Comprehensive, repeatable radio channel emulation for testing 3G wireless systems.

The TAS4500 FLEX5 possesses unique features to evaluate a wide range of wireless communications technologies, including:

- WCDMA
- CDMA2000
- Wireless LAN
- Location Based Services

The FLEX5 provides accurate and repeatable control of RF channel characteristics such as:

- Multi-Path Fading
- Path Loss
- Delay Spread
- Log Normal Shadowing

These effects result in significant signal distortion that can lead to errors and communication failures. Thorough and effective testing can lead to designs that mitigate the RF channel effects and render robust, high-quality products.

FLEX5 gives you the bandwidth you need to cover all CDMA2000, WCDMA and WLAN applications. The FLEX5 also provides, flexible radio channel emulation to meet wide range of testing standards from 3GPP2, 3GPP, ANSI, ITU, CDG and many more. It provides an easy way to comply with industry standards and to benchmark product performance. In addition, FLEX5 gives you the tools to go beyond mere standards compliance to completely and objectively characterize product performance.

Using the powerful Dynamic Environment Emulation (DEE) feature, you can emulate dynamic channel conditions, or playback field measurements in the lab. FLEX5 dynamic channel models meet WCDMA receiver test requirements by emulating real-world propagation conditions. This is achieved by dynamically changing key channel parameters versus time. FLEX5 can re-create a time-varying power-delay channel profile either from synthesized data or previously recorded field measurements.

FLEX5 creates a wide range of realistic RF propagation conditions, so that wireless communication products can be thoroughly tested in a laboratory setting. FLEX5 creates accurate, repeatable test conditions to facilitate systematic testing. Thorough testing with FLEX5 will reduce cost and time-to-market.

TAS4500 FLEX5 precisely emulates time-varying RF propagation effects to facilitate thorough evaluation of wireless communications equipment.

Major Features:

- Provides comprehensive channel models for evaluating CDMA2000 and WCDMA communications equipment
- Includes powerful, user programmable dynamic tests to accurately reproduce real-world conditions
- Expandable up to an eight branch diversity test system with full correlation control
- Vector channel model for adaptive antenna array testing
- Combines with Spirent Interference Emulator to provide programmable interference conditions across entire range of operating frequencies
- Supports JTC’94 models for indoor WLAN applications
- Large Doppler emulation range meets high-speed mobile test specifications
- Built-in and user-programmable environment models
- Wide dynamic range provides accurate results even at the lowest signal levels

Applications:

- Product Development
- System Performance Test
- Quality Assurance
- Manufacturing Test
- Product Evaluation
- Design Verification Test
- Conformance Test
**FLEX5 Capabilities**

TAS4500 FLEX5 addresses a wide range of wireless communications applications. FLEX5 provides accurate, repeatable emulation of the wireless communication medium that is independent of transceiver technology, so the same FLEX5 unit can be applied to a wide range of transmission schemes. FLEX5 also operates over a broad frequency range, so applications as diverse as WLAN, audio/video broadcast, land-mobile radio, cellular and PCS can all be addressed.

FLEX5 is a modular system that can be configured to fit the needs of a specific application. In addition, FLEX5 works in conjunction with other Spirent equipment such as our Interference Emulator and automatic test software to form complete test systems. All FLEX5 models come equipped with convenient front panel controls as well as TASKIT® software for Windows PC control.

**Standard Test Systems for Cellular, PCS, and Next Generation Wireless Applications**

TAS4500 FLEX5 emulates all RF propagation conditions required for wireless voice and data applications testing in one compact enclosure. FLEX5 tests both mobile station and base station equipment. Each FLEX5 unit can be configured with up to twelve independent signal paths, and can easily accommodate the required test conditions for both existing and emerging wireless communication standards. In addition, built-in local oscillators keep the test system integrated and easy to operate. TASKIT® software includes a pre-defined library of test conditions for popular wireless standards.

**Play-back field propagation conditions in the lab using Dynamic Environment Emulation**

In the past, the methods available to benchmark the performance of wireless systems under dynamic environment conditions were extremely limited. This type of comprehensive performance evaluation was typically restricted to time-consuming, costly, and unrepeatable field tests. Now, using FLEX5’s innovative Dynamic Environment Emulation (DEE) feature, real-world conditions can be recreated in the lab via TASKIT/4500 PC-software. Propagation conditions can be either synthesized or imported from field measurements to allow full, repeatable control over time-varying RF channel characteristics. DEE can help isolate potential field problems before deployment – saving both time and money.

Dynamic Environment Emulation makes it possible to synchronously emulate multiple forward and reverse links. When used in a multi-channel mode, DEE synchronizes the fading and multi-path characteristics across FLEX5 instruments enabling precise cause-and-effect correlation between channel conditions and system performance.

Test time-sensitive system handoff performance algorithms, using Dynamic Environment Emulation
TAS4500 FLEX5 Applications

**WCDMA UE Test Configuration**

**U-ATS System Configuration**

U-ATS is a comprehensive test setup that provides automated WCDMA performance test coverage, including 3GPP standards.

**C2K-ATS CDMA2000 Automatic Test System for Evaluating Mobile Devices**

**C2K-ATS System Configuration**

C2K-ATS is a comprehensive test setup that provides complete and automated coverage of IS-98 and IS-898 (CDG Stage 2).

**Wireless LAN Test Configuration**

**Wireless LAN System Configuration**

Spirent solutions enable both physical and MAC layer testing for WLAN applications.
Powerful Dynamic Environment Emulation (DEE) Lets You Accurately Pinpoint Real-World Performance Problems

Dynamic Environment Emulation varies key channel parameters at precise time intervals. This innovative feature allows complete performance evaluation of time-sensitive communications algorithms such as Rake demodulator, channel equalizer, or mobile hand-off scheme. By moving the test environment into the lab, this advanced capability enables different design iterations to be evaluated over repeatable test conditions and reduces the cost of testing.

Employing an easy-to-use Windows-based GUI, DEE makes it easy to generate and play-back a series of exhaustive channel conditions. The DEE test software allows control over eight synchronous RF emulation channels from a single PC. Multi-channel synchronization makes it possible to construct a comprehensive test bed for evaluating the performance of several forward and reverse links simultaneously. State transitions can be managed by internal timers or synchronized to system events via an external trigger signal.

FLEX5’s dynamic channel models meet WCDMA receiver test requirements

3GPDP simplifies receiver testing by allowing pre-defined WCDMA/3GPP channel models to be recalled with a touch of a button

FLEX5 with 3GPDP provides the ability to go beyond the two-path dynamic models defined in 3G standards by allowing the relative delay of the instrument’s entire path to be varied over time. 3GPDP’s Moving propagation and Birth-Death channel models emulate the temporal variations in the radio channel by changing delay-spread characteristics versus time.

- Emulates time-varying power-delay profiles (PDP’s)
- Evaluates performance of RAKE finger management and channel estimation algorithms
- Built-in Moving Propagation and Birth-Death Channel Models
- Surpasses requirements defined in CDMA2000 and WCDMA (3GPP) test specifications

3GPDP makes it easy to recall pre-defined 3GPDP channel models or to create more sophisticated dynamic multi-path test scenarios.
Advanced multi-branch and vector channel models for evaluation of diversity and antenna array systems

Many wireless systems utilize diversity receivers to optimize performance. Emerging networks are deploying antenna arrays to further reduce the effects of interference and increase system capacity. Diversity and antenna array systems require advanced channel models capable of synchronously emulating multiple propagation channels. Dual-branch diversity systems can be evaluated in a single TAS4500. Diversity systems with more than two branches require additional FLEX5 instruments to be synchronized. A system utilizing four diversity branches requires the channel characteristics of a pair of TAS4500’s. Additional FLEX5 instruments can be added to emulate up to an eight-branch diversity model with full correlation control between branches.

Evaluation of antenna array systems requires a new class of channel models. These vector channel models require control of both fading correlation and relative phase between emulation channels. The TAS4500 provides the advanced vector channel models required to evaluate antenna array systems.

The FLEX5 is the first fading emulator that expands to an eight-branch diversity test system. TAS4500 provides full correlation control by synchronizing fading characteristics across four instruments.

TASKIT/Smart Antenna software provides quick and easy access to powerful multi-channel modeling capabilities

TASKIT/Smart Antenna provides access to all the parameters necessary to configure multi-branch channel models. At the heart of the Smart Antenna Test Systems, the PC-based software makes it possible to program the spatial characteristics of the antenna array using simple geometric parameters.

This powerful channel modeling software precisely calculates the phase relationships between each of the antenna elements based on the user-defined antenna geometry. The result is an accurate and repeatable channel model that emulates the propagation environment seen by the diversity antenna system.

TASKIT/Smart Antenna’s innovative Random Angle of Arrival Test recreates real-time dynamic test conditions. Based on the antenna array geometry and user-defined angle of arrival statistics, TASKIT/Smart Antenna plays back a time-varying multi-branch channel model. The multi-branch test system fully evaluates the adaptive algorithms employed by Smart Antenna systems by randomly varying the angle of arrival characteristics of each propagation path.

Spirent’s Smart Antenna Test System can be programmed to randomly vary angle-of-arrival characteristics over time based on statistical distributions.
FLEX5 Application-Specific Systems

TAS4500 FLEX5 can be ordered in one of two ways:
- Pre-configured system, targeted for specific test applications
- A la carte, to create a custom system configuration

The following text provides a description of each available system product. The “Matrix of FLEX5 Models” shows how each specific 4500 model is equipped. The “FLEX5 Systems Components and Options” provides a brief description of each available FLEX5 option. Note that FLEX5 products are listed with the format: Part Number/Description. Please use these same part numbers and descriptions when placing an order.

FLEX5/3G - Complete RF channel emulator for third generation (3G) cellular and PCS applications. Includes two 6-path channels, two LO’s, enhanced feedthrough suppression, channel bypass function and RF output attenuators. Covers 800-2500 MHz range.

FLEX5/CELL - Complete RF channel emulator for cellular and personal communications systems (PCS) applications. Includes two 3-path channels, two LO’s, enhanced feedthrough suppression, channel bypass function and RF output attenuators. Covers 800-2500 MHz range.

SMART-LAB - Complete system for testing Smart Antenna and Antenna Diversity systems with up to eight branches. Includes up to four synchronized FLEX5 channel emulators.

Matrix of FLEX5 Models

<table>
<thead>
<tr>
<th>Model</th>
<th>Channels X Paths</th>
<th>Band Width (MHz)</th>
<th>Internal LO Type</th>
<th>Channel Bypass (CBP)</th>
<th>Enhanced Feed Through Suppression (EFX)</th>
<th>800-2500 MHz Output Attenuator (ATT1)</th>
<th>25-3000 MHz Output Attenuator (ATT3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FLEX5/3G</td>
<td>2 x 6</td>
<td>26</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>FLEX5/CELL</td>
<td>2 x 3</td>
<td>26</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
<td>opt</td>
</tr>
<tr>
<td>FLEX5/Q1</td>
<td>2 x 6</td>
<td>26</td>
<td>LD4</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

FLEX5 System Components and Options

FLEX5-ATT1 Atten. For 800-2500 MHz Range (each channel) — This option provides a precision RF attenuator to cover the 800-2500 MHz frequency range. A separate attenuator option must be purchased for each channel in the FLEX5 unit.

FLEX5-ATT3 Atten. For Extended Freq. Range (each channel) — This option provides an RF attenuator to cover the extended (25-3000 MHz) frequency range. A separate attenuator option must be purchased for each channel in the FLEX5 unit. ATT3 control not available when using DEE.

FLEX5-EFX Enhanced Feedthrough Suppression (each channel) — This option adds LO and Image Feedthrough suppression filtering over the 800 - 3000 MHz frequency range. A separate suppression filter must be purchased for each channel in the FLEX5 unit.

FLEX5-CBP Channel Bypass Option (each channel) — This option for the enhanced front end provides software controlled bypass of the channel. This option is not available with the FLEX5-FBP option.

FLEX5-EXTnn Extended Delay Option — Extended delay is available for all FLEX5 models. The FLEX5 has a 2000 msec relative path delay range when equipped with the extended delay option. The part number for extended delay depends on the number of paths contained in the FLEX5 system, as follows:
- 12-path systems – FLEX5-EXT12
- 6-path systems – FLEX5-EXT06
- 3-path systems – FLEX5-EXT03
FLEX5 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.

**RF Channel Specifications**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Input Signal Frequency Range</td>
<td>25 to 3000 MHz</td>
</tr>
<tr>
<td>RF Bandwidth</td>
<td>26 MHz</td>
</tr>
<tr>
<td>Number of Independent RF Channels</td>
<td>1 or 2</td>
</tr>
<tr>
<td>RF Input Signal Level Range</td>
<td>-5 to -30 dBm</td>
</tr>
<tr>
<td>RF Bandwidth Peak-to-Peak</td>
<td>1 dB</td>
</tr>
</tbody>
</table>

**RF Channel Options**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>RF Image and LO Feedthrough</td>
<td></td>
</tr>
<tr>
<td>Suppression (EFX Option)</td>
<td></td>
</tr>
<tr>
<td>Frequency Range</td>
<td>800 to 3000 MHz</td>
</tr>
<tr>
<td>RF Image Feedthrough on RF Out</td>
<td>-50 dBc maximum</td>
</tr>
<tr>
<td>RF LO Feedthrough on RF Out</td>
<td>-75 dBm</td>
</tr>
<tr>
<td>RF Output Attenuator</td>
<td></td>
</tr>
<tr>
<td>ATT1:</td>
<td></td>
</tr>
<tr>
<td>Attenuation Range</td>
<td>0 to 80 dB</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 dB</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>800 to 2500 MHz</td>
</tr>
<tr>
<td>ATT3:</td>
<td></td>
</tr>
<tr>
<td>Attenuation Range</td>
<td>0 to 90 dB</td>
</tr>
<tr>
<td>Resolution</td>
<td>0.1 dB</td>
</tr>
<tr>
<td>Frequency Range</td>
<td>25 to 3000 MHz</td>
</tr>
</tbody>
</table>

**Local Oscillator (LO) Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Local Oscillators (LO4 option) (All specs refer to LO OUT unless noted)</td>
<td></td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td>940-2860 MHz</td>
</tr>
<tr>
<td>Carrier Frequency Range (RF IN)</td>
<td>800-3000 MHz</td>
</tr>
<tr>
<td>Level</td>
<td>+13 dBm</td>
</tr>
<tr>
<td>External Local Oscillators (All specs refer to LO IN unless noted)</td>
<td></td>
</tr>
<tr>
<td>LO Frequency Range</td>
<td>165-3860 MHz</td>
</tr>
<tr>
<td>LO Offset from Carrier Frequency (Fc)</td>
<td></td>
</tr>
<tr>
<td>Fc &gt;800 MHz</td>
<td></td>
</tr>
<tr>
<td>Fc &gt; 140 MHz</td>
<td></td>
</tr>
<tr>
<td>Fc &lt;800 MHz</td>
<td></td>
</tr>
<tr>
<td>Fc &gt; 140MHz</td>
<td></td>
</tr>
<tr>
<td>Fc + 140 MHz</td>
<td></td>
</tr>
<tr>
<td>Level Range</td>
<td>+12 to +15 dBm</td>
</tr>
</tbody>
</table>

**Channel Emulation Characteristics**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Independent Paths per Channel</td>
<td>3, 6 or 12</td>
</tr>
<tr>
<td>Path Modulation</td>
<td>None, Rayleigh, Frequency Shift, Phase Shift, Rayleigh with Frequency Shift, Rician with Frequency Shift Nakagami, Rician</td>
</tr>
<tr>
<td>Fading Emulation Method Programmed with 2 modes:</td>
<td>Jakes, Filtered Noise</td>
</tr>
<tr>
<td>Fading Power Spectrum</td>
<td>Classical 6dB Flat, Classical 3dB Rounded</td>
</tr>
<tr>
<td>Fading (Rayleigh) Amplitude Distribution Deviation from Theoretical CPDF exceeds the following requirements (exceeds IS-137/138, and TIA/EIA-97/98 requirements):</td>
<td>From +10 to -30 dB of mean power level ( \pm 0.5 ) dB</td>
</tr>
<tr>
<td>Level Crossing Rate (LCR) Accuracy exceed the following requirements (exceeds IS-137/138, and TIA/EIA-97/98 requirements):</td>
<td>From +3 to -30 dB of mean power level ( \pm 2.5% ) deviation theoretical LCR curve of the simulated vehicle velocity</td>
</tr>
<tr>
<td>Fading Repetition Interval Emulation Method = Filtered Noise Programmable with 3 modes:</td>
<td>27 seconds, 20 minutes, 24 hours</td>
</tr>
<tr>
<td>Correlation Coefficient (Between Channel 1 and Channel 2 Paths)</td>
<td>Range 0 to 1 Resolution 0.01</td>
</tr>
<tr>
<td>Velocity</td>
<td>( \pm 0.1 ) to ( \pm 1199.2 ) km/hr (( \pm 0.1 ) to ( \pm 745.1 ) mph) Resolution 0.1 units</td>
</tr>
<tr>
<td>Fading Doppler Frequency Range</td>
<td>( \pm 0.1 ) to ( \pm 1000 ) Hz Resolution 0.1 Hz</td>
</tr>
<tr>
<td>Doppler Shift Frequency (Frequency Shift)</td>
<td>Range ( \pm 0.01 ) to ( \pm 1000 ) Hz Resolution 0.01 Hz</td>
</tr>
<tr>
<td>Line of Site (LOS) Arrival Angle (Modulation = Rician or Nakagami)</td>
<td>Range 0 to 360 degrees Resolution 0.1 degrees</td>
</tr>
<tr>
<td>Relative Phase Between Paths (Modulation = Phase)</td>
<td>Range 0 to 360 degrees Resolution 0.1 degrees</td>
</tr>
</tbody>
</table>
### Channel Emulation Characteristics (continued)

- **Rician K Factor** (Modulation = Rician)
  - Range: -30 to +30 dB
  - Resolution: 0.1 dB

- **Nakagami M Value** (Modulation = Nakagami)
  - Values: 1, 3, 5, 10, 15, 25, 100

- **Relative Path Delay**
  - Range: 0 to 125 μsec
  - Resolution: 0.5 nsec

- **Relative Path Loss**
  - Range: 0 to 50 dB
  - Resolution: 0.1 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

### 3GPP

- **Test Profiles**
  - Moving Propagation
    - Birth-Death
  - Minimum State Duration: 1 msec
  - State Duration Resolution: 1 msec
  - State Transition Trigger: Internal/External

### Dynamic Environment Emulation

- **Number of States**: >2 billion
- **Minimum State Duration**: 10 msec.
- **State Duration Resolution**: 1 msec.
- **State Transition Trigger**: Internal, External

### Channel Models

FLEX5 performs these standard multi-path fading environments and many more:

- **3GPP**
  - WCDMA: TS 25.141, TS 34.121, TS 25.142, TS 34.122, TR 25.943
  - 3GPP2: IS-97-D, IS-96-D

- **3GPPP**
  - IS-97-D, IS-96-D

### 3GDPDP

- **Moving Propagation**
  - Period of Oscillation: (10^{-3} rad/sec)
  - Number of Moving Paths: 1 to 6
  - Number of Active Paths: 1 to 6

### Interface and Environmental Characteristic

- **Power Requirements**
  - Voltage: 85-265 VAC (auto sensing)
  - Frequency: 47 - 63 Hz

- **Operating Environment**
  - Temperature: 0 to 50 degrees C (32 to 122 degrees F)
  - Height: 6.9 inches, 175 mm
  - Width: 17.7 inches, 450 mm
  - Depth: 19.9 inches, 505 mm
  - Weight: 45 pounds, 20.5 kg

- **Control Interfaces**
  - Interfaces Provided: RS-232 (DCE) and IEEE-488 (GPIB)

- **External 10 MHz Reference Requirements**
  - Input Frequency: 10.000 MHz