Electromagnetic Emissions Statements for Azimuth MX Instruction/Installation Manuals:

**USA Requirements: Federal Communications Commission (FCC) Compliance Notice: Radio Frequency Notice**

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy. If it is not installed and used in accordance with the instruction manual, it may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case users will be required to take whatever measures may be necessary to correct the interference at their own expense. To meet FCC and CE emissions requirements, a shielded CAT5 cable must be used to connect the Ethernet of the ACE MX to a network.

**Canada Requirements: Canadian Department of Communications Radio Interference Regulations**

This digital apparatus does not exceed the Class A limits for radio-noise emissions from digital apparatus as set out in the Radio Interference Regulations of the Canadian Department of Communications.

Règlement sur le brouillage radioélectrique du ministère des Communications Le présent appareil numerique n’emet pas de bruits radioelectriques depassant les limites applicables aux appareils numeriques de la class A prescrtes dans le Reglement sur le brouillage radioelectric edite par le ministere des Communications du Canada.

---

**Caution:** This is a Class A product. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.
About This Guide

Purpose of the Guide

This guide provides the information needed to set up, configure, and use the Azimuth Field-to-Lab (FTL) solution.

Intended Audience

This guide is intended for anyone that wants to collect field data, process it, and play it back in the lab in such a way that the radio environment created in the lab closely resembles the real-world environment where field data was collected.

Field-to-Lab Users Guide Organization

This Users Guide consists of the following information:

- Chapter 1, “Introduction” (page 1-1)
- Chapter 2, “Field-to-Lab Software Installation” (page 2-1)
- Chapter 3, “Field-to-Lab Hardware Installation” (page 3-1)
- Chapter 4, “Azimuth AzMapper” (page 4-1)
- Chapter 5, “Azimuth AzPlayer” (page 5-1)
- Chapter 6, “Quick Start Guide” (page 6-1)
- Appendix A, “Technical Specifications” (page A-1)
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Chapter 1: Introduction

This chapter consists of the following sections:

• Overview
• Concept
• Elements of Azimuth Field-to-Lab
• AzMapper
• AzPlayer
• ACE MX
• DIRECTOR II

1.1 Overview

Field-to-Lab is a comprehensive, end-to-end solution that allows operators, chipset manufacturers, and infrastructure vendors to minimize risk and accelerate time to market by minimizing the need for drive tests.

The Field-to-Lab solution provides an accurate and repeatable environment where data collected during drive tests (i.e. in the real world) can be utilized in the lab for pre-deployment infrastructure and device testing as well as for post-deployment field issue analysis, debugging, and resolution.

1.2 Concept

As shown in Figure 1-1, the concept of Field-to-Lab is to collect field data, process it, and play it back in the lab in such a way that the radio environment created in the lab closely resembles the real-world environment where field data was collected. The Field-to-Lab solution allows for one time field data collection and repeated testing of equipment in the lab.

The effectiveness of such a system depends on:

• The accuracy of re-creating real-world conditions.
• The repeatability of the environment re-created in the lab.
• The playback customization flexibility to match testbed capabilities.
• The ability to create different scenarios from the measured data or filter data based on varying criteria.
1.2 Concept

- The intelligence of the mapping software at removing extraneous and unintentional noise from the measured data; higher intelligence produces results that are not skewed by artificial remnants.
- The RF fidelity of the channel emulator.
- The intrinsic ability of the channel emulator to support complex topologies and real-world, bidirectional operation.

Scanned data goes through transformations while progressing through the data flow of the Field-to-Lab system, as shown in **Figure 1-2**.
1.3 Elements of Azimuth Field-to-Lab

As shown in Table 1-1, each of the elements of the Field-to-Lab system are specially designed to meet all requirements listed in the previous section, ensuring the performance of the system is enhanced and not compromised because of inherent restrictions in some areas, such as collecting data.

### Table 1-1: Elements of Field-to-Lab

<table>
<thead>
<tr>
<th>Module</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scanner/modified phone</td>
<td>Scans the radio channel and records the power of the cell(s) and channel conditions. Typically, these are commercially-available drive test tools owned by the customer. A comprehensive list of technologies and scanners/test mobiles supported by the Azimuth Field-to-Lab solution and their specifications can be found in Appendix A, “Technical Specifications” (page A-1).</td>
</tr>
<tr>
<td>AzMapper</td>
<td>• Extracts information from the scanned data so that it can be customized for play back in a lab testbed.</td>
</tr>
<tr>
<td></td>
<td>• Interprets the scanner specific proprietary data and loads it; use the scanner data from any scanner.</td>
</tr>
<tr>
<td></td>
<td>• Test different scenarios by providing a flexible and powerful mechanism to control all the critical parameters.</td>
</tr>
<tr>
<td></td>
<td>• Removes artificial effects induced by the scanner or measurement technique to facilitate the re-creation of real world conditions without any spurious vestiges.</td>
</tr>
<tr>
<td></td>
<td>• Generates rich, useful, and intuitive plots of the data at different points in the system, providing the ability to visualize the data and the effect of the parameter values.</td>
</tr>
<tr>
<td></td>
<td>• Provides a flexible and modular platform that can run custom algorithms and scripts.</td>
</tr>
<tr>
<td>AzPlayer</td>
<td>• Offers an intuitive, easy to use, end-to-end application that allows you to automate and control the Azimuth ACE MX.</td>
</tr>
<tr>
<td></td>
<td>• Plays back the mapped data from the AzMapper</td>
</tr>
<tr>
<td></td>
<td>• Adds degrees of realism and the ability to customize the scenario.</td>
</tr>
</tbody>
</table>
1.4 AzMapper

The AzMapper translates the data captured by scanners/test mobiles into data that can be played back in the lab without the loss of accuracy and artifacts that are embedded in field data. Table 1-2 shows some of the aspects of the AzMapper that facilitates the correlation of results in the lab to the field with Azimuth's Field-to-Lab solution.

<table>
<thead>
<tr>
<th>Testbed (Customer provided)</th>
<th>Offers an environment where the real world is re-created using the ACE MX Channel emulator, Base Stations (or Base Station emulators), and a mobile device.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACE MX (Azimuth provided)</td>
<td>• Provides real-world functionality, critical for bringing the testbed to life.</td>
</tr>
<tr>
<td></td>
<td>• Creates highly accurate, uncontaminated, and controllable radio environments.</td>
</tr>
<tr>
<td></td>
<td>• Allows the creation of complex and unique setups through a modular architecture that is built for customization and bi-directional operation.</td>
</tr>
<tr>
<td></td>
<td>• Enables automation (including third-party equipment) and allows customers to run standard or build their own test scripts.</td>
</tr>
<tr>
<td></td>
<td>• Offers high fidelity, low noise floor, and unmatched capabilities</td>
</tr>
</tbody>
</table>

1.5 AzPlayer

The AzPlayer is an efficient and powerful application that streams Field-to-Lab channel information in real-time to a selected group of ACE MXs. The AzPlayer was designed specifically to support Field-to-Lab, offering infinite flexibility and ease of use. Table 1-3 shows some of the aspects of the AzPlayer that make it the ideal control utility and streaming engine for Field-to-Lab.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intuitive interface</td>
<td>• Visual cues and information provide easy learning</td>
</tr>
<tr>
<td></td>
<td>• Quicker time to testing, quicker time to solution</td>
</tr>
<tr>
<td>Modular architecture</td>
<td>• Easy customization to meet your needs</td>
</tr>
<tr>
<td></td>
<td>• Enables re-use of modules</td>
</tr>
<tr>
<td>Drive Log Pooling</td>
<td>Combine (pool) drive logs from different drive tests</td>
</tr>
<tr>
<td>Drive Data Share</td>
<td>Open format mapped data allows you to share the data with other teams and provide the maximum testing impact.</td>
</tr>
<tr>
<td>Multimedia Rich Display</td>
<td>• Visualization of data at various stages of the process</td>
</tr>
<tr>
<td></td>
<td>• Facilitates visual identification of problem areas</td>
</tr>
<tr>
<td></td>
<td>• Enables creation of graphically rich reports for team meetings, executives, and others - such as suppliers and customers,</td>
</tr>
</tbody>
</table>
The ACE MX is the first and most advanced MIMO channel emulator in the industry, making it an ideal platform for the end-to-end, high fidelity Field-to-Lab solution, as shown in Table 1-4.

### Table 1-4: ACE MX’s features and implications

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Implication</th>
</tr>
</thead>
</table>
| Inherent Support for Downlink and Uplink Fading | • Ease of creating and using setups with fading on the downlink and uplink  
• Eliminates the need for bulky extraneous components such as isolators and circulators to perform fading on the downlink and uplink.  
• Higher fidelity signal at the mobile device (on the downlink) and the base station (on the uplink) since the military-grade specifications of the box are not compromised by external components.  
• Wider range of operation with the highest accuracy and fidelity |
| Very low EVM                                | • Signal being tested is not distorted by the channel emulator.  
• Enhanced support for transmission schemes (e.g., 64 QAM)  
• Higher confidence in test results |

---

**Table 1-3: AzPlayer’s features and their implications**

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Implication</th>
</tr>
</thead>
</table>
| Integrated with DIRECTOR II (see DIRECTOR II) | Ease of operation  
• Easy manipulation of playback files  
• Facilitates file sharing across teams, which maximizes productivity  
• Eliminates the need for special software to view or edit the files |
| Universal playback file format              | • Values are streamed in real-time  
• Eliminates the wait time for compiling, generating, or processing data  
• Starts playing in seconds |
| Real-time streaming                          | • Ability to playback infinitely long playback files  
• Facilitates stress-testing of the mobile device or system |
| Click to play in seconds                    | • Ability to play, pause, stop, step, and seek  
• Provides the ability to focus on trouble spots and spend less time on periods of normal operation|
| Unlimited playback duration                 | • Tracks the changes in the power to ensure that there is no clipping, thereby allowing you to run test cases without worrying about signal clipping and distortion.  
• Offsets the loss induced by cables, external components and ensures that the mobile device sees the intended power.  
• Support for typical and practical use cases that save time and effort |
| Power tracking and calibration              | • Ease of creating and using setups with fading on the downlink and uplink  
• Eliminates the need for bulky extraneous components such as isolators and circulators to perform fading on the downlink and uplink.  
• Higher fidelity signal at the mobile device (on the downlink) and the base station (on the uplink) since the military-grade specifications of the box are not compromised by external components.  
• Wider range of operation with the highest accuracy and fidelity |
1.7 DIRECTOR II

DIRECTOR II Test Executive software provides a comprehensive graphical user interface (GUI) to configure and control the channel emulator's parameters. In addition, DIRECTOR II enables full script control through a TCL API for automation or remote control of the ACE MX and third-party equipment. DIRECTOR II is one of the few user applications created with usability as a central theme. The result is a platform that serves the needs of typical and niche users. Table 1-5 shows some of the aspects of DIRECTOR II that make it an interface that truly simplifies and enriches the user experience and allows you to tap into the high-end capabilities of the ACE MX and Field-to-Lab solution.

Table 1-5: DIRECTOR II's features and implications

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra low noise floor</td>
<td>• Preserves the fidelity of the signal being transmitted</td>
</tr>
<tr>
<td></td>
<td>• Does not skew test results because of the emulator noise floor</td>
</tr>
<tr>
<td>Built for MIMO</td>
<td>• Ability to support simple and complex MIMO configurations (2x2 to 8x4 uni and/or bidirecctional)</td>
</tr>
<tr>
<td></td>
<td>• Support for beam forming and other antenna techniques</td>
</tr>
</tbody>
</table>

Table 1-4: ACE MX's features and implications

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Implication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ultra low noise floor</td>
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</tr>
<tr>
<td></td>
<td>• Support for beam forming and other antenna techniques</td>
</tr>
</tbody>
</table>
Chapter 2: Field-to-Lab Software Installation

This chapter includes the following sections:

• Licensing
• DIRECTOR II Installation
• AzMapper Installation
• AzPlayer Installation

2.1 Licensing

The Field-to-Lab solution consists of three primary software elements. These are DIRECTOR II, AzMapper, and AzPlayer.

• DIRECTOR II is the test executive for the ACE MX; a license is required for its operation. You can obtain this license from Azimuth Systems. Please refer to Chapter 2 of the Azimuth Systems DIRECTOR II and ACE MX User Guide for more details.

• AzMapper needs a license for its operation; you can get this license from Azimuth Systems. An Azimuth provided USB dongle is required to run AzMapper.

• AzPlayer needs a license for its operation; you can get this license from Azimuth Systems.

2.2 DIRECTOR II Installation

Installation of DIRECTOR II is easily achieved with the DIRECTOR II installation wizard. Please refer to Chapter 2 of the DIRECTOR II and ACE MX User Guide for more details.

2.3 AzMapper Installation

The AzMapper installer must be obtained from Azimuth systems, and can be run from the FTP site or a CD.
2.4 AzPlayer Installation

AzPlayer comes pre-installed, but requires a license key for activation. If AzPlayer is purchased at the same time as an ACE MX unit purchase, the AzPlayer license is added at the factory and is be included with the delivery of DIRECTOR II and any other licensed components. If purchased after the ACE MX is delivered, a new license key must be obtained. Refer to Chapter 2 of the DIRECTOR II and ACE MX User Guide for details.
Chapter 3: Field-to-Lab Hardware Installation

This chapter consists of the following sections:

- Overview
- Testbed Installation

3.1 Overview

The Azimuth Field-to-Lab utilizes log file data collected during drive tests for mapping and playback in the lab. Log files are supplied by the customer and are typically produced via commercially-available scanners/test mobiles. These devices measure/record a variety of pertinent channel conditions and other information such as signal power, noise power, and velocity (e.g., based on GPS coordinates); there is also the possibility of recording additional data, such as power delay profile (PDP), correlation, etc. The logs files of the measured data are used by AzMapper to produce files for playback in the ACE MX as part of a lab testbed.

The scanners/test mobiles are not sold by Azimuth. Further information on supported radio technologies, scanners, and test mobiles is included in Appendix A, “Technical Specifications” (page A-1).

3.2 Testbed Installation

A lab testbed is comprised of a number of Base Stations (or Base Station Emulators), mobile devices/UEs, supporting equipment, and the ACE MX - the critical component that brings life and reality to the testbed.

All testbed equipment can be automated and controlled from a single, central location using the DIRECTOR II's powerful Testbed Manager. The Testbed Manager provides quick setup and automation of the testbed. Refer to Section 1.6.1 of the Azimuth Systems DIRECTOR II and ACE MX User Guide for more details.

The modularity and capabilities of the ACE MX allow for the testing of a variety of configurations: SISO/MIMO, Downlink Only (Uni-directional)/Downlink and Uplink (Bi-directional) fading, and Receive Diversity/No Receive Diversity. Some of the network topologies and usage scenarios are shown in Figure 3-1, Figure 3-2, Figure 3-3, Figure 3-4, Figure 3-5, and Figure 3-6. While these are typical topologies, the ACE MX's inherent support for higher topologies and creating real life-like downlink and uplink fading gives you infinite flexibility and ease of use in setting up and using complex configurations. As shown in the aforementioned figures, you can create testbeds with anywhere from 2 to 8 base stations for SISO or MIMO configurations with just downlink fading or downlink and uplink fading.
The ACE MX's built-in high resolution power meters and fully automated calibration algorithms provide a short time-frame from "in the box" to a "fully automated testbed". Details of tracking varying signal powers and accounting for the loss induced by the cables and other components can be found in Configuring AzPlayer.

Figure 3-1: SISO downlink only fading
Figure 3-2: SISO downlink only fading with Rx diversity
3.2 Testbed Installation

Figure 3-3: SISO downlink and uplink fading
Figure 3-4: SISO downlink and uplink fading with Rx diversity
3.2 Testbed Installation

Figure 3-5: MIMO downlink only fading

Figure 3-6: MIMO downlink and uplink fading
Chapter 4: Azimuth AzMapper

This chapter includes the following sections:

- Overview
- Main Menu
- AzMapper User Interface
- Generating a Playback File

4.1 Overview

AzMapper facilitates the mapping of the measured data into data that can be played back in the ACE MX on a lab testbed.

AzMapper is a very critical component of the Field-to-Lab (FTL) system as it helps in mapping the measured data without loss of accuracy, which is critical due to its upstream position in the process.

AzMapper offers the following capabilities:

- **Extracts information from the scanned data to be customized for playback in a lab testbed.** The data from the scanner could reveal large numbers of cells depending on the length of the drive, the route etc. Since most lab setups have fewer cells than in the field, it is necessary to customize the data collected for playing back in the testbed. AzMapper is cognizant of the setup being used and maps the data to ensure accurate generation of the radio environment with the best possible use of resources.

- **Interprets the scanner-specific proprietary data and loads it so that scanner data from any scanner can be used.** There are a multitude of scanners and measurement devices/handsets on the market for collecting the data. The lack of a standard format of data collection means that each scanner has its own proprietary format for collection and storage. AzMapper's built-in interpretation engine allows the use of any off-the-shelf scanner without the necessity for writing custom code to extract the data.

- **Allows you to test different scenarios by providing a flexible and powerful mechanism to control all the critical parameters.** AzMapper allows you to filter the scanned data based on various criteria and customize the processing of the scanned data, facilitating the creation of different test scenarios.

- **Removes artificial effects induced by the scanner or measurement technique to facilitate the recreation of real world conditions without any spurious vestiges.** For example, many scanners can report measurements only at specific intervals, and as a consequence the scanner data might have artificial gaps without cells. AzMapper combats these effects by utilizing its built in smart algorithms to discern between a missing signal due to the scanner's restrictions/employed measurement technique and the sector/cell actually disappearing.
4.2 Main Menu

- Generates rich, useful, and intuitive plots of the data at different points in the system, allowing you to visualize the data and the effect of the parameter values. With the large volume of data that is generated from drive tests, it is very easy to miss "shocks" to the system when just looking at the numbers; AzMapper provides comprehensive plots of the data at all stages of the process to counter this problem; the plots can be customized to meet specific needs. Not only do these plots help in detecting, debugging and resolving issues, they also make it very easy to generate comprehensive, rich test reports.

- Provides a flexible and modular platform to run custom algorithms and scripts. AzMapper's inherent modularity provides a very flexible and open platform allowing maximization of returns by running custom algorithms.

4.2 Main Menu

AzMapper’s main menu provides save and export functions, access to various views for visualizing data, configuration settings, and the ability to export AzMapper information to send to Azimuth Support.

4.2.1 File Menu

The file menu allows you to open and save profile settings and save the current playback file; see Figure 4-1. Using the File menu, you can also save the graph from the currently selected tab, or you can select Save All Graphs, which saves all graphs across tabs.
4.2 Main Menu

Figure 4-1: File Menu

Selecting Export Data from the File menu exports graph data in XML format, which can be used for performing mathematical operations. The XML data allows easier manipulation and post-processing than CSV files and more than just the visualization that graphs offer. See Figure 4-2.
Figure 4-2: File Menu Export Graph Data
4.2.2 View Menu

AzMapper allows data visualization at different points in the data flow for all the previously discussed formats. This can be done by selecting View from the main menu as shown in Figure 4-3, Figure 4-4, Figure 4-5, and Figure 4-6. These plots help in visualizing the data as it goes through the transformation from raw scanner data to enhanced mapped data and allows visualization of the effect of changes to the mapping parameters. For instance, look at Figure 4-5 and Figure 4-6 to understand the effect of changing the Number of ACE Channels; while Figure 4-5 shows the mapped data with 2 playback channels, Figure 4-6 shows the mapped data with 8 playback channels.

![Figure 4-3: Scanner data view](image)

Figure 4-3: Scanner data view
4.2 Main Menu

Figure 4-4: Filtered data view
Figure 4-5: Mapped data view
Figure 4-6: Mapped data with 8 channels
4.2 Main Menu

4.2.3 Window Menu

Selection made from the Window menu configure various functions, including automatically opening images (e.g., saved graphs) after they are exported, automatically refreshing AzMapper after selections are made to update the profile, and making the current setting the default for the next time AzMapper is opened. See Figure.

Figure 4-7: Window menu
4.2 Main Menu

4.2.4 Help Menu

The Help menu, as seen in Figure 4-8, not only launches AzMapper help, but also provides an important function that saves time for both you and Azimuth Support. The About window, as seen in Figure 4-9, provides a button, **Export Information**, so that you can export your AzMapper information (.txt) and send it to Support when necessary.

![Figure 4-8: Help menu](image-url)
4.3 AzMapper User Interface

AzMapper is a standalone application that interoperates flawlessly with other Azimuth software, such as DIRECTOR II. The standalone nature of this application allows Azimuth to cater to specific needs and release enhancements at regular intervals.

4.3.1 Setup User Interface

The Setup UI shown in Figure 4-10 is the default UI that displays when the application is launched for loading a scanner file from a drive test.

**Note:** If the scanner log has no doppler or GPS information as found in some QXDM scanner logs, velocity data will not present.
Figure 4-10: Setup UI

The scanner file can be loaded by clicking the **Browse** button, which brings up the File Browser dialog as shown in Figure 4-11. The AzMapper can load multiple files simultaneously and supports loading multiple files of the following formats: Qualcomm QXDM text files and Agilent AOD files with GPS.

Save Microsoft Excel files as a .csv rather than an .xls in order for them to be imported into AzMapper. AzMapper is designed to work with .aod, .csv, .xml, and .txt file types.
Once a file selected, AzMapper parses the proprietary format of the data in the scanner and populates the Device field with the unique modules built into the scanner. For example, if this were a scanner supporting multiple technologies/bands, these are shown, allowing you to choose the data of interest (see Figure 4-12).

**Figure 4-11: Browse scanner file**
Once the data is selected, load this data by clicking **Load**. The data from the scanner is then parsed, interpreted, and loaded into AzMapper as shown in **Figure 4-13** and **Figure 4-14**. Since AzMapper has a built-in engine to interpret the proprietary data stream from different scanners, the specific scanner is transparent, saving considerable time and effort.
Figure 4-13: Loading scanner data in progress
4.3 AzMapper User Interface

4.3.2 Filtering User Interface

The Filtering UI shown in Figure 4-15 allows configuration of the different filters that could be applied to the scanned data to remove the artificial noise/effects in the data.

The Pin Hole Filter provides accounting for missing data samples that are not collected due to the refresh rate of the scanner and/or the scanner losing track of the cell. If the duration of the gap (between two samples) is less than the Fill Limit, the sector's signal level at the first data point is copied into subsequent data points where the sector does not exist until the data point reaches the sector's reported signal power.

The Fast Fading Filter allows removal of the variations in the signal power caused by fast fading. Fast fading effects are added using the ACE MX's high fidelity fading engine; this creates a more accurate fading envelope than what is captured by the scanner. A higher value of Alpha produces more filtering and lowers the micro variations in the signal. Drives with higher velocities (greater than 60 km/hr) and dense urban environments generally require higher alphas when compared to drives with lower velocities or rural environments.
Figure 4-15: Filtering UI
4.3.3 Mapping User Interface

The Mapping UI shown in Figure 4-16 allows customization of the criteria used by AzPlayer's powerful mapping engine to map the Filtered Data into Mapped Data. The data is then played back on the lab testbed.

The number of channels available in the lab testbed can be selected using the *Number of ACE Channels* drop-down menu. The higher the *Number of ACE Channels*, the better the accuracy of the playback. The Field-to-Lab solution leverages the ACE MX's high-fidelity AWGN source to simulate the effect of the noise seen by the scanner and also models other sectors/cells that are not being played back. A dedicated channel for the AWGN can be allocated by selecting true from the *Dedicated Noise Channel* drop-down menu. While this would reduce the number of channels available for playing back the signal, it ensures that there is always a channel available for simulating noise.

![Figure 4-16: Mapping UI](image-url)
Since field data typically includes many more sectors than what is available with a testbed, AzMapper takes all these sectors and maps them to the number of sectors available in the testbed. As shown in Figure 4-17, AzMapper allows you to map this data based on various criteria such as the Signal strength, Ec/Io, or the Prevalence of the sector through the Ranking Algorithm. The breadth of these options provides flexibility in choosing the best criterion to meet test needs. To preserve a sector on a channel, even if another sector with higher rank (as ranked by the Ranking Algorithm) appears, select true from the Ensure Preservation drop-down menu. Spurious Threshold allows specification of a minimum duration that a sector must be continuously present for it to qualify for mapping. Remapping Delay helps ensure that a UE does not camp on a single sector, but rather goes through the handoffs it did in the field. The value for the Remapping Delay is a tradeoff between ensuring that the UE's behavior resembles its real world behavior and the loss of accuracy because data is not being played back on a channel.

The Loading Factor Adjustment increases the output signal power played back by the ACE MX relative to the signal power that was reported by the scanner/test UE. For example, a 5dB loading factor increases output power by 5dB. The Noise Figure Adjustment decreases the noise level played back by the ACE MX relative to the noise level that was reported by the scanner/test UE. For example, a 5dB noise figure increases Ec/Io for all sectors by 5dB.

![Figure 4-17: Ranking Algorithms](image)
4.3.4 Total Power User Interface

The Total Power UI shown in Figure 4-18 displays the signal strengths recorded over the period of the drive test. The graph displays the total power at any point in time along with the signal and noise power. AzMapper's user friendly interface allows you to zoom in/out of the graph to focus on areas of interest or get a high-level overview of the entire drive.

Figure 4-18: Total Power UI
4.3.5 Histograms User Interface

Histogram graphs do not have units on the axis or a legend stating what they are; the y axis is always percentage from 0-100.

The Histograms UI shown in Figure 4-19 allows visualization and categorization of the data using expressive and powerful histograms.

![Histograms UI](image)

Figure 4-19: Histograms UI

As with any other plot in AzMapper, zoom into a specific area of interest; capabilities are available as shown in Figure 4-20.
In addition, different types of histogram views are supported as shown in Figure 4-21 and Figure 4-22. The gap size histogram is in milliseconds.
4.3 AzMapper User Interface

Figure 4-21: Histogram types
Figure 4-22: Histogram of RSCP

Date selectivity such as looking at data pertinent to a single cell is available as shown in Figure 4-23.
Figure 4-23: Histogram of RSCP filtered by cell
4.3.6 Per Channel User Interface

The Per Channel UI shown in Figure 4-24 allows viewing of the data that is played back on each of the ACE channels. The plot is very useful for visualizing the sector power after it gets mapped to specific channels on the testbed.

![Figure 4-24: Per Channel UI](image)
4.3.7 Per Sector User Interface

The Per Sector UI shown in Figure 4-25 allows viewing of the data at different points in the data flow; scanner data, filtered data, and mapped data. The plots are very powerful since they show the effect of changes made to the mapping parameters instantly. AzMapper also allows the user to look at the data for all the sectors or just focus on a handful of sectors of choice, allowing focus on just specific sectors/periods in time.

![Figure 4-25: Per Sector UI](image)
4.3 AzMapper User Interface

4.3.8 Sector Lifespan User Interface

The Sector Lifespan UI shown in Figure 4-26 displays the lifespan of each of the sectors; this shows the lifespan of a sector and all the sectors that are present at any point in time in the scanned, filtered, and mapped data. Zooming into a specific area of interest can be achieved using the provided Zoom functionality.

![Figure 4-26: Sector lifespan UI](image)
4.3.9 Velocity User Interface

The Velocity UI shown in Figure 4-27 displays the time profile of the velocity. This can also be zoomed in, as shown in Figure 4-28.

Figure 4-27: Velocity UI
Figure 4-28: Velocity plot with zoomed in data
4.3.10 GPS Track User Interface

The Velocity UI shown in Figure 4-29 displays the drive route using the GPS data collected during the drive test.

![Figure 4-29: GPS track UI](image-url)
4.4 Generating a Playback File

A playback file ready to be played on the ACE MX can be generated by clicking **Save Playback File** as shown in Figure 4-30, Figure 4-31, and Figure 4-32.

![Figure 4-30: Saving a playback file](image-url)
Figure 4-31: Save playback file dialog
The playback file is created as a comma separated value (CSV) file. This open format allows easy viewing, editing and manipulation of the data as shown in Figure 4-33.
Figure 4-33: Playback file as viewed in Excel
Chapter 5: Azimuth AzPlayer

This chapter consists of the following sections:

- Overview
- Configuring AzPlayer
- Selecting an ACE MX Chassis
- Playing a playback file

5.1 Overview

DIRECTOR II is Azimuth’s intuitive, end-to-end integrated application to automate and control the ACE MX as well as third-party equipment. Refer to the Azimuth Systems DIRECTOR II and ACE MX User Guide for a detailed description.

AzPlayer is an efficient and powerful application that streams Field-to-Lab channel information in real-time to a selected group of ACE MXs. The AzPlayer integrates seamlessly into the DIRECTOR II platform. More than one AzPlayer can be created and AzPlayers can share Field-to-Lab (FTL) playback files, but each AzPlayer must have one or more dedicated ACE MX chassis.

5.2 Configuring AzPlayer

A new AzPlayer can be added by right clicking the AzPlayers folder from the left-hand control pane as shown in Figure 5-1.
5.2 Configuring AzPlayer

When a new player is created, a playback file is added by clicking **Add New** as shown in Figure 5-2.

**Figure 5-1: Adding a new player**

**Figure 5-2: Adding a new playback file**
5.2 Configuring AzPlayer

Select a playback file as shown in Figure 5-3. **[Azimuth Testbed Calibration]**: If this is the first time using AzPlayer with a testbed or there has been any testbed modification, calibrate for the loss induced by the cables and external components so that the mobile device sees the desired power level. This can be accomplished by selecting a testbed Calibration File - x Channel.csv file (from the Install CD or the Azimuth FTP site) and following the steps detailed in the next sections. Customize the playback by configuring the topology, channel model, etc. as shown in Figure 5-4. The **Link Configuration** defines the topology of the setup where the file is played back; different SISO and MIMO topologies are offered. Choose the velocity from the scanner data or override it using the **Velocity Data** option. Choose one of the many channel models provided in DIRECTOR II or use the channel model from the file, or even use a static channel through the **Model** option. Use the **Noise Power** option to select the noise power from the file, specify a value, or select the option for no noise.

AzPlayer offers a wide variety of choices as far as the **Loop Mode** is concerned; this determines what is played back after the end of the playback file is reached. This allows synchronization between playback files of different lengths by waiting until the end or immediately starting the file that ended again. Configure the signal and noise bandwidth using **Signal Bandwidth** and **Noise Bandwidth**.
Input Power Tracking, which configures the ACE to handle changes in the base station transmit power, can be enabled by selecting the Auto option for the input power, as shown in Figure 5-5. Configure the frequency of the channels through the Frequency field. External losses can be accounted for by using the Output Power Calibration feature through the External Loss field. AzPlayer factors the external loss into the playback states by increasing the output power of the ACE MX. The External Loss can be computed using Azimuth's testbed calibration procedure, detailed in Configuring AzPlayer and Playing a playback file, or by using external equipment like a power meter. Note that the number of channels shown in Figure 5-5 depends on the Link Configuration selected in the Playback File Settings in Figure 5-4.

Note: If the external loss is too high, the power level of some of the playback states might be unattainable.
5.2 Configuring AzPlayer

Since the ACE MX was designed to inherently support downlink and uplink fading, Field-to-Lab allows the testing of both downlink only (uni-directional) and downlink and uplink fading (bi-directional) setups (as seen earlier in Section 3.3). Switch to bi-directional operation mode by clicking **Change to Bidirectional**, which brings up the **Playback File Settings** dialog shown in **Figure 5-6**. The dialog shown in is an extended version of the dialog in **Figure 5-4**; it allows configuration of a bypass or reciprocal channel for the uplink by using the **Uplink Data** field.

---

**Figure 5-5: System level configuration**

**Figure 5-6: Playback file settings for bi-directional operation**
5.2 Configuring AzPlayer

Since ease-of-use was a primary factor in the design of DIRECTOR II and AzPlayer, AzPlayer profiles can be saved and recalled as shown in Figure 5-7, Figure 5-8, and Figure 5-9 to increase the ease-of-operation. Manage the profiles through the **Clear** and **Delete** functionality, shown in Figure 5-9.

![Figure 5-7: Saving an AzPlayer Profile](image-url)
5.2 Configuring AzPlayer

Figure 5-8: Saving a profile in a group

Group created from which AzPlayer can be selected

Figure 5-9: Recalling a profile
5.3 Selecting an ACE MX Chassis

As mentioned earlier, each AzPlayer requires a dedicated ACE MX chassis to playback the field data. The ACE MX chassis can be added by clicking on the Add ACE in the Logical View on the right pane and then choosing the chassis of interest, as shown in Figure 5-10.

![Image](image.jpg)

Figure 5-10: Selecting a chassis

Since Director II has native support for controlling multiple ACEs, data can be played back on multiple ACEs with either a single or multiple AzPlayers. Multiple ACEs can be synchronized readily by clicking Click here to sync the ACE's, as shown in Figure 5-11.
5.4 Playing a playback file

The playback that is about to take place can be viewed in the *Play* tab as shown in Figure 5-12. AzPlayer comes equipped with a powerful playback engine that allows *Play*, *Pause*, *Stop*, *Seek*, and *Loop* as shown in Figure 5-13.
You now have the option to view and configure power measurement, including starting, stopping and saving traces while playback is running, as detailed in Power Measurement. You can also leverage the Visualizations tab for various power, dynamic velocity, and map views whether a playback file is running or not.
5.4 Playing a playback file

5.4.1 Power Measurement

The input and output power measured by the ACE MX's high precision power meters is displayed as shown in Figure 5-14 so that a visual idea is presented of the variations in the power.

![Figure 5-14: Instantaneous power measurement](image)

The ACE MX's internal integrated power meter's flexibility allows configuration in continuous or triggered mode, ensuring the right set of tools to measure the signal of interest. The power is measured continuously in continuous mode and measured only when the signal exceeds the threshold in triggered mode.

When the input power to the ACE MX RF connector exceeds the On Threshold for at least Start Delay seconds specified in the Power Meter Configuration table shown in Figure 5-15, the power meter begins to collect samples. The output power meter is triggered based on the input power meter trigger (with appropriate delays based on the channel model/propagation conditions set). Once triggered, the output power meter collects samples similar to the input power meter and can report both Instantaneous and Average Power. The total period of time that the power meter collects samples is called a Power Event. When a Power Event is completed, the power meter re-arms itself and starts again when the On Threshold is exceeded. The On Threshold is in dB and is relative to input power. For instance, if the input was -10dBm and the On Threshold was -10dB, the power meter collects samples when the power exceeds -20dBm. The Off Threshold is also in dB and is relative to the -20dBm computed from the input power and the On Threshold. So in the case above, if the Off Threshold was -15dB, -35dBm would be the cut off for the power meter.

**Note:** When AzPlayer is used, the On Threshold and Off Threshold have been configured to -30dB and -3dB, respectively.
5.4 Playing a playback file

Configure the plot that is being displayed by clicking the **Advanced Configuration** icon, as shown in Figure 5-16, and choosing an option that best suits your needs, as shown.
The measured power can be traced by clicking **Start Trace**, shown in Figure 5-17.

![Figure 5-17: Starting a trace](image)

The traced values can then be stored in an easy to manipulate CSV file by clicking **Save the file**, as shown in Figure 5-18 and Figure 5-19.

![Figure 5-18: Saving the trace](image)
5.4 Playing a playback file

[Azimuth Testbed Calibration]: If the testbed is calibrated using the Azimuth provided Testbed Calibration File, measure the power at the port where the mobile device is to be connected. The calibration file configures the output power of each of the ACE MX channels to -60 dBm, one port at a time. If the testbed is calibrated with more than 1 Number of ACE Channels, measure the power at the port of interest at 10 second intervals. This gives the measured power for each of the channels, since the output power of each ACE channel is held at -60dBm for 10 seconds, to make it easy to record the power. Compute the external loss for each channel by subtracting the measured power (for that channel) from the configured power (-60 dBm) i.e. -60 - Measured Power. Enter this loss in the External Loss shown in Figure 5-5 of Configuring AzPlayer.

5.4.2 Visualizations

The Visualizations tab provides the ability to view chart and map data even when a playback file is not running; see Figure 5-20. Visualization options include power graphs for each channel, a map, and dynamic velocity and totals; see Figure 5-21.
5.4 Playing a playback file

Figure 5-20: Visualizations tab

Figure 5-21: Visualizations options drop-down selected
5.4 Playing a playback file
Chapter 6: Quick Start Guide

This section provides entry into Field-to-Lab (FTL) operation in the least possible amount of time. Since AzMapper is configured with default values for all parameters, use it as is unless there is a necessity to change values.

If a playback file is available, skip to step 5.

1. Install AzMapper using the installer available on the installation CD or on the FTP site.
2. Launch AzMapper, **Browse** to the scanner file of interest and **Load** it as shown in Figure 6-1.
   
   ![Figure 6-1: Loaded scanner file](image)

3. Configure the *Number of ACE Channels* (**Figure 6-2**) to match the current setup. Modify the *Ranking Algorithm* to something that better meets your needs.
4. Create the playback file, as shown in Figure 6-3 and Figure 6-4.
Figure 6-3: Saving a playback file
5. Launch DIRECTOR II and create an AzPlayer by right-clicking on *AzPlayers* in the right-hand pane, as shown in Figure 6-5.
Add a new Playback file by clicking **Add New** and pointing to the playback file; if needed, configure the playback settings on the Playback File Settings dialog, shown in **Figure 6-6**.

If this is the first time AzPlayer is used with the testbed or the testbed has been modified, the Testbed Calibration File - x Channel.csv (from the Install CD of the Azimuth FTP site) may be used, where x is the *Number of ACE Channels* in your testbed, and proceeding through the following steps.
7. Configure the *Frequency* as shown in Figure 6-7 to make sure that it matches your operation frequency. If known, configure the *External Loss*; this can be computed using Azimuth's Testbed Calibration procedure listed in Step 6 and Step 10, or using external equipment such as a power meter.
8. Add the ACE chassis (Figure 6-8) by clicking Add ACE.

9. When the playback file is started, the screen looks similar to Figure 6-9.
10. If the testbed was calibrated using the Azimuth provided Testbed Calibration File (described in Step 6), observe the power at the port where the mobile device is going to be connected and enter this loss (-60dBm - Measured Power) in the *External Loss*, as shown in Step 7. When a testbed with more than one *Number of ACE Channels* is being calibrated, the output power of each ACE channel is held at -60dBm for 10 seconds; this allows power recording and *External Loss* entry for each channel.
Appendix A: Technical Specifications

This appendix consists of the following sections:
- Azimuth Field-to-Lab Specifications
- Scanner Specifications
- Hardware Scanners
- Software Scanners

A.1 Azimuth Field-to-Lab Specifications

Table A-1: Azimuth Field-to-Lab Specifications

<table>
<thead>
<tr>
<th>Convention or Object</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technologies supported</td>
<td>CDMA, EVDO, GSM, HSPA(+), LTE, UMTS</td>
</tr>
<tr>
<td>Scanners supported</td>
<td>Hardware and software scanners</td>
</tr>
<tr>
<td>Log file formats supported</td>
<td>AOD, MDB, XCAL, QXDM (CSV, TXT)</td>
</tr>
<tr>
<td>Topologies supported</td>
<td>1x1, 1x2, 2x1, 2x2</td>
</tr>
<tr>
<td>Modes supported</td>
<td>Downlink only fading, downlink and uplink fading</td>
</tr>
</tbody>
</table>

A.2 Scanner Specifications

Field-to-Lab (FTL) provides complete integrated support for Hardware Scanners and Software Scanners.

Note: Azimuth provides support for custom UEs/scanners.

A.2.1 Hardware Scanners

Agilent W1314A Scanner:

http://www.qualcomm.com/products_services/testing_diagnostics/qxdm_pro.html
PCTEL SeeGull Scanner:
http://rfsolutions.pctel.com/content.cgi?id_num=683

R&S TSM-W Scanner:
http://www2.rohde-schwarz.com/product/TSMW.html

A.2.2 Software Scanners

Accuver XCAL:

Ascom TEMS:

JDSU E6474A:

Qualcomm QXDM:
http://www.qualcomm.com/products_services/testing_diagnostics/qxdm_pro.html
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