Delay Offset Entry for Each Path in the System

This data entry screen allows the user to enter a phase offset and a delay offset to be added to each path in the system. The offset values are independent for each path.

Angle of Arrival Test Feature

This test varies the angle-of-arrival (AOA) dynamically on all 6 paths in each channel of an 8 branch test system. The variation of the angle of arrival can be either a *Uniform Random* or *Linear* variation. The *Uniform Random* variation option changes the AOA pseudo-randomly with a uniform distribution within the user defined range around a user defined mean value. The *Linear* variation option changes the AOA linearly from a user defined start value to a user defined stop value given a user defined slope.

Each state of Angle of Arrival Test is identical to the next except for the AOA. The changes in the 8 branches (channels) are synchronized together and can be synchronized to an external trigger signal.

3.3.2. Smart Antenna Option Installation

To install the TASKIT/Smart Antenna Option, you should proceed with following steps.

1. Install TASKIT/4500 as described in Section 3.1.2.
2. Insert the TASKIT/Smart Antenna CD into the CD ROM drive on your PC.
3. From the Windows Program Manager, select *Run* from the *File* Menu.
4. Type “*d:\tsktsman\setup*” to execute the TASKIT/Smart Antenna setup program.
5. The TASKIT setup program will guide you through the remainder of the program installation process.

TASKIT/Smart Antenna will be installed into the TASKIT/4500 directory to be run as one application.

3.3.3. Smart Antenna Option Hardware System Setup

The hardware setup requirements for Smart Antenna Testing with four, six, or eight channels can be found in Section 1.3.5 “Setup Requirements for Multiple System Test Configurations”. The hardware setup requirements for the Smart Antenna test feature are the same as the requirements for the Dynamic Environment Emulation Mode (DEE) feature. Consult the appropriate portion of Section 1.3.5 that outlines a four, six, or eight channel setup as required.

3.3.4. Programmable Channel Correlation

The TAS Smart Antenna Diversity System has programmable channel correlation. The data entry of correlation coefficients is implemented with a single table within TASKIT/4500. The user is provided with a range of valid values for each entry based on the previously entered correlation coefficients. See Section 4.3.4 for additional information on channel correlation.

Definition of Channel Correlation

The TAS Smart Antenna Diversity System has programmable channel correlation. The following example defines channel correlation. This example uses 8 branch diversity with 6 paths per channel:

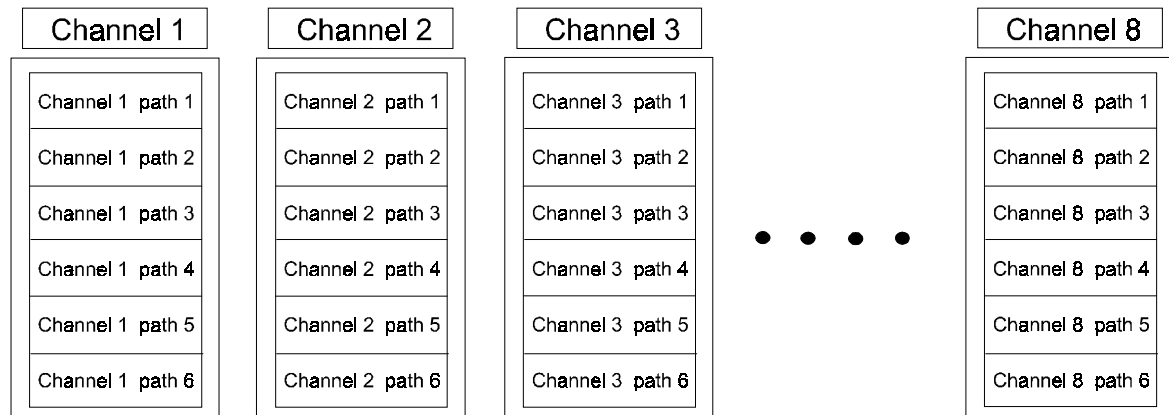


Figure 3-26. TAS 4500 Channels in an 8 Branch Configuration

Programming Channel Correlation:

The degree of correlation present between channel 1 path 1 and channel 2 path 1, channel 3 path 1, channel 4 path 1, channel 5 path 1, channel 6 path 1, channel 7 path 1 and channel 8 path 1 can be programmed by the user. Likewise the correlation between channel 1 path 2 and all other path 2s in the system can be programmed.

Channel 1 path 1 is independent (uncorrelated) of all other paths within channels 1, 2, 3, 4, 5, 6, 7 and 8.


Channel Correlation Features:

All modulation types are available in the channel correlation mode but only Rayleigh and Frequency Shifted Rayleigh will support the correlation settings.

The modulation parameters set in a specific path number (1 through 6) should be set the same for that path in every channel in order for the correlation setting to be valid.

The recommended test repetition rate is the longest (24 hour) rate in order to achieve the best possible channel correlation accuracy.

Interface for Entering Correlation Coefficients

The data entry of correlation coefficients is implemented with a single table. This table is present in the TASKIT software package and is accessed by either clicking on the  icon or selecting *View* → *Rayleigh Correlation Coefficients*. The table will have the following format for an 8 branch diversity configuration.

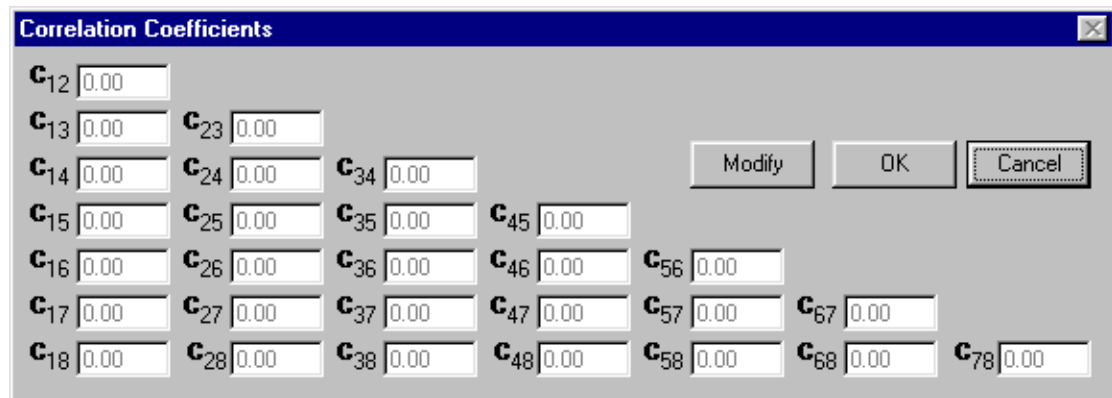


Figure 3-27. Correlation Coefficient Entry

The user is required to enter the data from left to right and from the top to the bottom in specific order. The correlation coefficients range from 0.00 to 1.00 with a resolution of 0.01.


The range that is possible for the correlation coefficients will become more limited as more correlation coefficients are entered. For example, if all c values are entered as 0.90 except the value for c_{78} , then its value could not be 0.00 since there is already some amount of correlation between channels 7 and 8 as defined indirectly by the previous 27 correlation coefficient entries.

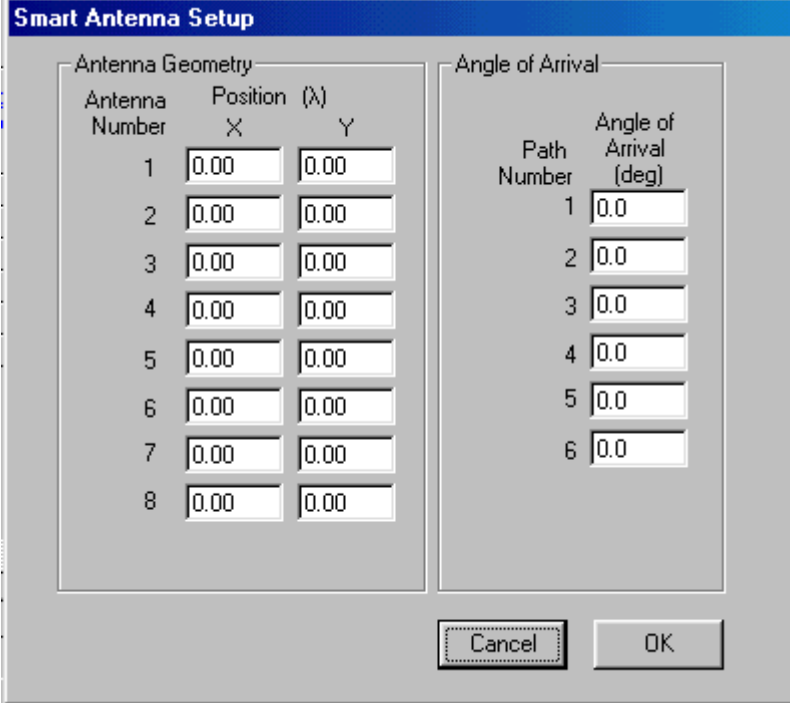
Error Checking of the Correlation Coefficients

The user is provided with a range of valid values for each entry based on the previously entered correlation coefficients. If the entry is invalid, the correlation

coefficient must be reentered before the user can proceed with additional data entry into the table.

3.3.5. Smart Antenna Geometry Entry

The Smart Antenna Setup table can be accessed by clicking on the  icon or by selecting *View* → *Smart Antenna Setup* from the menu. The data entry of antenna geometry is implemented with a single table in the format shown below.



The dialog box titled "Smart Antenna Setup" contains two main sections:

- Antenna Geometry:** A table with 8 rows and 3 columns. The columns are "Antenna Number", "Position (λ)", and "Y". The "Position (λ)" column is further divided into "X" and "Y" sub-columns. All numerical input fields contain "0.00".
- Angle of Arrival:** A table with 6 rows and 2 columns. The columns are "Path Number" and "Angle of Arrival (deg)". All numerical input fields contain "0.0".

At the bottom of the dialog are "Cancel" and "OK" buttons.

Figure 3-28. Antenna Geometry Data Entry

Both the X position and Y position may take on values from -100λ to $+100\lambda$ with a resolution of 0.01λ . The following formulas are used to generate the 48 phase shift values from the above antenna geometry and path angle of arrival data.

$$\theta(p,c) = 360 \times D(p,c)$$

Where:

$\theta(p,c)$ = computed phase offset value for path p within channel c in units of degrees based on the antenna geometry, path p angle of arrival

$D(p,c)$ = Euclidean distance from the origin to the path p wavefront arriving at antenna element c in units of λ .

$$D(p,c) = \text{sqrt}(Dy(c)^2 + Dx(c)^2) \times \cos(\arctan(Dy(c) / Dx(c)) - AOA(p))$$

Where:

$Dy(c)$ = distance from the origin to antenna element c along y axis in units of λ .

$Dx(c)$ = distance from the origin to antenna element c along x axis in units of λ .

$AOA(p)$ = the angle of arrival at which path p enters the antenna array relative to the mobile velocity referenced to the positive X axis.

Smart Antenna Geometry Example

The following example will demonstrate the above smart antenna geometry entry screen and phase offset calculations.

The screenshot shows a 'Smart Antenna Setup' dialog box with two main sections: 'Antenna Geometry' and 'Angle of Arrival'.

Antenna Geometry:

Antenna Number	Position (λ)	
	X	Y
1	0.10	0.00
2	0.20	0.00
3	0.30	0.00
4	0.40	0.00
5	0.50	0.00
6	0.60	0.00
7	0.70	0.00
8	0.80	0.00

Angle of Arrival:

Path Number	Angle of Arrival (deg)
1	0.0
2	60.0
3	90.0
4	0.0
5	0.0
6	0.0

Buttons: Cancel, OK

Figure 3-29. Smart Antenna Geometry Example Screen Capture

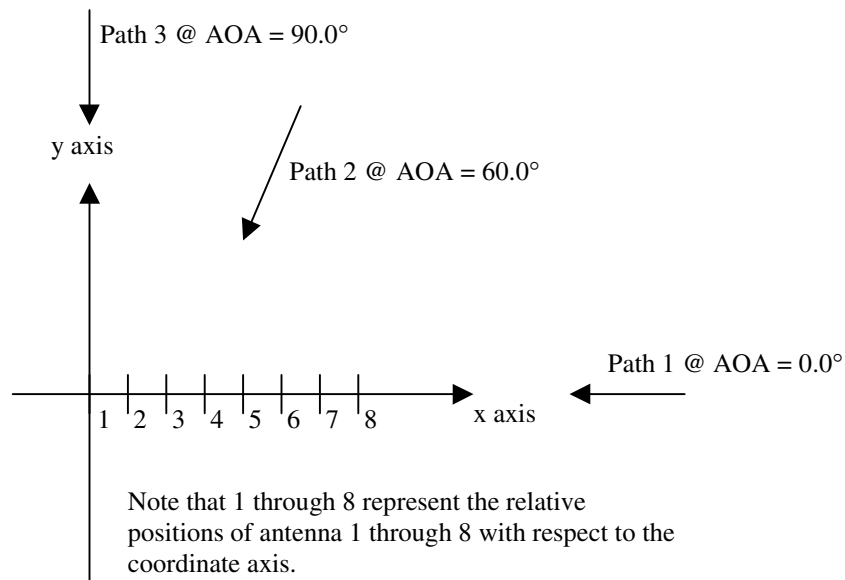


Figure 3-30. Smart Antenna Geometry Example

The above antenna geometry describes a linear antenna array positioned along the X axis. For this simple example we will list the phase offset of each path arriving at each antenna individually. For this example, paths 1, 2 and 3 are considered for simplicity.

Antenna Number	Path 1 Phase Offset	Path 2 Phase Offset	Path 3 Phase Offset
1	0.0°	0.0°	0.0°
2	36.0°	18.0°	0.0°
3	72.0°	36.0°	0.0°
4	108.0°	54.0°	0.0°
5	180.0°	90.0°	0.0°
6	216.0°	108.0°	0.0°
7	252.0°	126.0°	0.0°
8	288.0°	144.0°	0.0°

Table 3-8. Smart Antenna Geometry Example Phase Offset Results

Since path 1 is a signal arriving along the line of the linear array (0.0° AOA), this path experiences the largest phase offset at any given antenna. Path 3 is arriving tangential to the linear array that explains the constant 0° phase offset at all eight antenna. Path 2 arrives at a 60° angle of arrival which maps to a phase offset precisely $\frac{1}{2}$ that of path 1 since the $\cos(60^\circ) = \frac{1}{2}$.

3.3.6. Phase, Delay, & Amplitude Offsets

NOTE: The system is not phase stable. The absolute phase of any path is not guaranteed.

Signal phase, delay, and amplitude offsets are controllable. Phase offset and delay offsets are available with all modulation types. The phase and delay of each path can be adjusted relative to the phase and delay of that same path. By selecting *Options* → *Phase, Delay, & Amplitude Offsets* from within TASKIT, the user can enter data offsets for all paths. The table has the following format for an 8 branch test system.

Phase, Delay & Amplitude Offsets									
	Path 1			Path 2			Path 3		
	Phase	Delay	Loss	Phase	Delay	Loss	Phase	Delay	Loss
	(deg)	(us)	(db)	(deg)	(us)	(db)	(deg)	(us)	(db)
Chan 1	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 2	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 3	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 4	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 5	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 6	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 7	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 8	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0

	Path 4			Path 5			Path 6		
	Phase	Delay	Loss	Phase	Delay	Loss	Phase	Delay	Loss
	(deg)	(us)	(db)	(deg)	(us)	(db)	(deg)	(us)	(db)
Chan 1	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 2	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 3	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 4	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 5	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 6	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 7	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0
Chan 8	0.0	0.000	0.0	0.0	0.000	0.0	0.0	0.000	0.0

Save As... Open File Exit Cancel

Figure 3-31. Phase, Delay, and Amplitude Offset

The phase offset value may take on values from 0 to 360 degrees with a resolution of 0.1 degrees. The user is responsible for determining the value of phase offset. If no value is entered, the offset will be 0.0 degrees.

The delay offset values may take on values from 0.000 to 1.000 μsec with a resolution of 0.001 μsec . The delay offset value set in this table will be added on to any delay value set for the specified path by the system. It is important to note that the delay offset added here will limit the overall delay range of the system by the delay offset range utilized.

3.3.7. Angle of Arrival Test

The Angle of Arrival (AOA) test incorporates in the Smart Antenna feature the ability to vary the AOA dynamically. The variation of the AOA can be either a *Uniform Random* or *Linear* variation.


Each state in the angle of arrival test is identical to the next except for the AOA. The only parameter to vary during the test is the AOA. There is no variation of path loss, Doppler, delay, or any other parameter. The static parameters (path loss, Doppler, delay) can initially be set differently for each path in a channel and do not change during the test. Channel correlation settings can initially be set for the test when the Rayleigh modulation type or Frequency Shift Rayleigh modulation type is selected. The same paths in all channels present have the same AOA for each state. For each state:

$$\begin{aligned} \text{CH1 P1 AOA} &= \text{CH2 P1 AOA} = \text{CH3 P1 AOA} = \dots = \text{CH8 P1 AOA} \\ \text{CH1 P2 AOA} &= \text{CH2 P2 AOA} = \text{CH3 P2 AOA} = \dots = \text{CH8 P2 AOA} \\ &: \\ \text{CH1 P6 AOA} &= \text{CH2 P6 AOA} = \text{CH3 P6 AOA} = \dots = \text{CH8 P6 AOA} \end{aligned}$$

All channels are synchronized to one another, and either an internal or external trigger selection may be made to control the state transitions. If the internal trigger option is selected then the state transition timing is based on the user defined state duration. An external trigger may be provided to synchronize the state changes to some external activity. The trigger signal need only be provided to the primary unit in the system. Distribution to the remaining units in the system is handled via the RJ-45 synchronization cables. One application of this external trigger function would include synchronizing state changes to the occurrence of receiver time slots for a TDMA application.

The state timing has the following characteristics:

- The state duration is user programmable in the range of 4 ms to 60000 ms. This is the time from the beginning of a state transition to be beginning of the next state transition.
- The state duration resolution is 1 ms.
- The TAS 4500(s) begins a state transition between 2.9 and 4.3 ms after the assertion of the external trigger.
- The maximum transition time is 0.8 ms. This is the time from the beginning of the state transition until all state transitions are complete in all branches.

The Angle of Arrival Test is only supported from a PC using TASKIT. There is no front panel support for this feature. To access the test, click on the  icon or

select *View* → *Angle of Arrival Test* from the TASKIT menu. Click on <<*Edit Parameters* button to make changes to the setup. Choose the AOA variation, by clicking on the *Uniform Random* or *Linear* option button. Once all the parameters are entered press **OK**. At this point state data is downloaded to the 4500 systems. To start the test, press the **Run** button. Figure 3.32 shows the TASKIT window for Angle of Arrival Test with *Uniform Random* variation selected.

Angle of Arrival Test

Antenna Geometry

Antenna Number	Position (λ)	
	X	Y
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	0.00	0.00
6	0.00	0.00
7	0.00	0.00
8	0.00	0.00

Angle of Arrival

AOA Variation: Uniform Random Linear

Path Number	Angle of Arrival (deg)	Variance (+/- deg)
1	0.0	0.0
2	0.0	0.0
3	0.0	0.0
4	0.0	0.0
5	0.0	0.0
6	0.0	0.0

Buttons: << Edit Parameters, Run, Stop, Close, Cancel, OK

AOA State Trigger

Internal (dropdown)

Duration (ms): 4

Figure 3-32. Angle of Arrival Test Data Entry

Angle of Arrival Test External Trigger Characteristics.

The Angle of Arrival Test state transition will begin between 2.9 and 4.3 ms after the trigger signal has been raised from a logic low (between 0.0 V and 0.4 V) to a logic high (between 3.0 V and 5.0 V). The state transition will end between 3.7 and 5.1 ms after the trigger signal has been asserted. Due to the architecture of the triggering mechanism, the next trigger signal may be asserted before the state transition is complete. The trigger signal may be asserted at a maximum rate of 250 Hz which corresponds to a minimum state duration (the time between trigger assertions) of 4.00 ms. The trigger signal rise and fall times (the time between logic levels) should be between 10 nsec and 1 μs.

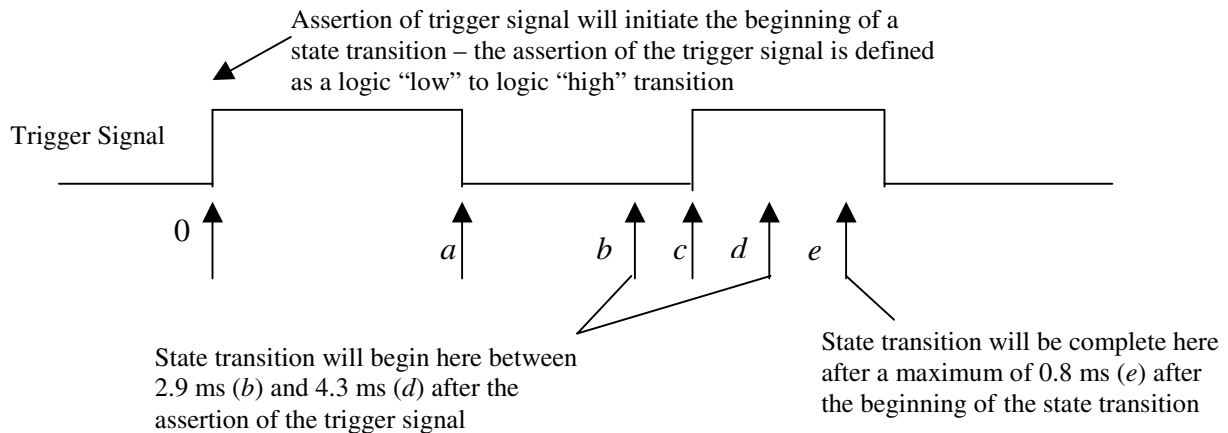


Figure 3-33. Angle of Arrival Test External Trigger Timing

Timing Parameter Definition

0 = time reference when the trigger signal is asserted (the low to high transition) by the receiver

a = the trigger signal must be held in the logic high state (between 3.0 V and 5.0 V) for a minimum of 1 μ s

b = the minimum delay between the assertion of the trigger signal and the beginning of the state transition = 2.9 ms

c = the next assertion of the trigger signal which may occur at $c \geq 4.0$ ms

d = the maximum delay between the assertion of the trigger signal and the beginning of the state transition = 4.3 ms

e = the maximum time from the assertion of the trigger signal at which the state transition will be complete = 4.3 ms + 0.8 ms = 5.1 ms

NOTE: Trigger assertion is defined as a logic low (between 0.0 V and 0.4 V) to a logic high (between 3.0 V and 5.0 V) transition on the trigger signal.

Parameter	Description	Minimum	Maximum
F_{CLK}	Trigger pulse frequency	-	250 Hz
T_{SST}	Time from trigger assertion to start of state transition	2.9 ms	4.3 ms
T_{EST}	Time from trigger assertion to end of state transition	3.7 ms	5.1 ms
T_{ST}	Time from start of state transition to end of state transition	-	0.8 ms

Table 3-9. Angle of Arrival Test External Trigger Timing

Uniform Random Variation

The *Uniform Random* variation option randomly changes the angle-of-arrival (AOA) on all paths in each channel of the test system. The AOA is generated based on a range around a mean entered by the user. The AOA varies pseudo-randomly with a uniform distribution within the user defined range. The number of states is not user programmable.

Uniform Random Variation Example

The following example will demonstrate the *Uniform Random* option. For this simple example we will assume the same Smart Antenna Geometry as used in 3.3.5.1 and assume only the first three paths are enabled.

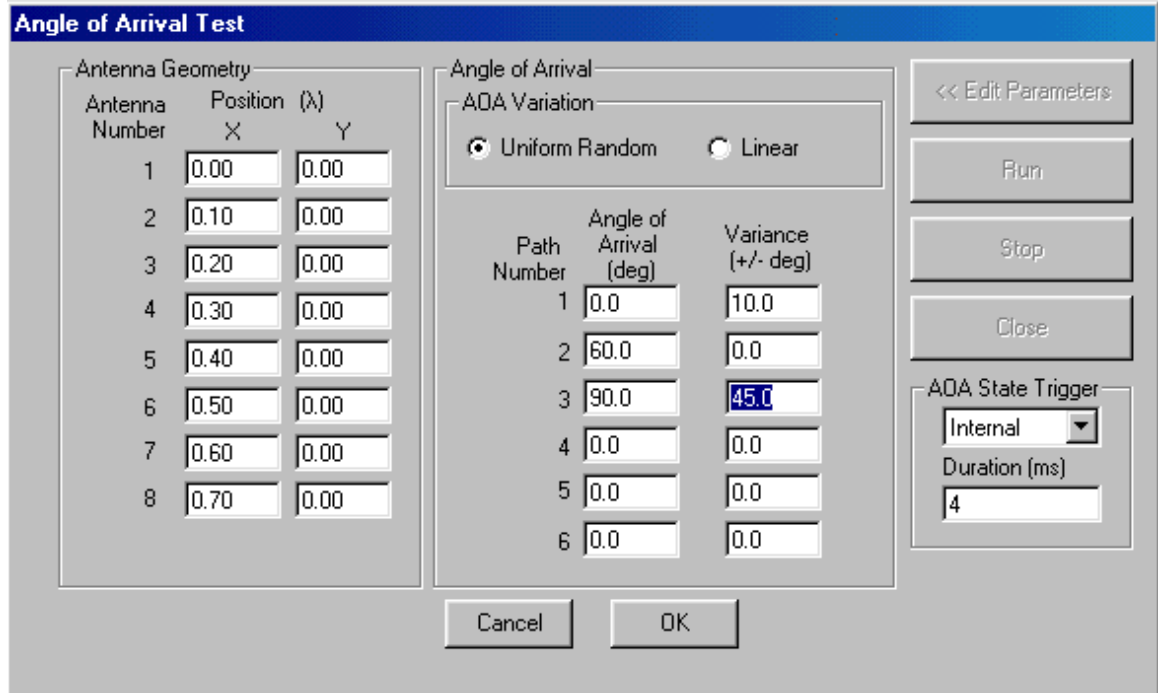


Figure 3-34. Angle of Arrival – Uniform Random Variation Example TASKIT Setup

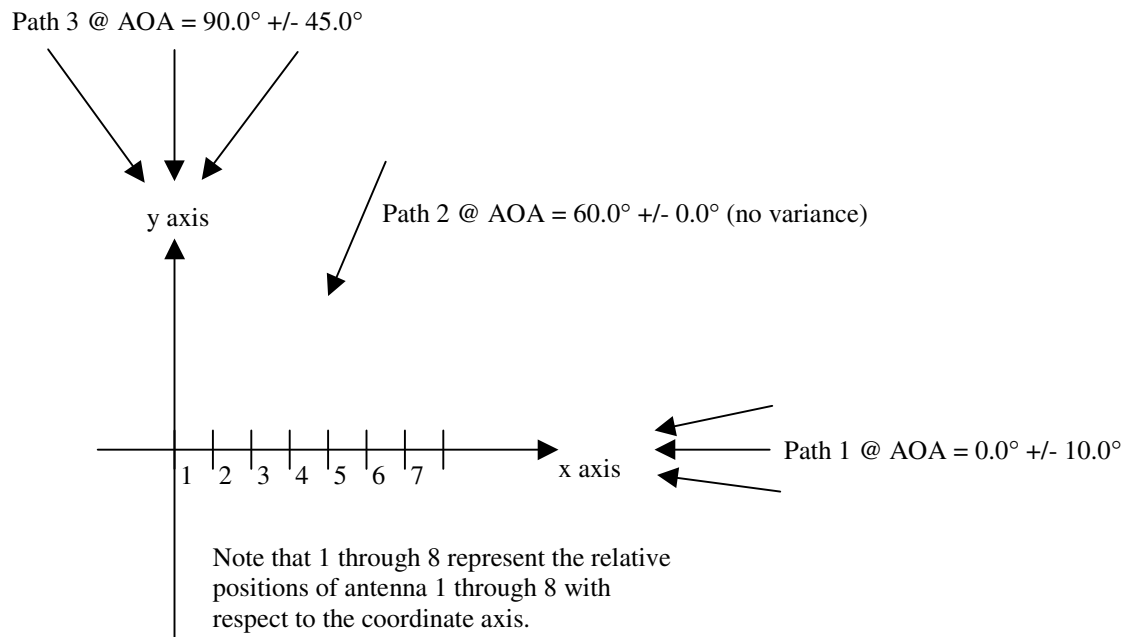


Figure 3-35. Angle of Arrival – Uniform Random Variation Example

The above antenna geometry describes a linear antenna positioned along the X axis. For this simple example we will list the phase offset of each path arriving at

each antenna individually. For this example, only paths 1, 2 and 3 are considered for simplicity.

Path 1 undergoes +/- 10.0° of angle of arrival variation from a mean angle of arrival of 0.0°. The following table demonstrates the clockwise extreme AOA phase offset, mean AOA phase offset and counter-clockwise AOA phase offset for path 1. See Section 3.3.5 for the formulae utilized to perform the following calculations.

Antenna Number	Clockwise extreme AOA (-10.0°) phase offset	Mean AOA (0.0°) phase offset	Counter-Clockwise extreme AOA (10.0°) phase offset
1	0.0°	0.0°	0.0°
2	35.5°	36.0°	35.5°
3	70.9°	72.0°	70.9°
4	106.4°	108.0°	106.4°
5	177.3°	180.0°	177.3°
6	212.7°	216.0°	212.7°
7	248.2°	252.0°	248.2°
8	283.6°	288.0°	283.6°

Table 3-10. Angle of Arrival – Uniform Random Variation Example Path 1

The phase offset spread from clockwise shifts of the AOA to counterclockwise shifts of the AOA are symmetric since path 1 has a mean AOA which arrives along the line of the linear antenna array. The phase offset seen by path 1 at each of the antenna will vary between the three values listed above for each antenna with a uniform distribution of the AOA.

Path 2 undergoes +/- 0.0° of angle of arrival variation from a mean angle of arrival of 0.0°. The following table demonstrates the clockwise extreme AOA phase offset, mean AOA phase offset and counter-clockwise AOA phase offset for path 2. Since path 2 has no AOA variation the phase offset seen at each of the antenna for path 2 will be static. See Section 3.3.5 for the formula utilized to perform the following calculations.

Antenna Number	Clockwise extreme AOA (60.0°) phase offset	Mean AOA (60.0°) phase offset	Counter-Clockwise extreme AOA (60.0°) phase offset
1	0.0°	0.0°	0.0°
2	18.0°	18.0°	18.0°
3	36.0°	36.0°	36.0°
4	54.0°	54.0°	54.0°
5	90.0°	90.0°	90.0°
6	108.0°	108.0°	108.0°
7	126.0°	126.0°	126.0°
8	144.0°	144.0°	144.0°

Table 3-11. Angle of Arrival – Uniform Random Variation Example for Path 2

Path 3 undergoes +/- 45.0° of angle of arrival variation from a mean angle of arrival of 0.0°. The following table demonstrates the clockwise extreme AOA phase offset, mean AOA phase offset and counter-clockwise AOA phase offset for path 3. See Section 3.3.5 for the formulae utilized to perform the following calculations.

Antenna Number	Clockwise extreme AOA (45.0°) phase offset	Mean AOA (90.0°) phase offset	Counter-Clockwise extreme AOA (135.0°) phase offset
1	0.0°	0.0°	0.0°
2	25.5°	0.0°	-25.5°
3	50.9°	0.0°	-50.9°
4	76.4°	0.0°	-76.4°
5	127.3°	0.0°	-127.3°
6	152.7°	0.0°	-152.7°
7	178.2°	0.0°	-178.2°
8	203.6°	0.0°	-203.6°

Table 3-12. Angle of Arrival – Uniform Random Variation Example for Path 3

The phase offset spread from clockwise shifts of the AOA to counterclockwise shifts of the AOA are symmetric since path 1 has a mean AOA which arrives tangential to the linear antenna array. The sign of the phase offset flips from positive to negative as the AOA cross the 90.0° tangential since the path has changed from arriving at antenna 8 first to arriving at antenna 1 first. The phase offset seen by path 3 at each of the antenna will vary between the three values listed above for each antenna with a uniform distribution of the AOA.

Linear Variation

The *Linear* variation option changes the angle of arrival (AOA) linearly on all paths of each channel of the test system. The *Start AOA* parameter defines the initial state of the test, and *Stop AOA* parameter defines the final state of the test. The *Step Size* parameter is then used to indicate the desired change in the AOA at each state transition. These user-defined parameters determine the number of states for each path. Figure 3-36 shows the TASKIT window for Angle of Arrival Test with *Linear Variation*.

Antenna Number	Position (λ) X	Position (λ) Y
1	0.00	0.00
2	0.00	0.00
3	0.00	0.00
4	0.00	0.00
5	0.00	0.00
6	0.00	0.00
7	0.00	0.00
8	0.00	0.00

Path Number	Start (deg)	Stop (deg)	Step Size (+/- deg)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0

Figure 3-36. Angle of Arrival – Linear Variation

The following rules apply to the *Linear Variation* AOA test:

- The test will **Run** from the *Start AOA* to the *Stop AOA*. It loops in this manner until the test is stopped.
- The range for *Start AOA* and *Stop AOA* is -180.0° to 180.0° with a 0.1° resolution.
- The step size determines the direction that is taken to go from *Start AOA* to *Stop AOA*. The angle of arrival traverses *counter clockwise* from *Start AOA* to *Stop AOA* if the *Step Size* ranges from 1.0° to 180.0° and *clockwise* if the *Step Size* ranges from -1.0° to -180.0° . The step size also has a resolution of 0.1° .

- The absolute value of minimum step size is 1.0° .
- If $Step\ Size > |Stop\ AOA - Start\ AOA|$ then there will be only two states, the *Start AOA* and *Stop AOA*.
- The *Start AOA* and *Stop AOA* takes precedent over the *Step Size*. This may result in a final state transition that is smaller than the requested *Step Size*.
- The number of states for each path is variable and depends on the *Start AOA*, *Stop AOA* and *Step Size*. The setup time for the *Linear* variation option is proportional to the number of states for each path.

Linear Variation Example

The following example below will illustrate how to setup and use the *Linear* Variation option of the Angle of Arrival test. Figure 3-37 shows the parameter values for this example. Only paths 1-3 are enabled on each channel.

Angle of Arrival Test

Antenna Geometry

Antenna Number	Position (λ)	
	X	Y
1	0.00	0.00
2	0.10	0.00
3	0.20	0.00
4	0.30	0.00
5	0.40	0.00
6	0.50	0.00
7	0.60	0.00
8	0.70	0.00

Angle of Arrival

AOA Variation

Uniform Random Linear

Path Number	Start (deg)	Stop (deg)	Step Size (+/- deg)
1	-10.0	20.0	1.8
2	80.0	55.0	-3.0
3	120.0	120.0	10.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0

AOA State Trigger

Internal

Duration (ms)

4

Buttons: << Edit Parameters, Run, Stop, Close, Cancel, OK

Figure 3-37. Angle of Arrival – Linear Variation Example TASKIT Setup

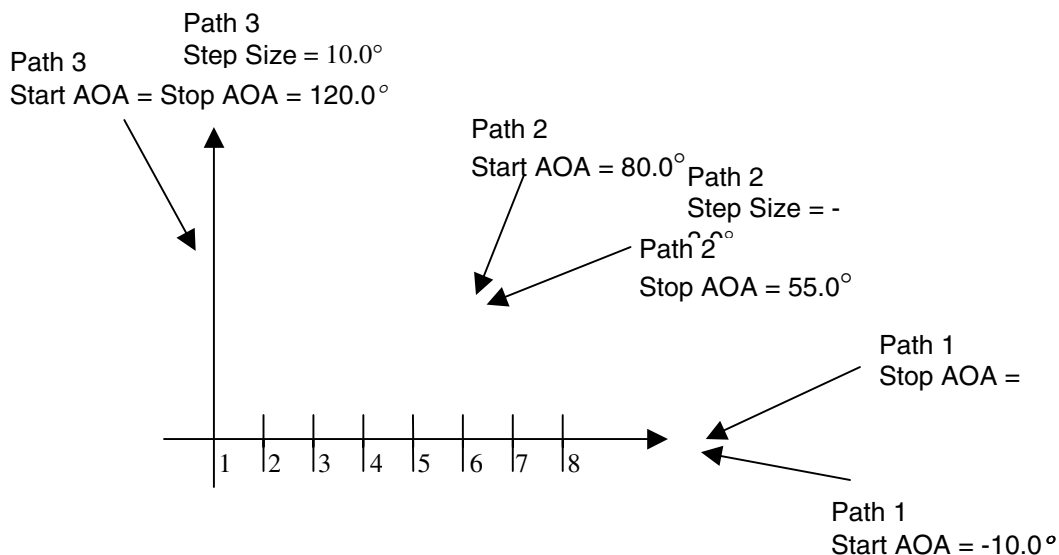


Figure 3-38. Angle of Arrival – Linear Variation Example

The diagram in figure 3-38 shows the antenna geometry along with the various angle of arrivals for each path. The example shows the discrete phase offset values that are generated for this test scenario.

Path 1 has *Start AOA* = -10°, *Stop AOA* = 20° and *Step Size* = 1.8°. Table 3-13 shows the AOA and phase offsets for each of the eight branches.

Antenna Number	State 1	State 2	State ..	State 17	State 18
Path 1 AOA	-10.0°	-8.2°	..	18.8°	20.0°
1	0.0°	0.0°	..	0.0°	0.0°
2	35.5°	35.6°	..	34.1°	33.8°
3	70.9°	71.3°	..	68.2°	67.7°
4	106.4°	106.9°	..	102.2°	101.5°
5	141.8°	142.5°	..	136.3°	135.3°
6	177.3°	178.2°	..	170.4°	169.1°
7	212.7°	213.8°	..	204.5°	203.0°
8	248.2°	249.4°	..	238.6°	236.8°

Table 3-13. Angle of Arrival Test – Linear Variation Example for Path 1

The AOA traverses counter clockwise across the x-axis (0°), which represents a peak phase offset value for this particular antenna geometry. Notice also that the transition between state 17 and 18 AOA's is less than 1.8°. This is because the *Start AOA* and *Stop AOA* takes precedent over the *Step Size*. Once **Run** is

pressed the test will start implementation from state 1 to state 18. Once at state 18, the test will return to step 1 and start over.

Path 2 has a *Start AOA* = 80° , a *Stop AOA* = 55° and a *Step Size* of -3° . Table 3-14 will show the resulting AOA and phase offset for each of the eight branches.

Antenna Number	State 1	State 2	State ..	State 9	State 10
Path 2 AOA	80.0°	77.0°	..	56.0°	55.0°
1	0.0°	0.0°	..	0.0°	0.0°
2	6.3°	8.1°	..	20.1°	20.6°
3	12.5°	16.2°	..	40.3°	41.3°
4	18.8°	24.3°	..	60.4°	61.9°
5	25.0°	32.4°	..	80.5°	82.6°
6	31.3°	40.5°	..	100.7°	103.2°
7	37.5°	48.6°	..	120.8°	123.9°
8	43.8°	56.7°	..	140.9°	144.5°

Table 3-14. Angle of Arrival – Linear Variation Example for Path 2

For Path 2, the AOA traverses *clockwise* from *Start* to *Stop* AOA because the *Step Size* is negative.

Path 3 has a *Start AOA* = *Stop AOA* = 120° and a *Step Size* of 10° . Table 3-15 shows the resulting AOA and phase offset for each of the eight branches.

Antenna Number	State 1	State 2
<i>Path 3 AOA</i>	120.0°	120.0°
1	0.0°	0.0°
2	-18.0°	-18.0°
3	-36.0°	-36.0°
4	-54.0°	-54.0°
5	-72.0°	-72.0°
6	-90.0°	-90.0°
7	-108.0°	-108.0°
8	-126.0°	-126.0°

Table 3-15. Angle of Arrival – Linear Variation Example for Path 3

Since the *Start AOA* equals *Stop AOA* there will be only *two* states for path 3. The result is that this path has a static AOA and a static phase offset for each antenna.


3.4. 3GPDP Operation

This section provides information on the dynamic channel emulation features of the TAS 4500 RF Channel Emulator. The FLEX5 3GPDP emulation modes allow time-varying power-delay profiles (PDPs) to be quickly constructed and executed. Emulating the RF propagation channel using time-varying power-delay profiles is essential for the evaluation of time-sensitive receiver algorithms such as rake finger management and adaptive equalization.

The 3GPDP feature was developed to meet the requirements of 3rd Generation wireless communications test applications. With its flexible channel emulation engine, 3GPDP can be used to validate W-CDMA and cdma2000 receiver designs beyond the minimum requirements specified in industry standards. 3GPDP provides a valuable tool for verifying a communication receiver's channel estimation capabilities.

3.4.1. Getting Started with 3GPDP

The operation of the TASKIT 3GPDP test mode requires a specific sequence of actions to be performed. The procedure for the operation of 3GPDP is as follows:

1. Install TASKIT/4500 and configure the TAS 4500 unit(s) and TASKIT software as detailed in Section 3.1.
2. Establish a remote connection using the GPIB remote protocol with the TAS 4500(s) as described in Section 3.1.2.
3. Configure the TAS 4500's RF and Channel I/O Parameters within the Channel Setup(Table) or Channel Setup(Graphic) screens. It is important to note that the 3GPDP application will only modify path delay. All other Channel/Path settings that are defined statically before executing a 3GPDP test will remain unchanged when the test is **Armed** and **Run**.
4. Click on the  icon on the Toolbar to enter the 3GPDP Configuration Screen.

NOTE: Choose the appropriate section below based on the type of test to be executed.

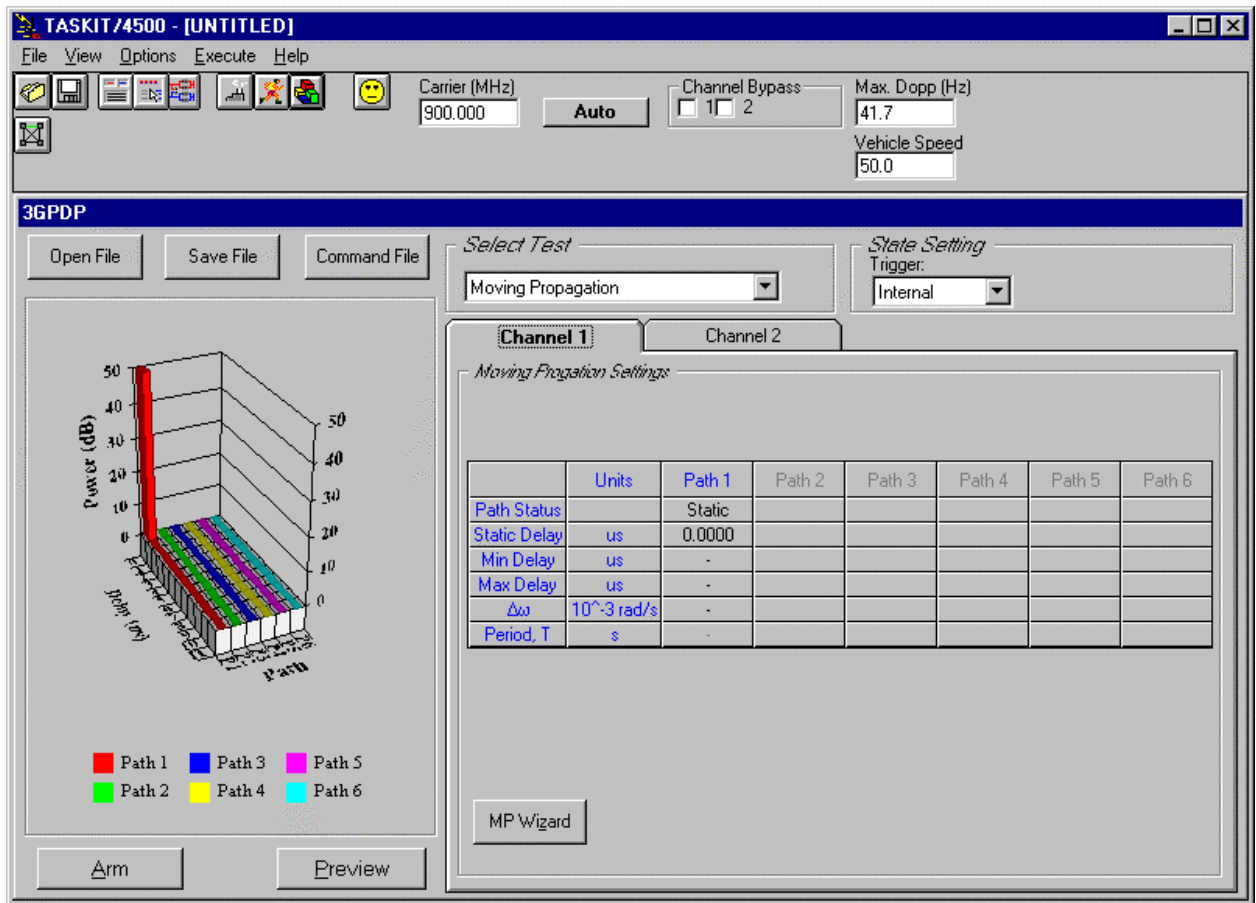


Figure 3-39. 3GPDP Moving Propagation Screen

Moving Propagation Test

Figure 3-39 shows the 3GPDP Moving Propagation graphical interface for reference in the procedure below. For more details on the definition of the Moving Propagation Test, see Section 4.8.

1. In the *Select Test* box, choose the *Moving Propagation Test* item from the drop down dialog box.
2. Make certain that the *State Setting* for the *Trigger* is set to *Internal* or *External* as desired.
3. In the grid for the proper Channel, define the *Path Status* to be either *Static* or *Moving*. All *Static* paths will remain at the defined delay value during the test with no change. Notice that only paths that have been made active from the Channel Setup screen are eligible for use in the 3GPDP test. All inactive paths will be grayed out in the table.

4. All *Moving* paths must be configured to define the rate and range of path movement. This is accomplished by setting the Max/Min delay values and the period ($\Delta\omega$) of oscillation. The **MP Wizard** can also be used to quickly define these parameters for all active paths.
5. When all paths have been properly setup, press the **Arm** button to prepare the system for testing.
6. If necessary, after the unit is **Armed** the user should establish a call connection with the UUT.
7. Press the **Run** button to begin test execution.
8. The test will continue to execute until the **Stop** has been pressed. When the test has been stopped, the unit will return to its original static state matching that defined in the Channel Setup table.

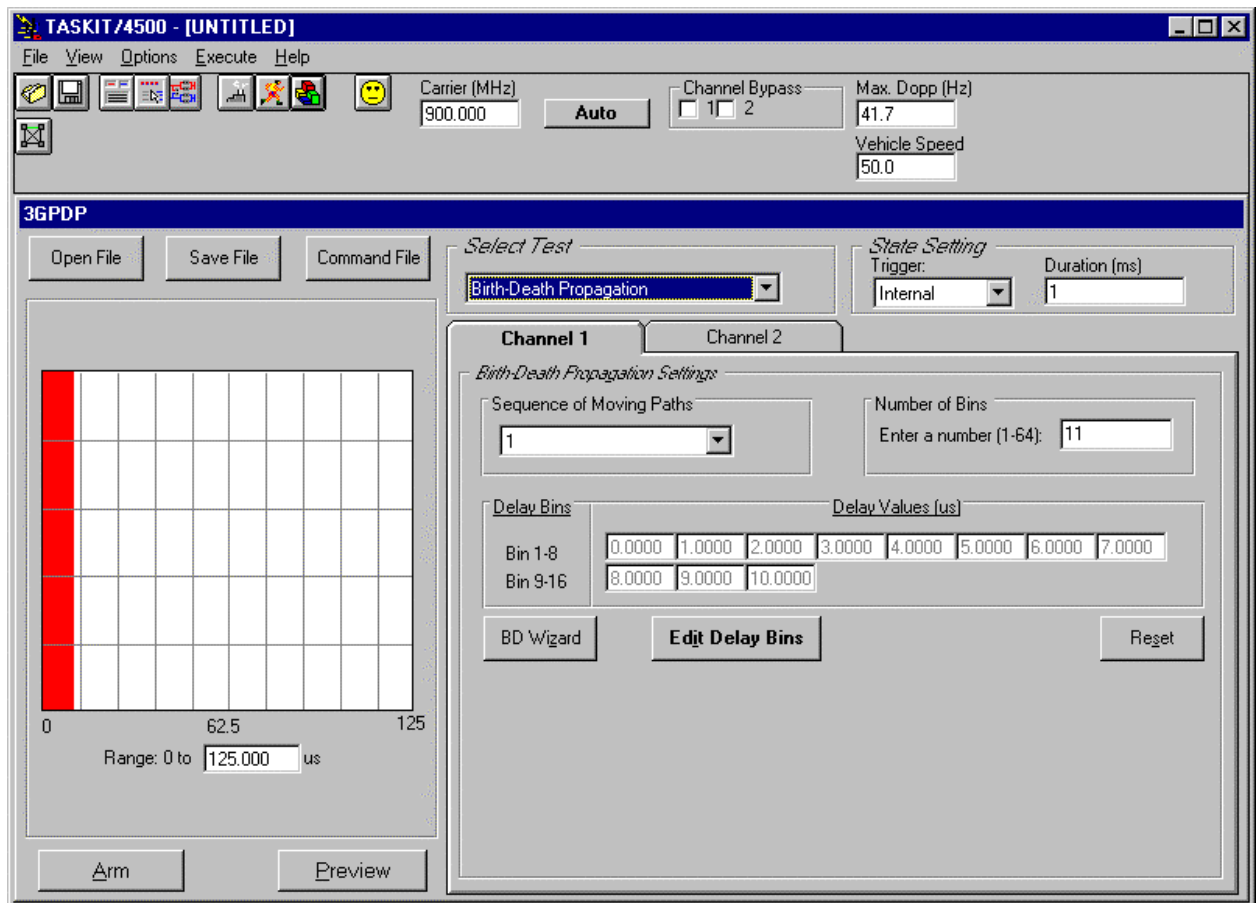


Figure 3-40. 3GPDP Birth-Death Screen

Birth-Death Test

Figure 3-40 shows the 3GPDP Moving Propagation graphical interface for reference in the procedure below. For more details on the definition of the Birth-Death Test, see Section 4.9.

1. In the *Select Test* box, choose the *Birth-Death Test* item from the drop down dialog box.
2. Make certain that the *State Setting* for the *Trigger* is set to *Internal* or *External* as desired. Also make certain that the desired state *Duration* has been defined for the test.
3. In the Birth-Death Propagation Settings frame, first define the *Number of Bins* and the *Sequence of Moving Paths*. The **Edit Delay Bins** button will then permit access to the individual delay setting for each active bin. The **BD Wizard** capability also provides a fast way for defining the bin values for the channel.
4. When all paths have been properly setup, press the **Arm** button to prepare the system for testing.
5. If necessary, after the unit is **Armed** the user should establish a call connection with the UUT.
6. Press the **Run** button to begin test execution.
7. The test will continue to execute until the **Stop** has been pressed. When the test has been stopped, the unit will return to its original static state matching that defined in the TASKIT Channel Setup table.

3.4.2. Configuring the Channel for 3GPDP

The 3GPDP Test definition interface provides access only to the dynamic Power Delay Profile information related to each path. Prior to defining the specific 3GPDP parameters, the standard Channel Setup(Table) or Channel Setup(Graphic) screens should be used to configure all RF Channel and Path related parameters.

The RF parameters would include the RF Carrier Frequency, the LO Mode and LO Frequency, the Input Reference Level, and the RF Attenuation setting. The Path parameter settings would include turning on all active paths and setting the desired path modulation, path velocity/Doppler, and path loss values. The path delay will be set automatically based on the 3GPDP parameter definition. The default 3GPP test standard specifies the use of static paths (modulation type set to “none”) with equal power (path loss set to 0.0 dB). A starting point for this default test can be loaded into TASKIT by recalling either the “mp_def.rce” or “bd_def.rce” file located in the “...\tas4500.win\3G\3GPDP\” directory. Alternate static RF/Path configurations can be saved using the standard TASKIT File Save/Recall mechanism.

3.4.3. TASKIT 3GPDP Moving Propagation Example

This section provides a simple example for configuring and running a Moving Propagation example. It also provides information on the MP Wizard and how it can be used to aid in test definition.

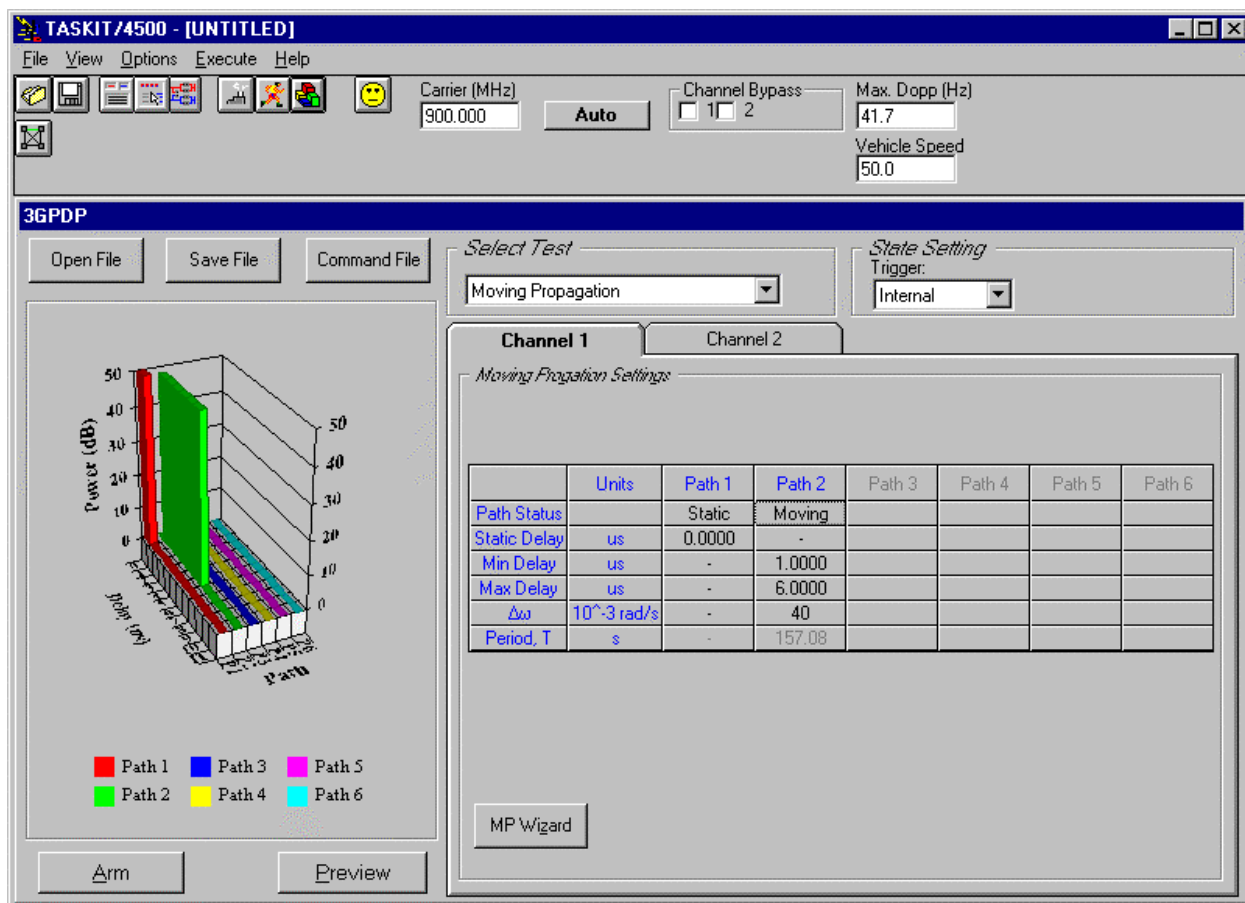



Figure 3-41. 3GPDP Moving Propagation Example

MP Example – Setting All Parameters to Run the Default Test

1. Setup the TAS 4500 and establish a remote connection to the unit.
2. On the Channel Setup(Table) screen, update the following parameters to properly configure Channel 1:
 - Enter the desired RF frequency in the *Carrier (MHz)* text box.
 - If required for the current setup, define the *LO Control* mode, the *LO Frequency (MHz)*, and the *Output Attenuation (dB)*.
 - Click on the **Auto** button to Auto Range the input signal to the 4500.
 - In the Table, make certain that the *State* for Path 1 and Path 2 is *On* and the *State* for all other paths is *Off*.

- Make certain that both active paths have *Modulation Type* set to *None*, *Delay (us)* set to *0.0000*, *Loss(dB)* set to *0.0* and *LN State* set to *Off*.
3. Click on the  icon on the Toolbar to enter the 3GPDP Configuration Screen
 4. In the *Select Test* box, choose the *Moving Propagation Test* item from the drop down dialog box.
 5. Make certain that the *State Setting* for the *Trigger* is set to *Internal* or *External* as desired.
 6. In the Moving Propagation Settings form for Channel 1,
 - For Path 1, set the *Path Status* to *Static* and the *Static Delay* to *0.0000*.
 - For Path 2, set the *Path Status* to *Moving* and define *Max Delay* of *6.0000(us)* and *Min Delay* of *1.0000(us)*. Also, Set $\Delta\omega$ to *40* (10^{-3} rads/sec) which will result in a *157.08* second period.
 7. Press the **Arm** button to prepare the system for testing.
 8. If necessary, after the unit is **Armed** the user should establish a call connection with the UUT.
 9. When the unit has been successfully **Armed**, the screen shown in Figure 3-42 will appear. Press the **Run** button to begin test execution or the **Disarm** button to return the unit to static operation.
 10. The test will continue to execute until **Stop** has been pressed. When the test is stopped, the unit will return to its original static state matching that defined in the Channel Setup table.

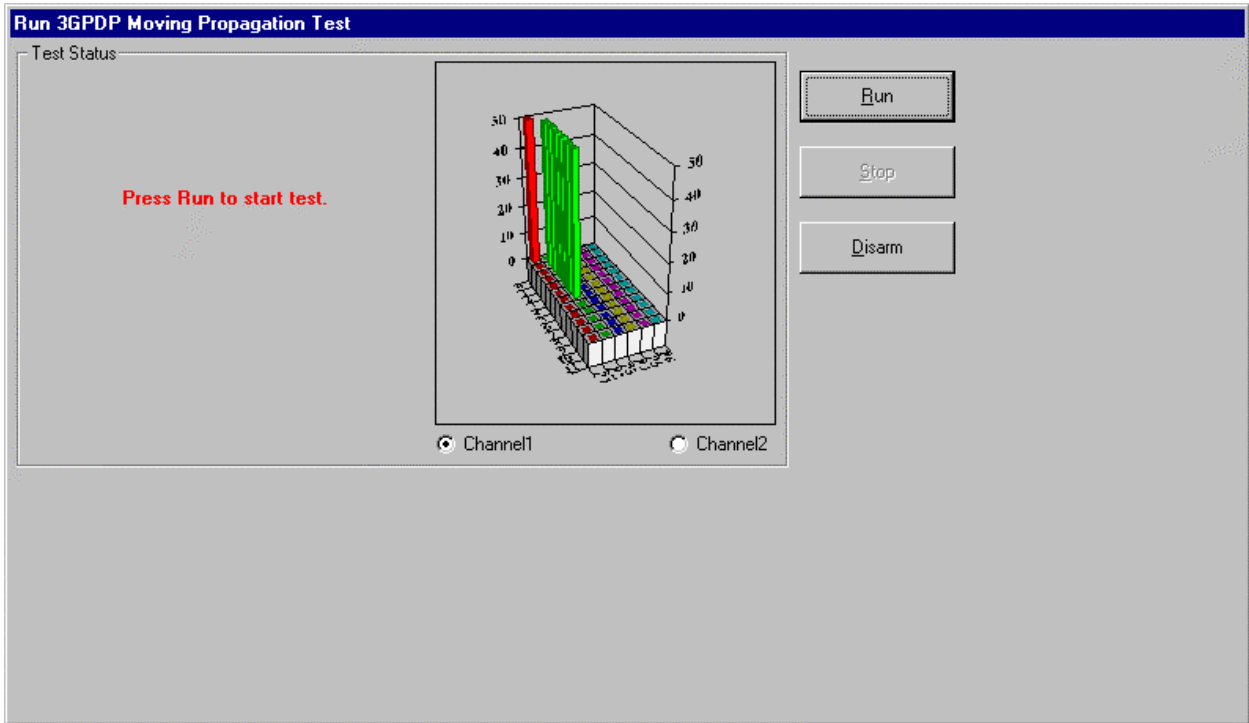


Figure 3-42. Run 3GDP Moving Propagation Test Screen

3.4.4. TASKIT 3GPDP Birth-Death Example

This section provides a simple example for configuring and running a Birth-Death test example. It also provides information on the BD Wizard and how it can be used to aid in test definition.

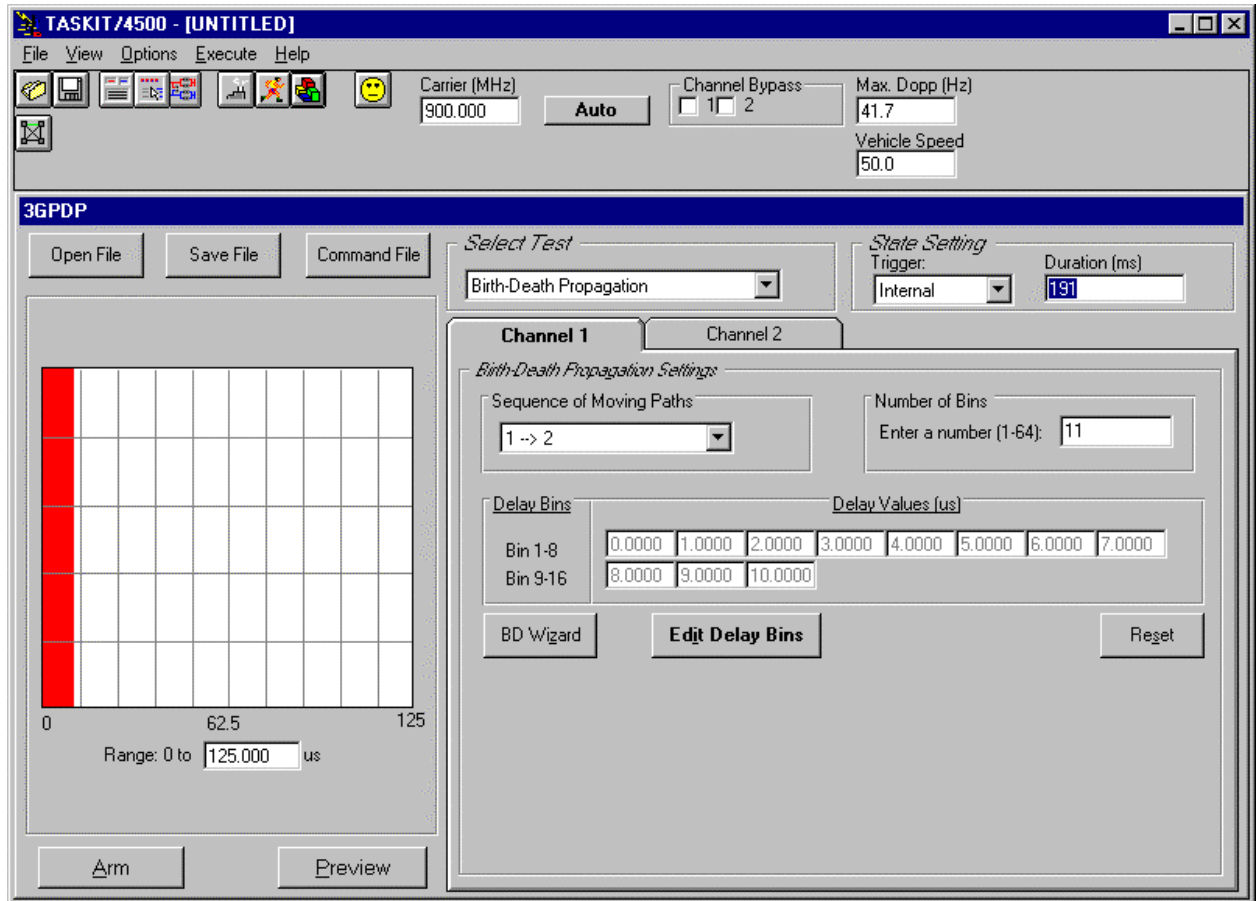



Figure 3-43. 3GPDP Birth-Death Example

BD Example – Setting all parameters to run the default test:

1. Setup the TAS 4500 and establish a remote connection to the unit.
2. On the Channel Setup(Table) screen, update the following parameters to properly configure Channel 1:
 - Enter the desired RF frequency in the *Carrier (MHz)* text box.
 - If required for the current setup, define the *LO Control* mode, the *LO Frequency (MHz)*, and the *Output Attenuation (dB)*.
 - Click on the **Auto** button to Auto Range the input signal to the 4500.

- In the Table, make certain that the *State* for Path 1 and Path 2 is *On* and the *State* for all other paths is *Off*.
 - Make certain that both active paths have *Modulation Type* set to *None*, *Delay (us)* set to *0.0000*, *Loss (dB)* set to *0.0* and *LN State* set to *Off*.
3. Click on the  icon on the Toolbar to enter the 3GPDP Configuration Screen.
 4. In the *Select Test* box, choose the *Birth-Death Test* item from the drop down dialog box.
 5. Make certain that the *State Setting* for the *Trigger* is set to *Internal* or *External* as desired. If using an internal trigger, set the *State Duration* to *191* (ms) for the default Birth-Death test.
 6. In the *Birth-Death Propagation Settings* form for Channel 1,
 - Set the *Sequence of Moving Paths* to *1 → 2*
 - Set the *Number of Bins* to *11*.
 - Click on the *Edit Delay Bins* button and manually enter the values *0.0000*, *1.0000*, *2.0000*, *3.0000*, *4.0000*, *5.0000*, *6.0000*, *7.0000*, *8.0000*, *9.0000*, *10.0000* sequentially in the eleven active text boxes. Then click *Finish Edit* to accept the changes.
 7. Press the **Arm** button to prepare the system for testing.
 8. If necessary, after the unit is **Armed** the user should establish a call connection with the UUT.
 9. When the unit has been successfully **Armed**, the screen shown in Figure 3-44 will appear. Press the **Run** button to begin test execution or the **Disarm** button to return the unit to static operation.
 10. The test will continue to execute until **Stop** has been pressed. When the test is stopped, the unit will return to its original static state matching that defined in the Channel Setup table.

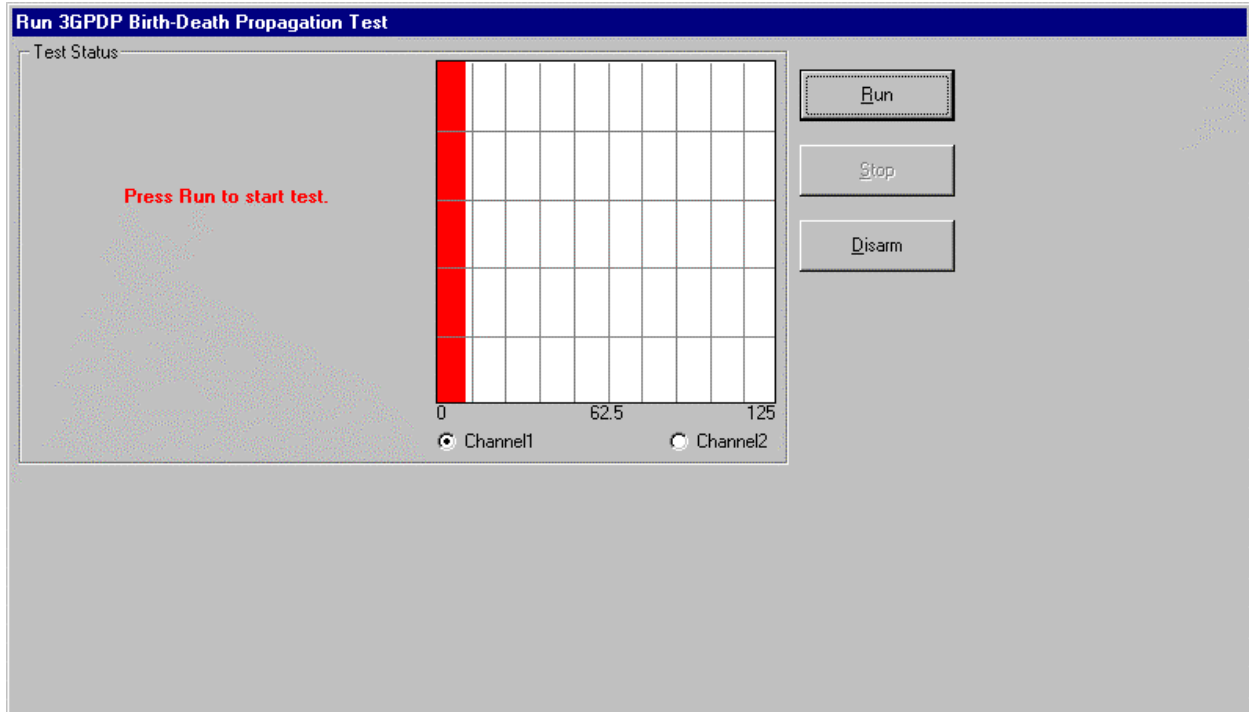


Figure 3-44. Run 3GPDP Birth-Death Propagation Test Screen

3.4.5. 3GPDP Additional Capabilities

Positioning the 3D Grid Display

The 3D grid that appears in the Moving Propagation screen and the Preview windows can be repositioned to permit an optimal viewing angle. While holding down the Control key on the keyboard, click and hold down the left mouse button. An arrow and a 3D box outline will appear. If you drag the mouse to a new position, you can see that the viewing angle of the 3D box will change. When you release the mouse button and the Control key, the 3D grid will be adjusted to reflect the new viewing angle. This process can be repeated until the viewing angle has been properly set.

Moving Propagation Test – MP Wizard

To aid with the parameter definition required for the Moving Propagation Test, the **MP Wizard** allows for channel wide definition of the key parameters. When the **MP Wizard** button is selected, the screen displayed in Figure 3-45 appears. It provides the macro capability to set the *Max Delay*, *Min Delay*, and $\Delta\omega$ for all active paths in the selected Channel.

Moving Propagation Setup Wizard - Channel 1	
Set all Min Delay:	<input type="text" value="0"/> us
Set all Max Delay:	<input type="text" value="0"/> us
Set all $\Delta\omega$	<input type="text" value="1"/> 10^{-3} rad/s
Period, T	<input type="text" value="6283"/> s
<input type="button" value="OK"/> <input type="button" value="Cancel"/>	

Figure 3-45. Using the MP Wizard

Birth-Death Test – BD Wizard

To aid with the parameter definition required for the Birth-Death Test, the **BD Wizard** allows for channel wide definition of the key parameters. When the **BD Wizard** button is selected, the screen displayed in Figure 3-46 appears. It provides the macro capability to set the *Number of Bins*, *Initial Delay*, and *Step Size* for the selected Channel. The *Initial Delay* value will be assigned to Bin 1, and the *Step Size* will be used to provide the delay delta from bin to bin up to the defined *Number of Bins*.

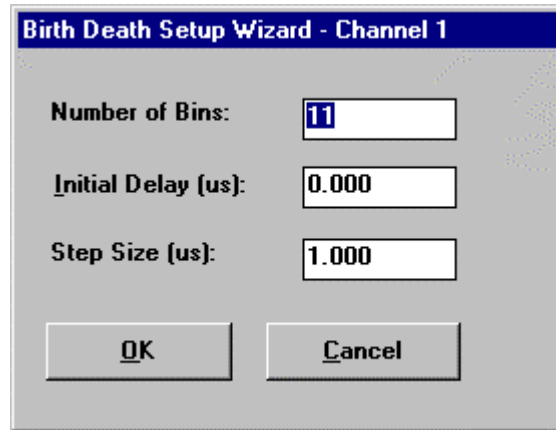


Figure 3-46. Using the BD Wizard

The Test Preview Screen

A graphical preview of either test profile is available by clicking on the **Preview** button. The window shown in Figure 3-47 will then appear. This feature allows for step-by-step view of the Power Delay Profile changes on each path in either Channel 1 or Channel 2. By repeatedly clicking on the **Step** button, the test can be executed one state at a time. The **Auto Update** button actually allows the state progression to be displayed automatically by TASKIT. The dwell time for each state in the preview screen can be adjusted by manipulating the scroll bar in the *Auto Update Rate* frame in the upper right corner of the Preview screen window. Sliding the scroll bar to the left will slow down the state progression while moving it to the right will speed up the state dwell time.

NOTE: When using the preview screen to view the Birth-Death state progression, the random sequence of delay values used in the preview may not match the exact sequence of random values obtained during the test.

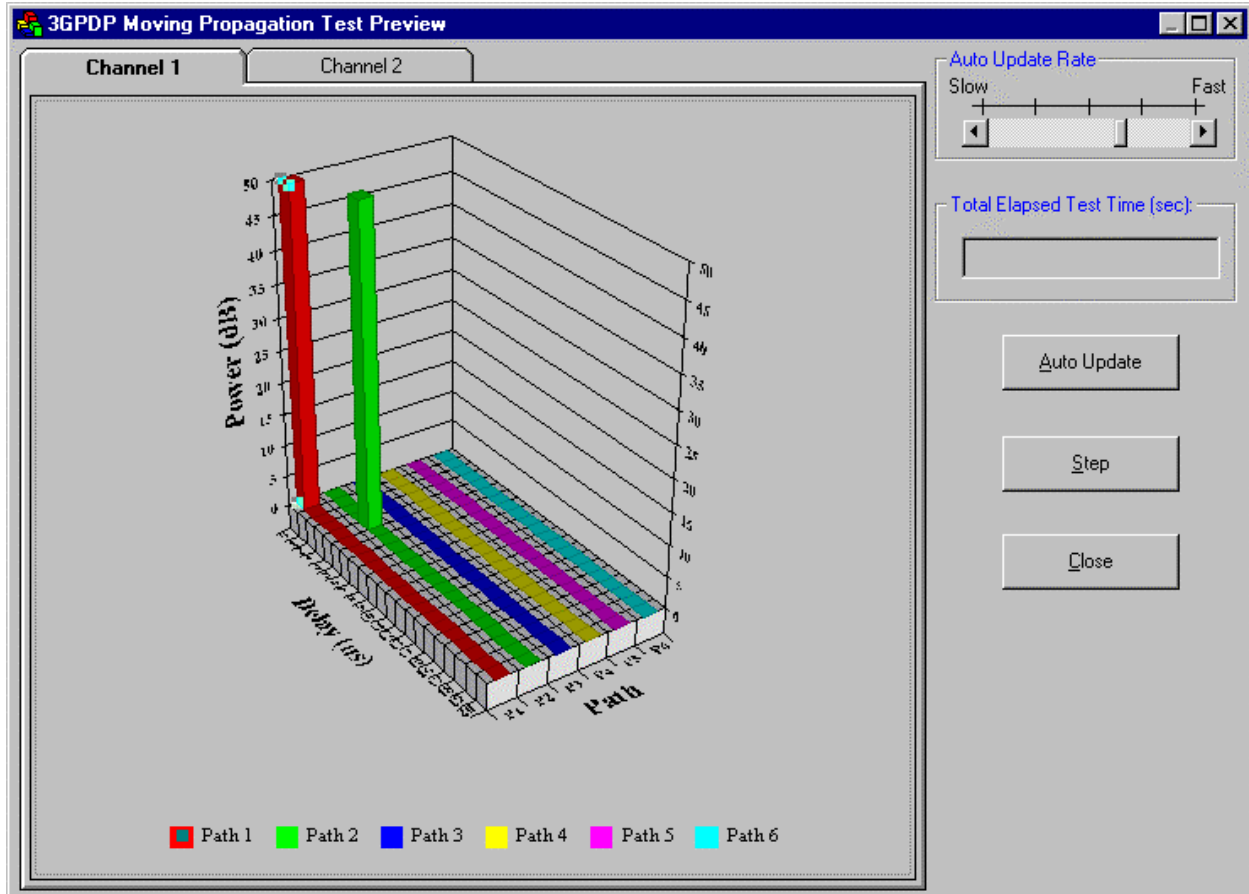



Figure 3-47. The Preview Screen

3.4.6. TASKIT 3GPDP File Save/Recall


Within the TASKIT 3GPDP application, the user has the ability to save and recall the specific 3GPDP parameters that have been defined to execute a particular test scenario. This Save/Recall capability should be used in conjunction with the standard .RCE files to completely restore a previous test scenario. The designated file extensions are .DMP for Moving Propagation files and .DBD for Birth-Death test files.

Complete System Setup Save Procedure

1. Completely define both the static Channel/Path parameters and the dynamic 3GPDP parameters using the TASKIT interface.
2. Select *File* → *Save* from the TASKIT Main Menu and save the Channel/Path configuration to a standard .RCE file.
3. Click on the  icon to bring up the 3GPDP application screen.

4. From the drop down box in the *Select Test* frame, make certain that the proper 3GPDP test profile is currently displayed, either Moving Propagation (.DMP) or Birth-Death (.DBD).
5. In the upper left corner, click on the **Save File** button and set the path and filename that would be associated with this configuration.
6. Click on the **Save** button to complete this process.


Complete System Setup Recall Procedure

1. Establish a remote connection to the unit.
2. Select *File* → *Open* from the TASKIT Main Menu
3. Locate and recall the .RCE file that will restore the static Channel/Path parameters in the unit.
4. Click on the  icon to bring up the 3GPDP application screen.
5. From the drop down box in the *Select Test* frame, make certain that the proper 3GPDP test profile is currently displayed, either Moving Propagation (.DMP) or Birth-Death (.DBD).
6. In the upper left corner, click on the **Open File** button and select the path and filename associated with the configuration to be recalled.
7. Click on the **Open** button to complete this process.

3.4.7. TASKIT 3GPDP Command File Creation

The TASKIT 3GPDP interface can serve as an easy way to generate the sequence of remote commands necessary to produce a particular test scenario. The **Command File** button that appears in the upper left corner of the 3GPDP display creates a .DDC text file that provides the command sequence. The procedure below could be used to produce a remote command sequence without manually entering each command.

Procedure for Command File Generation

1. Completely define both the static Channel/Path parameters and the dynamic 3GPDP parameters using the TASKIT interface.
2. Select *File* → *Make Command File* from the TASKIT Main Menu and save the Channel/Path configuration to a standard .RCC file. Notice that the .RCC file contains only the static Channel/Path configuration information; no 3GPDP parameters are included.
3. Click on the  icon to bring up the 3GPDP application screen.
4. From the drop down box in the *Select Test* frame, make certain that the proper 3GPDP test profile is currently displayed, either Moving Propagation or Birth-Death.
5. In the upper left corner, click on the **Command File** button and set the path and filename that should be associated with this configuration.
6. Click on the **Save** button to complete this process.

4.0. REFERENCE

4.1. Overview

This section of the operations manual provides reference information that describes the features provided in the TAS 4500 FLEX RF Channel Emulator. This information is grouped into the following sections:

Front and Rear Panel Interfaces

This includes all connectors, indicators, and input/output ports on the front and rear panels of the TAS 4500.

Parameter Description

This includes all of the parameters of the TAS 4500. These parameters are divided into system configuration, input/output, and path characteristics.

Dynamic Environment Emulation Mode

This section describes the Dynamic Environment Emulation Mode available through TASKIT/4500. The Dynamic Environment Emulation Mode allows the user to cascade multiple static parameter “states” to emulate a dynamic propagation environment.

4.2. Front and Rear Panel Interfaces

The front panel keys, display, and RF and LO input/output N-type connectors provide access to the features of the TAS 4500. The rear panel contains the remote control interfaces (IEEE-488 and RS-232), auxiliary (AUX) port, clock/synch input/output connectors, power entry module, and fan vent area.

4.2.1. Front Panel Displays and Interfaces

On the front right hand side of the TAS 4500 (Figure 4-1) are the display and key pad area consisting of the menu, select/edit/input and bypass key groups. On the left hand side of the front panel are the channel RF I/O and LO I/O N-type connectors.

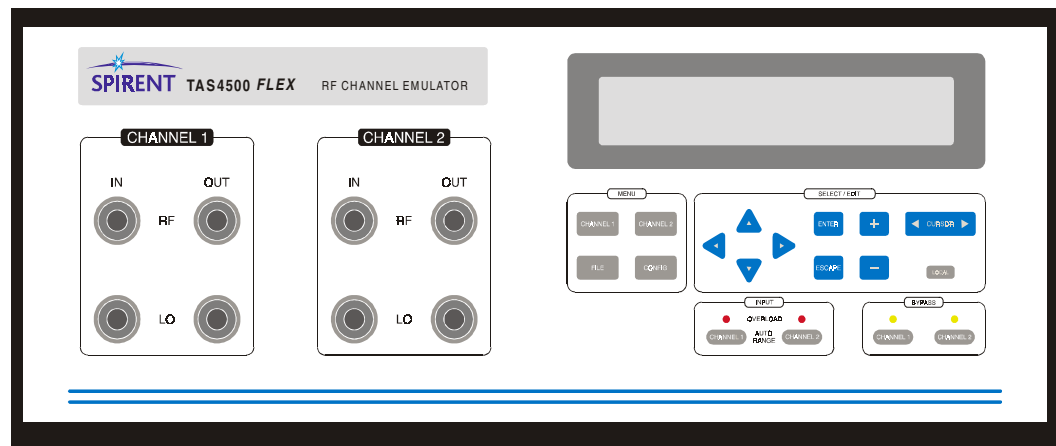


Figure 4-1. TAS 4500 Front Panel

Display

The TAS 4500 has a four row by forty character display on the front panel. The display will show the active menu tree. Parameters for the system, input/output, and path characteristics are visible from the front panel display. Error messages are also displayed here.

Menu Group Keys

There are four menu group keys on the TAS 4500 front panel as follows:

CHANNEL 1 - The channel 1 menu group controls the second simulated unidirectional RF channel that consists of up to six independently programmable transmission paths.

CHANNEL 2 - The channel 2 menu group controls the second simulated unidirectional RF channel that consists of up to six independently programmable transmission paths.

CONFIGURATION (CONFIG) - The configure menu group allows the configuration of the remote control interface, selects the displayed units for the path characteristics, sets the fading parameters and sets the LCD contrast. The system summary displays the instrument's software version, diagnostic status and hardware configuration.

FILE - The file menu group allows you to load both user and TAS defined parameter profiles and to save user define parameter configurations.

CHANNEL 1 and CHANNEL 2 Autorange Keys and Overload LEDs

These keys are located near the lower right of the front panel to provide direct access to the input level control function for both channels. The invoked button causes the channel emulator to measure the peak level of the transmit signal that is present at the input (RF IN) of the associated channel. The results of this measurement are then used to configure the channel's input level control circuit. The 4500 automatically forces the present INPUT REFERENCE LEVEL to the appropriate value to adjust the level of the input signal to approximately 3 dB below the full scale dynamic range of the channel. This provides the signal processing circuitry of the 4500 with the optimum conditions to emulate channel characteristics. When performing an input range, the overload LED will light momentarily, indicating that the TAS 4500 is optimizing the signal level.

The overload LEDs should be monitored to be sure the signal applied at the RF Channel input is within the specified range. When lit, the LED indicates the RF input signal has peak levels above the permitted range and will be clipped by the instruments input circuitry. If an overload condition occurs, the input reference level parameter should be increased and/or the input signal level should be reduced.

CHANNEL 1 and CHANNEL 2 BYPASS Keys

The bypass keys enable and disable the bypass feature for each channel. When the bypass for a channel is active, the bypass LED will be illuminated. When bypass is enabled, a minimum-loss, no-impairments path from the RF IN connector to the RF OUT connector is created.

LOCAL Key

The Local key disables remote control operation. When remote operation is enabled, menu parameters cannot be changed from the front panel. However, the menu navigation keys can still be used to view parameter values. The letter 'R' appears in the upper right corner of the display when the 4500 is in Remote Control Mode.

RF Input/Output N-Connectors

There are two N-type connectors per channel located on the upper left hand side of the TAS 4500 front panel for RF input and output. The transmit signal must be provided by the user to the RF IN connector. The received signal will be present at the RF OUT connector.

LO Input/Output Connectors

There are two N-type connectors per channel located on the lower left half side of the TAS 4500 front panel for LO (Local Oscillator) input and output. An LO signal must be present at the LO IN for that channel to operate.

4.2.2. Rear Panel Interfaces

Figure 4-2 shows the rear panel of a standard 4500.

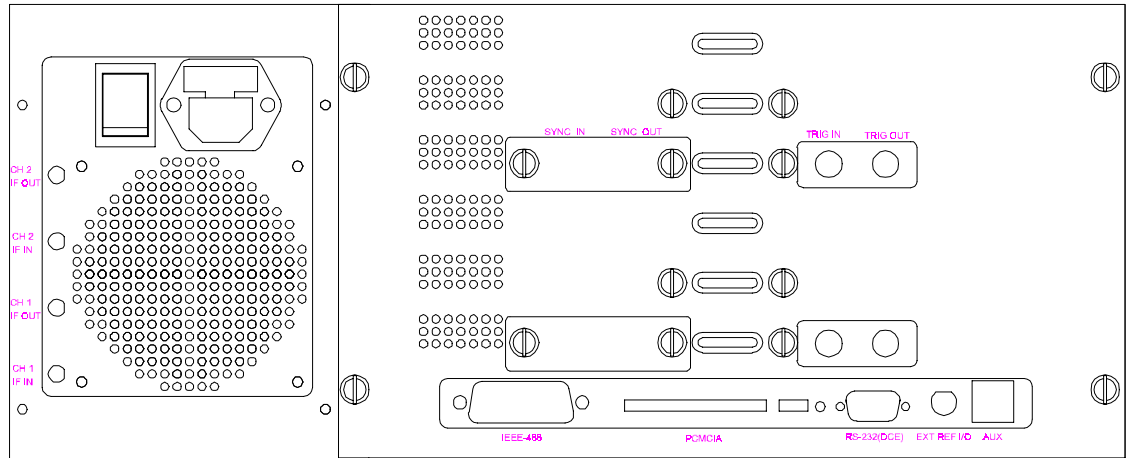


Figure 4-2. Rear Panel of the TAS 4500

PCMCIA Software Card Interface

The system software for the TAS 4500 is resident on a PCMCIA memory card which plugs into the PCMCIA System Software Interface on the lower portion of the instrument's rear panel. This PCMCIA card makes it easy to upgrade to the latest firmware version.

IEEE-488 Remote Control Port

The CONTROL (IEEE-488) port is a 24 pin IEEE-488 receptacle which supports the IEEE-488 (GPIB) protocol. This port must be connected to an IEEE-488 controller to control the TAS 4500 via IEEE-488. This connection may be either direct or via multi-point bus, which contains other IEEE-488 controlled equipment.

The IEEE-488 controller can be a generic PC with an embedded IEEE-488 control card installed, an IEEE-488 computer, an RS-232 to IEEE-488 converter, or some other IEEE-488 controller.

RS-232 (DCE) Remote Control Port

The CONTROL (DTE) port is a 9 pin female D-sub connector which supports RS-232C. The control port is wired as a Data Communications Equipment (DCE). All RS-232C remote control of the TAS 4500 must be done via this port. An RS-232C terminal or a PC (IBM compatible) can control the TAS 4500 through this port via a regular RS-232 cable. It is important to note that a null modem cable is not required. Two protocols are supported in RS-232 control mode, ACK/NAK (ACKnowledge/Negative AcKnowledge), and CR/LF (Carriage Return/Line Feed). Both of these protocols are explained in full detail in Section 5.0. "Remote Operation".

AUX Port

The AUX (auxiliary) port is a RJ-45 connector that is currently not used.

SYNC IN(OUT) Connectors

The SYNC input(output) connectors shown in Figure 4-2 are RJ-45 type connectors. The TTL digital signal on this connector is used to provide synchronization of the digital signal processing between 4500s that are configured in a multiple unit test setup.

TRIG IN(OUT) Connectors

The TRIG input(output) connectors shown in Figure 4-2 are BNC type connectors. The TRIG IN port is used to provide an external TTL trigger and synchronization mechanism. The state transitions in the Random Angle of Arrival Test and Dynamic Environment Emulation mode can be triggered using this interface. The TRIG OUT port can be used to track the state progression of a DEE test. A TTL output signal from the box indicates state transitions when in DEE mode.

CH1 IF IN/OUT and CH2 IF IN/OUT Connectors

The IF IN/OUT SMA type connectors shown in Figure 4-2 are part of the IFBO (IF Breakout) Option. These connectors provide access to the 140 MHz IF signal in the 4500 Up Converter. Additional information on the application of these signals can be found in Section 4.4.8 of the manual. These four holes will be filled with metal plugs if this option is not installed.

EXtErnal REFerence I/O Connector

The External Reference Input/Output connector is a BNC type connector that provides a 10 MHz sine wave reference signal as an output when the TAS 4500 is using its own internal reference. This connector can also accept an externally supplied 10 MHz sine wave reference signal which can be used to drive the internal signal processing circuitry of the TAS 4500.

AC Power Receptacle

The AC power receptacle is located on the upper left corner of the rear panel. The TAS 4500 has an autosensing AC voltage that operates over the range stated in Section 8.0 “Technical Specifications”. This receptacle also contains the fuses for the unit. If it becomes necessary to change the fuses, the proper procedure for performing the operation is described below:

1. Remove the power cord and slide the fuse holder out of the power entry module.
2. Replace the fuse(s) with the appropriate type (see Section 8.0 “Technical Specifications”).
3. Reinsert the fuse holder into the power entry module.

Fan Vent Areas

The rear panel of the TAS 4500 contains two fan vent areas. One vent area is below the AC power receptacle, the other to the left of this vent. The area behind these vents should be unobstructed for proper air flow to cool the TAS 4500.

4.3. System Configuration Parameters

In this section, parameters for the system configuration will be discussed. The system configuration parameters consist of the Unit parameters, System parameters, and the Remote Protocol parameters.

In this section, the different vehicle velocity formats will be explained along with how to convert between the various formats. The types of channel correlation available and their setup requirements will be listed. Also, the fading configuration choices will be discussed. Finally, the remote protocol formats will be reviewed.

4.3.1. Vehicle Velocity Parameter Formats

The TAS 4500 can be configured to display the vehicle velocity in four different data formats. The data formats are only selectable from the TAS 4500 front panel under the CONFIG menu. Refer to Section 2.4 “Setting the Display Format for Vehicle Velocity Parameters” for more details on configuring this parameter.

The vehicle velocity is the speed at which the mobile receiver is moving relative to the transmitter in a straight path. The vehicle velocity data formats are: kilometers per hour (km/h), meters per second (m/s), miles per hour (mi/h) and feet per second (f/s).

4.3.2. Emulation Method

The TAS 4500 allows the user to select the emulation method used to generate Rayleigh fading (also referred to as fast fading). Rayleigh fading is generated using an I/Q modulator shown in Figure 4-5. The I/Q signals are modulated with two independent and identically distributed band limited Gaussian signals. The two emulation methods supported are Jakes method and the filtered noise method. The filtered noise method is the default selection in the TAS4500.

Jakes emulation method generates the I/Q modulation waveforms from a weighted sum of sinusoids. Advantages of the Jakes method are:

- Perfectly band limited signal due to the sinusoidal nature of the I/Q modulation waveform generation.
- An excellent approximation of Rayleigh fading.

The filtered noise emulation method generates the I/Q modulation waveforms from two band limited Gaussian pseudo random noise sources. These noise sources provide the ability to control the spectral shape of the faded signal. Advantages of the filtered noise method are:

- Permits spectral shaping of the faded signal to emulate various environmental conditions.
- Allows for a controllable fading repetition rate.

For further details on setting this parameter see Section 2.4 “Selecting the Fading Emulation Method.”

4.3.3. Fading Repetition Rate

The TAS 4500 allows the user to select the nominal period of the pseudo random filtered noise sources. This period corresponds with the time it takes for the pseudo random Rayleigh power distribution to repeat. There are three repetition rates available. The nominal periods for these rates are: 20 minutes, 27 seconds, and 24 hours. The formula to compute the repetition rate for the filtered noise emulation method with Fading Doppler Tracking Mode set to System is as follows:

$$T_{\text{repeat}} = \frac{(T_{\text{fundamental}})}{(40 * F_{\text{system Doppler}})}$$

where

$$T_{\text{fundamental}} = \begin{array}{ll} 2^{22} & \text{for RATE1 (20 minutes)} \\ 2^{17} & \text{for RATE2 (27 seconds)} \\ 2^{28} & \text{for RATE3 (24 hours)} \end{array}$$

$$F_{\text{system Doppler}} = \text{current Rayleigh or Rician Doppler frequency setting}$$

The nominal repetition rates stated above were each computed based on typical test setup Doppler frequencies. For further details on setting this parameter see Section 2.4. “Selecting the Nominal Fading Repetition Rate.”

4.3.4. Correlation Coefficient Algorithm

The TAS 4500 allows the user to select the correlation algorithm used to specify the correlation between Rayleigh faded paths. Envelope correlation is between the Rayleigh faded signals at the output of the associated channels. While component defines the correlation between the In-Phase components of the associated Rayleigh faded signals in addition to the correlation between the Quadrature components.

The Correlation Algorithm parameter can be found in the CONFIG menu. For further details on setting this parameter see Section 2.4. "Selecting the Correlation Algorithm."

4.3.5. Remote Protocol Formats

The following remote protocol formats are available under the CONFIG menu from the TAS 4500 front panel: ACK/NAK (ACKnowledge/Negative AcKnowledge), CR/LF (Carriage Return/Line Feed), and GPIB. ACK/NAK and CR/LF are used with the RS-232C remote control port; GPIB is for the IEEE-488 port. These protocols are explained in full detail in Section 5.0. "Remote Operation" of this manual.

4.3.6. 10 MHz Reference Source

NOTE: The TAS 4500 generates a very high quality internal source, and it is not recommended that an external source be used unless the user has a specific reason for doing so.

The TAS 4500 requires a 10 MHz sinusoidal reference signal to synchronize the internal signal processing functions of the unit. The user can select either the internally generated 10 MHz reference or they can provide their own external source via the BNC connector labeled EXT REF I/O available on the rear panel. Refer to Section 8.0. "Technical Specifications" for the requirements on the external source.

It is important to note that the external signal source must be connected to the TAS 4500 and must have the proper frequency and power settings prior to changing the source selection. If the signal is not present or is detected to be out of the specified power or frequency range, the TAS 4500 will not allow use of an external source. Only when the signal present is determined to meet the specifications will the unit proceed and allow for an external source to be chosen.

The 10 MHz Reference parameter can be found in the CONFIG menu. For further details on setting this parameter see Section 2.4 "Setting the 10 MHz Reference Source."

NOTE: When the TAS 4500 is set to produce its own internal reference, there will be a 10 MHz sinusoidal output present on the BNC connector.

4.3.7. Fading Doppler Tracking Mode

With both the Jakes and filtered noise fading emulation methods, the user has the ability to choose the way in which the fading Doppler on each path in the 4500 is controlled. There are three possible tracking modes to choose from.

System mode designates that all paths in both channels of the 4500 must have the same Doppler frequency. Paths set to Rayleigh, Rician, Nakagami, or GSM_Rician must have a Doppler frequency equal to the Channel Maximum Doppler (CMD) Frequency. All Frequency Shifted paths must have a Doppler frequency set less than or equal to the CMD frequency. This mode forces both the carrier frequency and the CMD in both channels to be the same. If the Doppler frequency or path velocity is changed on any path in the system, then all other paths will be updated with the new matching rate.

Channel mode forces all paths within a particular channel of the 4500 to have the same fading Doppler frequency. Different carrier frequencies may be maintained on the two channels of the TAS 4500. Doppler frequency changes in Channel 1 will force only the paths present in Channel 1 to be updated.

Path mode allows each path to maintain an independent Doppler frequency. Changes to any particular path will have no effect on the other paths in the system. It should be noted that the two modulation types, Rayleigh with Frequency Shift and Rician with Frequency Shift, are only available when the Fading Doppler Tracking Mode is set to Path mode.

The Fading Doppler Tracking Mode parameter can be found in the CONFIG menu. For further details on setting this parameter see Section 2.4 “Setting the Fading Doppler Tracking Mode.”

4.3.8. I/O Frequency Tracking Mode

The TAS 4500 allows the user to independently set the RF carrier frequency and the Emulation carrier frequency using the I/O Frequency Tracking Mode parameter. The RF carrier frequency represents the actual RF input frequency of the signal a user will put into the 4500. The emulation carrier frequency is used to determine the proper fading Doppler frequency based on the velocity setting for a path.

In the Carrier mode option, both the RF carrier frequency and the emulation frequency will be the same. The two parameters do not need to be independently set in this mode. Both are controlled via the carrier parameter in the Channel menu.

In the I/O_Carrier mode, the emulation carrier frequency is still set via the carrier parameter in the Channel menu. This setting is used only to determine the appropriate Doppler frequency. However, the actual RF carrier frequency (I/O CARRIER FREQ) will be set in the Frequency Tracking Mode submenu.

The EXT BC (4-6 GHz) mode, is available when the 4500 is paired with the TAS5046 External Block Converter. The TAS5046 permits RF Operation of the 4500 in the 4-6 GHz range. When the 4500 is placed in this mode, the Carrier frequency and the emulation frequency are automatically controlled to permit proper mapping of the 4-6 GHz input of the TAS5046 into the 800-2800 MHz input range of the 4500. Note that when you enter this mode the carrier frequency setting will be limited to the 4-6 GHz range.

The I/O Frequency Tracking Mode parameter can be found in the CONFIG menu. For further details on setting this parameter see Section 2.4 “Setting the I/O Frequency Tracking Mode.”

One application of the I/O Frequency Tracking mode would be IF signal testing in a development environment. This mode would allow for signal injection into the TAS 4500 at a user specified IF frequency. At the same time, the unit can be configured to expose the user’s signal to the impairment levels (i.e. the Rayleigh Fading Doppler frequency) that will ultimately be encountered when the RF front end to the transmitter/receiver is present.

4.3.9. Channel Configuration

The TAS 4500 allows the user to dynamically change the channel/path configuration of the unit through the use of the Channel Configuration parameter. By selecting one of the four available configurations, the user is able to allocate the available emulation paths to either one or two RF channels. The default factory installed hardware configuration allows the user to select 1 or 2 RF Channels and 3 or 6 independent emulation paths per channel.

With a factory installed 1 Channel (3 or 6 path) system, the Channel Configuration parameter is not available. All paths are installed and available only in Channel 1.

The default Dual Channel Mode setting provides the user with two independent RF emulation channels with a total of 3 or 6 paths per channel. This was the only mode available in 4500 systems prior to Version 5.10. Dual Channel Mode should be used for applications requiring single channel 3 or 6 path testing. It can also be used for duplex test requirements as shown in the diagram below.

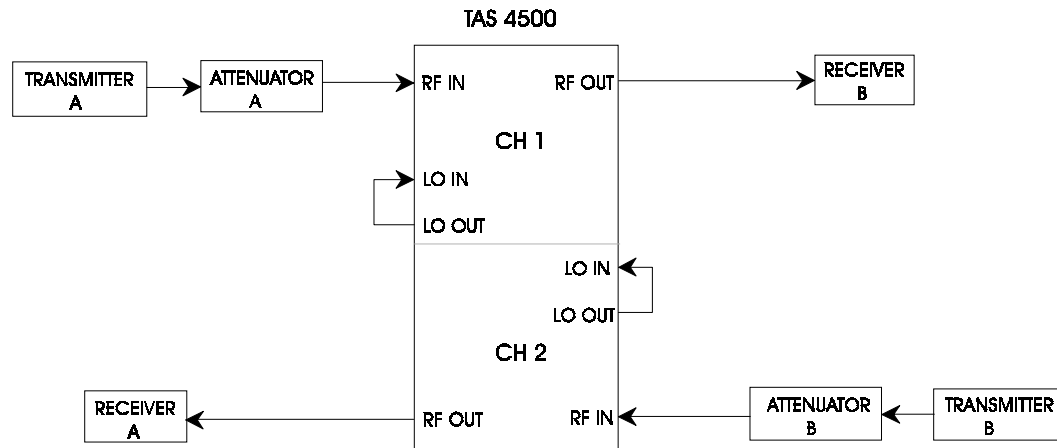


Figure 4-3. Duplex Test Setup - Dual Channel Mode

The two internal 4500 RF channels are completely independent in Dual Channel Mode. The diagram below shows the signal routing for these two channels when the unit is in this mode.

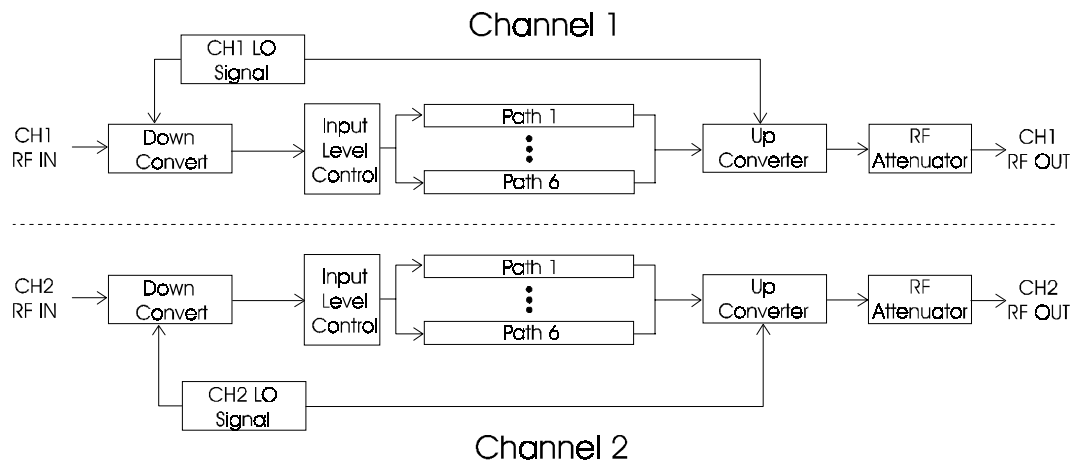


Figure 4-4. 4500 Signal Path - Dual Channel Mode

Single Channel Mode permits the emulation paths installed in Channel 2 to be reallocated and used in Channel 1. A 2 Channel, 6 Path unit (3 paths per RF Channel) would be dynamically reconfigured to provide a 1 Channel, 6 Path emulation channel. Similarly, a 2 Channel, 12 Path unit (6 paths per RF Channel) would be dynamically reconfigured to provide a 1 Channel, 12 Path emulation Channel. In either case, the Channel 1 RF IN/RF OUT and LO IN/LO OUT signals provide the external interface to the new single channel configuration. The Channel 2 front panel connections are not needed. Single Channel Mode should be applied to applications that require 6 or 12 path fading models as shown in the figure below.

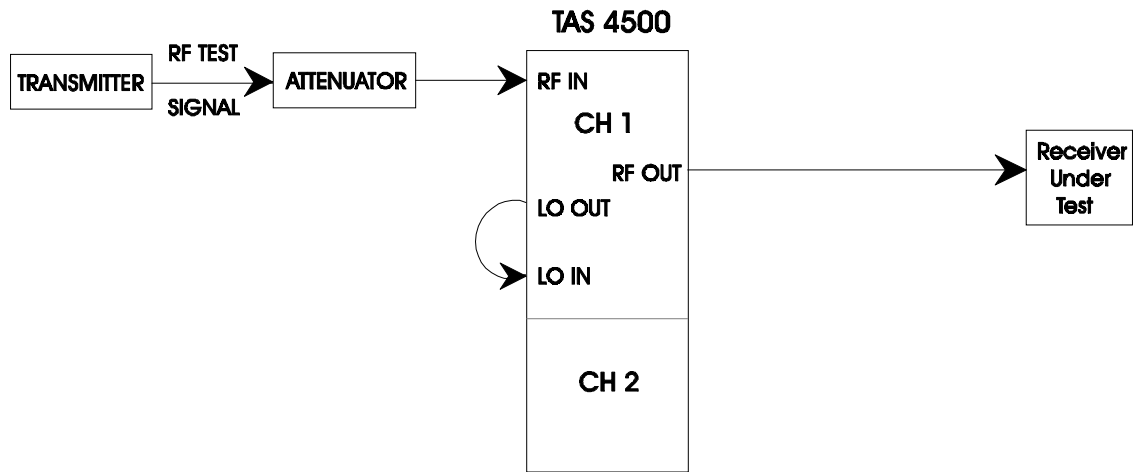


Figure 4-5. Single Channel Test Setup - Single Channel Mode

In Single Channel Mode, the 4500 Channel 1 RF Front End provides the RF Input/Output for all 12 paths. The Channel 2 RF Front End is not used in this case. The diagram below shows the signal routing for these two channels when the unit is in this mode.

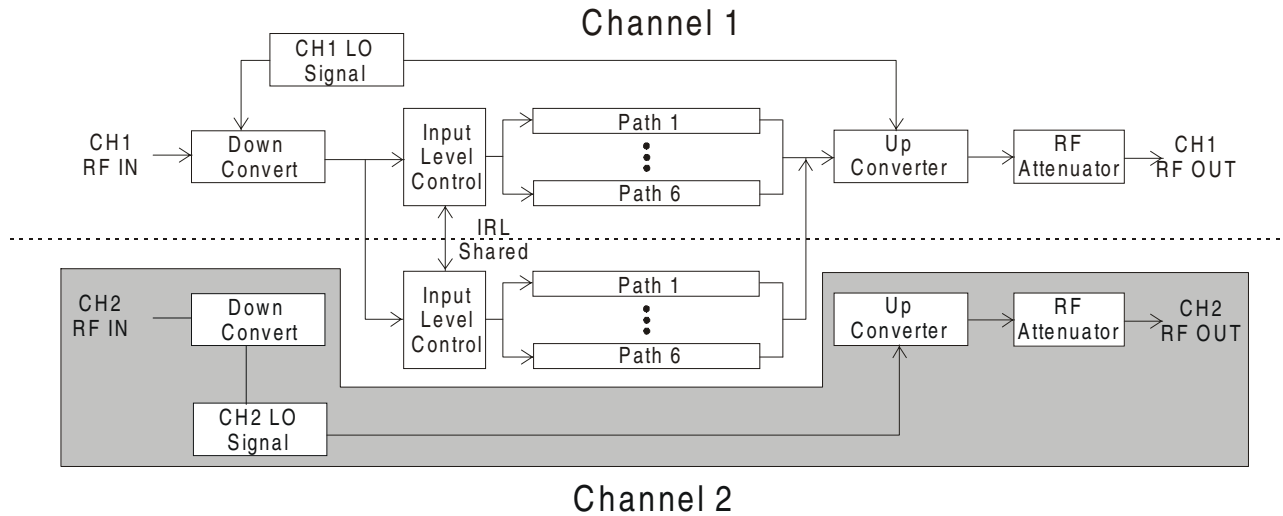


Figure 4-6. 4500 Signal Path - Single Channel Mode

Note: The shaded section of Channel 2 is not used in this configuration.

The 4500 front panel menus are remapped to provide access to all paths from within the Channel 1 submenu. The Channel 2 submenu is unavailable in this case. The Channel 2 Channel Bypass function is also inactive while in Single Channel Mode. The Channel 1 AutoRange function and Input Reference Level value are used to provide input level control for all paths. When operating the unit in Single Channel Mode, the Dynamic Environment Emulation feature and the Smart Antenna feature are not currently supported.

The Diversity Mode setting can be used to simplify the external cabling requirements when multiple system test setups are used. This mode splits the Channel 1 RF Input signal and provides this signal to both Channel 1 and Channel 2 of the unit. However, the internal signal processing and the RF Outputs are maintained as two separate Channels that can then be used as two distinct inputs to a diversity receiver. This is shown in the diagram below.

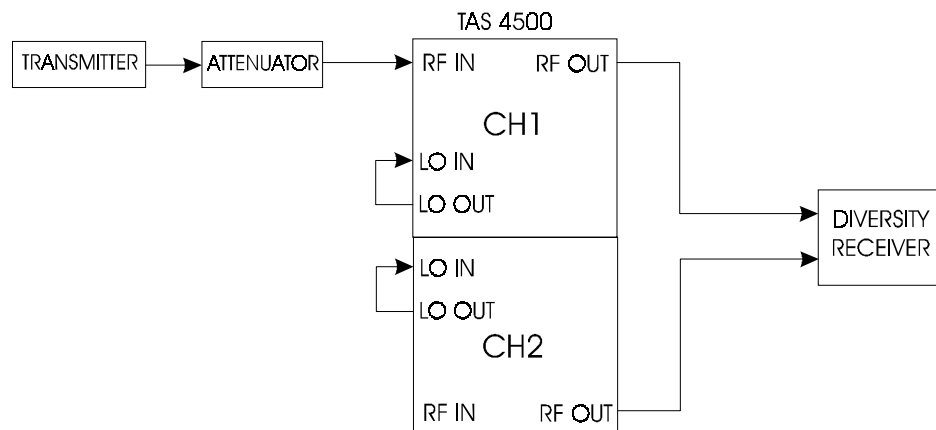


Figure 4-7. Diversity Test Setup - Diversity Mode

In Diversity Mode, the 4500 Channel 1 RF Front End provides the RF Input for all paths. However, the RF Outputs for the 2 Channels are maintained and provided separately. The diagram below shows the signal routing for these two channels when the unit is in this mode.

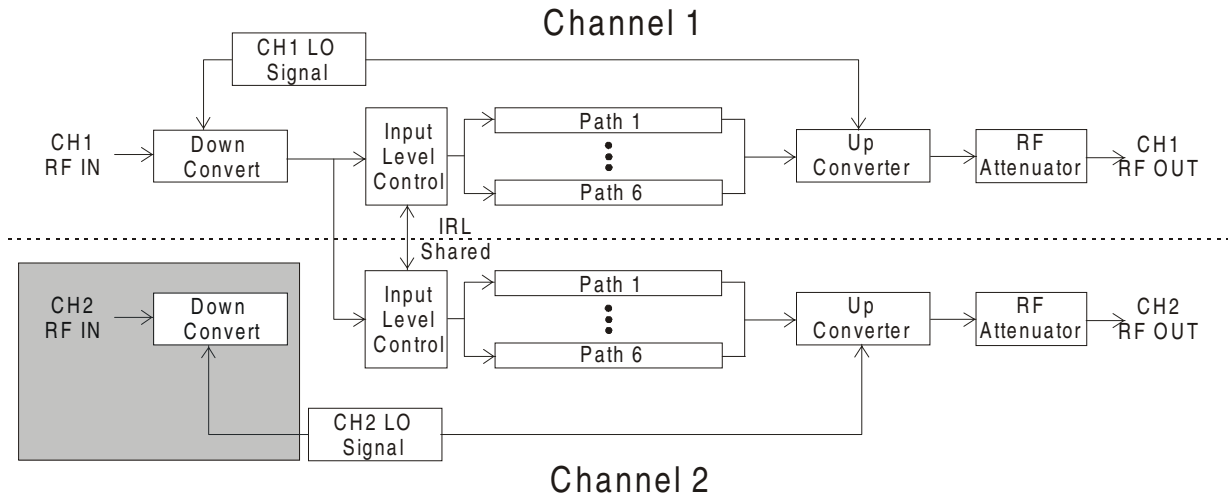


Figure 4-8. 4500 Signal Path - Diversity Mode

Note: The shaded section of Channel 2 is not used in this configuration.

While the Channel 2 RF Input is unused in Diversity Mode, an LO source must still be provided to Channel 2 in order to obtain an RF Output from Channel 2 of the TAS4500. The AutoRange function and Input Reference Level values are shared for both Channels to provide input level control for all paths in this mode.

The Interference Mode setting can be used to internally combine a desired signal with an interference signal inside of a single TAS 4500. Interference mode can only be applied when both signals are present at the same RF Carrier frequency. If the two signals are not located at the same RF frequency, external RF Splitter/Combiner networks must be used to combine the two signals.

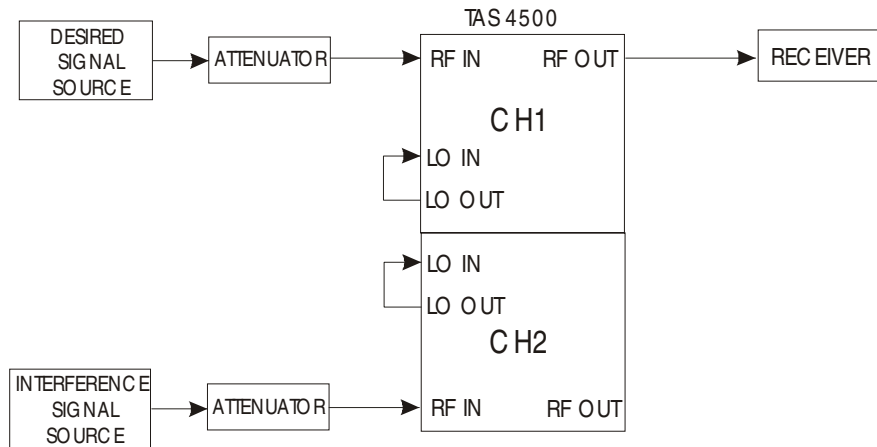


Figure 4-9. Interference Test Setup - Interference Mode

In Interference Mode, both the Channel 1 and Channel 2 RF Inputs are used to provide the Desired Signal and the Interference Signal respectively. However, the RF Outputs for the 2 Channels are combined prior to the Up-Converter and are provided on the Channel 1 RF Output port. The diagram below shows the signal routing for these two Channels when the unit is in this mode.

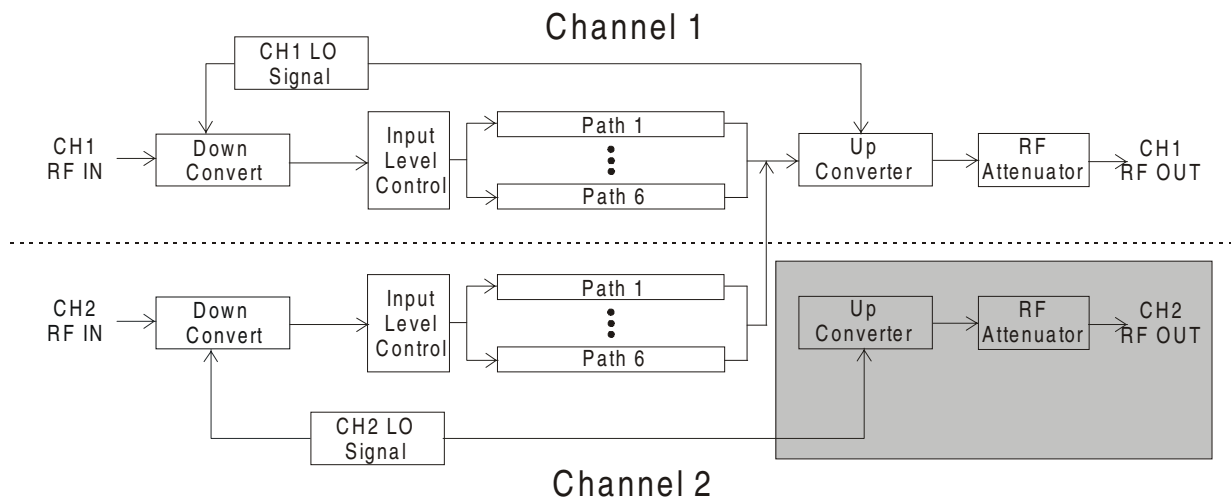


Figure 4-10. 4500 Signal Path – Interference Mode

Note: The shaded section of Channel 2 is not used in this configuration.

While the Channel 2 RF Output is not used in Interference Mode, an LO source must still be provided to Channel 2 in order to obtain an RF Output from the paths in Channel 2 of the TAS 4500. In Interference Mode, the AutoRange function and Input Reference Level values are maintained independently for each Channel to provide independent input level control for the desired signal and the interferer.

There is one additional note on the operation of Interference Mode. In applications that require this Channel Configuration, it is often desirable to provide a significant power difference between the Desired Signal output and the

Interference Signal output. To optimize the dynamic range of the signal processing within the TAS 4500, the Input Level Control for each channel should be optimized using the AutoRange capability. This will result in equal output power from the two channels. Since both Channel outputs are routed through the Channel 1 RF Attenuator, this will prevent the use of the RF Attenuator to offset the Desired Signal power from the Interference Signal power.

In this case, the Path Loss parameter must be applied to all paths in a Channel to set the necessary ratio of Desired Signal power to Interference Signal power. For example, to set a power ratio of 20 dB between Channel 1 and Channel 2, all paths in Channel 2 would be set to 20dB Path Loss while all paths in Channel 1 would be set to 0dB Path Loss.

NOTE: Applications that require a Desired Signal power to Interference Signal power of greater than 30dB must use an external combiner at the output of the TAS4500 and should not use the internal Interference Mode Channel Configuration.

4.4. Input and Output Parameters

In this section the input/output parameters consisting of the control of both the carrier and local oscillator frequencies, the local oscillator mode, and input reference level feature will be discussed. The carrier frequency is the first parameter that must be set for a channel to operate properly. The local oscillator must be set to ensure proper down conversion of the RF signal. The programmable input reference level parameter allows the TAS 4500 to function over a range of input levels.

4.4.1. Carrier Frequency

The carrier frequency parameter is set by the user to the RF input signal frequency. The carrier frequency is set independently for each channel, in a two channel unit. The two channels need not have the same carrier frequency. The carrier frequency must be set to ensure proper calculation of the fading parameters for the channel. Refer to Section 8.0 “Technical Specifications” for the carrier frequency range supported by your model 4500.

4.4.2. Local Oscillator Mode

A local oscillator signal is required for each channel of the 4500 to down convert the RF input signal for IF signal processing, and then to up convert the processed IF signal back to the original RF frequency. The 4500 can be equipped with internal local oscillators eliminating the need for an external signal source. The local oscillator has four possible modes, Internal Auto, Internal Manual, External and External from 4500. When equipped with two local oscillators, these modes are independently available for each channel.

The Internal Auto mode activates the internal synthesizer. In this mode the internal synthesizer is automatically set to the frequency offset required to down/up convert the carrier frequency. When in Internal Auto mode, the 4500 restricts the carrier frequency range that can be programmed to reflect only those frequencies that can be supported by the internal synthesizer. The carrier frequency will not be allowed outside of this range, and an error message will be displayed on the TAS 4500 front panel if an out-of-range value is selected. The local oscillator mode must be changed to External if a carrier frequency is required that resides outside the range supported by the internal local oscillators.

The Internal Manual mode activates the internal synthesizer and the frequency is controlled by the user. In this mode, the range of the carrier frequency is not limited by the internal synthesizer range. This allows the user the flexibility to manually program the frequency of the local oscillator for use in other lab applications. Special care must be taken when manually programming the local oscillator to down convert the RF input signal to the IF signal required by the 4500. The synthesizer's frequency must be chosen to provide the proper

frequency offset from the desired carrier frequency. Refer to Section 2.4 “Viewing the System Summary” for information on determining how your 4500 is equipped and Section 8.0 “Technical Specifications” for the required LO frequency and level.

The External local oscillator mode disables the internal synthesizer if installed. When this mode is selected, an externally-generated local oscillator signal must be provided by the user. The local oscillator must be set to provide the required frequency offset from the carrier frequency for proper down conversion of the RF input signal. Refer to Section 2.4 “Viewing the System Summary” for information on determining how your 4500 is equipped and Section 8.0 “Technical Specifications” for the required LO frequency and level.

The fourth mode, External from 4500 should be set when An LO signal is being supplied from another channel of a 4500. The LO signal can be from the other channel in the same unit or from a different 4500 unit. The internal LOs in a 4500 can be set either above or below the carrier frequency in order to maximize their range of coverage. In External from 4500 mode, the channel relies on the carrier frequency set in the channel to correctly determine the location of the LO signal, either above or below the carrier. The 4500 will automatically compensate for any inversion that takes place in the up/down converter due to the LO frequency.

4.4.3. Local Oscillator Frequency

The local oscillator frequency must be provided to the LO IN connector on the TAS 4500 front panel for each channel in use. The signal can be provided by either an internal local oscillator (if equipped) or an external signal source. In either case, the local oscillator is used to down convert the RF input signal to an acceptable IF frequency for signal processing. The local oscillator must be set to provide the required frequency offset from the carrier frequency for proper down conversion of the RF input signal. Refer to Section 8.0 “Technical Specifications” or the required LO frequency and level.

4.4.4. Input Reference Level & Autorange

The input reference level parameter allows the level of the RF input signal to be programmed in 0.1 dBm steps over a range defined in Section 8.0 “Technical Specifications” for your system. Using this parameter, the input level circuitry adds a fixed amount of gain to adjust the peak level of RF input signal for optimal performance of the TAS 4500. Note that the input power setting corresponds to the optimum performance for a sine wave at 900 MHz, which has a peak-to-average ratio of 3 dB. If the peak-to-average ratio of the RF input waveform is not 3 dB, the power level of the input signal will not directly match that of the optimal input level setting. To maximize the performance of the TAS 4500, the input level parameter should be used to make the peak level as large as possible *without* overloading the channel. If the input reference level parameter is set too low, or the RF input signal is too large, the overload LED for the corresponding channel will light. The input reference level setting should be increased or the RF signal reduced, until the LED goes off.

The amount of input gain placed on the down converted signal can be optimized by the Autorange. Selecting the AUTORANGE button on the TAS 4500 front panel will initiate an automatic input range. The input gain will be increased until the signal level overloads the TAS 4500 internal processing, and then the input gain will be decreased approximately 2 - 4 dB. It is recommended that the automatic input range be used each time a new input signal is presented to the TAS 4500.

Manual configuration of the Input Reference Level is recommended for applications with wideband or noise-like transmit signals. This will provide the most accurate and repeatable setting for the Input Reference Level parameter. The following procedure illustrates how to manually set the Input Reference Level parameter for the transmit signal present at either RF input of the TAS 4500.

1. Begin by setting the desired channel's Input Reference Level to its maximum value. Refer to Section 8.0 “Technical Specifications” for the maximum value for your system configuration.
2. Check the overload LED for the RF channel being configured. If the overload LED is already illuminated, the input level to the TAS 4500 is too high and must be lowered using an appropriate external attenuator.
3. Otherwise, monitor the overload LED and step the Input Reference Level down in 1 dB steps until the LED is illuminated.
4. If the minimum Input Reference Level, refer to Section 8.0 “Technical Specifications”, is reached before the LED becomes illuminated, the transmit signal level may be too low to optimize the dynamic range of the input level circuitry.

NOTE: Under many circumstances the TAS 4500 will continue to provide accurate emulation characteristics for signals less than the minimum Input Reference Level. However, it should be noted that for each dB that the input signal is less than the minimum Input Reference Level the optional dynamic range of the transmission channel will be reduced by an equal amount. To achieve the maximum dynamic range with very low transmit levels an external amplifier may be required.

5. After reaching the overload condition, step the Input Reference Level up by 3 dB. This creates approximately 3 dB headroom for the input circuitry of the TAS 4500 and helps to insure that the peaks of the transmit signal will not be clipped.

When changing the Channel Configuration parameter to the single channel or diversity modes, the Input Reference Level and AutoRange functions are maintained between channels.

4.4.5. Output Attenuator (Optional)

The TAS 4500 can be equipped with an RF output attenuator on a per channel basis. This output attenuator can be used to precisely set the output level of the RF channel over a wide range of levels. Refer to Section 8.0 “Technical Specifications” for the attenuator options that are available. The functionality of the Output Attenuator differs from that of Path Loss when multiple paths in a channel are enabled simultaneously. When multiple paths are used, the Path Loss settings are programmed on a per path basis to set the level of one path relative to another within the same channel.

The purpose of the Output Attenuator is to adjust the level of the composite channel after the paths have been summed together at the output of the emulation channel. Since this programmable attenuator is placed after the final up conversion it affects all signals, desired and spurious, equally. By doing so, the margin, or ratio between the desired carrier signal and any parasitic signals introduced by the up conversion is held constant regardless of the amount of loss introduced by the RF attenuator. This feature is especially important in order to maintain the channel’s spectral purity when using a large amount of attenuation.

4.4.6. LO Feed-through and RF Image Suppression (Optional)

The TAS 4500 can be equipped with a bandpass filter at the RF output used to suppress the LO feed-through and RF image signals present from the signal up conversion. This feature is available on a per channel basis. Refer to Section 8.0 “Technical Specifications” for the suppression options that are available. The filter will suppress the RF image signal, 280 MHz away from the desired output, and the LO feed-through signal, 140 MHz away from the desired output. This feature is especially important when the users receiver is not capable of filtering out of band RF signals.

4.4.7. RF Channel Bypass (Optional)

The TAS 4500 can be equipped with RF switches which are used to bypass the RF Front End and IF Signal Processing functions of the TAS 4500. The switches provide a direct signal path from RF IN to RF OUT to avoid the inherent insertion loss of the RF emulation channel. This feature is designed primarily for use in an automated test scenario where the fading emulation capability of the TAS 4500 is not required in all tests. In this case, the RF Channel may be bypassed during those tests which do not require fading emulation to avoid the insertion loss of the emulator.

4.4.8. IF Breakout (Optional)

The TAS 4500 can be equipped with SMA cable connections on the rear panel of the unit which provide access to the 140 MHz IF point in the 4500 Up Converter signal path. This option would permit the user to add additional impairments such as AWGN into the faded signal path prior to the final RF Up Conversion stage. The diagram below shows one possible application of the IF Breakout.

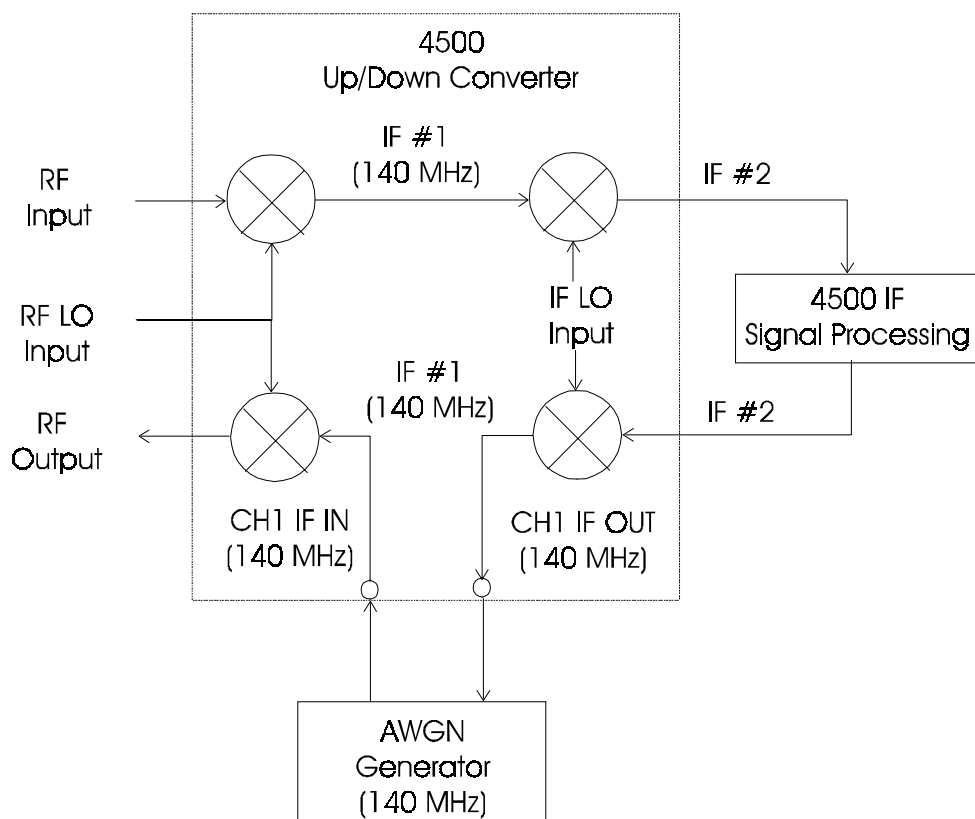


Figure 4-11. 4500 IF Breakout Application

Notice from the above diagram that the 140 MHz access is only available in the Up Convert signal path. The user interface to the unit is still via the RF IN/ RF OUT ports on the unit. The diagram also shows that the access point is provided after all of the 4500 impairments have been introduced. The main advantage of the IF Breakout Option is that by providing a single common frequency for additional impairment generation (i.e. adding AWGN for C/N control), the user can obtain RF signal impairments over the entire RF Output range of the TAS 4500. Please see Section 8 “Technical Specifications” to determine the RF Frequency range supported by a particular unit configuration.

Additional information and specifications on the use of this option is currently available in a TAS Application Note.

4.5. Path Characteristic Parameters

In this section, the theory and implementation associated with the TAS 4500's emulation of the path characteristics will be discussed. A block diagram of the TAS 4500 is shown in Figure 4-12. Using these blocks, parameters for the following path characteristics can be simulated in the TAS 4500:

- Relative Path Delay
- Path Modulation: Rayleigh, Frequency Shift, Phase Shift, Rician, Nakagami, Rayleigh Fading with Frequency Shift, and Rician with Frequency Shift
- Relative Path Loss
- Log-Normal Fading

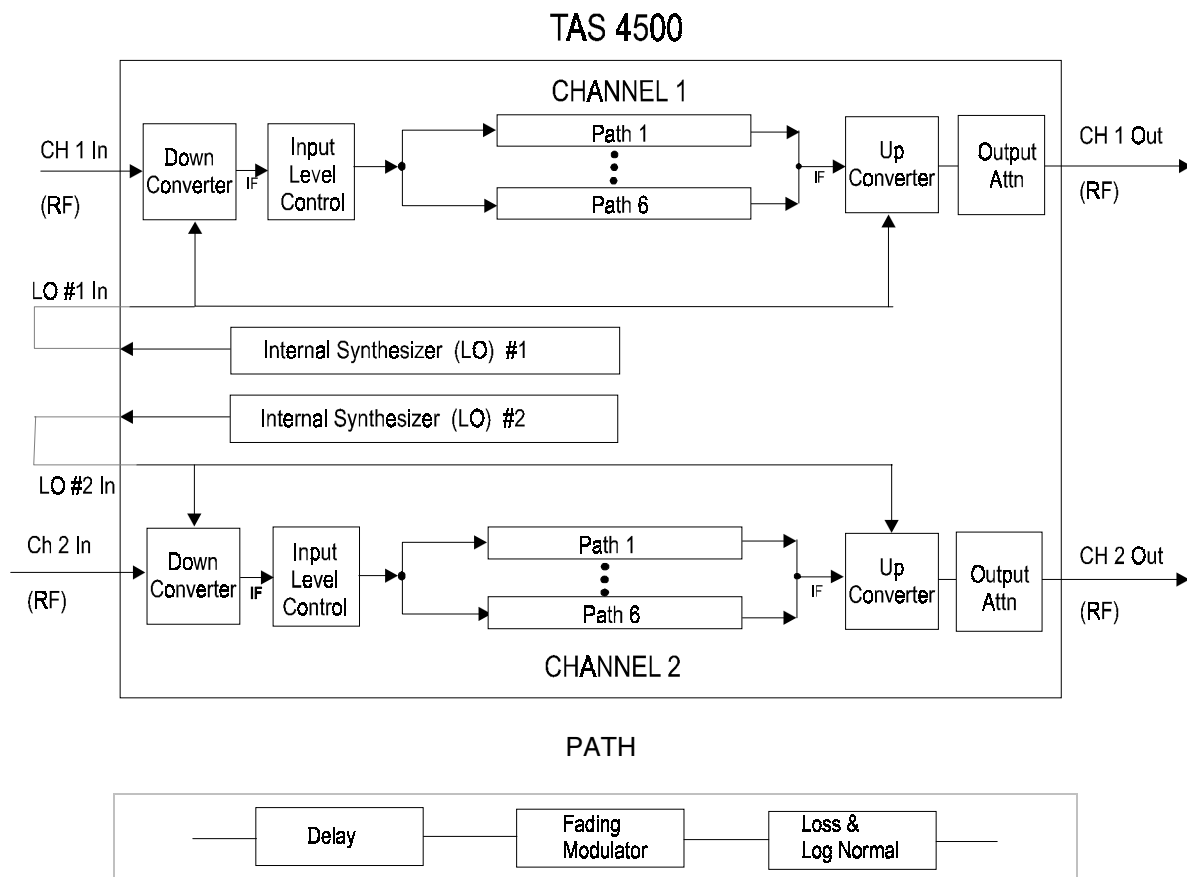


Figure 4-12. TAS 4500 Block Diagram

4.5.1. Path On/Off Status

Each channel in the TAS 4500 is comprised of three or six individual paths. Each path is capable of simulating all of the characteristics listed in Section 4.3. Each of the paths may be independently turned on or off. For a signal to pass through the channel, at least one of the available paths must be turned on. The Path On/Off status is controlled in the CHANNEL menu.

4.5.2. Relative Path Delay

Relative path delay is a phenomenon where individual signal paths from the transmitter to the receiver arrive at different times. An example of this is shown in Figure 4-13 between Paths (A) and (C). Path (C) will arrive at the receiver (the automobile) a finite time after signal Path (A). The net effect of the arrival time difference is to spread the signal in time. In a digital system this will cause received symbols to overlap resulting in inter-symbol interference.

The amount of relative path delay varies with terrain and application. In an indoor application, delays could be in the 10's of nanoseconds (ns), where 10 ns is about 10 feet. In outdoor applications, delays of 10 microseconds (μs) or less are typical (1 μs is about 1000 feet). Delays greater than 50 μs are rare in cellular environments. Consult the Section 8.0 "Technical Specifications" for the resolution and range of the relative path delay offered in your model TAS 4500

The relative path delay is implemented in the TAS 4500 by digital delay devices. Path clocks in the TAS 4500 are synchronized so that an accurate delay between paths is possible. The synchronization includes paths within a single channel, paths between two channels and paths between two TAS 4500's (when connected in the 12 path model).

Path delay in the TAS4500 is set relative to the 0.0000 μsec delay setting for each path. This delay setting does not reflect a desired electrical delay through the system. It only allows for relative delay offsets between paths.

4.5.3. Relative Path Loss

Relative path loss is a phenomenon where individual signal paths arriving at the receiver are at different absolute power levels. The difference in power levels between paths is caused by the physical obstructions in the signal path. Referring to Paths (A) and (C) in Figure 4-13, Path (C) will arrive at a lower power level than Path (A). This occurs since some amount of the power in signal Path (C) is lost when it reflects off the truck. Signal strength will also vary due to the distance the signal travels. The loss of signal strength should follow the $1/d^2$ law, where d is the distance between the transmitter and the receiver. In the actual cellular environment the loss is much worse, (between $1/d^3$ to $1/d^6$), due mainly to variations in the terrain.

The TAS 4500 is capable of path losses that far exceed any testing specs, most of which do not call for relative path losses to be greater than 20 dB. If a large amount of loss is needed on the entire channel, the internal Output Attenuator should be used.

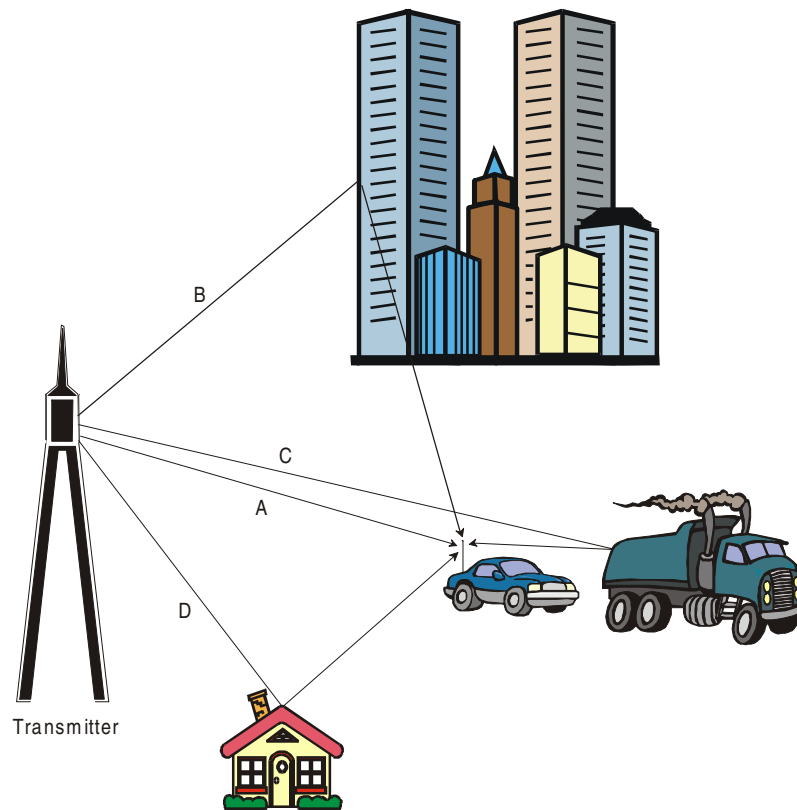


Figure 4-13. Transmitter to Receiver Signal Diagram

4.5.4. Path Modulation Type

Several different modulation types are supported by the TAS 4500 including Rayleigh fading, static frequency (Doppler) shift, static phase shift, Rician, Nakagami and Rayleigh Fading with Frequency Shift. All five of these modulation types are implemented using the same functional hardware block in the TAS 4500. There is one modulator per path in the TAS 4500.

The fading modulator hardware block consists of a 90° phase split filter, an in-phase and quadrature-phase modulator, and a summer as shown in Figure 4-14. The IF signal is phase split to produce an I and Q signal. The individual I and Q signals are then modulated with the selected type of modulation waveform. Finally, the I and Q signals are summed together.

The modulation waveforms are produced digitally. Therefore, all of the selectable modulation types can be generated using the same hardware.

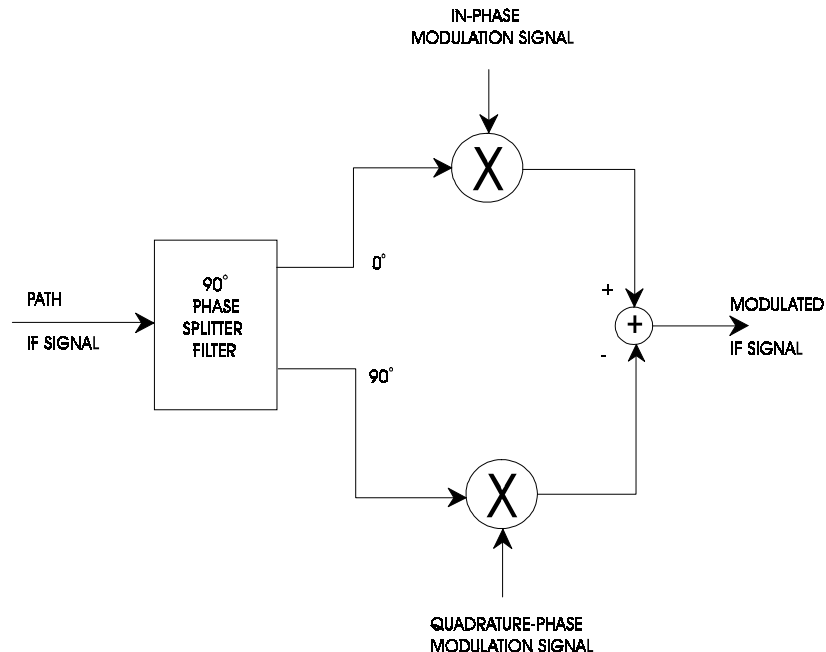


Figure 4-14. Path Modulator Block Diagram

4.5.5. Rayleigh Modulation

Rayleigh modulation is commonly referred to as fast fading. A Rayleigh modulated signal is caused by scattering from man-made and natural obstacles such as buildings and trees in the local geographical area (within a few hundred wavelengths of the receiver). It is formed by a large number of these scattered (reflected) signals combining at the receiver. Each of these signals has a random phase and amplitude at the receiver due to the reflections and difference in distance traveled.

The phenomenon that creates Rayleigh fading can be easily illustrated using a simple two path example. At the receiver the two paths can be of any amplitude and phase. If the two paths are of the same amplitude, and their phase is 180° apart, there will be total destructive interference and there will be no resultant signal. If the two signal paths are 0° apart in phase there will be constructive interference and the signal envelope will be 3 dB larger than the individual path's amplitudes.

The signals rarely combine to greater than 10 dB above the individual path's power. The deep fades (destructive interference) would range from just a few dB to fades of greater than 50 dB. The spacing and amplitude of the fades are a function of the carrier frequency. At 900 MHz the deep fades will occur at the mobile every few centimeters apart.

The fades and peaks of the signal envelope follow a Rayleigh distribution. This causes the signal strength to fluctuate rapidly between slightly higher levels to deep fades of greater than 50 dB. Figure 4-15 shows an example of the Rayleigh faded signal versus time. Rayleigh fading is called fast fading since the fluctuations are so rapid, as compared to log-normal or slow fading.

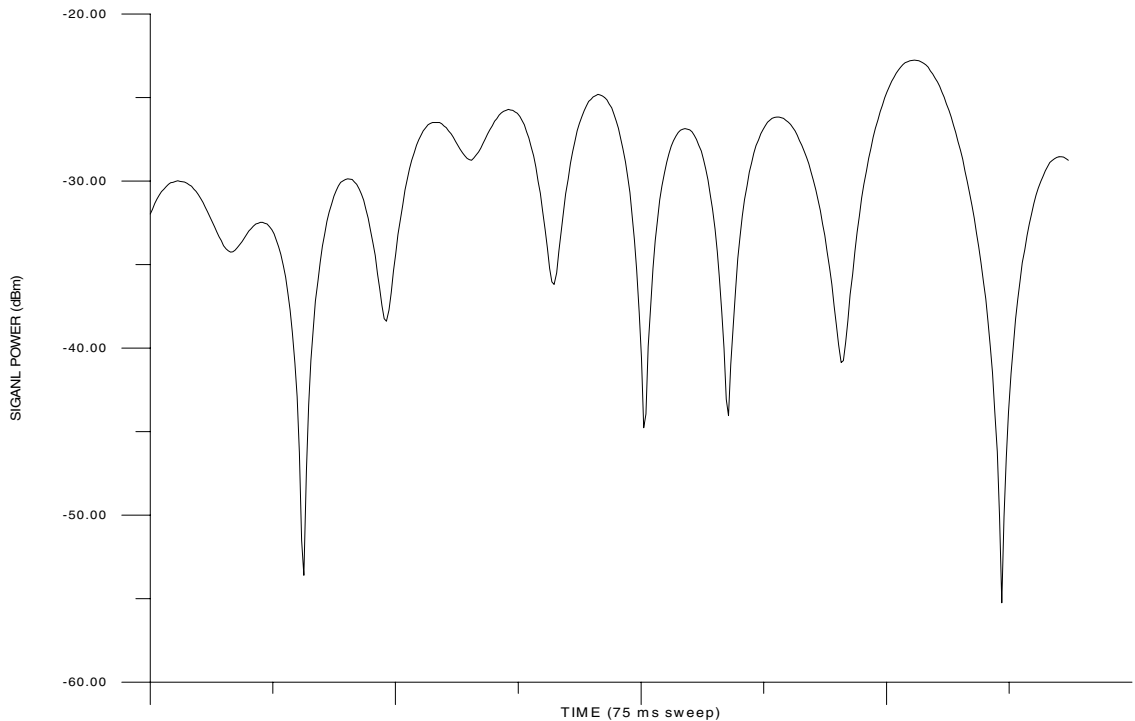


Figure 4-15. Rayleigh Faded Signal vs. Time

Doppler Freq. = 100 Hz
 Center Freq. = 900 MHz
 Span = 0 Hz
 RBW = 100 kHz
 Sweep Time = 75 msec

The Rayleigh distribution is generated using an I/Q modulator. The I/Q signals are modulated with two Gaussian distributed signals. Since Rayleigh fading occurs when there is relative movement between the transmitter and receiver, the signal is subjected to a Doppler shift (frequency shift). As a result the spectrum of Rayleigh fading is limited to plus or minus the Doppler frequency (which is a function of the vehicle velocity) assuming that there is an equal probability that the signal is received with an arrival angle anywhere within the range from 0 to 360 degrees. The theoretical power spectral density of a Rayleigh faded signal is shown in Figure 4-16. Also shown, in Figure 4-17, is the measured power spectral density from a TAS 4500.

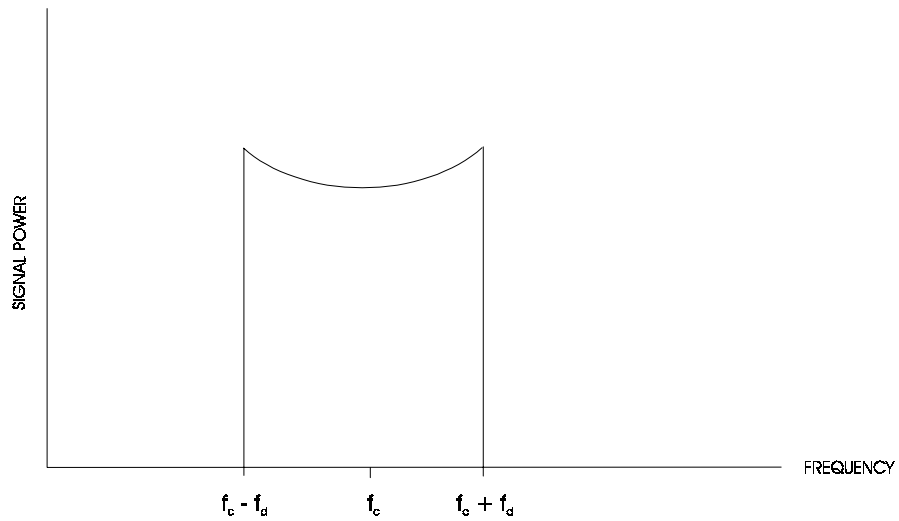


Figure 4-16. Theoretical Rayleigh Power Spectral Density

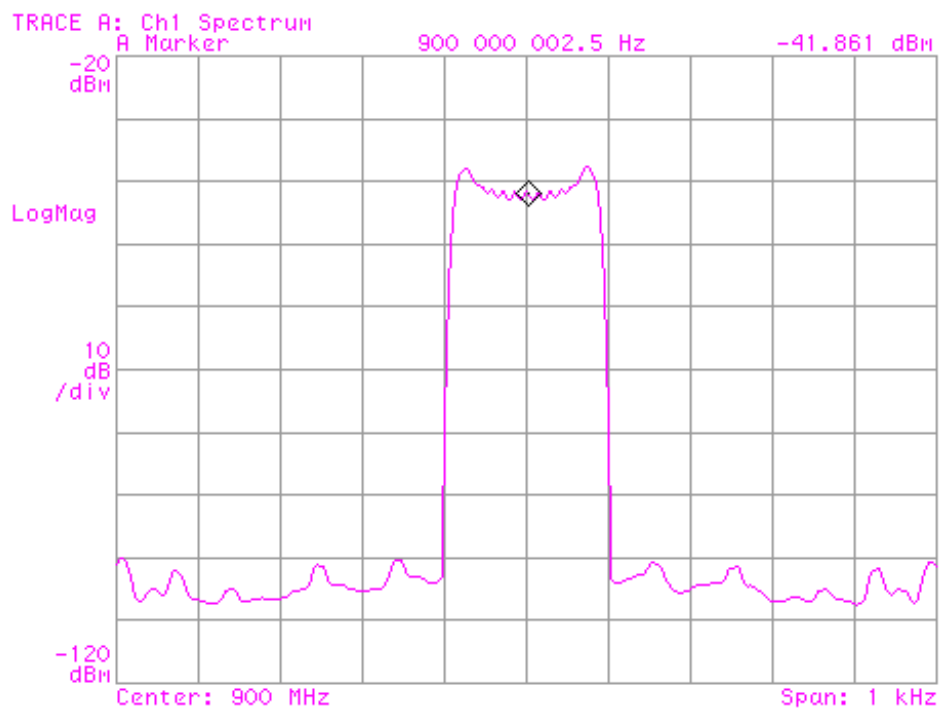


Figure 4-17. Measured Rayleigh Power Spectral Density

Doppler Freq. = 80 Hz
 Center Freq. = 900 MHz
 Span = 1 kHz
 RBW = 10 Hz
 Sweep Time 30 sec
 Emulation Method = Jakes

To evaluate the performance of Rayleigh fading implemented in the TAS 4500, it must be compared to a defined standard to ensure consistent performance. A set of standard performance criteria can be found in the EIA/TIA IS-137/138 and IS-97/98 documents. The primary performance criteria that are used to evaluate Rayleigh fading are the Cumulative Probability Distribution Function (CPDF) and the Level Crossing Rate (LCR). The specifications state that an unmodulated carrier with Rayleigh fading should meet the following performance:

1. The measured Rayleigh (CPDF) should match the calculated CPDF using the following criterion:
 - a) The measured CPDF of power shall be within ± 1 dB of the calculated CPDF from +10 dB above the mean power to 20 dB below the mean power.
 - b) The measured CPDF of power shall be within ± 5 dB of the calculated CPDF from 20 dB to 30 dB below the mean power.
2. The measured LCR should match the calculated LCR, and not deviate more than $\pm 10\%$ of the simulated vehicle speed over a range of 3 dB above the mean power level to 30 dB below the mean power level.

The theoretical and measured CPDF are shown in Figure 4-18. This plot is the probability of a signal level being less than the mean level. The LCR plots, shown in Figure 4-19, are the number of crossings per second versus the signal power. In both of these plots the signal power is relative to the mean. The CPDF and LCR were taken with an 80 Hz Doppler frequency. Both of these plots show that the measured performance of the TAS 4500 well exceeds the above standards for Rayleigh fading.

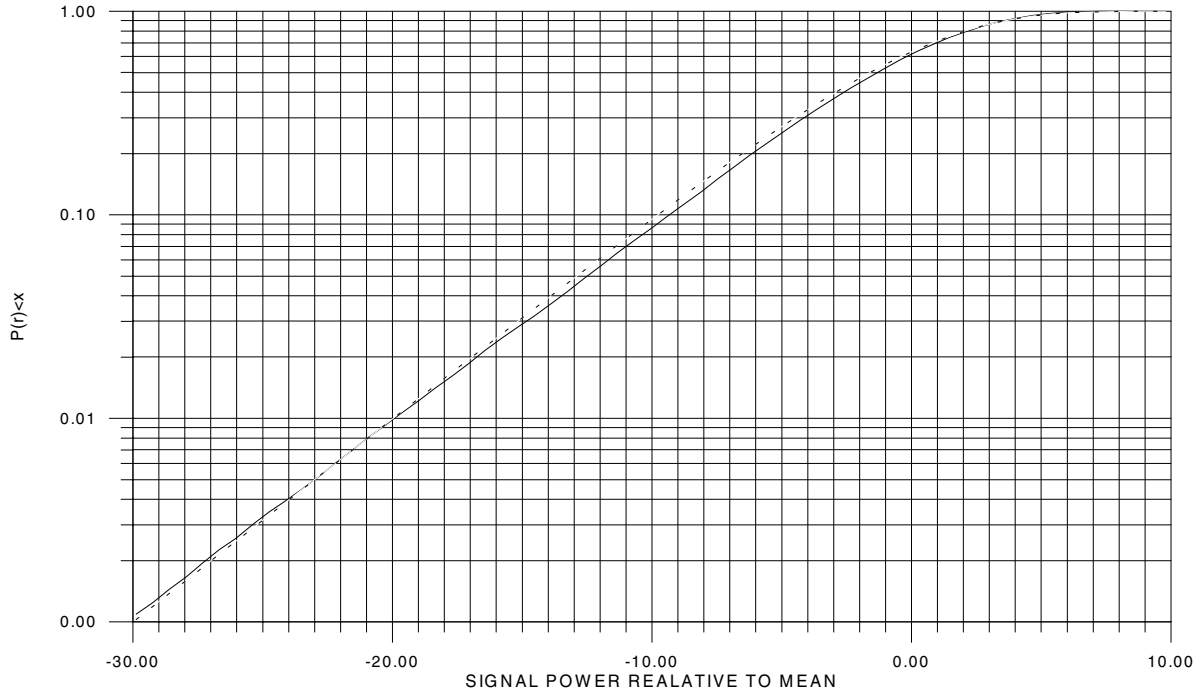


Figure 4-18. Measured vs. Theoretical CPDF

— Measured
 - - - Theoretical

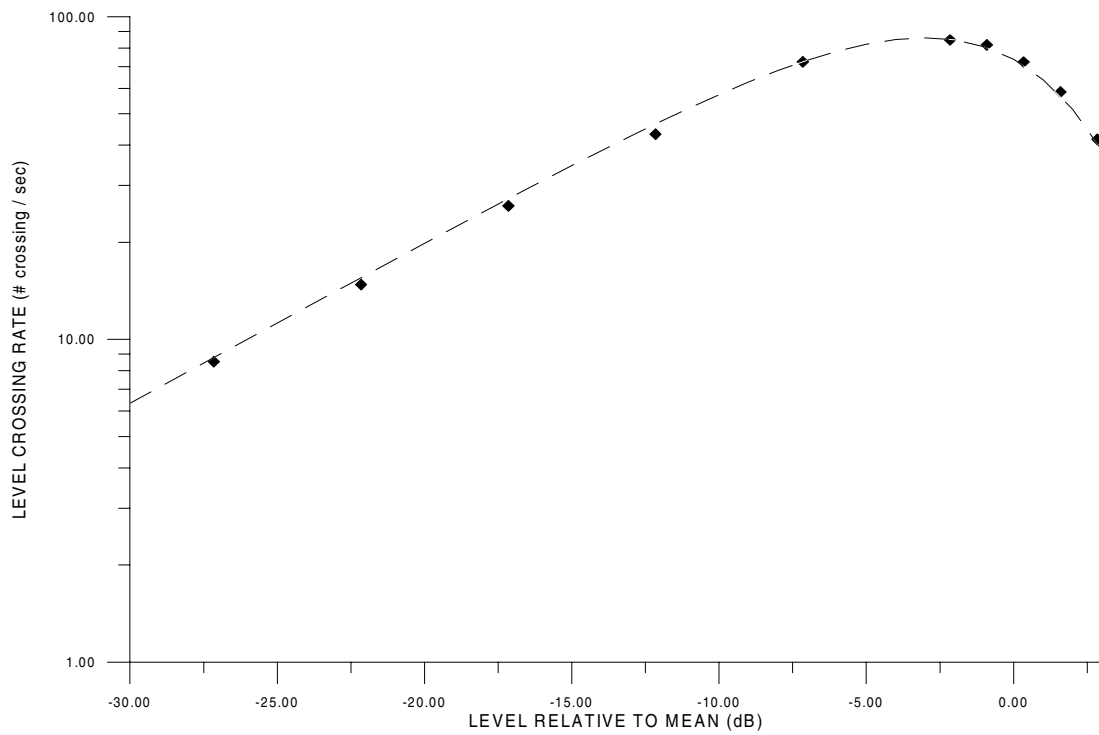


Figure 4-19. Measured vs. Theoretical LCR

◆ ◆ ◆ ◆ Measured
 - - - Theoretical

4.5.6. Fading Power Spectrum

The TAS 4500 allows the user to select the shape of the power spectrum produced by multipath fading. The four possible spectrum shapes that can be set are shown in Figure 4-20. The first shape, Classical 6 dB, adheres to the spectral requirements detailed in the IS137/138 (TDMA North American Dual-Mode Cellular) and IS97/98 (CDMA North American Dual Model Cellular) test specifications for Rayleigh fading conditions. The Flat spectrum shape has been determined to be representative of the multi-path propagation effects experienced in some indoor applications. The Classical 3 dB and Rounded spectrum shapes are available in the TAS 4500.

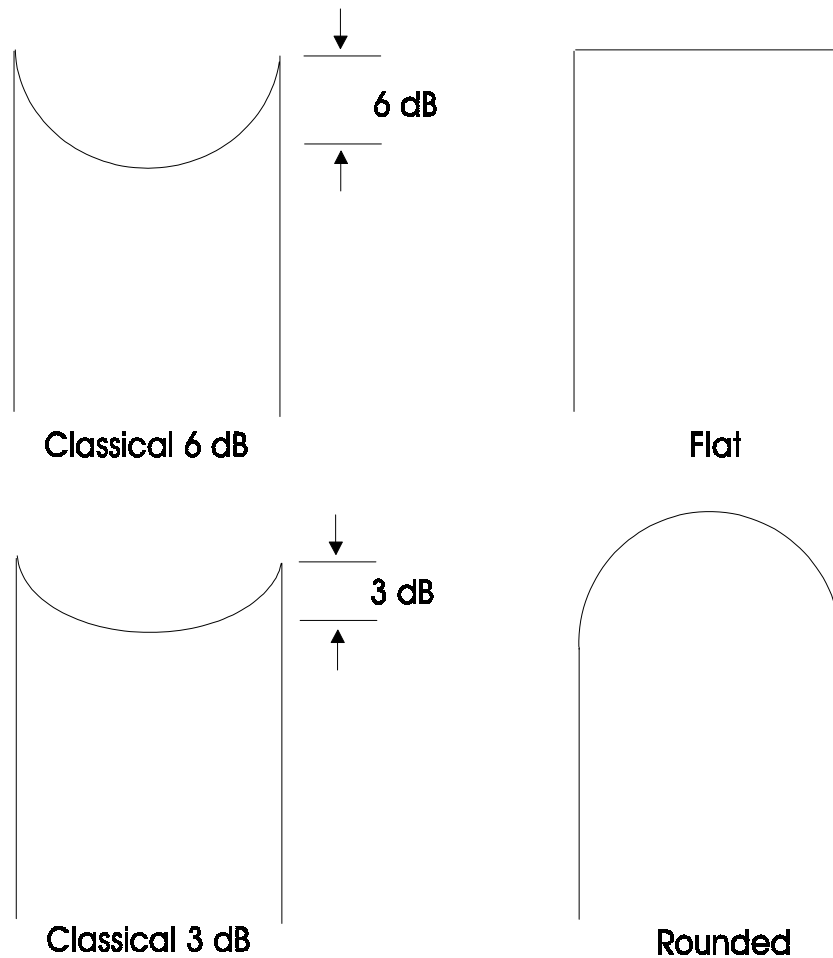


Figure 4-20. Fading Power Spectrum Shape

The Classical 6 dB and Flat shapes are available when in Jakes Emulation Mode. All four shapes are available when in filtered noise Emulation Mode. The fading power spectrum is set locally in the channel modulation submenus. For further details on setting this parameter see Section 2.6.5 “Selecting the Fading Power Spectrum Shape.”

4.5.7. Correlation Between Rayleigh-Faded Paths in Different Channels

The test channel for diversity applications requires programmable correlation between Rayleigh faded paths in different branches (channels). Each channel of the 4500 represents a branch of a diversity test channel. As a result one 4500 unit supports dual diversity test applications, two 4500 units support either triple or quadruple diversity applications, and four 4500 units support eight branch diversity applications. The TAS 4500 allows the user to program the correlation factor (coefficient) between two Rayleigh faded paths in different channels. The correlation factor is a measure of the similarity between the two paths' output waveforms. Diversity receiver schemes often use the lack of perfect correlation between multipath signals to help resolve the original transmit signal.

The amplitude characteristics of a path using Rayleigh modulation can be described as a random variable with a Rayleigh distribution. For example if CH1 is the random variable that represents the amplitude characteristics of Channel 1 Path 1, and CH2 is the random variable that represents the amplitude characteristics of Channel 2 Path 1, the correlation coefficient, r , that defines the relationship between Channel 1 and Channel 2 is given below:

$$r = \frac{C_{CH1CH2}}{\sigma_{CH1}\sigma_{CH2}}$$

Where C_{CH1CH2} is the covariance, and σ_{CH1} and σ_{CH2} are the standard deviations of CH1 and CH2. A correlation factor of 1.00 between Channel 1 Path 1 and Channel 2 Path 1 means that the two paths fade in harmony with each other. While a correlation factor of 0.00 indicates the paths fade independently. Correlation factors that fall between the extremes of 0.00 and 1.00, describe the degree of the relationship between the output signal amplitudes of the two paths at any instant in time.

The correlation factor between liked numbered paths in Channel 1 and Channel 2 can be programmed from 0.00 to 1.00 in 0.01 steps as described in Section 2.6 "Setting Rayleigh Fading Correlation." A correlation factor of 1.00 between a given pair of paths means that the two paths fade in harmony with each other. While a correlation factor of 0.00 indicates the paths fade independently. Correlation factors that fall between the extremes of 0.00 and 1.00, describe the degree of the relationship between the output signal amplitudes of the two paths at any instant in time.

Phase Offset Related to Diversity Applications

Phase misalignment between correlated signals may introduce measurement errors. Many diversity receivers compensate for phase offset but some types of receivers or measurement techniques may not do this compensation.

Two common causes of phase offset are:

- Non-symmetrical measurement setups
- Small propagation delay differences between channels

If the test setup is not symmetric (balanced) such as in the case where the signals being measured pass through different length cables, a phase offset (shift) will be created. At 1.8 GHz, the wavelength is only 16.67 cm, so that a small difference in cable length has a significant effect on the phase. This phase offset may prevent some measurement techniques from obtaining consistent and accurate measurement results.

A phase offset is also caused by a difference in propagation delay between the channels (branches). The propagation delay between channels of the 4500 FLEX may not be identical. The resulting phase shift may prevent some measurement techniques from obtaining consistent and accurate results.

One method for compensating for phase offset before performing correlation measurements is as follows:

1. Set correlation between channels to 1.00.
2. Observe the down converted signals using two channels of a storage oscilloscope.
3. If channel 1 signal is not aligned with channel 2 signal, adjust the Path Delay within each channel in the TAS 4500 FLEX until they are aligned on the oscilloscope.

Correlation Coefficient Algorithm

The TAS 4500 allows the user to set the algorithm used to determine the correlation coefficient. The correlation algorithm can be set in two modes, envelope and component. Figure 4-19 shows a TAS 4500 providing the inputs to a 2 branch diversity receiver. Inside the diversity receiver the signals are quadrature demodulated. With the correlation algorithm set to envelope, the correlation coefficient is a measure of the correlation between the signals at points A and B in the diversity receiver. This is the standard definition of correlation, and is the default setting for the TAS 4500. When the correlation algorithm is set to component, the correlation coefficient is a measure of the correlation between signals at points A_I and B_I in addition to the correlation between points A_Q and B_Q . In this setting the correlation coefficient defines the correlation between the In-Phase components of the associated Rayleigh faded signals in addition to the correlation between the Quadrature components.

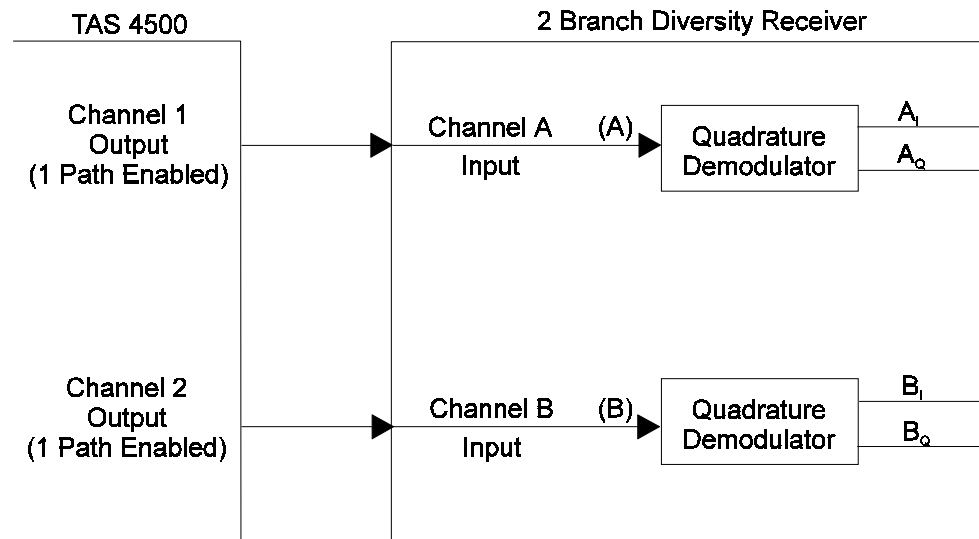


Figure 4-21. 2 Branch Diversity Receiver with Demodulator

4.5.8. Path Correlation for 2 Branch Diversity Test Applications

The correlation factor between liked numbered paths in Channel 1 and Channel 2 can be programmed from 0.00 to 1.00 in 0.01 steps. This can be done from the front panel as described in Section 2.6 or with the remote control command set as described in Section 6.3.

The following is a list of helpful tips that should be considered when using the 4500 in a 2 branch diversity test application.

1. The CHANNEL CORR (CNFG:CHCORR) parameter must be set to TYPE1.
2. The correlation factor (coefficient) is programmable between specific pairs of paths; one path in channel 1 and one path in channel 2 as follows:

- Path 1 in channel 1 to Path 1 in channel 2
- Path 2 in channel 1 to Path 2 in channel 2
- Path 3 in channel 1 to Path 3 in channel 2
- Path 4 in channel 1 to Path 4 in channel 2 (if installed)
- Path 5 in channel 1 to Path 5 in channel 2 (if installed)
- Path 6 in channel 1 to Path 6 in channel 2 (if installed)

Paths should be enabled as a pair as defined above, a path from channel 1 and the associated path from channel 2. **Path loss and path delay for each path in a pair should be set to equivalent values.** For example, if path 1 is enabled in channel 1 with a path loss of 6 dB and a delay of 5 microseconds and path 2 is enabled with a path loss of 8 dB and a delay of 9 microseconds then paths 1 and 2 should be enabled in channel 2 with the same path loss and delay settings as paths 1 and 2 of channel 1.

3. All active (enabled) paths in channel 1 and in channel 2 must be programmed to Rayleigh modulation with the Doppler frequency set to the same value. Programmable correlation is undefined for other modulation types.
4. The input reference level, and the output attenuation should be set to equivalent levels to align the average output power from both channels to be the same. Typically the most convenient method to configure the input reference level is to perform an autorange after the transmit signal is present at the RF IN ports of the TAS 4500.
5. The correlation factor (coefficient) should be programmed to zero (0.00) to disable channel correlation.

It is recommended that you allow the TAS 4500 unit to warm up for at least thirty minutes before beginning any tests.

4.5.9. Path Correlation for 4 Branch Diversity Test Applications

TAS 4500 units are equipped with a factory installed 4 Branch Diversity feature that can provide comprehensive control of the correlation factor (coefficient) between paths in up to four channels. Two 4500 units (a primary unit provides channels 1 and 2, while a secondary unit provides channel 3 and 4) used in conjunction with the TASKIT/4500 software provide up to six programmable Correlation Coefficients (CC). These coefficients apply to the entire channel (branch) and will affect all the paths that are enabled within the channel. The table below defines the relationship between correlation coefficients and the paths that will be affected. Note, paths 4, 5 and 6 are only available if installed into the unit and are not required for 4 branch diversity.

Channel (CH) Output Affected by Correlation Coefficients	Applicable Correlation Coefficients (CC)	Path (P) Correlation Defined By Coefficient(s)
1	CC _{1,2}	(P1) _{CH1} to (P1) _{CH2} (P2) _{CH1} to (P2) _{CH2} (P3) _{CH1} to (P3) _{CH2} (P4) _{CH1} to (P4) _{CH2} (P5) _{CH1} to (P5) _{CH2} (P6) _{CH1} to (P6) _{CH2}
2	CC _{1,2}	(P1) _{CH1} to (P1) _{CH2} (P2) _{CH1} to (P2) _{CH2} (P3) _{CH1} to (P3) _{CH2} (P4) _{CH1} to (P4) _{CH2} (P5) _{CH1} to (P5) _{CH2} (P6) _{CH1} to (P6) _{CH2}
3	CC _{1,3} , CC _{2,3}	(P1) _{CH1} to (P1) _{CH2} to (P1) _{CH3} (P2) _{CH1} to (P2) _{CH2} to (P2) _{CH3} (P3) _{CH1} to (P3) _{CH2} to (P3) _{CH3} (P4) _{CH1} to (P4) _{CH2} to (P4) _{CH3} (P5) _{CH1} to (P5) _{CH2} to (P5) _{CH3} (P6) _{CH1} to (P6) _{CH2} to (P6) _{CH3}
4	CC _{1,4} , CC _{2,4} , CC _{3,4}	(P1) _{CH1} to (P1) _{CH2} to (P1) _{CH3} to (P1) _{CH4} (P2) _{CH1} to (P2) _{CH2} to (P2) _{CH3} to (P2) _{CH4} (P3) _{CH1} to (P3) _{CH2} to (P3) _{CH3} to (P3) _{CH4} (P4) _{CH1} to (P4) _{CH2} to (P4) _{CH3} to (P4) _{CH4} (P5) _{CH1} to (P5) _{CH2} to (P5) _{CH3} to (P5) _{CH4} (P6) _{CH1} to (P6) _{CH2} to (P6) _{CH3} to (P6) _{CH4}

The Correlation Coefficients (CC) are defined as follows:

$CC_{1,2}$: specifies the amount of correlation between the paths in channel 1 and those in channel 2.

$CC_{1,3}$: specifies the amount of correlation between the paths in channel 1 and those in channel 3.

$CC_{2,3}$: specifies the amount of correlation between the paths in channel 2 and those in channel 3.

$CC_{1,4}$: specifies the amount of correlation between the paths in channel 1 and those in channel 4.

$CC_{2,4}$: specifies the amount of correlation between the paths in channel 2 and those in channel 4.

$CC_{3,4}$: specifies the amount of correlation between the paths in channel 3 and those in channel 4.

To illustrate the effect of the correlation coefficients on the output characteristics of a specific channel consider the following example involving the channel 4 output (2nd channel in the secondary unit). The characteristics of the Rayleigh fading of this output can be influenced by the fading from each of the 12 paths depending on the value of the three coefficients ($CC_{1,4}$, $CC_{2,4}$, $CC_{3,4}$) defined above. As a consequence, the composite Rayleigh modulation for path 1 of channel 4 is formed by scaling and summing the independent modulation from path 1 of channel 4 ($(M1)_{CH4}$) with that of path 1 of channel 1 ($(M1)_{CH1}$), along with path 1 of channel 2 ($(M1)_{CH2}$), and path 1 of channel 3 ($(M1)_{CH3}$) as illustrated below:

Output Rayleigh Modulation for Path 1 of Channel 4 = $(CH4C_1) * (M1)_{CH1}$
 $+ (CH4C_2) * (M1)_{CH2} + (CH4C_3) * (M1)_{CH3} + (CH4C_4) * (M1)_{CH4}$

Similarly:

Output Rayleigh Modulation for Path 2 of Channel 4 = $(CH4C_1) * (M2)_{CH1}$
 $+ (CH4C_2) * (M2)_{CH2} + (CH4C_3) * (M2)_{CH3} + (CH4C_4) * (M2)_{CH4}$

Output Rayleigh Modulation for Path 3 of Channel 4 = $(CH4C_1) * (M3)_{CH1}$
 $+ (CH4C_2) * (M3)_{CH2} + (CH4C_3) * (M3)_{CH3} + (CH4C_4) * (M3)_{CH4}$

Output Rayleigh Modulation for Path 4 of Channel 4 = $(CH4C_1) * (M4)_{CH1}$
 $+ (CH4C_2) * (M4)_{CH2} + (CH4C_3) * (M4)_{CH3} + (CH4C_4) * (M4)_{CH4}$

Output Rayleigh Modulation for Path 5 of Channel 4 = $(CH4C_1) * (M5)_{CH1}$
 $+ (CH4C_2) * (M5)_{CH2} + (CH4C_3) * (M5)_{CH3} + (CH4C_4) * (M5)_{CH4}$

Output Rayleigh Modulation for Path 6 of Channel 4 = $(CH4C_1) * (M6)_{CH1}$
 $+ (CH4C_2) * (M6)_{CH2} + (CH4C_3) * (M6)_{CH3} + (CH4C_4) * (M6)_{CH4}$

where:

CH4C_1, CH4C_2, CH4C_3, and CH4C_4 are amplitude scalars whose value are a function of the correlation coefficients

$(M1)_{CH1}$, $(M2)_{CH1}$, ... $(Mx)_{CHy}$ are the Rayleigh independently modulated signals from path x of channel y.

The following is a list of helpful tips that should be considered when using the 4500 in a 4 branch diversity test application.

1. The 4500 test setup must be configured in a manner that is consistent with the installation instructions in Section 1.3.5 “Setup Requirements for Multiple System Test Configurations.”
2. Control of the parameters associated with 4 branch diversity is not available from the front panel of the 4500 and is provided only from the remote control interface via TASKIT/4500.
3. The correlation factor (coefficient) is programmable between specific groups of paths as follows:
 - (path 1 in channel 1) to (path 1 in channel 2) to (path 1 in channel 3) to (path 1 in channel 4)
 - (path 2 in channel 1) to (path 2 in channel 2) to (path 2 in channel 3) to (path 2 in channel 4)
 - (path 3 in channel 1) to (path 3 in channel 2) to (path 3 in channel 3) to (path 3 in channel 4)
 - (path 4 in channel 1) to (path 4 in channel 2) to (path 4 in channel 3) to (path 4 in channel 4) (if installed)
 - (path 5 in channel 1) to (path 5 in channel 2) to (path 5 in channel 3) to (path 5 in channel 4) (if installed)
 - (path 6 in channel 1) to (path 6 in channel 2) to (path 6 in channel 3) to (path 6 in channel 4) (if installed)
4. Paths should be enabled as a group as defined above; a path from channel 1 and the associated path in each of the other channels. **Path loss and path delay for each path in a group should be set to equivalent values.** For example, if path 1 is enabled in channel 1 with a path loss of 6 dB and a delay of 5 microseconds then path 1 should be enabled with 6 dB of path loss and a delay of 5 microseconds in all the other channels that are being used.
5. All active (enabled) paths in all channels must be programmed to Rayleigh modulation with the Doppler frequency set to the same value. Programmable correlation is undefined for other modulation types.
6. The input reference level, and the output attenuation should be set to equivalent levels to align the average output power from all channels to be the

same. Typically the most convenient method to configure the input reference level is to perform an autorange after the transmit signal is present at the RF IN ports of the TAS 4500.

7. The correlation coefficients for channel 1 to 2, channel 1 to 3, and channel 1 to 4 are all independent parameters and can be programmed over the range from 0.00 to 1.00. The valid programmable range that is available to the channel 2 to 3 correlation coefficient depends on values that have been specified for the channel 1 to 2 correlation coefficient and the channel 1 to 3 coefficient. Similarly the valid programmable range that is available to the channel 2 to 4 correlation coefficient depends on values that have been specified for the channel 1 to 2 correlation coefficient, channel 1 to 3 coefficient, channel 2 to 3 coefficient and the channel 1 to 4 coefficient. Finally, the valid programmable range that is available to the channel 3 to 4 correlation coefficient depends on values that have been specified for all the other correlation coefficients.
8. The correlation factor (coefficient) should be programmed to zero (0.00) to disable channel correlation.

It is recommended that you allow the TAS 4500 unit to warm up for at least thirty minutes before beginning any tests.

4.5.10. Static Frequency Shift (Static Doppler)

Static frequency shift from the carrier frequency occurs when the distance between the receiver and transmitter is changing. An example of this is when a mobile receiver (car) is driving away from the transmitter. Path (A) in Figure 4-12 will have a static frequency shift due to the movement of the car. The amount of the frequency shift (Doppler frequency) from the carrier is determined by the following formula:

$$\text{Freq}_{\text{Doppler}} = \frac{\text{Velocity}_{\text{mobile}} \times \text{Freq}_{\text{carrier}}}{C}$$

where C = Speed of Light (3 x 10⁸ m/s)

The Doppler frequency can be either positive or negative depending whether the mobile receiver is moving away from or towards the transmitter respectively. The TAS 4500 implements a static frequency shift through the modulator circuit (Figure 4-13).

4.5.11. Static Phase Shift

A static phase shift is a result of the random distance between the transmitter and receiver. This distance is very rarely going to be an integer number of carrier wavelengths; a non-integer value will result in a static phase shift on the signal path. The amount of phase shift can vary between 0 and 360 degrees.

The TAS 4500 implements the static phase shift through the modulator circuit shown in Figure 4-13. Refer to Section 8.0 “Technical Specifications” for the range of phase shift supported by your TAS 4500.

4.5.12. Rician Fading

Rician fading is formed by the sum of a Rayleigh distributed signal and a Line-Of-Site (LOS or direct path) signal, where the LOS signal is typically subjected to a static frequency shift (static Doppler). A fading environment typically associated with Rician fading is that where one strong direct path reaches the receiver at roughly the same delay as multipath from local scatterers.

The 4500 supports the general case of Rician fading with programmable Angle of Arrival (AOA) and K factor. The specific Rician fading characteristics defined in the GSM specification can be obtained by setting the AOA and K factor appropriately. Version 3.50 of GSM Recommendation 5.05 specifies the angle of arrival of the LOS signal path to be 45°, resulting in a Doppler shift that is 0.7 of the maximum Doppler shift of the Rayleigh distributed signal (classical Doppler spectrum). GSM also specifies that the signal power of Rician fading be split equally between the LOS and multipaths (where the power envelope of the multipaths combine to form a Rayleigh distribution) with no relative delay. This corresponds to a K factor setting of 0. A theoretical power spectral density for GSM compliant Rician fading is shown in Figure 4-22 and a measured spectral density is shown in Figure 4-23.

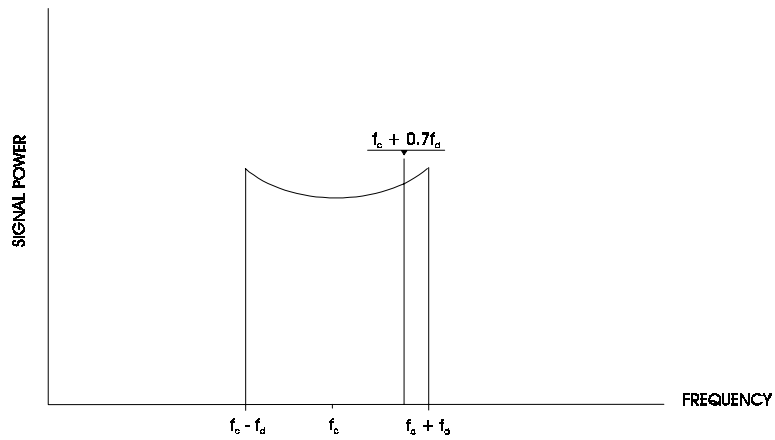


Figure 4-22. Theoretical Power Spectral Density for GSM Rician

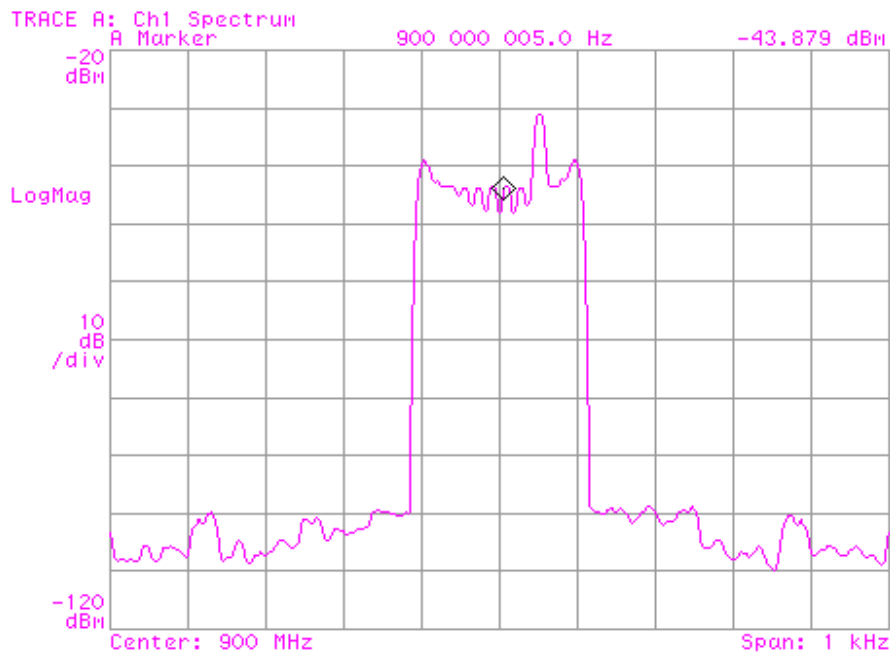


Figure 4-23. Measured GSM Rician Fading Power Spectral Density

Doppler Freq. = 100 Hz
 Center Freq. = 900 MHz
 Span = 1 kHz
 RBW = 10 Hz
 Sweep Time = 30 sec.
 Emulation Method = Jakes

In the general case of Rician fading the arrival angle of the LOS path at the receiver is programmable, as is the ratio of power between the LOS path and the multipath. The TAS 4500 provides access to both the LOS arrival angle and the LOS path to multipath power ratio, defined as the K factor expressed in dB. Changing the LOS arrival angle will move the relative location of the direct path with respect to the faded spectrum by changing the static Doppler shift of this component. This Doppler shift is set according to the following equation:

$$\text{Doppler}_{\text{direct component}} = \text{Doppler}_{\text{faded component}} \times \cos(\text{LOS arrival angle})$$

The K factor setting then controls the relative power of the direct path and the multipath and has a valid range of -30dB (faded spectrum will dominate) to +30dB (LOS signal will dominate).

4.5.13. Rayleigh with Frequency Shift and Rician with Frequency Shift

Rayleigh fading with frequency shift cascades frequency shift modulation with Rayleigh modulation within a single path. Rician with frequency shift cascades frequency shift modulation with Rician modulation within a single path. These modulation types are useful when modeling the environment seen by an antenna array. The following is a representation of these new modulation types:

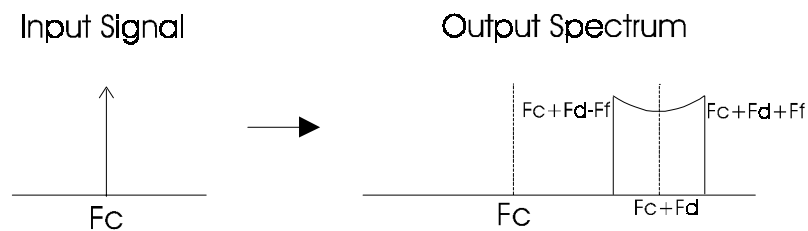


Figure 4-24. Frequency Shift Rayleigh

F_c = carrier frequency

F_d = spectrum offset

F_f = fading Doppler

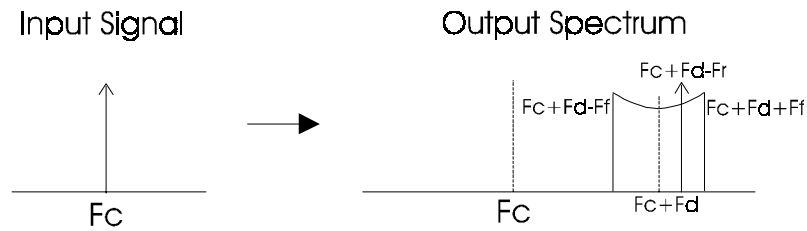


Figure 4-25 Frequency Shift Rician

F_c = carrier frequency
 F_d = spectrum offset
 F_f = fading Doppler
 F_r = LOS frequency

In Frequency Shift Rician emulation mode, the direct path component is not required to be within the fading spread in the frequency domain. This will allow for angle of arrival entry of the direct Rician path component independent of the angle of arrival spread of the fading component of the path modulation. By using the Line of Sight Reference (LOS_R) parameter which is only available via TASKIT/4500 or the remote command interface, the user has the ability to move the direct path component beyond the spread of the fading component. For details on the LOS_R remote command see Section 6.0.

Another use for these modulation types is to allow a channel of the 4500 to generate multiple Rayleigh or Rician faded carriers from a single transmit carrier input. For example, consider the case where a transmitter with carrier frequency F_c is input into a 4500 that is equipped with 3 paths per channel. Three different Rayleigh faded carriers will be generated and combined for input into the receiver that is connected to the output of the 4500 channel. The following table provides a general illustration of this feature.

Path	Input Carrier Freq.	Modulation Type	Shift Freq.	Path Output
1	F_c	Rayleigh	none	Rayleigh faded carrier at F_c
2	F_c	Rayleigh with Freq. Shift	F_{s1}	Rayleigh faded carrier at $F_c + F_{s1}$
3	F_c	Rayleigh with Freq. Shift	F_{s2}	Rayleigh faded carrier at $F_c + F_{s2}$

Refer to Section 8.0 “Technical Specifications” for the range of fading Doppler and the range of the shift frequency provided by the TAS 4500.

4.5.14. Log-Normal Fading (Active Terrain Emulation™)

Log-Normal fading is the slow variation of the average signal power over time. A plot of signal power versus time for log-normal fading is shown in Figure 4-26. Note that the time scale is much larger than that for Rayleigh fading shown in Figure 4-15. The variation in signal strength at the receiver is due to blockage or absorption of the signal by large-scale variations in the terrain profile and by changes in the nature of the local topography in the path from the transmitter to the receiver. The blockage of the signal is caused by elements in the environment such as hills or a building. This phenomenon is often called shadowing since the receiver is passing through a large "shadow" of an object. An example of this can be seen in Figure 4-27 as the mobile receiver (car) passes in the "shadow" of the building, the signal strength would fade.

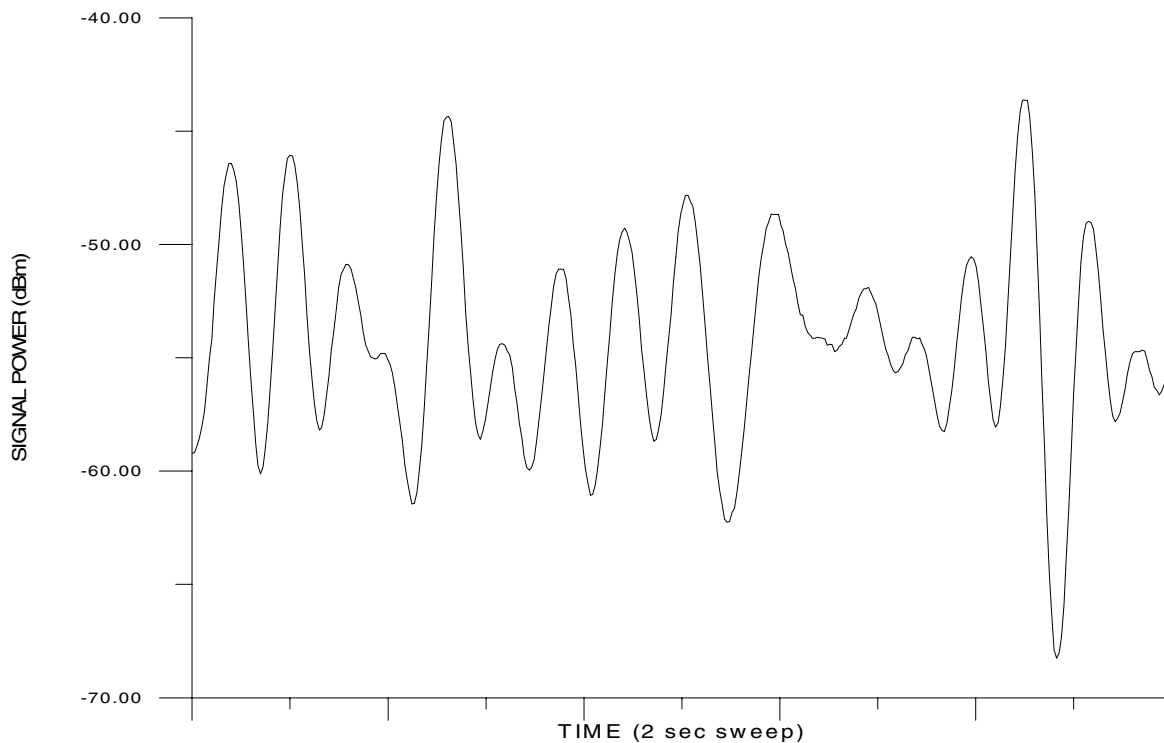


Figure 4-26. Log-Normal Fading vs. Time

Log-Normal Standard Deviation = 10 dB

Log-Normal Rate = 10 Hz

Path Loss = 25 dB

Center Freq. = 900 MHz

Span = 0 Hz

RBW = 100 kHz

Sweep Time = 2 sec.

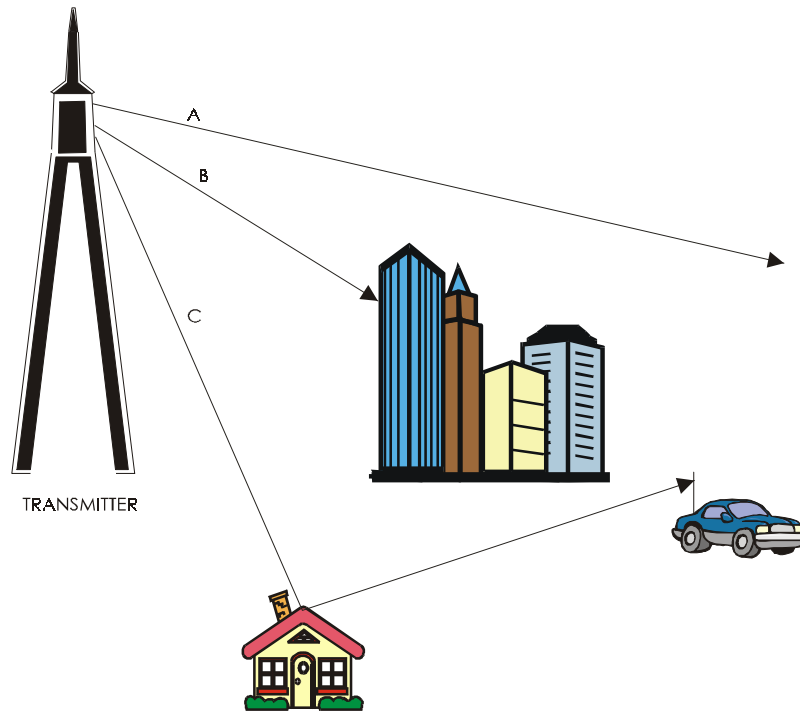


Figure 4-27. Transmitter to Receiver Log-Normal Diagram

This fading has statistical characteristics that are represented by a log-normal distribution of fluctuations in the mean (average) signal power expressed in decibels (dB). The standard deviation of the log-normal distribution is determined by the characteristics of the terrain where the transmitter and receiver are located. For example, a standard deviation of between 6-8 dB is typical for urban areas, while a deviation of 10-12 dB can be observed in rural locations.

The maximum rate of the log-normal fading must also be specified. The rate of log-normal fading is the maximum frequency of the fading spectrum and defines the maximum pace that the mobile will move through the shadow of elements in the terrain. An example can be given of a mobile receiver (car) driving at a fixed speed along a road. If the car is in a rural area behind hills far apart, the log-normal rate would be small since the car is moving through "shadows" at a slow rate. If the car is in an urban area behind rows of buildings, the rate would be larger since the mobile would be passing through "shadows" at a higher rate.

The following relationship holds for log-normal fading:

$$\text{Log Normal Rate (Hz)} = \frac{\text{Mobile Velocity (m / s)}}{\text{Min. Shadow Length (m)}}$$

The log-normal frequency in this equation will be the maximum rate that the mobile will move through "shadows". This corresponds to the maximum frequency of the log-normal fading spectrum that has a span that begins near DC.

As described above log-normal is terrain-induced fading that has statistical properties that are defined by its standard deviation and rate. The ability to program these parameters allows the 4500 to actively emulate a variety of terrain. This capability is called Active Terrain Emulation™.

Referring to Figure 4-12, the log-normal circuitry follows the modulator circuit. Both the log-normal and path loss are implemented using the same hardware. The hardware consists of a single modulator in the IF signal path. The log-normal modulation signal is formed with a digital synthesis method.

When log-normal fading is enabled, the user can independently program the log-normal standard deviation and log-normal rate for each of the instrument's paths.

Before programming the log-normal parameters, it is important to understand the interrelationship of the path LOSS and LOG NORMAL STD parameters. To attain a minimum of two sigma amplitude variation for the log-normal standard deviation parameter on the desired path the following upper and lower bound requirements must be met:

1. Two times the LOG NORMAL STD value plus the path LOSS value is upper bounded by a total of 50 dB.
2. The path LOSS value minus two times the LOG NORMAL STD value is lower bounded by 0 dB.

As an example with LOG NORMAL STD set to 12 dB, a two sigma amplitude variation can be achieved with path LOSS set to 25 dB.

If the path loss and the standard deviation parameters are programmed in such a way that a 2 sigma variation cannot be met, the amplitude variation, induced by log-normal fading, will remain symmetrical around the mean power level but will be limited by the minimum distance of the current loss setting to either 0 or 50 dB.

For example, with the log-normal standard deviation set to 10 dB and the path loss set to 16 dB, the maximum amplitude variations will be constrained by ± 16 dB. Since $16 \text{ dB} < 20 \text{ dB}$ ($2 \times 10\text{dB} = 20\text{dB}$), a two sigma amplitude variation cannot be achieved.

4.5.15. Suzuki Fading

Suzuki fading is the superposition of Rayleigh fading and log-normal fading. Log-normal is the variation in the mean (average) received signal power as the receiver moves from place to place within a given area. This is caused by large-scale variations in the terrain profile along the path to the transmitter and by changes in the nature of the local topography. Log-normal is often termed “slow fading.” Superimposed on this slow fading are the rapid and severe variations in the received signal strength caused by multipath propagation in the immediate vicinity of the receiver. This is Rayleigh fading which is caused by scattering from man-made and natural obstacles such as buildings and trees in the local geographical area (within a few hundred wavelengths of the receiver). Rayleigh fading is commonly called “fast fading”.

The TAS 4500 is easily configured to generate Suzuki fading by setting the characteristics of a specific path to Rayleigh modulation and enabling log-normal fading with the desired standard deviation and rate.

4.5.16. Nakagami Fading

Nakagami fading describes the time domain characteristics of the envelope power of a faded signal. There are two controllable parameters associated with this fading type, the direct path angle of arrival and the M value. The Probability Density Function of the envelope of the Nakagami faded signal is controlled by the M value. The Nakagami M value provides a means of differentiating the typical fading environments by providing a relative measure of how ‘direct’ the received paths are.

The programmable M value describes the fading condition as the ratio of the direct signal component to multi-path faded signal components. The discrete range of M values supported in the TAS 4500 offer a progression from a Rayleigh faded distribution (M=1) to a single direct path (M=100) which approaches a pure frequency shifted component. The values between these two limits (M=3, 5, 10, 15, and 25) describe an environment where both a direct path and a multi-path are present, where the M value defines a relative power ratio of the direct path to faded path components.

The programmable angle of arrival will then change the position of the direct path relative to the multi-path component. This is accomplished by scaling the static Doppler shift of the direct path appropriately. This Doppler shift is set according to the following equation:

$$\text{Doppler}_{\text{direct component}} = \text{Doppler}_{\text{faded component}} \times \cos(\text{angle of arrival})$$

4.6. Dynamic Environmental Emulation (DEE) Mode

The Dynamic Environmental Emulation Mode allows the user to cascade multiple static parameter “states” to emulate a dynamic propagation environment. Each “state” is defined by the modulation type, modulation setting, path loss and delay for each path in the system. Each “state” is active for a user specified time before stepping to the next “state” in the environment. The user has the ability to run through the states once, loop through the states N times, or loop through the states indefinitely.

The powerful Dynamic Environmental Emulation Mode can be used in many applications, such as adaptive antenna array and Rake receiver testing, and “playback” of measured propagation data. This mode is only available through TASKIT 4500 with direct GPIB control of the 4500 unit(s). For additional information on the mode of operation see Section 3.2 of this manual.

4.7. Insertion Loss Estimation

The TAS 4500 has been equipped with an insertion loss estimation capability which can be accessed only through the TASKIT control interface. This feature is designed to provide the user with an insertion loss estimate from the RF input of the instrument to the RF output. This feature is not designed to be an absolute power measurement tool, but rather a reasonable estimate of the insertion loss in the TAS 4500. It is assumed that the contributions of all paths are orthogonal to one another ignoring the possible effects of constructive or destructive interference between paths with relative phase or delay offsets.

4.8. 3GPDP Moving Propagation Test Application

The TAS 4500's Moving Propagation Emulation Method enables complex dynamic power-delay profiles to be quickly constructed by defining a handful of emulation parameters. The Moving Propagation emulation method smoothly varies the temporal location of individual multi-path components using a periodic sinusoidal function as shown in Figure 1 below.

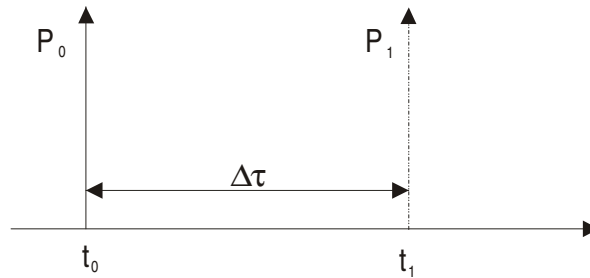


Figure 4-28. Default Moving Propagation Test Definition

The following excerpt that is derived from the 3GPP test specification (*TS 34.121 V3.0.1 dated 2000-03*) forms the basis for the current implementation.

3GPP Test Specification (TS 34.121 V3.0.1 dated 2000-03)

Annex B: Propagation Conditions

Section B.2.3 Moving Propagation Conditions

The dynamic propagation conditions for the test of the baseband performance are non-fading channel models with two taps. The moving propagation condition has two taps, one static, Path0, and one moving, Path1. The time difference between the two paths is according to Equation (B.1). Refer to Figure 4-28 above.

$$\Delta\tau = \left(1 + \frac{A}{2} (1 + \sin(\Delta\omega \cdot t)) \right) \mu\text{s}$$

Equation B.1

The parameters in the equation are shown in.

A: 5μs

Δω: 40*10⁻³ s⁻¹

To summarize, the active paths in the multi-path profile sequence move, or slide along the delay axis at a rate defined by a periodic sinusoidal function. Equation B.1 defines the rate and range of movement experienced by each of the paths in the multi-path profile. These parameters can be independently programmed for each of the active paths in either channel.

4.8.1. MP Test Execution Procedure

The following high-level procedure is used to define and execute a Moving Propagation profile using the remote command set. For similar information using TASKIT, please see Section 3.4.

1. Use the remote command set to define the following test related parameters:
 - Set the delay profile to TYPE1 (DDPROF)
 - Set the desired state duration (RSD)
 - For each active path, set the minimum delay value (DMIN)
 - For each active path, set the maximum delay value (DMAX)
 - For each active path, set the frequency of the sinusoidal oscillation (DELTAW)
2. Configure the TAS 4500's RF and I/O Parameters
3. Enable the desired number of paths in the emulated channel
4. Configure modulation and path loss characteristics of the active paths
5. Change the Emulation mode to the 3GPDP mode (MODE5)
6. Establish call connection with the UUT
7. Run the Birth Death Test profile as defined above (PDP_RUN)
8. Terminate the test sequence after test execution by returning the unit to static operation (EMULM=MODE1)

The details and syntax for the required remote commands can be found in Section 6.3.6 of this manual. A step-by-step outline of the above execution sequence is provided in the detailed setup example in Section 4.8.4.

4.8.2. MP Key Parameter Definition

From the procedure outline provided above, there are several key parameters associated with this test that are defined below. For the Moving Propagation test, these parameters can be uniquely defined for each active path in the unit.

To provide maximum flexibility in the MP test, the 3GPDP mode takes a slightly more generic approach to the problem than the 3GPP test specification (*TS 34.121 V3.0.1 dated 2000-03*). The figure below shows one period of the sinusoidal delay oscillation. The parameters in the diagram are explained in detail below.

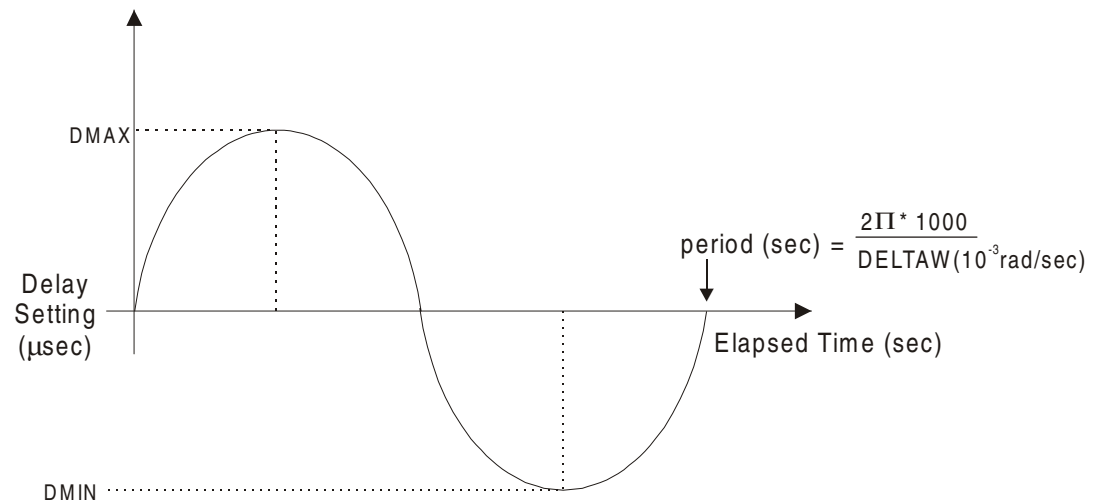


Figure 4-29. MP Test Parameter Definition

DDPROF: Defines the current test profile to be executed. The Moving Propagation test is defined as TYPE1.

RSD: Defines the state duration for the Moving Propagation test. This parameter defines how long a particular delay profile will be held with its current settings before a change is made as defined by the 3GPP test specification (*TS 34.121 V3.0.1 dated 2000-03*). For the Moving Propagation test, it is recommended that the minimum state duration of 1msec be used in all cases to assure maximum delay resolution.

DMIN: From Figure 4-29 above, it defines the minimum delay value that will be reached by the sinusoidal variation. From the Moving Propagation Equation B.1 defined above, DMIN is obtained by setting the quantity

$$\sin(\Delta\omega \bullet t) = -1.$$

This results in the minimum possible separation between the static Path0 and the moving Path1 of 1 μ sec. This is the DMIN value that should be sent to the TAS 4500 to execute the default test.

DMAX: From Figure 4-29 above, it defines the Maximum delay value that will be reached by the sinusoidal variation. From the Moving Propagation Equation B.1 defined above, DMAX is obtained by setting the quantity

$$\sin(\Delta\omega \bullet t) = +1.$$

This results in the maximum possible separation between the static Path0 and the moving Path1 of 6 μ sec. This is the DMAX value that should be sent to the TAS 4500 to execute the default test.

DELTAW: Defines the frequency of oscillation in units of 10^{-3} radians per second. The default definition sets DELTAW= 40×10^{-3} radians per second. This is equivalent to a sinusoidal period of 157.08 seconds as shown below:

$$\frac{40 \times 10^{-3} \text{ radians}}{1 \text{ second}} \times \frac{1 \text{ cycle}}{2\pi \text{ radians}} = \frac{.00637 \text{ cycles}}{1 \text{ second}}$$

$$\left(\frac{.00637 \text{ cycles}}{1 \text{ second}} \right)^{-1} = \frac{157.08 \text{ seconds}}{1 \text{ cycle}}$$

From the parameters provided it is possible to have an active path remain stationary at any delay value by setting DMAX=DMIN. This eliminates any sinusoidal variation in the path delay.

4.8.3. 3GPDP Moving Propagation Test Example

The example below demonstrates the standard procedure for configuring and running the 3GPDP Moving Propagation Test. The example looks specifically at the requirements and procedures associated with the 3GPDP test mode. For further details on the front panel and remote operation of the TAS 4500, the user should consult Section 2.0 “Local Operation” or Section 6.0 “Remote Operation” of the manual. Figure 4-30 shows a time elapse sequence of the Moving Propagation Test.

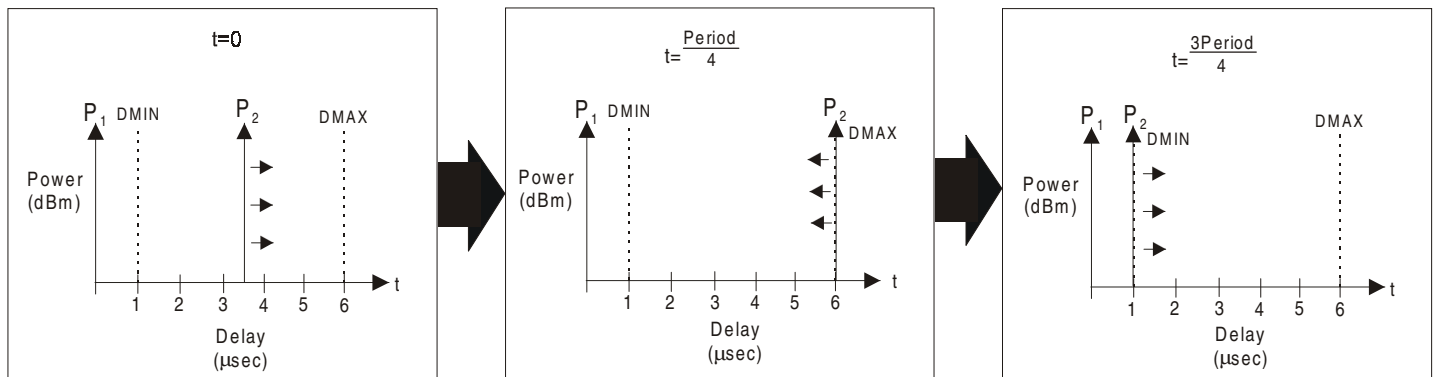


Figure 4-30: Moving Propagation Test Example

Step One: Configuring the Moving Propagation Parameters

The key parameters outlined in Section 4.8.2 must be set to the desired values prior to entering the test mode. The remote commands detailed in Section 6.3.6 provide the ability to modify these values. These new parameters can be saved in one of the user defined RAM files (file0 to file4) available in the 4500 for recall at a later date. It should be noted that when the factory “default” file is recalled in the 4500, these parameters will be returned to their factory installed values as defined by the listing below:

- $DDPROF = TYPE1$ 3GPDP test mode default set to MP test
- $RSD = 1$ State duration of 1msec
- $CHx_P1:D_{MIN} = 0$ Min. value of variation set to 0 µsec.(not moving)
- $CHx_P1:D_{MAX} = 0$ Max. value of variation set to 0 µsec.(not moving)
- $CHx_P1:DELTA W=40$ Oscillation freq. of $40 \cdot 10^{-3}$ rads/sec(not moving)
- $CHx_P2:D_{MIN} = 10000$ Min. value of variation set to 1µsec.
- $CHx_P2:D_{MAX} = 60000$ Max. value of variation set to 6µsec.
- $CHx_P2:DELTA W=40$ Oscillation freq. of $40 \cdot 10^{-3}$ rads/sec

The sample command sequence below shows the necessary remote commands to initialize the test parameters for the default test scenario. In this case only Channel 1 Paths 1 and 2 are being configured for use during the test so it is not necessary to configure the remaining paths in the system. The expected response from the unit is in italics.

```
/CNFG:DDPROF=TYPE1/  
/C/  
/PATHS:RSD=1/  
/C/  
/CH1_P1:DMAX=0/  
/C/  
/CH1_P1:DMIN=0/  
/C/  
/CH1_P1:DELTAW=40/  
/C/  
/CH1_P2:DMAX=60000/  
/C/  
/CH1_P2:DMIN=10000/  
/C/  
/CH1_P2:DELTAW=40/  
/C/
```

Step Two: Configuring the RF Parameters

The user should configure all RF parameters to match the testing requirements. These parameters include the RF Carrier Frequency, the LO Mode and LO Frequency, the Input Reference Level, and the RF Attenuation setting. The user may set these parameters using the front panel or the standard TAS 4500 remote command set. For further details on the front panel and remote operation of the FLEX5 TAS 4500, the user should consult Section 2.0 “Local Operation” or Section 6.0 “Remote Operation” of the manual. These settings can be saved and recalled for future use through the RAM files in the TAS 4500.

Step Three: Configuring the Path Parameters

The final step in preparing the unit to run the Moving Propagation test is to activate and configure all active paths. When the test is started, the only path impairment that is modified is the delay setting on each active path. Therefore, prior to entering the 3GPDP mode, the user must turn on all active paths and set the desired path modulation, path velocity/Doppler and path loss values. The path delay will be set automatically based on the 3GPDP parameters as outlined in Step Four below. The default test standard (*TS 34.121 V3.0.1 dated 2000-03*) specifies the use of static paths (modulation type set to “none”) with equal power (path loss set to 0.0 dB).

Step Four: Entering the Moving Propagation Test Mode

When all parameters have been configured, you are ready to start the test. This is a two step process. The **Arm** action is the first step in the test execution process. This places the unit into the 3GPDP mode and downloads all necessary data to the unit to prepare for test execution.

NOTE: During the **Arm** process, there may be breaks in the signal path continuity through the 4500 while the unit is prepared to execute the test. Therefore, it is recommended that call setup with the Unit Under Test (UUT) only be established after the unit has been **Armed**.

The following command should be used to ARM the unit placing it in the 3GPDP test mode.

```
/CNFG:EMULM = MODE5/  
/C/
```

At this point, the initial delay profile is setup in the unit to guarantee a repeatable and smooth delay transition when the test is started. For the Moving Propagation test, the initial delay profile places each active path at the value given by

$$\frac{D_{MAX} - D_{MIN}}{2}$$

In the default test, Path1 will remain at the 0.0 μsec delay value, and Path 2 will follow the sinusoidal oscillation defined by the test specification.

Step Five Executing the Test

When the unit has been successfully **Armed** and communication has been established with the UUT, the test execution can be initiated by sending the following command. The test will immediately begin execution, and execution will continue indefinitely until the unit is returned to static operation. The user should avoid sending any commands to the unit while this test is in progress.

```
/CNFG:PDP_RUN /  
/C/
```

Step Six: Terminating the Test

When the desired test duration has been reached, the unit should be returned to static operation before any changes to the configuration of the unit are made. When leaving the 3GPDP test mode, the path delay settings for all paths will be reset to the static values present prior to entering the test mode. The following command will restore static operation.

```
/CNFG:EMULM=MODE1/  
/C/
```

Once the unit has returned to static operation, there are no further limitations on the modification of parameters.

4.8.4. Extending the Capability of the Moving Propagation Test

The Moving Propagation test has been implemented based on the current 3GPP test definition. Additional flexibility has been provided in an attempt to allow the user to extend testing beyond that explicitly called for in the specification. The implementation will also permit the user to modify the test parameters immediately should the specification change.

The extended capabilities of the Birth-Death test mode include the following:

- The RSD parameter allows the state duration to be programmed anywhere in the range from 1 msec to 60 seconds with 1 msec resolution.
- The DMIN value can be set to any value in the permitted range of the unit. (as long as $DMIN \leq DMAX$)
- The DMAX value can be set to any value in the permitted range of the unit. (as long as $DMIN \leq DMAX$)
- The DELTAW parameter permits the oscillating frequency of the delay change to be set anywhere in the range from $1 * 10^{-3}$ radians per second to $32767 * 10^{-3}$ radians per second.
- The number of active paths can be set from 1 to the maximum number of paths per channel in the unit (3 or 6 paths per channel). This is accomplished by turning on the required number of paths before entering the test mode.

These capabilities make the Moving Propagation test extremely powerful when trying to push the performance of the receiver algorithms beyond the basic requirements of the test specification.

4.9. 3GPP Birth-Death Test Application

The TAS 4500's Birth-Death Emulation Method enables complex dynamic power-delay profiles to be quickly constructed by defining a handful of emulation parameters. The Birth-Death Emulation Method randomly varies the location of the multi-path components along the delay spread axis as shown in the sequence of power-delay profiles in Figure 4-29.

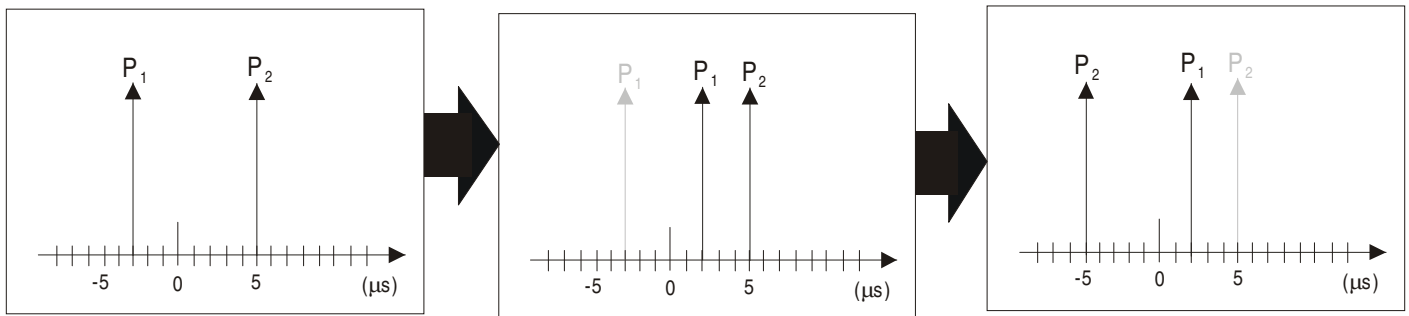


Figure 4-31. Default Birth-Death Test

4.9.1. Birth-Death Overview

The following excerpt is derived from the 3GPP test specification for W-CDMA development and forms the basis for the current implementation.

3GPP Test Specification (TS 34.121 V3.0.1 dated 2000-03)

Annex B: Propagation Conditions

Section B.2.4 Birth-Death Propagation Conditions

The dynamic propagation conditions for the test of the baseband performance is a non-fading propagation channel with two taps. The moving propagation condition has two taps, Path1 and Path2 which alternate between 'birth' and 'death.' The positions the paths appear are randomly selected with an equal probability rate and is shown in Figure 4-31 above.

NOTE:

1. Two paths, Path1 and Path2 are randomly selected between $-5\mu\text{s}$ and $+5\mu\text{s}$.
2. After 191 ms, Path1 vanishes and reappears immediately at a new location randomly selected between $-5\mu\text{s}$ and $+5\mu\text{s}$ but excludes the point Path2.
3. After an additional 191 ms, Path2 vanishes and reappears immediately at a new location randomly selected between $-5\mu\text{s}$ and $+5\mu\text{s}$ but excludes the point Path1.
4. The sequence in 2) and 3) is repeated.

To summarize, the active paths in the multi-path profile sequence alternate changing their location along the delay axis at each state change. During each

state, only one path changes its temporal location. This “death” of the path in its current delay bin and subsequent “birth” in a new unoccupied bin is performed using a uniform random distribution. The user defines the individual delay bins that make up the distribution set. This test does not permit more than one path to be located in any delay bin at any particular time instant.

4.9.2. B-D Test Execution Procedure

The following high-level procedure should be followed to define and execute a Birth-Death profile. For similar information using TASKIT, please see Section 3.4.

1. Use the remote command set to define the following test related parameters
 - Set the delay profile to TYPE2 (DDPROF)
 - Set the desired state duration (RSD)
 - Define the number of active delay bins in each channel (DDBINS)
 - Define the number of active paths in each channel (DDPATHS)
 - Set the delay values to be used in the active delay bins. (DDx)
2. Configure the TAS 4500's RF and I/O Parameters
3. Enable the desired number of paths in the emulated channel
4. Configure modulation and path loss characteristics of the active paths
5. Change the Emulation mode to the 3GPDP mode (EMULM=MODE5)
6. Establish call connection for the UUT
7. Run the Birth Death Test profile as defined above (PDP_RUN)
8. Terminate the test sequence after test execution by returning the unit to static operation (EMULM=MODE1)

The details and syntax for the required remote commands can be found in Section 6.3.6 of the manual. A step-by-step outline of the above execution sequence is provided in the detailed setup example in Section 4.9.4.

4.9.3. B-D Key Parameter Definition

From the procedure outline provided above, there are several key parameters associated with this test which will be defined below. For the Birth-Death test, these parameters are shared by all paths in a channel and can be independently defined for each channel of the TAS 4500.

DDPROF: Defines the current test profile to be executed. The Birth-Death test is defined as TYPE2.

RSD: Defines the state duration for the Birth-Death test. This parameter defines how long a particular delay profile will be held with its current settings before a change is made as defined by the 3GPP test specification.

DDBINS: Defines the number of independent delay bins that will be active during the test. The total number of usable discrete delay values must be provided by the user to define the valid positions for the active paths. The actual contents of these DDBINS will be set using the DDx command.

DDPATHS: Defines the number of active paths that should be included in the test. Only one path can change bins per state transition, so this parameter controls how many paths will be included in this cycle. This parameter **does not** turn paths on and off. The active paths must be turned on prior to starting the test. The test will then cycle one at a time through the paths from Path "1" to Path "DDPATHS" modifying the delay value appropriately.

DDx: Where x ranges from 1 to 8. These values are used to define the actual delay settings that will fill the active bins as defined by the DDBINS command.

4.9.4. 3GPDP Birth-Death Test Example

The example below demonstrates the standard procedure for configuring and running the 3GPDP Birth-Death Test. The example looks specifically at the requirements and procedures associated the 3GPDP test mode. For further details on the front panel and remote operation of the TAS 4500, the user should consult Section 2.0 "Local Operation" or Section 6.0 "Remote Operation" of the manual.

Step One: Configuring the Birth-Death Parameters

The key parameters outlined in Section 4.9.3 must be set to the desired values prior to entering the test mode. The remote commands detailed in Section 6.3.6 provide the ability to modify these values. These new parameters can be saved in one of the user defined RAM files (file0 to file4) available in the 4500 for recall at a later date. It should be noted that when the factory "default" file is recalled in the 4500, these parameters will be returned to their factory installed values as defined by the listing below:

- DDPROF = TYPE1
3GPDP test mode default set to MP test
- RSD = 1
State duration of 1msec
- DDBINS = 11
11 delay bins - 1 µsec spacing covering the range 0-10 µsec.
- DDPATHS = 2
Path1 and Path2 active for this test
- DDx
Delay bin values(0,1,2,3,4,5,6,7,8,9,10 µsec)

DD1 = 0;10000;20000;30000;40000;50000;60000;70000

DD2 = 80000;90000;100000;0;0;0;0

DD3 = 0;0;0;0;0;0;0

DD4 = 0;0;0;0;0;0;0

DD5 = 0;0;0;0;0;0;0

DD6 = 0;0;0;0;0;0;0

DD7 = 0;0;0;0;0;0;0

DD8 = 0;0;0;0;0;0;0

NOTE: Due to the large storage requirements for the DDx data, the actual delay bins **are not** stored in the user RAM files (file0 – file4). They must be uploaded via the remote command set every time power is cycled in the unit. At power up the default delay bins provided in the listing above will be restored, but any user modifications will be lost.

The sample command sequence below shows the necessary remote commands to initialize the test parameters. In this case only Channel 1 is being configured for use during the test so it is not necessary to configure the Channel 2 parameters. The expected response from the unit is in italics.

```

/CNFG:DDPROF=TYPE2/
/C/
/PATHS:RSD=191/
/C/
/CHAN1:DDBINS=11/
/C/
/CHAN1:DDPATHS=2/
/C/
/CHAN1:DD1 = 0;10000;20000;30000;40000;50000;60000;70000/
/C/
/CHAN1:DD2 = 80000;90000;100000;0;0;0;0;0/
/C/
/CHAN1:DD3 = 0;0;0;0;0;0;0;0/
/C/
/CHAN1:DD4 = 0;0;0;0;0;0;0;0/
/C/
/CHAN1:DD5 = 0;0;0;0;0;0;0;0/
/C/
/CHAN1:DD6 = 0;0;0;0;0;0;0;0/
/C/
/CHAN1:DD7 = 0;0;0;0;0;0;0;0/
/C/
/CHAN1:DD8 = 0;0;0;0;0;0;0;0/
/C/

```

NOTE: Although each DDx command must send eight values to avoid a syntax error. The user is not required to fill unused delay bins with “0”. The test will only use the bins from 1 to DDBINS; all other unused bins will be ignored.

Step Two: Configuring the RF Parameters

The user should configure all RF parameters to match the testing requirements. These parameters include the RF Carrier Frequency, the LO Mode and LO Frequency, the Input Reference Level, and the RF Attenuation setting. The user may set these parameters using the front panel or the standard TAS 4500 remote command set. For further details on the front panel and remote operation of the TAS 4500, the user should consult Section 2.0 “Local Operation” or Section 6.0 “Remote Operation” of the manual. These settings can be saved and recalled for future use through the RAM files in the TAS 4500.

Step Three: Configuring the Path Parameters

The final step in preparing the unit to run the Birth-Death test is to activate and configure all active paths starting with Path "1" and proceeding to Path "DDPATHS". When the test is started, the only path impairment that is modified is the delay setting on each active path. Therefore, prior to entering the 3GPDP mode, the user must turn on all active paths and set the desired path modulation, path velocity/Doppler, and path loss values. The path delay will be set automatically based on the 3GPDP parameters as outlined in Step Four below. The default 3GPP test standard specifies the use of static paths (modulation type set to "none") with equal power (path loss set to 0.0 dB).

Step Four: Entering the Birth-Death Test Mode

When all parameters have been configured, you are ready to start the test. This is a two step process. The **Arm** action is the first step in the test execution process. This places the unit into the 3GPDP test mode and downloads all necessary data to the unit to prepare for test execution.

NOTE: During the **Arm** process, there may be breaks in the signal path continuity through the 4500 while the unit is prepared to execute the test. Therefore, it is recommended that call setup with the Unit Under Test (UUT) only be established after the unit has been **Armed**.

The following command should be used to **Arm** the unit placing it in the 3GPDP test mode.

```
/CNFG:EMULM = MODE5/  
/C/
```

At this point, the initial delay profile is setup in the unit to guarantee a repeatable and smooth delay transition when the test is started. For the Birth-Death test, the initial delay profile places the active paths in the following bin locations as the starting point for the test:

- Path1 in delay bin 1
- Path2 in delay bin 2
- Path3 in delay bin 3
- Path4 in delay bin 4
- Path5 in delay bin 5
- Path6 in delay bin 6

Notice that the number of delay bins **must** be greater than or equal to the number of active paths. From this starting point, state one will move path1 to an unoccupied delay bin with an equal probability distribution. The test will continue from there as defined in the 3GPP test specification.

Step Five: Executing the Test

When the unit has been successfully **Armed** and call setup has been completed with the Unit Under Test, the test execution can be initiated by sending the following command. The test will immediately begin execution, and execution will continue indefinitely until the unit is returned to static operation. The user should avoid sending any commands to the unit while this test is in progress.

```
/CNFG:PDP_RUN /  
/C/
```

Step Six: Terminating the Test

When the desired test duration has been reached, the unit should be returned to static operation before any changes to the configuration of the unit are made. When leaving the 3GPDP test mode, the path delay settings for all paths will be reset to the static values present prior to entering the test mode. The following command will restore static operation.

```
/CNFG:EMULM=MODE1/  
/C/
```

Once the unit has returned to static operation, there are no further limitations on the modification of parameters.

4.9.5. Extending the Capability of the Birth-Death Test

The Birth-Death test has been implemented based on the current 3GPP test definition. Additional flexibility has been provided in an attempt to allow the user to extend testing beyond that explicitly called for in the specification. The implementation will also permit the user to modify the test parameters immediately should the specification change.

The extended capabilities of the Birth-Death test mode include the following:

- The RSD parameter allows the state duration to be programmed anywhere in the range from 1 msec to 60 seconds with 1 msec resolution.
- The DDBINS parameter permits between 1 and 64 independent delay bins to be utilized during this test.
- The DDPATHS parameter allows up to 6 paths to be included in the dynamic delay profile where each active path will be placed in an unoccupied delay bin.
- The DDx commands allow up to 64 independent delay bins to be defined. The spacing for these bins can be set as small as 15ns and as large as the maximum delay setting available in the unit. Delay bins will automatically be rounded to the nearest 15ns due the architecture of the delay implementation.

These capabilities make the Birth-Death test extremely powerful when trying to push the performance of the receiver algorithms beyond the basic requirements of the test specification.

4.10. 3GPDP Helpful Hints

1. To run the current 3GPP test specification (*TS 34.121 V3.0.1* dated 2000-03), you may rely on the restoration of all parameters (including the delay bins DDx values) at system power up. The default dynamic profile (DDPROF) is the Moving Propagation test (TYPE1). The only shared parameter between the two tests is the state duration parameter (RSD). This parameter is set by default to 1 msec since this is the recommended state duration for the Moving Propagation Test. The state duration must set to 191 ms using the PATHS:RSD command in order to run the Birth Death test as defined.
2. It is recommended that the user have no fewer than two active paths in either test.
3. In each test scenario, the active paths are used in the following order Path 1, Path 2, Path 3, Path 4, Path 5, and Path 6. It is not possible to select the specific paths you use during the test, only the total number of active paths (Path “1” through Path “DDPATHS”) will be applied to the test.
4. When the EMULM:MODE5 command is sent, there may be a temporary disruption in the signal path of the fading emulator. Therefore, the call setup operation should only be completed after this command has been sent. When the PDP_RUN command is then sent to the unit, the state transitions will begin with no disruption in the signal path.
5. While the default test profiles utilize static paths of equal power, the user may configure the active paths prior to the start of the test to incorporate any desired impairments including multipath fading and path loss.
6. Even though the user is able to define the number of active paths, the test will not modify any parameters in the box other than delay. The user must activate and define the desired impairments prior to starting either test.
7. While the unit will accept commands and modify parameters while the test is in progress, it is **strongly recommended** that no commands be forwarded to the unit while the 3GPDP test mode is active. Unpredictable performance may result.

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5.0. REMOTE OPERATION

5.1. Overview

A computer or terminal can control the TAS 4500 by issuing commands through the GPIB or RS-232C remote control port. The TAS 4500 supports three control link protocols:

- RS-232 CR/LF
- RS-232 ACK/NAK
- GPIB

CR/LF (carriage return/line feed) is a simple command-line protocol, and allows you to control TAS 4500 from a dumb terminal or a computer. In addition to being easiest to implement, the CR/LF protocol provides a convenient way to practice using the 4500 command set.

ACK/NAK is a more sophisticated serial control protocol that includes error-checking and command retransmission.

GPIB (General Purpose Instrumentation Bus) is the industry-standard parallel-bus instrument control protocol.

5.2. Remote Control Features

TAS 4500 commands are arranged in functional groups. The following brief descriptions outline the function of each TAS 4500 command group. For a complete description, refer to Section 6.0 “Command Reference.”

- The CHAN1/CHAN2 command groups are used to setup parameters common to a transmission channel.
- The CNFG command group is used to setup system configuration parameters.
- The FILE command group is used to save and recall standard and user-defined files.
- The MEAS command group is used to make measurements on transmission channel.
- The CH1_Px/CH2_Px command groups are used to setup parameters common to a transmission path.
- The PATHs command groups are used to setup parameters common to all transmission paths in both channels.

5.3. Configuring the TAS 4500 for Remote Control

1. Verify that the letter 'R' is not present in the upper right corner of the LCD, thus indicating that the unit is in local operation mode.
2. Select the **CONFIG** menu tree.
3. Go to the **REMOTE PROTOCOL** field.
4. Select the desired protocol (**gpib**, **crlf**, or **acknak**).
5. Enter the submenu of the specified protocol and set the protocol specific options.
6. The 4500 goes into Remote Operation Mode as soon as a command is sent using the selected protocol.

For example, to configure TAS 4500 for RS-232 CR/LF control, select **REMOTE PROTOCOL: crlf**, and press **ENTER** to select the **crlf** submenu. Next, set the **BAUD RATE**, **DATA**, **PARITY**, and **STOP** parameters for the CR/LF protocol. Figure 5-1 shows the screens used to configure the remote protocol parameters.

```

CONFIG SUBMENU (ESC TO EXIT)
CRLF REMOTE PROTOCOL
BIT RATE: 4800
DATA: 7          PARITY: odd          STOP: 1
```

Figure 5-1. Menu Screen to Configure Remote Protocol Parameters

For more information on the TAS 4500 CONFIG menu tree, see Section 2.0. "Local Operation." For detailed information on each of the TAS 4500 link control protocols, see the "Remote Control Protocol" information in this section.

5.4. TAS 4500 Command Protocol

5.4.1. Command Types

TAS 4500 supports three distinct types of commands. These command types are SET commands, REPORT commands, and EXECUTE commands.

SET commands simply assign a value to a TAS 4500 configuration parameter. If TAS 4500 receives a SET command without a parameter value, it returns the current setting of the parameter.

REPORT commands return a value. For example, the CNFG command that returns the version number of the firmware is a REPORT command.

EXECUTE commands instruct TAS 4500 to perform an operation. For example, the GPIB command that disables the front control panel is an EXECUTE command. EXECUTE commands do not return a value.

5.4.2. Command Sequence

To execute a TAS 4500 command, a controller must execute a simple three-step sequence:

1. Check for any pending command response. TAS 4500 does not execute a new command if the result from a previous command has not been read.
2. Send the command to the TAS 4500.
3. Read the command response from the TAS 4500.

5.4.3. Command Messages

A TAS 4500 command message consists of one or more command frames. A command frame consists of a command group name and one or more commands. A slash precedes and follows each command frame. A colon follows the command group name, and a comma follows each command name except the last command. TAS 4500 ignores white space within the command frame and characters are not case sensitive. The command frame has the following syntax:

```
/command group: command1, command2, ..., commandn/
```

All of the commands within a command frame must belong to the same command group. An example of a command group is CH1_P1:

```
/CH1_P1: MOD=FS, DOPP=100/
```

The above command sets the following Channel 1 Path 1 parameters:

- SET Channel 1 Path1 modulation to frequency shift
- SET Channel 1 Path1 Doppler frequency to +10 Hz.

NOTE: All of the commands in the previous example are SET commands.

An example of a REPORT command is:

```
/CNFG:MODL/
```

This command instructs the instrument to report its model number. The response would be:

```
/CNFG:MODL=4500/
```

If TAS 4500 receives a SET command without a parameter value, it returns the current value of the parameter. For example, the following message tells TAS 4500 to return the value of the PATH1 modulation parameter:

```
/CH1_P1: MOD/
```

The TAS 4500 would respond with the following message:

```
/CH1_P1: MOD=FS/
```

An example of an EXECUTE command is:

```
/FILE: FRCL/
```

This command tells TAS 4500 to EXECUTE a file recall.

A command message can contain more than one command frame. For example, the following command message tells TAS 4500 to EXECUTE diagnostics, SET the RESPONSE mode to TERSE, and REPORT the current value of the Doppler frequency for Path 1:

```
/CNFG:DIAG, RESP=TERSE/CH1_P1:DOPP/
```

A single slash separates the CNFG command group from the CH1_P1 command group.

5.4.4. Response Format

TAS 4500 provides an explicit response to each command message that it receives. A command message can be one of three types:

- Command Completion message
- Value message
- Error message

Command Completion Message

TAS 4500 returns a command completion message in response to a SET command or EXECUTE command. The command completion message is:

```
/C/
```

Parameter Value Readback

TAS 4500 returns a value message in response to a REPORT command. The form of the value message is:

```
/command group: command=value/
```

For example, if the controller sends the message

```
/CH1_P2: MOD/
```

TAS 4500 might respond with

```
/CH1_P2: MOD=RAYL/
```

This response indicates that Rayleigh modulation is selected for Channel 1 Path 2.

Error Message Format

TAS 4500 returns an error message when it detects a problem with command syntax, or when it detects an internal processing error. The form of the error message is:

```
/command group: Exxx/
```

where *xxx* is the error number.

Response to a Multiple-Command Message

TAS 4500 returns only one response for each command message that it receives. If the command message contains multiple commands, TAS 4500 responds to the last command in the message. If one of the commands in a multiple command message results in an error, TAS 4500 ceases processing the command message and reports the error.

Terse Responses

If the PROTOCOL RESPONSE MODE is **terse**, TAS 4500 does not include the slashes, command group name, or parameter name in the response. The following command transactions illustrate the format of terse responses.

```
Command: /CNFG: MODL/
```

```
Response: 4500
```

5.5. Transmission Layer Protocols

TAS 4500 provides three remote control protocol options: RS-232 CR/LF, RS-232 ACK/NAK, and GPIB. The command syntax remains the same, regardless of the remote protocol. The remote control protocol determines only the method by which TAS 4500 receives commands and provides responses.

5.5.1. RS-232C CR/LF Protocol

The TAS 4500 RS-232 CR/LF is the simplest remote control protocol. You can use this protocol to control TAS 4500 from a data terminal or a computer. The RS-232 CR/LF protocol does not perform error checking, so you should not use this protocol unless the control terminal or computer is co-located with the TAS 4500.

TAS 4500 provides a > prompt when it is ready to receive a command. To enter a command, simply type the command, then press CARRIAGE RETURN. TAS 4500 executes the command and provides a response. After TAS 4500 provides the response, it sends another > prompt to indicate that it is again ready to receive a command.

5.5.2. ACK/NAK Protocol

The TAS 4500 ACK/NAK protocol supports RS-232 multipoint communication between a controller and one or more TAS devices. ACK/NAK also detects command transmission errors, and provides for retransmission of corrupted commands.

The controller initiates all ACK/NAK protocol transactions. To effect a command transaction with TAS 4500, the controller must perform the following operations:

- Poll the TAS 4500 for a pending response.
- Send the command to TAS 4500.
- Poll TAS 4500 for the command response.

The following example illustrates a command transaction between a controller and TAS 4500.

First, the controller polls for any pending response. This ensures that the TAS 4500 response buffer is empty so that TAS 4500 can process the next command.
[addr]p<ENQ>

The TAS 4500 response buffer is empty, so it responds:

[addr]<EOT>

Next, the controller sends the command to TAS 4500:

[addr]s<ENQ><SOH><STX>/CNFG: CHCORR=TYPE1/<ETX>[checksum]

TAS 4500 receives the command, does not detect any errors, and responds:

[addr]<ACK>

The controller then polls for the response to the command:

[addr]p<ENQ>

TAS 4500 has finished executing the command, so it responds:

[addr]<SOH><STX>/C/<ETX>[checksum]

NOTE: [addr] is the device address. The address can be any decimal number from 0 to 99. If the address is less than 10, the controller must left-pad the address with a space.

[checksum] is the message checksum. The message checksum is a three-digit decimal number. [checksum] is the two's complement of the module 256 sum of all characters from the first address character through the <ETX> character. For example, if the checksum is 201, then the block checksum should be 055 (256-201).

<ENQ> is the ASCII INQUIRE control character.

<EOT> is the ASCII END OF TRANSMISSION control character.

<SOH> is the ASCII START OF HEADER control character.

<STX> is the ASCII START OF TEXT control character.

<ETX> is the ASCII END OF TEXT control character.

Polling the TAS 4500 for a Response

When TAS 4500 receives a command from the controller, it executes the command and prepares a response. The controller must poll TAS 4500 to receive this response. The poll sequence is:

[addr]p<ENQ>

The poll message results in one of the following:

- TAS 4500 does not respond.
- TAS 4500 has no response waiting.
[addr] <EOT>
- TAS 4500 provides a response.
[addr] <SOH><STX> [response] <ETX> [checksum]

TAS 4500 does not respond to a poll if one of the following conditions exists:

- The TAS 4500 configuration is not proper. For example, TAS 4500 does not respond if its ACK/NAK address does not match the address contained in the poll message.
- TAS 4500 is currently processing a command.
- The poll message has been corrupted by an error.
- TAS 4500 AC power is off.

If the controller does not receive a response from TAS 4500, it should poll again. TAS 4500 responds with [addr]<EOT> if it has no response pending.

Sending Commands to the TAS 4500

To send a command to TAS 4500, the controller must assemble and send a SELECT message. The format of the SELECT message is shown below.

[addr]s<ENQ><SOH><STX>[command]<ETX>[checksum]

The select message yields one of three possible results:

- TAS 4500 does not respond to the message.
- TAS 4500 detects an error in the message:
[addr]<NAK>
- TAS 4500 receives the message and does not detect any errors:
[addr]<ACK>

TAS 4500 does not respond to the SELECT message if one of the following conditions exists:

- The TAS 4500 address does not match the address contained in the SELECT message.
- TAS 4500 AC power is off.

TAS 4500 responds with a negative acknowledgment (NAK) if it detects a transmission error in the SELECT message (bad checksum), or if the message is too long (greater than 512 characters). If TAS 4500 detects a transmission error in the message, the controller should send the message again.

Receiving Responses from the TAS 4500

TAS 4500 provides a command response when it is polled by the controller. If the controller detects a transmission error in the TAS 4500 response, it should perform the following steps:

- Poll TAS 4500 until TAS 4500 responds with [addr]<EOT>.
- Send the message again.
- Poll TAS 4500 again for the response.

5.5.3. GPIB Protocol

The TAS 4500 GPIB protocol supports a parallel bus control architecture in which TAS 4500 is one of the devices being controlled. The controller must meet all GPIB electrical and mechanical specifications.

The controller initiates all GPIB protocol transactions. In order to communicate with TAS 4500, a GPIB controller must perform the following operations:

- Poll TAS 4500 for a pending response.
- Send the message to TAS 4500.
- Poll TAS 4500 for the command response.

TAS 4500 provides a GPIB status byte to indicate its current state. Possible states include:

- IDLE - 02H
- BUSY - 01H
- READY TO RESPOND (RTR) - 04H or 44H

IDLE indicates that TAS 4500 does not have a message to send and is ready to accept a command.

BUSY indicates that TAS 4500 is currently processing a command. TAS 4500 does not accept a new command until it has finished processing the current command and has provided the response to the controller.

READY TO RESPOND (RTR) indicates that TAS 4500 currently has a message to send to the controller. TAS 4500 is always Ready to Respond when it finishes processing a command.

When TAS 4500 is ready to respond, it activates the service request line (SRQ), and sets the RTR status to 44 hex. After the controller conducts the serial poll, SRQ goes inactive, and TAS 4500 sets the RTR status to 04 hex.

Figure 5-2 shows a flowchart for a typical bus controller sequence.

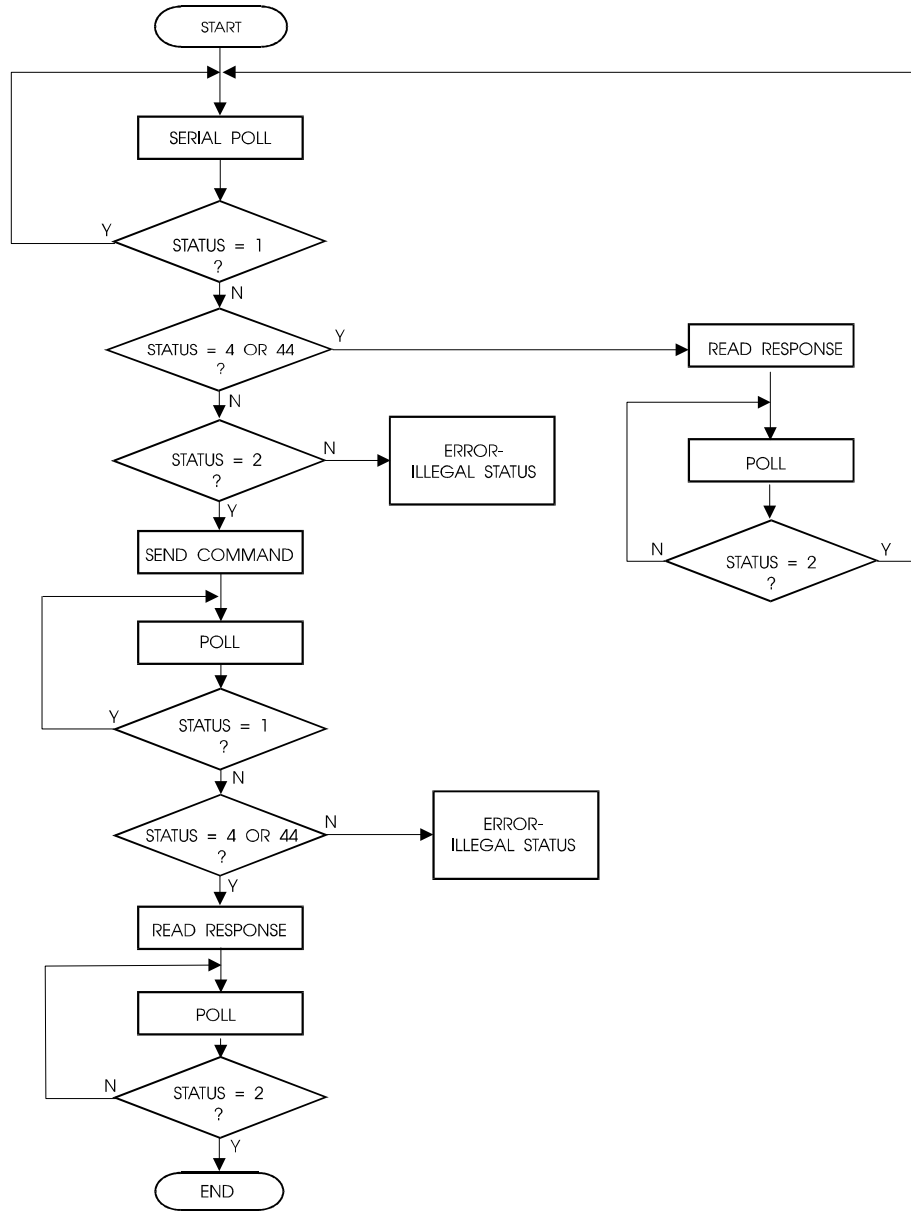


Figure 5-2. GPIB Controller Sequence

Polling for a Response

The controller must conduct a serial poll to receive a command response from TAS 4500. The following example shows the typical GPIB sequence required to achieve a serial poll of TAS 4500. Your actual bus sequence may be different:

- a. ATN active
- b. UNT - (UNTalk)
- c. UNL - (UNListen)
- d. SPE - (Serial Poll Enable)
- e. MTA - (TAS 4500 My Talk Address)
- f. Controller programmed to listen
- g. ATN inactive
- h. TAS 4500 sends status
- i. ATN active
- j. SPD - (Serial Poll Disable)
- k. UNT - (UNTalk)

Always conduct a serial poll before sending a command to TAS 4500. If TAS 4500 has a pending message to send, it does not accept a new command.

Sending Commands to the TAS 4500

The following example shows the typical GPIB sequence required to send a command to TAS 4500. Your actual bus sequence may be different.

- a. ATN active
- b. UNT - (UNTalk)
- c. UNL - (UNListen)
- d. MLA - (TAS 4500 My Listen Address)
- e. Controller programmed to talk
- f. ATN inactive
- g. Controller sends command to TAS 4500 and asserts EOI with last command character
- h. ATN active
- i. UNL - (UNListen)

Command strings must not be terminated with CARRIAGE RETURN or CARRIAGE RETURN+LINE FEED. The controller must signal the end of a command message by asserting EOI (end of interrupt) while it sends the last character of the message.

Some commands require several seconds of TAS 4500 processing time. While TAS 4500 completes most commands in less than 100 msec., some commands may require up to 3 seconds. The controller should conduct serial polls until the TAS 4500 status is RTR.

Receiving Responses from the TAS 4500

The following example shows the typical GPIB sequence required to receive a command from TAS 4500. Your actual bus sequence may be different.

- a. ATN active
- b. UNT - (UNTalk)
- c. UNL - (UNListen)
- d. MTA - (TAS 4500 My Talk Address)
- e. Controller programmed to listen
- f. ATN inactive
- g. TAS 4500 sends data to controller
- h. Controller reasserts control when EOI goes active
- i. ATN active
- j. UNT - (UNTalk)

TAS 4500 does not terminate its response message with a CARRIAGE RETURN or CARRIAGE RETURN+LINE FEED. TAS 4500 signals the end of a response message by raising EOI while it sends the last character of the response.

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6.0. COMMAND REFERENCE

This section is designed to help those who are already familiar with the TAS 4500 command set easily find and use commands. The TAS 4500 Parameter Reference provides a complete description of each command group and all commands within each group.

The user should be thoroughly familiar with Section 5.0. “Remote Operation”, before attempting to use the TAS 4500 remote commands. The “Remote Operation” section provides the details of the TAS 4500 command message format and syntax.

6.1. Conventions to Specify Commands

The TAS 4500 commands are divided into three types: SET, REPORT, and EXECUTE. In the Command Summary, these three types are indicated in the column type.

SET commands are issued to the TAS 4500 in the format:

/command group:parameter=setting/

The TAS 4500 will respond to a legal SET command with the response:

/C/

REPORT commands require the format:

/command group:name/

The TAS 4500 will provide the requested information as:

/command group:name=response/

where *response* can be more than one value separated by commas. All SET commands respond like REPORT commands if “=*setting*” is left out. The returned value is the current setting of the parameter.

EXECUTE commands require the format:

/command group:command/

If the command is successful, the TAS 4500 will respond with:

/C/

6.2. Command Summary

Channel 1 or Channel 2 **CHAN1:** or **CHAN2:**

Name	Description	Data Range	Type
ALT_FC	Set Alternate Channel Carrier Frequency	25000 to 4000000 (25.000MHz to 4000.000MHz)	SET
CBP	RF Channel Bypass	ON,OFF	SET
CMD	Set Channel Maximum Doppler	FADEM = TYPE1 (Jakes) 10 to 10000 (1.0 to 1000.0 Hz) FADEM = TYPE2 (Filtered Noise) 1 to 10000 (0.1 to 1000.0 Hz)	SET
DDy DD1 DD2 DD3 DD4 DD5 DD6 DD7 DD8	Defines the delay value for each bin ¹ Delay Bins 1-8 for Channel x Delay Bins 9-16 for Channel x Delay Bins 17-24 for Channel x Delay Bins 25-32 for Channel x Delay Bins 33-40 for Channel x Delay Bins 41-48 for Channel x Delay Bins 49-56 for Channel x Delay Bins 57-64 for Channel x	Standard Delay: 0 to 1250000 (0.0 - 25.0 µsec) Extended Delay: 0 to 20000000 (0.0 - 2000.0 µsec)	SET
DDBINS	Sets the number of active delay bins in Channel x	1 to 64	SET
DDPATHS	Sets the number of active paths in Channel x	1 to 6	SET
FC	Set Channel Carrier Frequency	25000 to 6000000 ² (25.000MHz to 6000.000MHz)	SET
ILEVEL	Set Channel Input Level	50 to -300 (5.0 to -30.0 dBm)	SET
LOFRQ	Set LO Frequency In Manual Mode 200 MHz LO Option 940 MHz to 2860 MHz LO Option	20000 to 40000 (200.00 MHz to 400.00 MHz) 94000 to 286000 (940.00 MHz to 2860.00 MHz)	SET
LOSEL	Select Local Oscillator Control	EXT, AUTO, MANU, EX4500	SET
OUTATTEN	Set output attenuator loss (Optional) 800 to 2500/2700 MHz Attenuator 25 to 4000 MHz Attenuator	0 to 800 (0.0 to 80.0 dB) 0 to 900 (0.0 to 90.0 dB)	SET
RANGE	Perform Automatic Input Range	None	EXEC

Stand alone 4500 allows operation to 4000 MHz. Use with External TAS5046 permits operation from 4000 to 6000 MHz

¹ Each of the eight delay bin values for each DDx command should be separated by a semicolon as in the following example:

/CHAN1:DD1=0;10000;20000;30000;40000;50000;60000;70000/

² Stand alone 4500 allows operation to 4000 MHz. Use with External Tas5046 permits operation from 4000 to 6000 MHz

File Save & Recall FILE:

Name	Description	Data Range	Type
FNAM	Set File Name	(see Note ³)	SET
FRCL	Recall File With Current Name (See FNAM)	None	EXEC
FSAV	Save File To Current Name	None	EXEC

System Configuration CNFG:

Name	Description	Data Range	Type
CHCORR	Sets the Channel Correlation	TYPE1, TYPE6, TYPE7, TYPE8, TYPE9	SET
CORRAL	Sets the Correlation Algorithm	TYPE1 (envelope) TYPE2 (component)	SET
DDPROF	Sets the 3GPDP test profile to be executed	TYPE1 (Moving Propagation) TYPE2 (Birth-Death)	SET
DEE_TRIG	Sets the DEE Trigger Mode	INT (internal) EXT (external) SSTEP (single step)	SET
DIAG	Perform Diagnostics	None	EXEC
DSP1	Report DSP1 Version Number	None	RPT
DSP2	Report DSP2 Version Number	None	RPT
EMULM	Sets the Emulation Mode	MODE1 (Static operation) MODE5 (3GPDP mode)	SET
ESYS	Report Extended System Configuration	None	RPT
FADEM	Fading Emulation Method	TYPE1 (Jakes Method) TYPE2 (Filtered Noise Method)	SET
FDTM	Fading Doppler Tracking Mode	SYS, CHAN, PATH	SET
IOFTM	I/O Frequency Tracking Mode	MODE1 (carrier) MODE2 (alt. Carrier) MODE3 (Ext. UDC 4-6 GHz)	SET
LOC	Enable Local Control (Enter Local)	None	EXEC
LOSR	Line of Site Reference	PD, CMD	SET
MODL	Report System Model Number	None	RPT
PATHSW	Set the Channel Configuration	MODE1 (dual channel) MODE2 (single channel) MODE3 (diversity) MODE4 (interference)	SET
PDP_RUN	Starts the selected test execution	None	EXEC
RAYPS	Sets the shape of the Rayleigh Power Spectrum (only available in Jakes emulation mode)	TYPE1 (classical 6 dB) TYPE2 (flat)	SET
REF	Selects Internal/External 10 MHz reference	INT, EXT	SET
REM	Enable Remote Control (Enter Remote)	None	EXEC
RESP	Sets the remote response format	VERBOSE, TERSE	EXEC
SCV	Report System Controller Version Number	None	RPT
STAT	Report Last Error Status (Diagnostics Status)	None	RPT

³FNAM options are the read/write files: file0, file1, file2, file3, file4, and the read-only files IS55-56_1, IS55-56_2, IS55-56_3, CDMA_1, CDMA_2, CDMA_3, CDMA_4, CDMA_5, HT100_1, HT100_2, TU50_1, TU50_2, EQ50, EQ100, RA100_1, RA100_2, RA250_1, RA250_2 and FDEFAULT

Control All Paths **PATHS:**

Name	Description	Data Range	Type
FADREP	Set nominal Fading Repetition Rate (only available for filtered noise emulation mode)	RATE1 (20 minutes) RATE2 (27 seconds) RATE3 (24 hours)	SET
RSD	Sets the state duration	1 to 60000 (.001 sec to 60.000 sec)	SET

Path Correlation CH2_Pi (i=1 to 6):

Name	Description	Data Range	Type
ECORR	Set Path Correlation Coefficient	0 to 100 (0.00 to 1.00)	SET

Path Control CH1_Pi, CH2_Pi: (i=1 to 6)

Name	Description	Data Range	Type
AOA	Rician and Nakagami Angle of Arrival	0 to 3600 (0.0 to 360.0 degrees)	SET
DELAY	Set Relative Path Delay With extended delay option	0 to 1250000 (0 to 125.0000µs) 0 to 20000000 (0 to 2000.0000µs)	SET
DELTAW	Sets the frequency for the sinusoidal delay oscillation for Channel x, Path y	1 to 32767 (1E-3 to 32767E-3 rad/sec)	SET
DMAX	Sets the max value for the sinusoidal delay oscillation for Channel x, Path y	Standard Delay: 0 to 1250000 (0.0 - 125.0 µsec) Extended Delay: 0 to 20000000 (0.0 - 2000.0 µsec)	SET
DMIN	Sets the min value for the sinusoidal delay oscillation for Channel x, Path y	Standard Delay: 0 to 1250000 (0.00- 125.0 µsec) Extended Delay: 0 to 20000000 (0.0 - 2000.0 µsec)	SET
DOPP	Set Fading Doppler Frequency	FADEM = TYPE1 (Jakes) (-10000 to -10, 10 to 10000) (-1.0 to -1000.0, 1 to 1000.0 Hz) FADEM = TYPE2 (Filtered Noise) -10000 to -1, 1 to 10000 (-1000.0 to -0.1, 0.1 to 1000.0 Hz)	SET
FADET	Set fading environment type (only available in Filtered Noise emulation mode)	TYPE1 (classical 6 dB) TYPE2 (flat) TYPE3 (classical 3 dB) TYPE4 (rounded)	SET
FS_DOPP	Set Frequency Shift Doppler Frequency	-100000 to -1, 1 to 100000 (-1000.00 to -0.01, 0.01 to 1000.00 Hz)	SET
FSF	Set Shift Frequency for Rayleigh With Frequency Shift (Jakes emulation mode only)	-9990 to 9990 (-999.0 Hz to 999.0 Hz)	SET
LNCAL	Report Log-normal calibration status	yes, no	RPT
LNRT	Set Path Log-normal rate	0 to 20000 (0 to 20.000 Hz)	SET

Name	Description	Data Range	Type
LNSTAT	Set Log-normal status	on, off	SET
LNSTD	Set Path Log-normal standard deviation	0 to 12	SET
LOSS	Set Relative Path Loss	0 to 500 (0 to 50.0 dB)	SET
MOD	Set Path Modulation Type	NONE, RAYL, FS, PHAS, FSRAY, NAK, RICE_K, FSRICE	SET
NM	Set Nakagami M Value	1, 3, 5, 10, 15, 25, 100	SET
PHAS	Set Phase For Phase Modulation	0 to 3600 (0 to 360.0 degrees)	SET
RK	Set Rician K Factor	-300 to 300 (-30 dB to +30 dB)	
STAT	Set Path Status	ON, OFF	SET

6.3. Command Descriptions

All commands summarized in the previous Section 6.2 "Command Summary" will be described in detail in this section.

6.3.1. Channel 1 & Channel 2 Configuration (CHAN1 & CHAN2)

Command Group Format:

/CHAN1:command(s)/ or /CHAN2:command(s)/

Command Group Description:

The CHAN1 and CHAN2 command groups allow the user to configure channel settings of the TAS 4500. The CHAN1 command group controls settings of channel 1 of the TAS 4500 while the CHAN2 command group controls settings of the channel 2 setting if the system is equipped with a second channel.

Commands:

ALT_FC, CBP, CMD, DDx, DDBINS, DDPATHS, FC, IGAIN, LOSEL, LOFRQ, OUTATTEN, RANGE

Alternate Carrier Frequency (ALT_FC)

Command Description:

Sets the alternate carrier frequency for the specific channel. This feature is used when the I/O frequency tracking mode is set to MODE2 (alternate carrier).

Valid Command Data:

Range: 25000 to 4000000 (25 MHz to 4000 MHz)

<p>NOTE: Range may vary according to RF options present. Consult Section 8.0 "Technical Specifications" for your model 4500 to confirm the valid range supported.</p>
--

Example:

To set channel 1 carrier frequency to 245 MHz.

/CHAN1:ALT_FC=245000/

Expected Response:

/C/

RF Channel Bypass (CBP)

Command Description:

Enable or Bypass the selected RF Channel

Valid Command Data:

Range: ON, OFF

Example:

To bypass Channel 1 of the TAS 4500.

```
/CHAN1:CBP = ON/
```

Expected Response:

```
/C/
```

Channel Maximum Doppler (CMD)

Command Description:

Defines the maximum Doppler frequency for the channel. The CMD can only be set via the remote interface or TASKIT/4500 software. The Doppler for all paths in a channel must be set less than or equal to the CMD. See Section 4.5.14 for more information on the use of CMD.

Valid Command Data:

FADEM (Fading Emulation Method) = TYPE1 (Jakes Method)

Range: 10 to 10000
(1.0 to 1000.0 Hz)

FADEM (Fading Emulation Method) = TYPE2 (Filtered Noise Method)

Range: 1 to 10000
(0.1 to 1000.0 Hz)

Example:

To set the Channel Maximum Doppler for Channel 1 to 41.7 Hz:

```
/CHAN1:CMD=417/
```

Expected Response:

```
/C/
```

Delay Data(1:8) (DD1:DD8)

Command Description:

Used in the 3GPDP test application to define the location of the delay bins used in the Birth-Death test. There are 64 possible delay bin values that are provided right values at a time. This breakdown requires DD1 to provide bins 1 thru 8 and DD8 to provide bins 57 to 64.

Valid Command Data:

Range: 0 to 1250000 (0.0000 μ s to 125.0000 μ s)

0 to 20000000 (0.0000 μ s to 2000.0000 μ s) optional

Example:

To provide a Channel 1 bin spacing that includes bin1=0 μ sec; bin2=1 μ sec; bin3=2 μ sec; bin4=3 μ sec; bin5=4 μ sec; bin6=5 μ sec; bin7=6 μ sec; bin8=7 μ sec:

```
/CHAN1:DD1 = 0;10000;20000;30000;40000;50000;60000;70000/
```

Expected Response:

```
/C/
```

Delay Data Bins (DDBINS)

Command Description:

Used in the 3GPDP test application to define the number of active delay bins used in the Birth-Death test. This is a channel wide parameter, and cannot be defined for individual paths.

Valid Command Data:

Range: 1 to 64

Example:

To set the number of active bins to 20:

```
/CHAN1:DDBINS=20/
```

Expected Response:

```
/C/
```


Delay Data Paths (DDPATHS)

Command Description:

Used in the 3GPDP test application to define the number of active paths in a given channel for the Birth-Death test.

Valid Command Data:

Range: 1 to 6

Example:

To set the number of active paths in Channel 1 to 3:
/CHAN1:DDPATHS=3/

Expected Response:

/C/

Carrier Frequency (FC)

Command Description:

Sets the carrier frequency for the specific channel.

Valid Command Data:

Range: 25000 to 6000000 (25 MHz to 6000 MHz)

NOTE: Range may vary according to RF options present. Consult Section 8.0 “Technical Specifications” of your model 4500 to confirm the valid range supported. The 4000 to 6000 MHz range is available only when using the External TAS5046 in conjunction with the 4500.

Example:

To set channel 1 carrier frequency to 900 MHz.
/CHAN1:FC=900000/

Expected Response:

/C/

Input Level (ILEVEL)

Command Description:

Sets the input reference level for the specific channel.

Valid Command Data:

Range: 50 to -300 (5.0 dBm to -30.0 dBm)

Example:

To set channel 2 input reference level to -15.0 dBm.

```
/CHAN2:ILEVEL= -150/
```

Expected Response:

```
/C/
```

Local Oscillator Control Mode (LOSEL)

Command Description:

This command selects the control mode of the local oscillator associated with the channel. AUTO and MANUal are only for systems that are equipped with internal local oscillator(s),

Valid Command Data:

EXT - External LO used. (i.e. Disable internal LO output)

AUTO - Internal LO frequency automatically tracks the carrier frequency

MANU - Internal LO enabled, but the user has to set the frequency manually

EX4500 - External LO from another 4500 channel used.

Example:

To change the channel 2 LO control to auto:

```
/CHAN2:LOSEL=AUTO/
```

Expected Response:

```
/C/
```

Local Oscillator Frequency (LOFRQ)

Command Description:

If equipped with this option, this command sets the LO frequency when the LO control is in manual mode. If the LO control is not in manual mode, an error will be returned. As different LO options support distinct frequency ranges, be sure to check to see which LO module is present in your system. This can be done by using the /CNFG:ESYS/ command described in Section 6.3.2. See Section 4.4 for more details on setting the local oscillator control.

Valid Command Data:

LO 3 option

Range: 20000 to 40000 (200.00 MHz to 400.00 MHz)

LO 4 option

Range: 94000 to 286000 (940.00 MHz to 2860.00 MHz)

Example:

To set the channel 1 local oscillator frequency to 940.00 MHz (in manual mode):

```
/CHAN1:LOFRQ=94000/
```

Expected Response:

```
/C/
```

Programmable Output Attenuator (OUTATTEN)

Command Description:

If equipped with this option, this command allows the amount of loss provided by the output attenuator to be programmed. See Section 4.4 for more information on the output attenuator.

Valid Command Data:

800 to 2500/2700 MHz Attenuator / 0.1 dB step size

0 to 800 (0.0 to 80.0 dB)

25 to 4000 MHz Attenuator / 0.1 dB step size

0 to 900 (0.0 to 90.0 dB)

Example:

To set the output attenuator to 60.0 dB on channel 1:

```
/CHAN1:OUTATTEN=600/
```

Expected Response:

```
/C/
```

Automatic Input Range (RANGE)

Command Description:

Performs an automatic input range on the channel. If the input to the channel is out of the possible range, an error will be returned to signal a failure of the input range operation. See Section 4.4 for more information on the input range.

Valid Command Data:

None

Example:

To perform an automatic input range on channel 1:

```
/CHAN1:RANGE/
```

Expected Response:

If the input range is successful:

```
/C/
```

6.3.2. System Configuration (CNFG)

Command Group Format:

/CNFG:command(s)/

Command Group Description:

The CNFG command group allows the user to query, execute and select different system configuration settings.

Commands:

CHCORR, CORRAL, DDPROF, DEE_TRIG, DIAG, DSP1, DSP2, EMULM, ESYS, FADEM, FDTM, IOFTM, LOC, LOSR, MODL, PATHSW, PDP_RUN, RAYPS, REF, REM, SCV, STAT

Channel Correlation (CHCORR)

Command Description:

Selects different channel correlation configurations for the system. Under normal single instrument operation (power up system default is TYPE1), this parameter does not need to be changed. TYPE2, TYPE3, TYPE4, and TYPE5 are reserved values. TYPE6, TYPE7, TYPE8 and TYPE9 are only used in a 4/6/8 branch configuration for TAS 4500 units that are equipped with this test feature.

Valid Command Data:

TYPE1 - Normal single instrument configuration

TYPE2 – Reserved

TYPE3 – Reserved

TYPE4 – Reserved

TYPE5 – Reserved

TYPE6 – Unit 1 (Primary) in a 4/6/8 branch diversity configuration

TYPE7 – Unit 2 in a 4/6/8 branch diversity configuration

TYPE8 - Unit 3 in a 4/6/8 branch diversity configuration

TYPE9 - Unit 4 in a 4/6/8 branch diversity configuration

Example:

To configure the 4500 as Unit 2 in a dual-instrument configuration:

```
/CNFG:CHCORR=TYPE7/
```

Expected Response:

```
/C/
```

Correlation Algorithm (CORRAL)

Command Description:

Selects the correlation algorithm used to calculate the correlation coefficient.

Valid Command Data:

TYPE1 (Envelope) - Defines the correlation between the Rayleigh faded signals at the output of the associated channels.

TYPE2 (Component) - Defines the correlation between the In-Phase components of the associated Rayleigh faded signals in addition to the correlation between the Quadrature components.

Example:

To set the correlation algorithm based on the output of associated channels:

```
/CNFG:CORRAL=TYPE1/
```

Expected Response:

```
/C/
```

Delay Data Profile (DDPROF)

Command Description:

Used in the 3GPDP test application to select the desired characteristics of the delay changes. The two currently supported delay profiles are the Moving Propagation Test (TYPE1) and the Birth-Death Test (TYPE2).

Valid Command Data:

Range: TYPE1 (Moving Propagation)

TYPE2 (Birth-Death)

Example:

To set the 3GPDP test profile to Birth-Death:

```
/CNFG:DDPROF=TYPE1/
```

Expected Response:

```
/C/
```

DEE Trigger (DEE_TRIG)

Command Description:

Sets the trigger mechanism for Dynamic Environment Emulation testing.

Valid Command Data:

INT – Use the internal timing mechanism to trigger state changes

EXT – Permit user to inject TTL signal to control state transitions.

SSTEP – Allow user to trigger state transitions one at a time from TASKIT.

Example:

To set the DEE trigger to Single Step:

```
/CNFG:DEE_TRIG=SSTEP/
```

Expected Response:

```
/C/
```

System Diagnostics (DIAG)

Command Description:

Performs a self-test and report system diagnostics. If the system encounters an error during the diagnostic, the system error will be returned. For more information on system errors, see Section 7.0 for a listing of the error codes.

Valid Command Data:

None

Example:

To perform a system diagnostic:

```
/CNFG:DIAG/
```

Expected Response:

If no error is encountered during the diagnostic:

```
/C/
```

Digital Signal Processors Version Numbers (DSP1 & DSP2)

Command Description:

Reports the version numbers of the digital signal processors. Command DSP1 queries the version number of processor 1 while command DSP2 queries the version number of processor 2.

Valid Command Data:

None

Example:

To query the version number of the digital signal processor 2:

```
/CNFG:DSP2/
```

Expected Response:

```
/CNFG:DSP2=5.10/
```

Emulation Mode (EMULM)

Command Description:

Used in the 3GPDP test application to perform the system arm and stop operations. By sending the MODE5 command, the unit is prepared for test execution that is then accomplished by sending the PDP_RUN command immediately following. The MODE1 command is used to stop test execution and return to static operation.

Valid Command Data:

Range: MODE1 (Static Operation)
 MODE5 (Arm 3GPDP Mode)

Example:

To arm the unit for 3GPDP testing:

```
/CNFG:EMULM=MODE5/
```

Expected Response:

```
/C/
```


Extended Query of the System Configuration (ESYS)

Command Description:

Extended report of the system's configuration.

Valid Command Data:

The system configuration information is encoded into a 32 digit string. The following list explains each of the digit assignments.

DIGIT	DESCRIPTION	VALUES	
28-31	Digit 28 to digit 31 are reserved for future use	default value = 0	
27	Reserved	default value = 0	
26	Channel Configuration	0=Not Installed	1=Installed
25	CH 1 RF Channel Bypass	0=Not Installed	1=Installed
24	CH 2 RF Channel Bypass	0=Not Installed	1=Installed
23	Insertion Loss Estimate	0=Not Installed	1=Installed
22	Selectable 10 MHz Reference	0=Not Installed	1=Installed
21	CH1 RF Carrier Frequency Range	1=800 to 2500 MHz 3=25 to 3000 MHz 5=800 to 2700 MHz 7=25 to 4000 MHz	2=25 to 2500 MHz 4=800 to 3000 MHz 6=25 to 3600 MHz 8=800 to 4000 MHz
20	CH2 RF Carrier Frequency Range	1=800 to 2500 MHz 3=25 to 3000 MHz 5=800 to 2700 MHz 7=25 to 4000 MHz	2=25 to 2500 MHz 4=800 to 3000 MHz 6=25 to 3600 MHz 8=800 to 4000 MHz
19	Dynamic Emulation Capability	0=Not Installed	1=Installed
18	Doppler Frequency Range	1=-740 to -1, 1 to 740 Hz 2=-1000 to -1, 1 to 1000 Hz	
17	Input reference Level Range	1=8 to -32 dBm 3=5 to -30 dBm	2=5 to -35 dBm
16	Relative Path Loss Range	1=0 to 50 dB 3=0 to 30 dB	2=0 to 40 dB
15	Relative Delay Resolution	1=10 nsec 3=0.5 nsec	2=1 nsec
14	Relative Delay Range	1=200 µsec 3=800 µsec 5=66.666 µsec 7=125.0000 µsec	2=100 µsec 4=1600 µsec 6=533.328 µsec 8=2000µsec
13	IF Channel Bandwidth	1=6 MHz 3=26 MHz 5=FLEX5	2=15 MHz 4= 8 MHz
12	DSP Module Type	1=Type 1 DSP FW Version = 1.10 2=Type 2 DSP FW Version = 2.00 3=Type 3 DSP FW Version = 3.00 or 3.20 4=Type 4 DSP FW Version = 4.00 5=Type 5 DSP FW Version = 4.10,4.11,4.20 6=Type 6 DSP FW Version = 4.40 7=Type 7 DSP FW Version = 5.00 8=Type 8 DSP FW Version = 5.10 9=Type 9 DSP FW Version = 5.20 – 5.24 A=Type A DSP FW Version =5.30	

DIGIT	DESCRIPTION	VALUES
11	CH1 Tunable RF Filter Type	0=not present 1=Type 1 (800 to 2500 MHz) 2=Type 2 (800 to 3000 MHz/30 MHz) 3=Type 3 (800 to 3000 MHz/35 MHz) 4=Type 4 (800 to 4000 MHz/35 MHz) 5=Type 5 (800 to 4000 MHz/35 MHz) +2 dB 6=Type 6 (800 to 3000 MHz/35 MHz) +2 dB
10	CH2 Tunable RF Filter Type	0=not present 1=Type 1 (800 to 2500 MHz) 2=Type 2 (800 to 3000 MHz/30 MHz) 3=Type 3 (800 to 3000 MHz/35 MHz) 4=Type 4 (800 to 4000 MHz/35 MHz) 5=Type 5 (800 to 4000 MHz/35 MHz) +2 dB 6=Type 6 (800 to 3000 MHz/35 MHz) +2 dB
9	Number of RF channels	1 or 2
8	Total number of paths	1=3 paths 2=6 paths 3=9 paths 4=12 paths
7	IF Module Type	1=Type 1 (reserved) 2=Type 2 (6 MHz, 10nsec/200µsec) 3=Type 3 (15 MHz, 1nsec/100µsec) 4=Type 4 (15 MHz, 1nsec/800µsec) 5=Type 5 (Universal)
6	Reserved	1
5	CH1 Up/Down Converter Type	0=not present 1=Type 1 (reserved) 2=Type 2 (6 MHz enhanced conversion) 3=Type 3 (6 MHz basic conversion) 4=Type 4 (15 MHz enhanced conversion) 5=Type 5 (15 MHz basic conversion) 6=Type 6 (Universal)
4	CH2 Up/Down Converter Type	0=not present 1=Type 1 (reserved) 2=Type 2 (6 MHz enhanced conversion) 3=Type 3 (6 MHz basic conversion) 4=Type 4 (15 MHz enhanced conversion) 5=Type 5 (15 MHz basic conversion) 6=Type 6 (Universal)
3	CH1 Output Attenuator Type	0=not present 1=Type 1 (0.1 dB step/800 to 2500 MHz) 2=Type 2 (0.5 dB step/25 to 2500 MHz) 3=Type 3 (0.5 dB step/25 to 3000 MHz) 4=Type 4 (0.1 dB step/800 to 2700 MHz) 5=Type 5 (0.1 dB step/25 to 4000 MHz)
2	CH2 Output Attenuator Type	0=not present 1=Type 1 (0.1 dB step/800 to 2500 MHz) 2=Type 2 (0.5 dB step/25 to 2500 MHz) 3=Type 3 (0.5 dB step/25 to 3000 MHz) 4=Type 4 (0.1 dB step/800 to 2700 MHz) 5=Type 5 (0.1 dB step/25 to 4000 MHz)
1	CH1 Local Oscillator Type	0=not present 1=Type 1 (reserved) 2=Type 2 (800-1100 MHz) 3=Type 3 (1800-2500 MHz) 4=Type 4 (200-400 MHz)

DIGIT	DESCRIPTION	VALUES
		5=Type 5 (940-2860 MHz) 6,7=reserved
0	CH2 Local Oscillator Type	0=not present 1=Type 1 (reserved) 2=Type 2 (800-1100 MHz) 3=Type 3 (1800-2500 MHz) 4=Type 4 (200-400 MHz) 5=Type 5 (940-2860 MHz) 6,7=reserved

Example:

```
/CNFG: ESYS/
```

Expected Response:

```
/CNFG: ESYS= 00000111117712313758442451665555/
```

NOTE: Bit 0 is to the right.

This response would indicate the unit was equipped with the following features:

- Channel Configuration Installed
- RF Channel 1 Bypass Installed
- RF Channel 2 Bypass Installed
- Output Power Estimation Installed
- Selectable 10 MHz Reference Installed
- Channel 1 RF Carrier Range : 25 to 4000 MHz
- Channel 2 RF Carrier Range : 25 to 4000 MHz
- Dynamic Environment Emulation Capability Installed
- Doppler Frequency Range of -1000 to 1000 Hz
- Input Reference Level Range of 5 to -30 dBm
- Relative Path Loss Range of 0 to 50 dB
- Relative Path Delay 125 µsec range / 0.5nsec resolution
- Type 8 DSP Module
- Channel 1 Type 2 (800 to 4000 MHz) Tunable RF Filter present
- Channel 2 Type 2 (800 to 4000 MHz) Tunable RF Filter present
- Two RF channels
- Six total paths
- Universal (Type 5) IF module
- Reserved
- Universal (Type 6) Channel 1 Up/Down Converter Type

- Universal (Type 6) Channel 2 Up/Down Converter Type
- Channel 1 Type 5 Output Attenuator present
- Channel 2 Type 5 Output Attenuator present
- Channel 1 Type 5 LO present (940-2860 MHz)
- Channel 2 Type 5 LO present (940-2860 MHz)

Fading Emulation Method (FADEM)

Command Description:

Sets the Fading Emulation Method used by the system. The Jakes method (TYPE1) uses a discrete set of tones to emulate Rayleigh fading. The Filtered Noise method (TYPE2) uses a band limited noise signal to emulate Rayleigh fading. The default method is Jakes (TYPE1).

Valid Command Data:

TYPE1, TYPE2

Example:

To set the system in Jakes Method:

```
/CNFG:FADEM=TYPE1/
```

Expected Response:

```
/C/
```

Fading Doppler Tracking Mode (FDTM)

Command Description:

Sets the way in which the fading Doppler on each path in the 4500 is controlled. There are three possible tracking modes to choose from. System mode (SYS) designates that all paths in both channels of the 4500 must have the same Doppler frequency. Channel mode (CHAN) sets all paths within a particular channel of the 4500 to have the same fading Doppler frequency. Path mode (PATH) allows each path to maintain an independent Doppler frequency.

Valid Command Data:

SYS, CHAN, PATH

Example:

To set the fading Doppler tracking mode to system.

```
/CNFG:FDTM=SYS/
```

Expected Response:

```
/C/
```

I/O Frequency Tracking Mode (IOFTM)

Command Description:

The user may independently set the RF carrier frequency and the Emulation carrier frequency using the I/O Frequency Tracking Mode parameter. The RF carrier frequency is used to set the actual RF input frequency of the signal a user will put into the 4500. The emulation carrier frequency is used to determine the proper fading Doppler frequency based on the velocity setting for a path.

In MODE1 (carrier mode), both the RF carrier frequency and the emulation frequency will be set the same using the FC command. In MODE2 (alternate carrier mode), the emulation carrier frequency is still set using the FC command. However, the actual RF carrier frequency is set using the ALT_FC command. In MODE3 (Ext UDC (4-6 GHz)), the RF carrier frequency is limited to the 4-6 GHz range, and the I/O Frequency will automatically be set to map the 4-6 GHz range into the 800-2800 MHz range on the 4500. The use of the TAS5046 is assumed when using MODE3.

Valid Command Data:

MODE1 (carrier), MODE2 (alternate carrier), MODE3 (Ext. UDC (4-6 GHz))

Example:

To set the I/O frequency tracking mode to alternate carrier.

```
/CNFG:IOFTM=MODE2/
```

Expected Response:

```
/C/
```

Line of Site Reference (LOSR)

Command Description:

Sets the reference for determining the Angle of Arrival (AOA) for the direct path component of the Nakagami, Rician, and Rician with Frequency Shift modulation types. When the LOSR is set to Path Doppler (PD), the AOA is set with reference to the Doppler frequency of the individual paths. When the LOSR is set to Channel Maximum Doppler (CMD), the AOA is set with reference to the value of the CMD parameter. When the CMD mode is selected, the direct path component may reside outside of the multipath spread. See Section 4.5.13 for more information on the use of CMD and LOSR.

Valid Command Data:

PD, CMD

Example:

To set the Line of Site Reference to CMD mode:

```
/CNFG:LOSR=CMD/
```

Expected Response:

```
/C/
```

Local Control (LOC)

Command Description:

Puts the system into local (front panel) control mode.

Valid Command Data:

None

Example:

```
/CNFG:LOC/
```

Expected Response:

```
/C/
```

Query System Model Number (MODL)

Command Description:

Reports the system model number.

Valid Command Data:

None

Example:

/CNFG:MODL/

Expected Response:

/CNFG:MODL=4500/

Channel Configuration (PATHSW)

Command Description:

Sets the Channel Configuration to allow the user to change the Channel/Path configuration of the unit.

Valid Command Data:

MODE1 – Dual Channel Mode provides 2 RF Channels with 3 or 6 paths available in each Channel.

MODE2 – Single Channel Mode allows all paths in the system to be used in one RF Channel providing up to 12 paths in a single Channel.

MODE3 – Diversity Mode allows for the simplification of multiple system test configurations that provide diversity test capability.

MODE4 – Interference Mode allows for the internal combination of a Desired Signal and an Interference Signal located at the same RF Carrier Frequency

Example:

/CNFG:PATHSW=MODE2/

Expected Response:

/C/

PDP Run (PDP_RUN)

Command Description:

Used in the 3GPDP test application to begin to execute the test. This operation is only valid after a unit has been successfully armed.

Valid Command Data:

Range: None

Example:

To begin 3GPDP test execution following the arm action:
/CNFG:PDP_RUN/

Expected Response:

/C/

Rayleigh Power Spectrum (RAYPS)

Command Description:

Selects the shape of the Rayleigh modulation power spectrum.

NOTE: This command only applies when Emulation Method is set to Jakes.

Valid Command Data:

TYPE1 - Classical 6 dB fading power spectrum shape as specified in IS55/56 and IS97/98 standards.

TYPE2 - Flat fading power spectrum shape observed for some indoor propagation models

Example:

To configure the fading power spectrum to have the classical 6 dB shape:
/CNFG:RAYPS=TYPE1/

Expected Response:

/C/

Reference (REF)

Command Description:

Selects either internal or external generation of the 10 MHz system reference signal utilized by the internal signal processing circuitry of the TAS 4500.

Valid Command Data:

INT - Selects internal reference so the TAS 4500 will utilize its own 10 MHz signal source.

EXT - Selects external reference source which requires a 10 MHz sinusoidal source be provided via the EXT REF I/O connector on the rear panel. Refer to Section 8.0 “Technical Specifications” for the requirements for the external source.

Example:

To set the reference source to external:

```
/CNFG:REF=EXT/
```

Expected Response:

```
/C/
```

Remote Control (REM)

Command Description:

Puts the system into remote control mode. Only available when in RS-232 control mode.

Valid Command Data:

None

Example:

```
/CNFG:REM/
```

Expected Response:

```
/C/
```

Response Format (RESP)

Command Description:

Sets the remote response format to either verbose or terse. If the RESP format is TERSE, TAS 4500 does not include the slashes, command group name, or parameter name in the response. The default value for RESP format is VERBOSE.

Valid Command Data:

VERBOSE: Causes the TAS 4500 to use its usual command response format as shown in the following example.

Command: /CNFG:MODL/
Response: /CNFG:MODL=4500/

TERSE: Causes the TAS 4500 to use the terse command response format shown in the following example:

Command: /CNFG:MODL/
Response: 4500

Example:

To set remote response format to TERSE:
/CNFG:RESP=TERSE/

Expected Response:

/C/

System Controller Version Number (SCV)

Command Description:

Reports the system controller processor firmware version number.

Valid Command Data:

None

Example:

/CNFG:SCV/

Expected Response:

/CNFG:SCV=5.00/

Diagnostics Status (STAT)

Command Description:

Reports the system status or the last diagnostics performed.

Valid Command Data:

None

Example:

/CNFG:STAT/

Expected Response:

/CNFG:STAT=ok/

6.3.3. File Save & Recall (FILE)

Command Group Format:

/FILE:command(s)/

Command Group Description:

The FILE command group allows the user to save system configurations to a user file or recall system configurations from a read-only file or predefined user file.

Commands:

FNAM, FRCL, FSAV

File Name (FNAM)

Command Description:

Selects the file name of the file to save to or recall from. For the configurations of the predefined read-only files, see Section 9.0 Appendix 1: Standard Test Profiles. Note that this command only sets the file name of the file to be used; no actual save or recall action is carried out. To perform a file save or recall the command FSAV and FRCL are used. The FSAV and FRCL commands are described in the following sections.

Valid Command Data:

FDEFAULT System factory default configuration (read-only)

FILE0-FILE4 User defined files (read/write)

other read-only files:

IS55/56 Test Files

IS55-56_1, IS55-56_2, IS55-56_3

IS97/98 Test Files

CDMA_1, CDMA_2, CDMA_3, CDMA_4, CDMA_5

GSM Test Files

HT100_1, HT100_2, TU50_1, TU50_2, RA100_1, RA100_2, RA250_1, RA250_2, EQ50, EQ100, HT100_1_12, HT100_2_12, TU50_1_12, TU50_2_12

Example:

To set the file name to the system default file:

/FILE:FNAM=FDEFAULT/

Expected Response:

/C/

File Recall (FRCL)

Command Description:

Performs a file recall with current file defined by the command FNAM. See Section 6.3.3 for details on the FNAM command.

NOTE: For the user file0 to file4, they have to be predefined first before they can be recalled. i.e. a configuration has to be saved to the user files before they can be recalled.

Valid Command Data:

None

Example:

/FILE:FRCL/

Expected Response:

/C/

File Save (FSAV)

Command Description:

Performs a file save with current file defined by the command FNAM. See Section 6.3.3 for details on the FNAM command.

NOTE: A file save operation can only be done on the user (read/write) files - file0 to file4. Any attempt to save the system configuration to a read-only predefined standard file will result in an error.

Valid Command Data:

None

Example:

/FILE:FSAV/

Expected Response:

/C/

6.3.4. Control of all Paths (PATHS)

Command Group Format:

/PATHS:command(s)/

Command Group Description:

The PATHS command groups allow the user to configure all paths of the unit simultaneously.

Commands:

FADREP, RSD

Fading Repetition Rate (FADREP)

Command Description:

Sets the repetition rate of the fading pattern when using Filtered Noise Emulation Mode. Since the repetition rate is dependent on the Doppler frequency, the times given below are approximate. Equations to calculate the exact repetition rate can be found in Section 4.0 "Reference."

Valid Command Data:

RATE1 (20 Minutes)

RATE2 (27 Seconds)

RATE3 (24 Hours)

Example:

To set the Fading Repetition Rate to 24 hours:

/PATHS:FADREP=RATE3/

Expected Response:

/C/

State Duration (RSD)

Command Description:

Within the 3GPDP application, this parameter sets the state dwell time for each defined state in the execution sequence.

Valid Command Data:

1 to 60000 (.001 to 60.000 seconds)

Example:

To set the state duration for the Birth-Death Test to 191ms:

```
/PATHS:RSD=191/
```

Expected Response:

```
/C/
```


6.3.5. Path Control (CH1_P1 to CH1_P6, CH2_P1 to CH2_P6)

Command Group Format:

/CH1_Pn:command(s)/ where n=1 to 6 for Channel 1.

/CH2_Pn:command(s)/ where n=1 to 6 for Channel 2.

Command Group Description:

The CH1_Pn and CH2_Pn command groups allow the user to configure each path of the unit separately.

Commands:

AOA, DELAY, DOPP, FADET, FSF, LNCAL, LNRT, LNSTAT, LNSTD, LOSS, MOD, PHAS, RK, STAT

Angle of Arrival (AOA)

Command Description:

Sets the arrival angle of the direct line of site component for the selected Rician or Nakagami modulated path.

Valid Command Data:

Range: 0 to 3600 (0 to 360.0 degrees)

Example:

To set the angle of arrival for Channel 1 Path 1 to 10.0 degrees:

/CH1_P1:AOA=100/

Expected Response:

/C/

Relative Delay (DELAY)

Command Description:

Sets the relative delay between paths. The TAS 4500 will round data to the nearest 0.5ns.

Valid Command Data:

Range: 0 to 1250000 (0.0000 μ s to 125.0000 μ s)
0 to 20000000 (0.0000 μ s to 2000.0000 μ s) optional

Example:

To set the relative path delay for Channel 1 Path 3 to 1.0000 μ s:
/CH1_P3:DELAY=10000/

Expected Response:

/C/

Delta ω (DELTAW)

Command Description:

Used in the 3GPDP application to set the frequency of the sinusoidal delay oscillation in the Moving Propagation test.

Valid Command Data:

Range: 1 to 32767 (1E-3 to 32767E-3 radians/second)

Example:

To set the frequency of oscillation to 40E-3 rads/sec (157 second period):
/CH1_P1:DELTAW=40/

Expected Response:

/C/

Delay Maximum (DMAX)

Command Description:

Used in the 3GPDP application to set the maximum delay value to be obtained during the sinusoidal variation of the delay setting presented in the Moving Propagation test. Note that prior to the start of a dynamic test, DMAX must set to a value greater than or equal to DMIN.

Valid Command Data:

Range: 0 to 1250000 (0.0000 μ s to 125.0000 μ s)
0 to 20000000 (0.0000 μ s to 2000.0000 μ s) optional

Example:

To set the maximum delay value for Path 1 to 20 μ s:

```
/CH1_P1:DMAX=100000/
```

Expected Response:

```
/C/
```

Delay Minimum (DMIN)

Command Description:

Used in the 3GPDP application to set the minimum delay value to be obtained during the sinusoidal variation of the delay setting presented in the Moving Propagation test. Note that prior to the start of a dynamic test, DMIN must set to a value less than or equal to DMAX.

Valid Command Data:

Range: 0 to 1250000 (0.0000 μ s to 125.0000 μ s)
0 to 20000000 (0.0000 μ s to 2000.0000 μ s) optional

Example:

To set the minimum delay value for Path 1 to 5 μ s:

```
/CH1_P1:DMIN=50000/
```

Expected Response:

```
/C/
```

Doppler Frequency (DOPP)

Command Description:

Sets the Doppler frequency for the path to be used for Rayleigh, Rician, Nakagami, Rayleigh with Frequency Shift and Rician with Frequency Shift. This parameter will only be in effect if the modulation type of the path is set to one of these types. The Doppler frequency range is dependent on the fading emulation method as shown below. Changes to the DOPP parameter will also update the FS_DOPP parameter for the selected path.

Valid Command Data:

FADEM (Fading Emulation Method) = TYPE1 (Jakes Method)

Range: -10000 to -10, 10 to 10000
(-1000.0 to -1.0, 1.0 to 1000.0 Hz)

FADEM (Fading Emulation Method) = TYPE2 (Filtered Noise Method)

Range: -10000 to -1, 1 to 10000,
(-1000.0 to -0.1, 0.1 to 1000.0 Hz)

Example:

To set the Doppler frequency of Channel 1 Path 1 to 20.5 Hz:

```
/CH1_P1:DOPP=205/
```

Expected Response:

```
/C/
```

Frequency Shift Doppler Frequency (FS_DOPP)

Command Description:

Sets the Doppler frequency for the path to be used when the selected modulation type is Doppler shift (frequency shift). The frequency shift Doppler has resolution of 0.01 Hz. Changes to the FS_DOPP parameter will also update the DOPP parameter for the selected path.

Valid Command Data:

Range: -100000 to -1, 1 to 100000
 (-1000.00 to -0.01, 0.01 to 1000.00 Hz)

Example:

To set the Doppler frequency of Channel 1 Path 1 to 20.53 Hz:
 /CH1_P1:FS_DOPP=2053/

Expected Response:

/C/

Fading Power Spectrum / Fading Environment Type (FADET)

Command Description:

Sets the fading power spectrum, also referred to as the fading environment type. This parameter will only be in effect if the emulation mode is set to filtered noise.

Valid Command Data:

TYPE1 - Classical 6 dB fading power spectrum shape as specified in IS55/56 and IS97/98 standards.

TYPE2 - Flat fading power spectrum shape observed for some indoor propagation models.

TYPE3 - Classical 3 dB fading power spectrum shape.

TYPE4 - Rounded fading power spectrum shape.

Example:

To configure the fading power spectrum to have the classical 6 dB shape:
 /CH1_P1:FADET=TYPE1/

Expected Response:

/C/

Shift Frequency for Rayleigh with Frequency Shift (FSF)

Command Description:

Sets the shift frequency for the path to be used for the modulation type of Rayleigh with Frequency Shift and Rician with Frequency Shift. This parameter will only be in effect if the modulation type of the path is set to one of these types. See Section 6.3.5. for information on setting the modulation type of the path.

Valid Command Data:

Range: -9990 to 9990 (-999.0 Hz to 999.0 Hz)

Example:

To set the shift frequency of Channel 1 Path 1 to 40.5 Hz:

```
/CH1_P1:FSF=40.5/
```

Expected Response:

```
/C/
```

Log-Normal Calibration (LNCAL)

Command Description:

Reports whether or not the log-normal standard deviation and path loss are set to allow a minimum of two sigma variation for Log-normal fading on the specified path. See Section 2.6. “Setting Log-Normal Parameters”.

Valid Command Data:

yes – system settings allow for at least 2 sigma deviation

no – system settings will not allow for the minimum 2 sigma deviation

Example:

To report the status of the Log-normal sigma variation of Channel 1 Path 1:

```
/CH1_P1:LNCAL/
```

Expected Response:

```
/CH1_P1:LNCAL=yes/
```

Log-Normal Rate (LNRT)

Command Description:

Sets the Log-normal rate of the path.

Valid Command Data:

Range: 0 to 20000 (0.000 Hz to 20.000 Hz)

Example:

To set the Log-normal rate of Channel 1 Path 2 to 0.005 Hz:

```
/CH1_P2:LNRT=5/
```

Expected Response:

```
/C/
```

Log-Normal Status (LNSTAT)

Command Description:

Sets the Log-normal fading status to on (enable) or off (disable) for the specified path.

Valid Command Data:

on, off

Example:

To turn Log-normal fading on for Channel 1 Path 1:

```
/CH1_P1:LNSTAT=ON/
```

Expected Response:

```
/C/
```

Log-Normal Standard Deviation (LNSTD)

Command Description:

Sets the Log-normal standard deviation of the path.

Valid Command Data:

Absolute Range: 0 to 12 (0 dB to 12 dB)

Example:

To set the Log-normal standard deviation of Channel 1 Path 2 to 5 dB:

```
/CH1_P2:LNSTD=5/
```

Expected Response:

```
/C/
```

Relative Path Loss (LOSS)

Command Description:

Sets the relative path loss of the path.

Valid Command Data:

Range: 0 to 500 (0.0 dB to 50.0 dB)

Example:

To set the relative path loss of Channel 1 Path 2 to 10.0 dB:

```
/CH1_P2:LOSS=100/
```

Expected Response:

```
/C/
```


Path Modulation Type (MOD)

Command Description:

Set the modulation type of the path. Note that the FSRAY and FSRICE modulation types will only be available when the Fading Doppler Tracking Mode(FDTM) is set to path mode.

Valid Command Data:

NONE	No modulation
RAYL	Rayleigh fading
FS	Frequency shift (Doppler shift)
PHAS	Phase shift
FSRAY	Rayleigh with Frequency Shift
FSRICE	Rician with Frequency Shift
NAK	Nakagami fading with programmable M value and angle of arrival
RICE_K	Rician fading with programmable K factor and LOS arrival angle

Example:

To sets the modulation type of Channel 1 Path 1 to Rayleigh fading:

```
/CH1_P1:MOD=RAYL/
```

Expected Response:

```
/C/
```

Nakagami M Value (NM)

Command Description:

Sets the M value for a Nakagami faded signal. This parameter will only be in effect if the modulation type of the path is set to Nakagami. See Section 6.3.5 for information on setting the modulation type of the path. For more details on setting an appropriate M value refer to Section 4.6.17 on the theory of operation for Nakagami fading.

Valid Command Data:

Range: 1, 3, 5, 10, 15, 25, 100

Example:

To set an M value of 3 for Channel 1 Path 2 with Nakagami modulation set:
/CH1_P2:NM=3/

Expected Response:

/C/

Phase Angle (PHAS)

Command Description:

Sets the phase angle of the path for phase shift modulation. This parameter will only be in effect if the modulation type of the path is set to phase shift. See Section 4.3.5 for information on setting the modulation type of the path.

Valid Command Data:

Range: 0 to 3600 (0.0 degrees to 360.0 degrees)

Example:

To set the phase angle of Channel 1 Path 2 to 45.0 degrees:
/CH1_P2:PHAS=450/

Expected Response:

/C/

Rician K Factor (RK)

Command Description:

Sets the K factor for a Rician faded signal. See Section 6.3.5 for information on setting the modulation type of the path. For more details on setting an appropriate K factor refer to Section 4.6.13 on the theory of operation for Rician fading.

Sets the path status to on (enable) or off (disable) for the specific path.

Valid Command Data:

Range: -300 to 300 (-30.0 dB to +30.0 dB)

Example:

To set a K factor of +12.0 for Channel 1 Path 2 with Rician modulation set:

```
/CH1_P2:RK=120/
```

Expected Response:

```
/C/
```

Path Status (STAT)

Command Description:

Sets the path status to on (enable) or off (disable) for the specific path.

Valid Command Data:

ON, OFF

Example:

To turn off Channel 1 Path 2:

```
/CH1_P2:STAT=OFF/
```

Expected Response:

```
/C/
```

Extended Rayleigh Fading Path Correlation Coefficient (ECORR)[CH2_P1 to CH2_P6]

Command Description:

Sets the Rayleigh fading path correlation coefficient between paths. This parameter will only be in effect if the modulation type of both paths to be correlated is in Rayleigh fading. See Section 6.3.5 for information on setting the modulation type of the path.

CH2_P1:ECORR controls the correlation between CH1-CH2 Path 1

CH2_P2:ECORR controls the correlation between CH1-CH2 Path 2

CH2_P3:ECORR controls the correlation between CH1-CH2 Path 3

CH2_P4:ECORR controls the correlation between CH1-CH2 Path 4

CH2_P5:ECORR controls the correlation between CH1-CH2 Path 5

CH2_P6:ECORR controls the correlation between CH1-CH2 Path 6

Valid Command Data:

Range: 0 to 100 (0.00 to 1.00 of correlation coefficient)

Example:

To set the correlation coefficient of Rayleigh faded CH1-CH2 Path 5 to 0.75:

```
/CH2_P5:ECORR=75/
```

Expected Response:

```
/C/
```

7.0. ERROR CODES

The TAS 4500 provides error codes to indicate its current state of operation. Error conditions are reported on the front panel and the remote control (GPIB or RS-232) interfaces. For more information on reading error codes, see the CNFG command group in Section 6.0. "Remote Commands Reference".

Error Code	Description
000	TAS 4500 OK
001	Command value error
002	Command syntax error
003	Command group syntax error
004	Command failure
005	Undefined command group
006	Undefined command
007	File recall operation failed
008	Reserved
009	Reserved
010	Reserved
011	Database failure
012	Reserved
013	EPROM checksum failed
014	Reserved
015	Reserved
016	Reserved
017	Reserved
018	Reserved
019	Remote Command ignored when in local mode
020-027	Reserved
028	CCB1 DSP1 checksum failed
029	CCB1 DSP2 checksum failed
030	CCB1 DSP1 no response
031	CCB1 DSP2 no response

Error Code	Description
032	Channel 1 not present
033	Reserved
034	Reserved
035	Reserved
036	Reserved
037	Reserved
038	Synthesizer 1 timeout
039	Synthesizer 2 timeout
040-050	Reserved
051	Channel 2 not present
052	Input signal out of range
053	Reserved
054	Reserved
055	Reserved
056	Value of Doppler frequency is out of range for the selected channel correlation type
057	Reserved
058	CCB2 DSP1 checksum failed
059	CCB2 DSP2 checksum failed
060	CCB2 DSP1 no response
061	CCB2 DSP2 no response
062-063	Reserved
064	External Reference Signal not detected
065-076	Reserved
077	Insufficient hardware configuration for desired file recall
078-079	Reserved
080	Dynamic Environment Emulation: byte count mismatch
081	Dynamic Environment Emulation: state duration too short for parameter setting
082	Dynamic spooling: PC too slow for selected state duration
083-084	Reserved

Error Code	Description
085	IGB1 flash checksum fail
086	IGB2 flash checksum fail
087	IGB3 flash checksum fail
088	IGB4 flash checksum fail
090	DMAX < DMIN in 3GPDP test

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8.0. TECHNICAL SPECIFICATIONS

The following specifications describe warranted performance over the temperature range 0-50 degrees C and include a 30 minute warm-up time from ambient conditions. Supplemental characteristics are in italics and provide useful information by giving non-warranted performance parameters.

The specifications are measured under the following channel conditions unless otherwise indicated:

- RF Input Signal = 900 or 1800 MHz sinewave
- RF Input Level = -10 dBm (Input Reference Level set 3.0 dB less than input overload)
- Output Attenuator = 0 dB
- LO Input Level = +13 dBm
- LO Input Frequency = RF Input Frequency -140 MHz
- One Path On, Path Modulation = none, Path Loss = 0 dB, Path Delay = 0 μ s
- Channel Configuration = Dual Channel

RF Channel Specifications

RF Input Signal Frequency Range	25 to 4000 MHz
RF Bandwidth	26 MHz
Number of Independent RF Channels	1 or 2
RF Input Signal Level	
Range	+5 to -30 dBm
Nominal	-10 dBm
Damage Level	+20 dBm
<i>Automatic Reference Level Range</i>	<i>0 to -25 dBm</i>
RF Bandwidth Peak to Peak Amplitude Variation	<i>1dB typical</i> 2dB maximum
Channel Insertion Loss	<i>12 dB typical</i> 16 dB maximum

Technical Specifications are subject to change without notice.

Spurious Emission Levels on RF Out (without EFX option)

Within Channel Pass Band ($f_c \leq 200$ MHz)	-45 dBc maximum -15 dBc
<i>RF Image Feedthrough</i>	= <i>RF OUT level typical</i>
RF LO Feedthrough	0 dBm maximum

Group Delay Distortion ±30 ns

Path Insertion Delay

RF In to RF Out 4.0 μ s maximum

Physical Interface Characteristics

<i>Impedance</i>	50 ohms
<i>Input SWR</i>	< 1.5
<i>Connector Type</i>	Type N Female

RF Channel Options

RF Image and LO Feedthrough Suppression (EFX Option)

Frequency Range	800 to 3000 MHz
RF Image Feedthrough on RF Out	-50 dBc maximum
RF LO Feedthrough on RF Out	-75dBm maximum
Additional Channel Insertion Loss	<i>6 dB typical</i> 8 dB maximum
Additional Channel Amplitude vs. Freq. Variation	<i>1 dB typical</i> 2 dB maximum

RF Output Attenuator

ATT1:

Attenuation Range	0 to 80 dB
Resolution	0.1 dB
Frequency Range	800 to 2500 MHz
Accuracy	
0 to 10 dB attenuation	<i>±0.75 dB</i>
>10 to 20 dB attenuation	<i>±1.5 dB</i>
>20 to 30 dB attenuation	<i>±2.0 dB</i>
>30 to 60 dB attenuation	<i>±3.0 dB</i>
>60 to 80 dB attenuation	<i>±5.0 dB</i>
Additional Channel Insertion Loss	2.5 dB maximum

ATT3:

Attenuation Range	0 to 90.0 dB
Resolution	0.1 dB
Frequency Range	25 to 3000 MHz
Accuracy (25 to 3000 MHz)	
0 to 49.9 dB attenuation	<i>±1.0 dB</i>
50.0 to 85.0 dB attenuation	<i>±2.0 dB</i>
85.0 to 90.0 dB attenuation	<i>±2.5 dB</i>
Additional Channel Insertion Loss	1.5 dB maximum

Technical Specifications are subject to change without notice.

RF Filter Bypass (FBP Option) and RF Channel Bypass (CBP Option)

Additional Insertion Loss	<i>1 dB typical</i> 2 dB maximum
---------------------------	-------------------------------------

Local Oscillator (LO) Characteristics**Internal Local Oscillator (LO 4 option)**

(All specs refer to LO OUT unless noted)

LO Frequency Range	940-2860 MHz
Carrier Frequency Range (RF IN)	800-3000 MHz
Frequency Resolution	100 kHz
<i>Frequency Accuracy</i>	<i>2 kHz</i>
<i>Phase Noise (1 kHz offset)</i>	<i>-75 dBc/Hz</i>
Level	+13 dBm typical +10 dBm minimum

External Local Oscillators

(All specs refer to LO IN unless noted)

LO Frequency Range	165-3860 MHz
LO Offset from Carrier Frequency (F_c)	
$F_c \geq 800$ MHz	$F_c - 140$ MHz
$F_c < 800$ MHz	$F_c + 140$ MHz
Level Range	+12 to +15 dBm
Nominal Level	
$F_c < 3.6$ GHz	+13 dBm
$F_c \geq 3.6$ GHz	+15 dBm
Damage	+23 dBm
LO Impedance	50 Ω

Technical Specifications are subject to change without notice.

Channel Emulation Characteristics

Number of Independent Paths per Channel	3 or 6
Path Modulation	None, Rayleigh, Frequency Shift, Phase Shift, Rician, Rayleigh with Freq. Shift, Rician with Frequency Shift, Nakagami
Fading Emulation Method	
Programmable with 2 modes:	Jakes, Filtered Noise
<i>Fading (Rayleigh) Amplitude Distribution</i>	
<i>Deviation from Theoretical CPDF exceeds the following requirements (exceeds IS-137/138 and IS-97/98 requirements):</i>	
<i>From +10 to -30 dB of mean power level</i>	± 0.5 dB
<i>Level Crossing Rate (LCR) Accuracy exceed the following requirements (exceeds IS-137/138 and IS-97/98 requirements):</i>	
<i>From +3 to -30 dB of mean power level</i>	$< \pm 2.5\%$ deviation theoretical LCR curve of the simulated vehicle velocity
Fading Power Spectrum	
Emulation Method = Jakes Programmable with 2 shapes:	Classical 6 dB, Flat
Emulation Method = Filtered Noise Programmable with 4 shapes:	Classical 6 dB, Flat, Classical 3 dB, Rounded
<i>Fading Repetition Interval</i>	
<i>Emulation Method = Jakes</i>	
<i>Simulated Doppler frequency ≤ 500 Hz</i>	> 20 minutes
<i>Simulated Doppler frequency > 500 Hz</i>	> 10 minutes
<i>Emulation Method = Filtered Noise</i>	
<i>Programmable with 3 modes:</i>	27 seconds, 20 minutes, 24 hours

Technical Specifications are subject to change without notice.

Correlation Coefficient

(Between Channel 1 and Channel 2 Paths)

Range	0 to 1
Resolution	0.01

Velocity

Range ($f_c = 900$ MHz)	± 0.1 to ± 1199.2 km/hr (± 0.1 to ± 745.1 mph)
Resolution	0.1 units
Units	m/s, km/hr, feet/sec, mph

Fading Doppler Frequency

Range	
Jakes Mode	± 1 to ± 1000 Hz
Filtered Noise Mode	± 0.1 to ± 1000 Hz
Resolution	0.1 Hz

Doppler Shift Frequency (Frequency Shift)

Range	± 0.01 to ± 1000.00 Hz
Resolution	0.01 Hz

Line of Site (LOS) Arrival Angle

(Modulation = Rician or Nakagami)

Range	0 to 360 degrees
Resolution	0.1 degrees

Relative Phase Between Paths

(Modulation = Phase)

Range	0 to 360 degrees
Resolution	0.1 degrees

Rician K Factor

(Modulation = Rician)

Range	-30 to +30 dB
Resolution	0.1 dB

Nakagami M Value

(Modulation = Nakagami)

M Values	1, 3, 5, 10, 15, 25, 100
----------	--------------------------

Technical Specifications are subject to change without notice.

Fading Shift Frequency

(Modulation = Rayleigh with Frequency Shift, Rician with Frequency Shift)

Range	-999.0 to +999.0 Hz
Resolution	0.1 Hz

Relative Path Delay

Range	
Standard System	0 to 125 μ sec
Extended Delay Option	0 to 2000 μ sec
Resolution	0.5 nsec
Accuracy	± 10 nsec

Relative Path Loss

(measurement performed with Modulation = Rayleigh)

Range	0 to 50 dB
Resolution	0.1 dB
Accuracy	
0 to 30 dB attenuation	± 0.3 dB
>30 to 40 dB attenuation	± 1.0 dB
>40 to 50 dB attenuation	± 3.0 dB

Log Normal Fading Standard Deviation

(Relative Path Loss = 25 dB)

Range	0 to 12 dB
Resolution	1 dB

Log Normal Fading Rate

Range	0 to 20 Hz
Resolution	0.001 Hz

Technical Specifications are subject to change without notice.

Dynamic Environment Emulation

NOTE: Dynamic Environment Emulation is available via remote operation only. The front panel interface is disabled while in Dynamic Environment Emulation mode.

Number of States:	> 2 billion
Minimum State Duration	5 msec ⁴
State Duration Resolution	1 msec
State Transition Trigger	internal, external
Programmable Parameters For Standard State Durations (≥ 10msec)	Delay Path Loss RF Attenuation (ATT1 only) Modulation Type Velocity LOS Component Spectrum Offset Rician K / Nakagami M Phase Shift Fading Power Spectrum
Programmable Parameters For Accelerated State Durations(5 - 9 msec)	Delay Path Loss RF Attenuation (ATT1 only)
All other specifications in Section 8.0. apply except the following:	
Relative Path Delay Resolution	15 nsec
Fading Emulation Method:	Filtered Noise Only
Fading Doppler Tracking Mode:	Path Mode
Channel Maximum Doppler:	1 kHz
Line of Site Reference:	Channel Maximum Doppler
Log Normal Fading:	Not Available
Channel Configuration	Dual Channel, Diversity, or Interference

⁴ A Minimum State Duration in the range from 5 msec to 9 msec is only supported with a subset of programmable parameter changes. For test cases that require other Path Parameters to be modified, a state duration of 10 msec or greater is required.

3GPDP Specifications

Test Profiles:	Moving Propagation
	Birth-Death
Minimum State Duration	1 msec
State Duration Resolution	1 msec
State Transition Trigger	internal, external
Parameter Modified During Test	Path Delay
Moving Propagation	
Frequency of Oscillation(units E-3 rads/sec)	1 to 32767
Number of Moving Paths:	1 to 6
Birth-Death	
Number of Delay Bins	1 to 64
Number of Active Paths:	1 to 6

Interface and Environmental Characteristics

Power Requirements

Voltage	85-265 VAC (auto sensing)
Frequency	47-440 Hz
Power	265 Watt (maximum)
Fuse Type fuse	8.0 Amp, 250 Volt slow-blow
Number of Fuses	2
Fuse Location conductor	Hot conductor, Neutral

Operating Environment

<i>Temperature degrees F)</i>	<i>0 to 50 degrees C (32 to 122</i>
<i>Humidity</i>	<i>10% to 90%, noncondensing</i>

Dimensions and Weight

<i>Height</i>	<i>6.9 inches</i>
<i>Width</i>	<i>17.7 inches</i>
<i>Depth</i>	<i>19.9 inches</i>
<i>Weight</i>	<i>45 pounds</i>

Control Interfaces

Interfaces Provided	RS-232 (DCE) and IEEE-488 (GPIB)
---------------------	-------------------------------------

Serial Control Port Parameters

Bit Rates	300, 1200, 2400, 4800, 9600
Format	asynchronous
Bits/Char.	7 or 8
Parity	none, odd, even
Stop Bits	1, 1.5, 2

External 10 MHz Reference Requirements

Input Frequency	10.000 MHz
Input Power Level	2.5 dBm \pm 1 dB

Technical Specifications are subject to change without notice.

External Trigger Requirements

V_{IH}	3.0 to 5.0 Volts
V_{IL}	0 to 0.4 Volts
I_{IH}	1 mA maximum
I_{IL}	1 mA maximum
Trigger Pulse Width	1 μ s minimum
Trigger rise time	10 ns to 1 μ s
Trigger fall time	10 ns to 1 μ s

Technical Specifications are subject to change without notice.

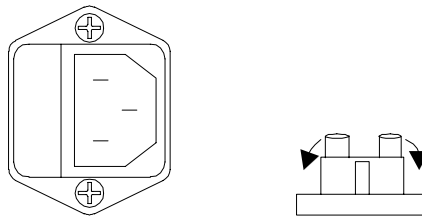


Fuse Replacement Procedure

The fuse is installed at the factory to match the most commonly used line voltage in the country of destination.

Caution - Disconnect from the supply before servicing

1. Locate the power entry module on rear panel.
2. Using a small screwdriver, pry out the fuse holder using the notch at the top of the power entry module (refer to diagram below).



3. Pull the fuse from the fuse holder as shown above.
4. To reinstall, select the proper fuse and place in the fuse holder.

TAS Part Number	Type
1800-3958	8A 250V Slow-Blow Fuse

5. Reinsert the fuse holder into the power entry module.

Technical Specifications are subject to change without notice.

APPENDIX A: STANDARD TEST AND FACTORY DEFAULT PROFILES

The following sections list the contents of the read-only standard test profile parameters that will be set when a recall is performed. The profile for the factory default is also included for reference purposes. Parameters that are not listed in the profiles will remain the same as before the recall operation.

NOTE: The RF Channel Status (Enabled or Bypassed) is reset to the Enabled state only when the factory default profile is recalled. The standard test profiles listed below do not modify the status of this parameter when recalled.

NOTE: In systems equipped with firmware version 4.40 or later, the recallable ROM based configuration files that setup the factory default parameters and the industry standard test procedures were changed to use the filtered noise emulation method for multipath fading. Also, the configuration files that setup the industry standard test files were changed to have both channel 1 and channel 2 share the same carrier frequency. This configures the test setup to operate as the forward channel (base station to mobile link).

The list of standard test profiles is divided into three main groups:

1. IS-55/56 and IS-137/138 North American Dual mode (TDMA) cellular test profiles
2. IS-97/IS-98 North American Dual mode spread spectrum (CDMA) cellular test profiles
3. GSM test profiles (6 path and 12 path models)

The order of the profiles listed is as follows:

Default

IS55-56_1, IS55-56_2, IS55-56_3

CDMA_1, CDMA_2, CDMA_3, CDMA_4, CDMA_5

GSM_EQ50, GSM_EQ100

GSM_RA100_1, GSM_RA100_2, GSM_RA250_1, GSM_RA250_2

GSM_HT100_1, GSM_HT100_2

GSM_TU50_1, GSM_TU50_2

GSM_HT100_1_12, GSM_HT100_2_12

GSM_TU50_1_12, GSM_TU50_2_12

The GSM files listed above utilize a six path emulation model except those with a “_12” suffix which refer to a 12 path emulation model.

A.1. Default Values

Default Values													
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System I/O Frequency Tracking Mode – Carrier Line of Site Reference – PD (Path Doppler) Channel Configuration – Dual Channel												
Channel	1						2						
Input Reference Level	-10.0 dBm						-10.0 dBm						
Output Attenuator	0 dBm						0 dBm						
LO Mode	external						external						
Carrier Freq. (MHz)	900.00						900.00						
Alternate I/O Freq. (MHz)	900.00						900.00						
RF Channel	enabled						enabled						
Channel Max. Doppler(Hz)	41.7						41.7						
Vehicle Speed (km/h)	50						50						
Path	1	2	3	4	5	6	1	2	3	4	5	6	
Status	on	off	off	off	off	off	on	off	off	off	off	off	
Relative Delay (µs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
Modulation Type	none	none	none	none	none	none	none	none	none	none	none	none	
Doppler Freq. (Hz)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50	
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0	
Ray. Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0	
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0	
Relative Loss (dB)	0	0	0	0	0	0	0	0	0	0	0	0	
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0	
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0	
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0	

* Fading Power Spectrum = Classical (6dB)

A.2. IS55-56 Dual Mode Cellular Test Profiles

The standard test profiles for IS-55 and IS-56 were derived from the EIA/TIA/IS-55 December 1991, and the EIA/TIA/IS-56-A October 1993 specifications. These test profiles are identical to those in the EIA/TIA/IS-137 December 1994, and the EIA/TIA/IS-138 December 1994 specifications. See Section 9.1 for more information.

IS55-56_1												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	6.5						6.5					
Vehicle Speed (km/h)	8						8					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	on	off	off	off	off	off
Relative Delay (μs)	0.0	41.2	-	-	-	-	0.0	41.2	-	-	-	-
Modulation Type	Rayl.	Rayl.	-	-	-	-	Rayl.	Rayl.	-	-	-	-
Doppler Freq. (Hz)	6.5	6.5	-	-	-	-	6.5	6.5	-	-	-	-
Velocity (km/h)	8	8	-	-	-	-	8	8	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

IS55-56_2												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
	1						2					
Channel												
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	40.8						40.8					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	on	on	off	off	off	off
Relative Delay (µs)	0.0	41.2	-	-	-	-	0.0	41.2	-	-	-	-
Modulation Type	Rayl.	Rayl.	-	-	-	-	Rayl.	Rayl.	-	-	-	-
Doppler Freq. (Hz)	40.8	40.8	-	-	-	-	40.8	40.8	-	-	-	-
Velocity (km/h)	50	50	-	-	-	-	50	50	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

IS55-56_3												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	81.6						81.6					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	on	on	off	off	off	off
Relative Delay (µs)	0.0	41.2	-	-	-	-	0.0	41.2	-	-	-	-
Modulation Type	Rayl.	Rayl.	-	-	-	-	Rayl.	Rayl.	-	-	-	-
Doppler Freq. (Hz)	81.6	81.6	-	-	-	-	81.6	81.6	-	-	-	-
Velocity (km/h)	100	100	-	-	-	-	100	100	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

A.3. IS-97/98 Dual Mode Wideband Spread Spectrum (CDMA) Cellular Test Profiles

The standard test profiles for IS-97 and IS-98 were derived from the EIA/TIA/IS-97 (PN-3120) Ballot Version and EIA/TIA/IS-98 (PN-3121) Ballot Version. The following chart can be used to cross-reference the TAS test file name with the IS-97/98 test configuration.

- CDMA_1: IS-98 Test 1, IS-97 Test 1
- CDMA_2: IS-98 Test 2
- CDMA_3: IS-98 Test 3, IS-97 Test 2
- CDMA_4: IS-98 Test 4, IS-97 Test 3
- CDMA_5: IS-98 Test 5

CDMA_1												
Configuration	Velocity Units = km/h Emulation Method – Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	6.5						6.5					
Vehicle Speed (km/h)	8						8					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	On	on	off	off	off	off
Relative Delay (µs)	0.0	2.0	-	-	-	-	0.0	2.0	-	-	-	-
Modulation Type	Rayl.	Rayl.	-	-	-	-	Rayl.	Rayl.	-	-	-	-
Doppler Freq. (Hz)	6.5	6.5	-	-	-	-	6.5	6.5	-	-	-	-
Velocity (km/h)	8	8	-	-	-	-	8	8	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

CDMA_2												
Configuration	Velocity Units = km/h Emulation Method – Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	24.5						24.5					
Vehicle Speed (km/h)	30						30					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	on	on	off	off	off	off
Relative Delay (µs)	0.0	2.0	-	-	-	-	0.0	2.0	-	-	-	-
Modulation Type	Rayl.	Rayl.	-	-	-	-	Rayl.	Rayl.	-	-	-	-
Doppler Freq. (Hz)	24.5	24.5	-	-	-	-	24.5	24.5	-	-	-	-
Velocity (km/h)	30	30	-	-	-	-	30	30	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

CDMA_3												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	24.5						24.5					
Vehicle Speed (km/h)	30						30					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	off	off	off	off	off	on	off	off	off	off	off
Relative Delay (µs)	0.0	-	-	-	-	-	0.0	-	-	-	-	-
Modulation Type	Rayl.	-	-	-	-	-	Rayl.	-	-	-	-	-
Doppler Freq. (Hz)	24.5	-	-	-	-	-	24.5	-	-	-	-	-
Velocity (km/h)	30	-	-	-	-	-	30	-	-	-	-	-
Fading Power Spectrum	C6*	-	-	-	-	-	C6*	-	-	-	-	-
Phase Shift (deg)	0	-	-	-	-	-	0	-	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	-	-	-	-	-	0	-	-	-	-	-
Angle of Arrival (deg)	0	-	-	-	-	-	0	-	-	-	-	-
Relative Loss (dB)	0	-	-	-	-	-	0	-	-	-	-	-
Log-normal Freq. (Hz)	0	-	-	-	-	-	0	-	-	-	-	-
Log-normal STD (dB)	0	-	-	-	-	-	0	-	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	-	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

CDMA_4												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	81.6						81.6					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	off	off	off	on	on	on	off	off	off
Relative Delay (µs)	0.0	2.0	14.5	-	-	-	0.0	2.0	14.5	-	-	-
Modulation Type	Rayl.	Rayl.	Rayl.	-	-	-	Rayl.	Rayl.	Rayl.	-	-	-
Doppler Freq. (Hz)	81.6	81.6	81.6	-	-	-	81.6	81.6	81.6	-	-	-
Velocity (km/h)	100	100	100	-	-	-	100	100	100	-	-	-
Fading Power Spectrum	C6*	C6*	C6*	-	-	-	C6*	C6*	C6*	-	-	-
Phase Shift (deg)	0	0	0	-	-	-	0	0	0	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	0	-	-	-	0	0	0	-	-	-
Angle of Arrival (deg)	0	0	0	-	-	-	0	0	0	-	-	-
Relative Loss (dB)	0	0	3	-	-	-	0	0	3	-	-	-
Log-normal Freq. (Hz)	0	0	0	-	-	-	0	0	0	-	-	-
Log-normal STD (dB)	0	0	0	-	-	-	0	0	0	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	-	-	-

* Fading Power Spectrum = Classical (6dB)

CDMA_5												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	881.01						881.01					
Channel Max. Doppler(Hz)	1.0						1.0					
Vehicle Speed (km/h)	1.2						1.2					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	off	off	off	off	on	on	off	off	off	off
Relative Delay (µs)	0.0	2.0	-	-	-	-	0.0	2.0	-	-	-	-
Modulation Type	none	none	-	-	-	-	none	none	-	-	-	-
Doppler Freq. (Hz)	1.0	1.0	-	-	-	-	1.0	1.0	-	-	-	-
Velocity (km/h)	1.2	1.2	-	-	-	-	1.2	1.2	-	-	-	-
Fading Power Spectrum	C6*	C6*	-	-	-	-	C6*	C6*	-	-	-	-
Phase Shift (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Rayl. Fading Shift Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Angle of Arrival (deg)	0	0	-	-	-	-	0	0	-	-	-	-
Relative Loss (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal Freq. (Hz)	0	0	-	-	-	-	0	0	-	-	-	-
Log-normal STD (dB)	0	0	-	-	-	-	0	0	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

A.4. GSM Test Profiles

All GSM profiles require at least six paths to be present in the TAS 4500. The six paths may be either in a single channel or split between two channels. The tables of parameter settings below assume all six paths are in a single channel. If only three paths per channel are present the parameter settings for CH1 paths 4-6 will be shifted to CH2 paths 1-3. The “Hilly Terrain” and “Typical Urban” profiles have both six and twelve path model test configurations. For the twelve path model configuration six paths must be present in each channel of the TAS 4500. The profiles are configured with carrier frequency of 947.4 MHz.

The following test configurations were derived from GSM Recommendation 05.05 version 3.5.0. The name of each model and its abbreviation is as follows:

6 Path Configurations:

Equalization test @50 km/h	GSM_EQ50
Equalization test @100 km/h	GSM_EQ100
Rural area @ 100 km/h options 1 & 2:	GSM_RA100_1, GSM_RA100_2
Rural area @ 250 km/h options 1 & 2:	GSM_RA250_1, GSM_RA250_2
Hilly terrain @100 km/h options 1 & 2:	GSM_HT100_1, GSM_HT100_2
Typical urban @50 km/h options 1 & 2:	GSM_TU50_1, GSM_TU50_2

12 Path Configurations:

Hilly terrain @100 km/h options 1 & 2:	GSM_HT100_1_12, GSM_HT100_2_12
Typical urban @50 km/h options 1 & 2:	GSM_TU50_1_12, GSM_TU50_2_12

Note for all GSM recall files: The following brief description is provided to clarify the method TAS has used to implement Rician fading in all applicable predefined GSM files. Specifically, all Rural Area (RA) files require path 1 of a four or six path model to implement Rician fading. As defined in the TAS 4500, the Rician K factor is a measure of the ratio of the power of the faded signal to the power of the Line of Sight (LOS) signal. According to the GSM specification, this ratio should be set to 0.0 meaning that the power of the faded signal should be set equal to the power of the LOS signal.

The pre-defined files provided in the TAS4500 set the Rician K-factor for path 1 to 0.0. This set the power of the faded portion of **Path 1 only** equal to the LOS component of **Path 1 only**. An alternate approach here would be to set the total fading power of the faded signal present on **each active path** within a channel (4 or 6 path models) equal to the LOS component of **Path 1 only**. This alternate approach is not available for recall in the TAS4 500.

However, the following Path 1 K-factor settings should be applied if the user wishes to set the total power of the faded signal present on **all active paths combined** (4 or 6 path models) equal to the LOS component of **Path 1 only**.

Use Path 1 K-factor of **K=6.8** for all **6 path** GSM models.

Use Path 1 K-factor of **K=8.3** for all **4 path** GSM models.

These values should be set only after the chosen pre-defined GSM file has been recalled.

GSM_EQ50												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	43.9						43.9					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	3.2	6.4	9.6	12.8	16.0	0.0	3.2	6.4	9.6	12.8	16.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_EQ100												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	3.2	6.4	9.6	12.8	16.0	0.0	3.2	6.4	9.6	12.8	16.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
Velocity (km/h)	100	100	100	100	100	100	100	100	100	100	100	100
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_RA100_1												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	off	off	off	off	off	off
Relative Delay (µs)	0.0	0.1	0.2	0.3	0.4	0.5	-	-	-	-	-	-
Modulation Type	Rice	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	-	-	-	-	-	-
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	-	-	-	-	-	-
Velocity (km/h)	100	100	100	100	100	100	-	-	-	-	-	-
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	-	-	-	-	-	-
Phase Shift (deg)	0	0	0	0	0	0	-	-	-	-	-	-
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	-	-	-	-	-	-
Angle of Arrival (deg)	45.0	0	0	0	0	0	-	-	-	-	-	-
Relative Loss (dB)	0	4	8	12	16	20	-	-	-	-	-	-
Log-normal Freq. (Hz)	0	0	0	0	0	0	-	-	-	-	-	-
Log-normal STD (dB)	0	0	0	0	0	0	-	-	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	-	-	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

GSM_RA100_2												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
	Channel	1						2				
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	off	off	off	off	off	off	off	off
Relative Delay (µs)	0.0	0.2	0.4	0.6	-	-	-	-	-	-	-	-
Modulation Type	Rice	Rayl.	Rayl.	Rayl.	-	-	-	-	-	-	-	-
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	-	-	-	-	-	-	-	-
Velocity (km/h)	100	100	100	100	-	-	-	-	-	-	-	-
Fading Power Spectrum	C6*	C6*	C6*	C6*	-	-	-	-	-	-	-	-
Phase Shift (deg)	0	0	0	0	-	-	-	-	-	-	-	-
Rayl Fading Shift Freq. (Hz)	0	0	0	0	-	-	-	-	-	-	-	-
Angle of Arrival (deg)	45.0	0	0	0	-	-	-	-	-	-	-	-
Relative Loss (dB)	0	2	10	20	-	-	-	-	-	-	-	-
Log-normal Freq. (Hz)	0	0	0	0	-	-	-	-	-	-	-	-
Log-normal STD (dB)	0	0	0	0	-	-	-	-	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	-	-	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

GSM_RA250_1												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	219.5						219.5					
Vehicle Speed (km/h)	250						250					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	off	off	off	off	off	off
Relative Delay (µs)	0.0	0.1	0.2	0.3	0.4	0.5	-	-	-	-	-	-
Modulation Type	Rice	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	-	-	-	-	-	-
Doppler Freq. (Hz)	219.5	219.5	219.5	219.5	219.5	219.5	-	-	-	-	-	-
Velocity (km/h)	250	250	250	250	250	250	-	-	-	-	-	-
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	-	-	-	-	-	-
Phase Shift (deg)	0	0	0	0	0	0	-	-	-	-	-	-
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	-	-	-	-	-	-
Angle of Arrival (deg)	45.0	0	0	0	0	0	-	-	-	-	-	-
Relative Loss (dB)	0	4	8	12	16	20	-	-	-	-	-	-
Log-normal Freq. (Hz)	0	0	0	0	0	0	-	-	-	-	-	-
Log-normal STD (dB)	0	0	0	0	0	0	-	-	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	-	-	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

GSM_RA250_2												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
	Channel	1						2				
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	219.5						219.5					
Vehicle Speed (km/h)	250						250					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	off	off	off	off	off	off	off	off
Relative Delay (µs)	0.0	0.2	0.4	0.6	-	-	-	-	-	-	-	-
Modulation Type	Rice	Rayl.	Rayl.	Rayl.	-	-	-	-	-	-	-	-
Doppler Freq. (Hz)	219.5	219.5	219.5	219.5	-	-	-	-	-	-	-	-
Velocity (km/h)	250	250	250	250	-	-	-	-	-	-	-	-
Fading Power Spectrum	C6*	C6*	C6*	C6*	-	-	-	-	-	-	-	-
Phase Shift (deg)	0	0	0	0	-	-	-	-	-	-	-	-
Rayl Fading Shift Freq. (Hz)	0	0	0	0	-	-	-	-	-	-	-	-
Angle of Arrival (deg)	45.0	0	0	0	-	-	-	-	-	-	-	-
Relative Loss (dB)	0	2	10	20	-	-	-	-	-	-	-	-
Log-normal Freq. (Hz)	0	0	0	0	-	-	-	-	-	-	-	-
Log-normal STD (dB)	0	0	0	0	-	-	-	-	-	-	-	-
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	-	-	-	-	-	-

* Fading Power Spectrum = Classical (6dB)

GSM_HT100_1												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.1	0.3	0.5	15	17.2	0.0	0.1	0.3	0.5	15	17.2
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
Velocity (km/h)	100	100	100	100	100	100	100	100	100	100	100	100
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	0	1.5	4.5	7.5	8	17.7	0	1.5	4.5	7.5	8	17.7
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_HT100_2												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.2	0.4	0.6	15	17.2	0.0	0.2	0.4	0.6	15	17.2
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
Velocity (km/h)	100	100	100	100	100	100	100	100	100	100	100	100
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	0	2	4	7	6	12	0	2	4	7	6	12
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_TU50_1												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	43.9						43.9					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (μs)	0.0	0.2	0.5	1.6	2.3	5.0	0.0	0.2	0.5	1.6	2.3	5.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	3	0	2	6	8	10	3	0	2	6	8	10
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_TU50_2												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Dual Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	43.9						43.9					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.2	0.6	1.6	2.4	5.0	0.0	0.2	0.6	1.6	2.4	5.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	3	0	2	6	8	10	3	0	2	6	8	10
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_HT100_1_12												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Single Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.1	0.3	0.5	0.7	1.0	1.3	15.0	15.2	15.7	17.2	20.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
Velocity (km/h)	100	100	100	100	100	100	100	100	100	100	100	100
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	10	8	6	4	0	0	4	8	9	10	12	14
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_HT100_2_12												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition - 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Single Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	87.8						87.8					
Vehicle Speed (km/h)	100						100					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.2	0.4	0.6	0.8	2.0	2.4	15.0	15.2	15.8	17.2	20.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8	87.8
Velocity (km/h)	100	100	100	100	100	100	100	100	100	100	100	100
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	10	8	6	4	0	0	4	8	9	10	12	14
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_TU50_1_12												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition – 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Single Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	43.9						43.9					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.1	0.3	0.5	0.8	1.1	1.3	1.7	2.3	3.1	3.2	5.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	4	3	0	2.6	3	5	7	5	6.5	8.6	11	10
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

GSM_TU50_2_12												
Configuration	Velocity Units = km/h Emulation Method - Filtered Noise Nominal Fading Repetition – 20 minutes Correlation Algorithm – Envelope Fading Doppler Tracking Mode – System Channel Configuration – Single Channel											
Channel	1						2					
Carrier Freq. (MHz)	947.4						947.4					
Channel Max. Doppler(Hz)	43.9						43.9					
Vehicle Speed (km/h)	50						50					
Path	1	2	3	4	5	6	1	2	3	4	5	6
Status	on	on	on	on	on	on	on	on	on	on	on	on
Relative Delay (µs)	0.0	0.2	0.4	0.6	0.8	1.2	1.4	1.8	2.4	3.0	3.2	5.0
Modulation Type	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.	Rayl.
Doppler Freq. (Hz)	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9	43.9
Velocity (km/h)	50	50	50	50	50	50	50	50	50	50	50	50
Fading Power Spectrum	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*	C6*
Phase Shift (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Rayl Fading Shift Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Angle of Arrival (deg)	0	0	0	0	0	0	0	0	0	0	0	0
Relative Loss (dB)	4	3	0	2	3	5	7	5	6	9	11	10
Log-normal Freq. (Hz)	0	0	0	0	0	0	0	0	0	0	0	0
Log-normal STD (dB)	0	0	0	0	0	0	0	0	0	0	0	0
Ch1-Ch2 Path Correlation	-	-	-	-	-	-	0	0	0	0	0	0

* Fading Power Spectrum = Classical (6dB)

APPENDIX B: INSTALLATION OF V5.X FIRMWARE UPDATES

This section provides details on how to update an existing TAS 4500 FLEX5 unit to the latest firmware release. This upgrade is carried out using one or more PCMCIA cards to internally store the new System Firmware. It should be noted that this procedure **only** applies to FLEX5 (V5.00 or later).

NOTE: This upgrade procedure will erase all of the stored settings in the TAS 4500. Communications settings will have to be re-entered after the upgrade has been completed.

Both System Firmware and the Operating Firmware Version releases are sequential. This means for example that V5.20 is a newer Version of Firmware than both V5.00 and V5.10. In general, you should only replace the current firmware in a unit with a newer version.

NOTE: For the purposes of this document the following terminology will be applied throughout:

V5.OLD	Used to refer to the current Version of FW in the unit.
V5.NEW	Used to refer to the new Version of FW to be installed.
RFPD-XX	Used as reference to the System Firmware Update
RFPD-YY	Used as reference to the Operating Firmware Update

The following process describes how to upgrade a TAS 4500 from V5.OLD to the V5.NEW. Provided with the upgrade kit are four PCMCIA cards which will be used during this process. This process will approximately 40 minutes to complete.

The cards which are labeled “TAS 4500 5.NEW System Firmware Update” are used to update the internal DSP code in the TAS 4500. These cards will be used only once.



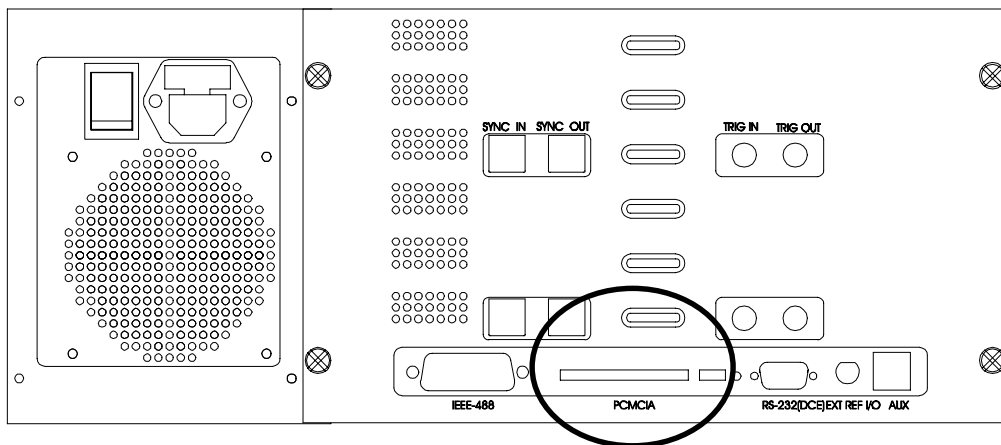


The card labeled “TAS 4500 Operating Firmware” is the new system code. This card will remain in the 4500 after the upgrade process is complete.



The five New System Firmware Update cards **MUST** be used before inserting the new operating firmware into the system.

1. Turn the TAS 4500 off.
2. Disconnect any GPIB or Serial cables connected to the 4500. Attempting to communicate with the 4500 during the upgrade process may cause the upgrade to fail.
3. Remove the PCMCIA card from the back of the 4500. To do this press on the black button located next to the PCMCIA slot.



4. Place the card marked RFPD-XX **CARD 1 of 3** into the PCMCIA slot. Make sure that it is fully seated in the slot.



5. Turn the TAS 4500 on.
6. The 4500 will now power up, and you may receive the following message.

Memory loss, restored from default.

This is normal, just press the [ESC] key of the front panel.

7. After system initialization, the following message should appear on the display screen.

DSP Module Firmware Upgrade Mode
 2 CCB(s) detected at version 5.OLD

 Press ENTER to upgrade to 5.NEW

NOTE: If the TAS 4500 is a 1 Channel 3 Path or 2 Channel 6 Path system, the above message will read “1 CCB(s) detected at version 5.OLD”

8. Press the ENTER button on the front of the 4500.
9. The following message should appear on the display screen.

DSP Module Firmware Upgrade Mode
 2 CCB(s) detected at version 5.OLD

 DSP Firmware upgrade in progress...

NOTE: If power is lost during the upgrade, this process must be restarted from the first step. The TAS 4500 will not function properly until this is done.

10. Within two minutes, the 4500 should report “Upgrade Completed Successfully”. If this is not the case, please contact TAS customer support.

```
DSP Module Firmware Upgrade Mode
2 CCB(s) detected at version 5.NEW

Upgrade Completed Successfully.
```

11. Turn the TAS 4500 off.
12. Remove RFPD-99 **CARD 1 of 3** from the PCMCIA slot on the rear of the 4500.
13. Place the card marked RFPD-99 **CARD 2 of 3** into the PCMCIA slot. Make sure that it is fully seated in the slot.



14. Turn the TAS 4500 on.
15. The 4500 will now power up, and you may receive the following message.

```
Memory loss, restored from default.
```

This is normal, just press the [ESC] key of the front panel.

16. After system initialization, the following message should appear on the display screen.

```
DSP Module FIR Filter Download Mode
2 CCB(s) detected at version 5.NEW

Press ENTER to download filter coef.
```

NOTE: If the TAS 4500 is a 3 path or 6 path system, the above message will read “1 CCB(s) detected at version 5.OLD”

17. Press the ENTER button on the front of the 4500.
18. The following message should appear on the display screen.

```
DSP Module FIR Filter Download Mode
2 CCB(s) detected at version 5.NEW

Filter download in progress...0%
```

NOTE: If power is lost during the upgrade, this process must be restarted from the first step. The TAS 4500 will not function properly until this is done.

19. Within fifteen minutes, the 4500 should report “Download Completed Successfully”. If this is not the case, please contact TAS customer support.

```
DSP Module FIR Filter Download Mode

Download Completed Successfully.
```

20. Turn the TAS 4500 off.
21. Remove RFPD-XX **CARD 2 of 3** from the PCMCIA slot on the rear of the 4500.
22. Repeat steps 13–21 for RFPD-XX **CARD 3 of 3**.
23. Insert the card marked “TAS 4500 Operating Firmware, Version 5.NEW, RFPD-YY” into the TAS 4500. Make sure that the card is fully seated.



NOTE: Be sure not to re-install the original card that was used in the system that has the old version of Operating Firmware on it.

24. Turn the TAS 4500 on.
25. The 4500 will now power up, and you may receive the following message.

```
Memory loss, restored from default.
```

This is normal, just press the [ESC] key of the front panel.

26. After the system has powered up, press the CONFIG button on the front panel of the TAS 4500. The following text should appear on the display screen.

```
CONFIG                               ↓
CHANNEL CONFIG: NOT AVAILABLE
10MHz REFERENCE: internal
REMOTE PROTOCOL: crlf↓             SUMMARY↓
```

27. Move the cursor to SUMMARY and press the ENTER button. The following text should appear on the display screen.

```
CONFIG SUBMENU (ESC TO EXIT)        ↓
SYSTEM SUMMARY
STATUS:ok   FW VER:5.NEW DSP VER:5.NEW
RF RANGE CH1: 25-3000 CH2: 25-3000 MHz_
```

If Status = OK, FW VER = 5.NEW and DSP VER = 5.NEW, the upgrade was successful and the TAS 4500 is ready to use.

If Status ≠ OK, the upgrade has failed. Please contact TAS technical support.

28. If you received the warning “Memory loss, restored from default” during any part of the upgrade process, you will need to reset any communications settings in order to communicate with the 4500.