EPS™ ENHANCED POWER SCAN FOR
SEEGULL® EX AND MX SCANNING RECEIVERS

Introduction

This application note explains the functions and applications of a powerful unique feature of the SeeGull EX and MX Scanning Receivers: the Enhanced Power Scan (EPS). Unlike standard tools, EPS enables RF engineers to isolate any part of the RF signal in both, time and frequency, leading to better detection and understanding of specific noise or interference problems. Similarly, EPS's precise timing capabilities improve spectrum clearing by detecting intermittent signals more reliably than a standard Spectrum Analysis.

Finally, EPS provides RF engineers with unprecedented flexibility in adapting to new technologies and unexpected problems. With EPS, RF engineers won't need to wait for equipment manufacturers to fine-tune existing scans or develop new tools when basic scans fail to isolate all network issues. Using EPS, RF engineers can push hardware capabilities to their limits in their efforts to improve networks and reduce the need for capital expenditures on new mobile network test equipment.

This paper discusses the need for and the benefit of the precise time-domain settings which EPS provides. It will then explain in greater detail how EPS meets the need for greater precision in RF power measurements with customizable power and frequency settings. Finally, it will discuss a number of specific applications for EPS. Engineers equipped with EPS can detect and solve a wide variety of network problems more quickly and accurately, reducing overall infrastructure and labor costs while increasing customer satisfaction.

The Need for Precise Timing in RF Power Measurements

The proliferation of data-intensive mobile devices and applications has created an environment in which mobile network operators must provide more bandwidth to meet increasing consumer demand. This results in heavy new infrastructure investments as operators deploy the latest technologies, roll out new frequency bands, and fine-tune their networks for consistent service quality and coverage. Network optimization is an essential part of this process, since problems with the Radio Access Network (RAN) frequently impede both a network's bandwidth capacity and its coverage area. Careful measurement of network propagation allows operators to identify and fix these problems, increasing returns on network infrastructure investments and providing high levels of service to mobile subscribers.

Drive test scanning receivers are a key element in optimizing the RAN. Scanning receivers are used through all phases of the network life cycle, from planning and deployment through operational maintenance and troubleshooting. They typically offer a basic set of power measurements such as RSSI and Spectrum Analysis. Although these capabilities can detect many RF network problems by isolating particular frequencies, such as a set of channels, they cannot isolate time-based components of radio signals. Therefore, RF engineers equipped with only the standard scanning tools may have difficulty analyzing or even detecting problems such as interference that are narrow-band, random or periodic through time. Without power data tuned precisely to both time and frequency, engineers must rely on time-consuming guesswork or else allow network problems to fester, leading to reduced service quality and dissatisfied customers.

APPLICATION NOTE

The move to more advanced and complicated technologies such as LTE makes customizable scanning even more critical. Not only do these newer technologies divide the RF signal into a greater number of parts, each holding a unique piece of data or calibration signal, they also divide the RF signal across both time and frequency domains. The result is that each segment of time and frequency in the signal carries its own data load and is uniquely susceptible to both interference and transmission errors. Ultimately, the complexity of 4G protocols multiplies the parts of the signal where problems may potentially occur, and in some situations makes those parts difficult or impossible to isolate using conventional scanning methods.

The limited, frequency-based nature of SA and RSSI are inadequate to meet the demands of analyzing power in an LTE signal. In addition, most older protocols also have a time-domain component that can cause or be subject to intermittent problems which may go undetected by traditional power scans. EPS solves these problems by allowing the user to focus on any part of the RF signal with customizable power and frequency settings.

How EPS's Customizable Power and Frequency Settings Work

EPS is a measurement of total received power within user-designated time and frequency intervals. By contrast, standard power measurements, such as Spectrum Analysis, provide measurements of total received power within standard frequency intervals. They can, therefore, be easily represented in a two-dimensional chart, with frequency in the x-axis and power in the y-axis, as shown in **Figure 1.**

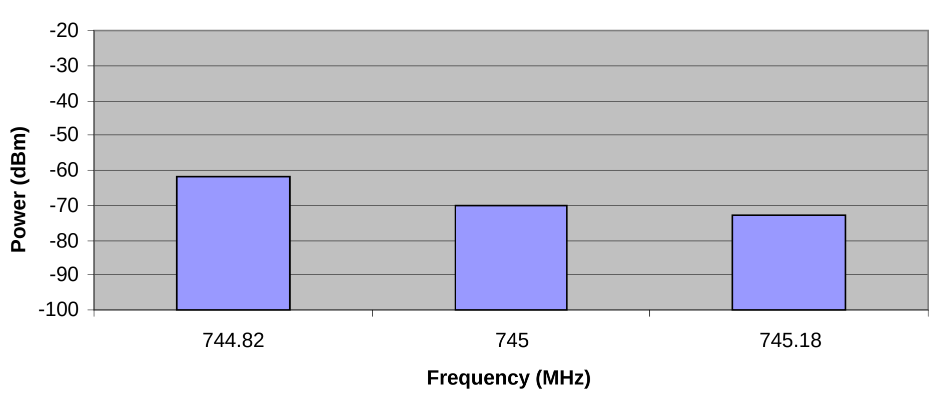

Figure 1 – Portion of a Frequency band with Standard Power Measurements

EPS however, measures power within measurement points located at specific times and frequencies, which adds a third dimension. As shown in **Figure 2**, the x-axis still represents frequency, the y-axis represents time, and the vertical z-axis represents power.

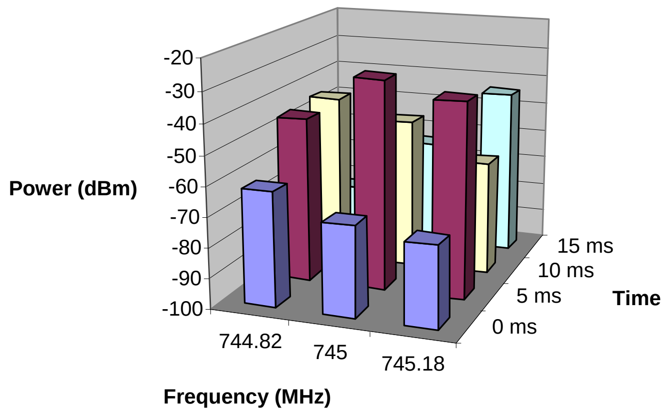

Figure 2 – Portion of a Frequency Band with EPS

Whereas users of standard power scans have only limited control of a single axis (frequency), EPS provides the user highly flexible control of two axes: time and frequency. By allowing users full control of its fine-grained Frequency Domain parameters, EPS makes it easy to measure the power of a specific channel or sub-channel. In addition, unlike any other scanning receiver feature, EPS's GPS-aligned Time Domain parameters allow users to examine a particular frame or part of a frame with a granularity of 50µs (1 chip). Together, EPS's parameters allow experienced RF engineers to supplement standard Spectrum Analysis scans with their own custom scans. EPS users can hone in on individual pieces of a signal, allowing for greater problem-solving flexibility, particularly with complex 4G technologies.

Like a standard Spectrum Analysis scan, EPS measures power in each of one or more measurement points (bins) in the frequency domain. However, the flexibility of EPS's Frequency Domain settings means that the location and resolution bandwidth (RBW) of each of these bins can be finely tuned to measure one or more channels, or any other portion of the frequency band the user wishes to view. EPS can scan all of these bins at one finely-tuned point in time, or repeat the scan at regular intervals in a measurement cycle defined by EPS's Time Domain parameters. These Time Domain parameters allow for repeated measurements of specific frames, slots, or other time-dependent elements of the protocol. They can also be used simply to obtain a more fine-grained analysis of how power readings vary over time than is available with standard power measurements. EPS outputs a separate total power reading for each frequency bin in each measurement cycle, including power from all Cell IDs available in the area. These highly precise power readings can then be analyzed to isolate problems with individual parts of the signal not covered by standard RSSI or Spectrum Analysis scans.

EPS includes the following features:

- Absolute Time Stamp
- Auto and Immediate Measurement Modes
- Channel and Frequency Requests
- Power Flags: Minimum, Center, or Maximum Frequency
- Spans 5 kHz to 18 MHz and is user selectable in multiples of 2.5 kHz (on each side of center frequency)
- 1 chip (50 µs) to 20,000 chips (1 sec.) granularity

These features combine for a high degree of flexibility and precision in setting EPS measurements. With the highly customizable settings of EPS, users can better detect and analyze a wide range of network problems.

EPS Applications

EPS is useful in a wide range of RF network setup, troubleshooting, and verification applications. For most applications, EPS is more effective when used as a stationary tool, though a pre-configured EPS scan may also supplement or replace traditional power scans during drive testing. EPS allows for detailed time-based measurements that are more granular than those that can be obtained from normal Spectrum Analysis. For example, if there is an interference component that occurs periodically or is bursty, EPS allows for measurements to be collected in a small window and can be done continuously over a 24 hour period or longer to nail down the characteristics of the interference. The following list of EPS applications includes both specific interference-related troubleshooting cases and a variety other ways EPS's precise measurements can help network operators:

Base Station Turn-up and Tuning: EPS can verify that the power emanating from the base station for each LTE slot is flat for each channel over time, ensuring that there are no signal-processing errors. Furthermore, EPS can view empty slots during turn-up to determine if there are any interfering signals present. These power readings can also be archived as a base signature during turn-up for later comparison when troubleshooting the base station.

LTE Frequency Error: EPS enables the user to verify if the frequency is centered on the channel on which it resides, over time. This is not only a regulatory requirement, but also a wavering frequency can result in dropped calls when traveling at high speeds and in severe cases will result in failed call handoffs between sectors. The root cause is typically a problem with the base station frequency distribution system, which can be caused by a GPS problem in LTE-TDD systems or issues with the base station software algorithms. Temperature can also affect frequency. Since base station temperatures are not tightly controlled, frequencies can drift, and in severe cases, result in failed call handoffs.

Synchronization Channel Verification: Using EPS, with both frequency and time domain analysis, can help identify synchronization issues that may not be seen with a single scan pass. Synchronization channel issues can result in low data rates or excessive soft hand-offs. The causes of synchronization channel problems are co-channel interference (pollution) from other sectors, illegal interference sources, or improper base station antenna tilt, many of which have unique time signatures that can be identified using EPS.

Troubleshooting Interference Challenges: Complaints may arise over low quality or dropped calls in a specified area, or over certain channels where current drive test data indicates no problems. EPS can look at the power over a specified time period to identify power bursts or time-based interference that cannot be found by traditional means. With EPS's robust data, engineers could determine that a bursty GSM signal is interfering with an LTE signal, or that a WCDMA signal is operating over the same bands. Potential sources of interference include:

- Personal, commercial or government 2.4G wireless routers (Wi-Fi)
- Ships coming into port with on-board radio systems
- Large electric motors (trains, electric cars, industrial operations - can affect signals below 1G)
- University or government experiments
- Ham radios
- Emergency responders radio dispatch operating near a cell tower (US at 850 MHz)

Because of EPS's customizable settings, the above list of applications is far from exhaustive. In all of these applications and many others, EPS's flexibility in the frequency domain and ability to measure specific parts of the signal in the time domain allow users to pinpoint problems that could easily be missed with traditional tools.

Conclusion

EPS is a powerful tool for detecting and analyzing network problems that may be missed by ordinary power scans such as Spectrum Analysis or RSSI, including LTE frequency errors and intermittent interference problems. In many cases, EPS can be pre-configured by engineers to search for these problems during a drive test. EPS can also be used to meet unanticipated measurement needs posed by new network technologies. With EPS, both users and integrators can set up precisely the power measurements they need to measure any portion of an RF signal that may prove crucial to network design, rollout, optimization, or troubleshooting. However, EPS is at its most powerful when used as a stationary tool by engineers in the field, allowing knowledgeable professionals to acquire precise power measurements at the exact time and frequency they desire.

Featuring a unique set of parameters designed for maximum precision and flexibility. EPS is not simply a Spectrum Analysis or RSSI scan with customizable frequency settings. Instead, EPS's unique time domain parameters allow precise measurement of time-differentiated signals. Finally, EPS provides this flexibility without requiring any extra equipment by harnessing the sophisticated architecture already present in PCTEL's SeeGull Scanning Receivers.