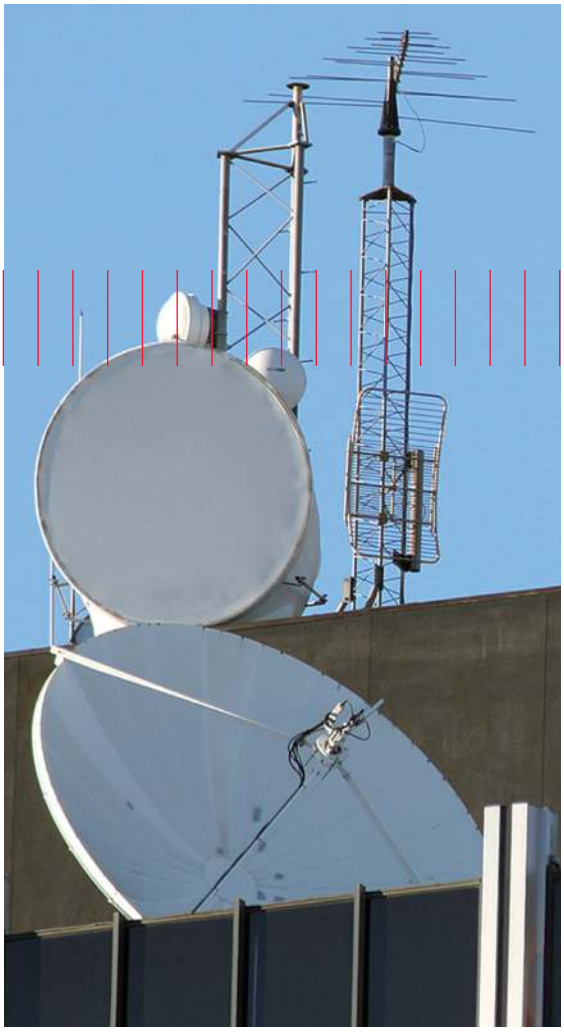
Keysight Technologies Conducting Site Surveys

Using the N934xC Series Handheld Spectrum Analyzers



Application Note

KEYSIGHT TECHNOLOGIES

Introduction

Rapid expansion of wireless services, consumer expectations and needs, and the complexity of wireless communication signaling approaches have brought huge value. But with that value the evolution has led to spectral crowding, difficulty in deploying new services, and higher potential for interference. These factors have made site surveys a necessity in a range of industries including military, medical, regulatory agencies, and wireless service providers.

Fortunately, technological advances in instrumentation have progressed along with the evolution of wireless communication. As this paper explains, those new technologies have allowed the development of progressive handheld spectrum analyzers (HSAs) such as Keysight Technologies N934xC family, which includes the 20 GHz N9344C, the 13.6 GHz N9343C, and the 7 GHz N9342C. These HSAs are easily capable of meeting the requirements of modern site surveys which has not always been the case with site survey equipment used in the past.

The features and performance of the N934xC HSAs make the units ideal tools to measure signal strength. The ability to load cable and antenna calibration factors allows the operator to measure a vendor-assigned RSSI or to directly measure emission strength in absolute units such as dBµV/m. In addition, all traces can be stamped with GPS coordinates and measurement time. Those factors, combined with use of the optional Task Planner ensure that measurements are made with the same settings and sequence so that the data is directly comparable to the initial site survey.

Site Surveys and Applications

Why do Site Surveys?

The need for site surveys is driven by the need to control the spectrum or channel in which a transceiver is operating. The International Telecommunications Union (ITU) is a specialized agency of the United Nations, with 192 member nations and 700 Sector Members and Associates. The ITU sets guidelines to allocate and control spectrum through licensing to "enable the growth and sustained development" of wireless networks worldwide. It accomplishes that through close links with member nation's regulatory agencies such as the Federal Communications Commission (FCC) in the US. One of the major roles of the FCC is to allocate and control spectrum through licensing. The FCC and its parallel agencies in other countries set the foundation for spectrum monitoring and control of the spectrum they use through site surveys.

Entities planning, installing and maintaining wireless communication networks conduct site surveys in order to ensure that the system is optimized to meet designed performance and to create and maintain compliance with ITU spectral regulation.

Site surveys have two main uses:

- Spectrum clearing
- Signal strength mapping

Spectrum clearing

Spectrum clearing, for the purposes of this paper, is the identification and elimination of unwanted or elicit emitters that have the potential to degrade the performance of the supported system. The very fact that the transmitters may not be licensed means that finding them will require one or more forms of direction finding. There is also a time-based element to unlicensed signal capture and identification since these transmitters may share spectrum with TDD (time division duplexing) schemes, making detection more difficult. Licensed transmitters can also present this problem (consider taxis, emergency vehicles, and two-way radios with push-to-talk capability). For example, licensed operators may not transmit uniformly across a geographic area, such as taxi transmissions that are much higher in metropolitan areas and during commute hours. Spectrum clearing, as a subset of the site survey, can be complex, and as such, exploration of specific interference analysis and identification is beyond the scope of this application note. For more information about interference analysis and spectral clearing, refer to application note *Interference Testing with Handheld Spectrum Analyzers*, literature number 5990-6041EN.pdf

Signal strength mapping

The N934xC family of handheld spectrum analyzers supports measurement output with a comma separated variable (.csv) extension. The PC software package provided with the handhelds has a translation function that converts .csv-formatted data to keyhole marking language, .kml, which is the international standard of the Open Geospacial Consortium. The translation allows the data collected by the HSAs to be imported and displayed by Google Earth (.kml) or MapInfo (.csv) software packages.

Applications

Many commercial and public sector operators routinely conduct site surveys to geographically map signal strength.

Site Surveys and Applications (continued)

Military

Armed Forces spectrum management personnel are required to enforce spectral control on bases, aircraft, shipboard, and in the battle theater. Driving their enforcement is the need to ensure availability of spectrum for critical command, control, communication, and intelligence (C^3I) systems, situation awareness, and weapons delivery systems. They are also tasked with ensuring the interoperability of the systems of partner nations.

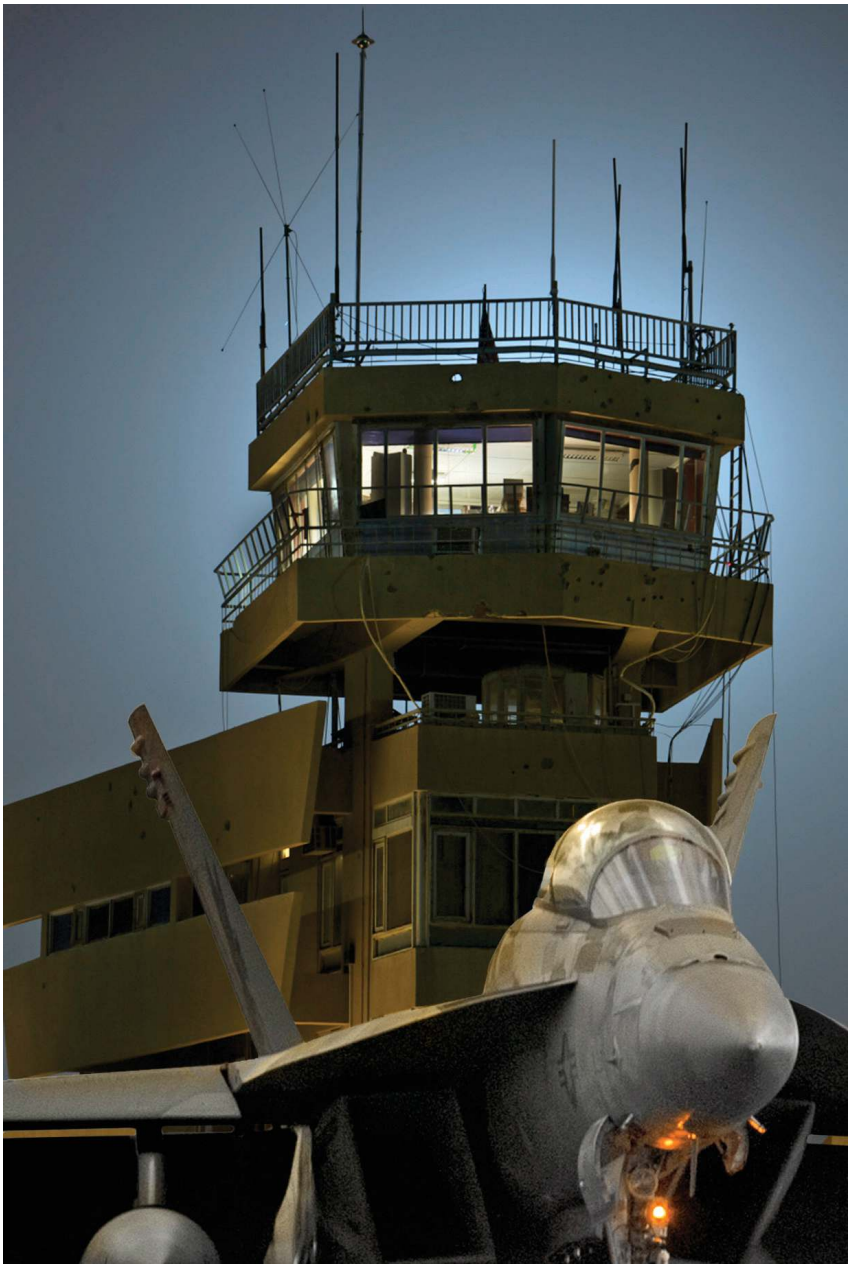


Figure 1. The military's need for spectrum analysis includes ensuring spectral control for aircraft communications

Site Surveys and Applications (continued)

Government agencies and commercial operators

Both these groups conduct site surveys to ensure security and/or wireless coverage at large events. An example is the international cooperation of regulatory agencies and broadcasters prior to Olympic events. The event will occur once, and the broadcasters must ensure adequate televised coverage within the authorized channels. Any unauthorized broadcast or interfering signal must be quickly located and mitigated. The baseline site survey is essential for these operations.

Wireless service providers

Wireless service providers conduct site surveys to baseline the spectral environment prior to installation of new service. The survey process is repeated post-installation to ensure that the designed system coverage is provided. Service providers also must be able to quickly and accurately identify system impairments or failures that can result in dropped calls and revenue reduction. As more services are brought on line, the potential for interference increases. In turn, this increases the provider's the reliance on original site survey data.

Site Surveys and Applications (continued)

Modern hospitals

Medical facilities routinely use monitoring and treatment devices employing wireless telemetry that can be 20 years old. The combination of multiple frequencies, modulation types, and outdated shielding of these devices creates the potential for interference between devices. The constant addition of new medical devices creates the potential for the introduction of additional interference. The array of medical equipment, combined with ubiquitous WLAN, wireless PDA use by medical personnel, and emergency vehicle two-way radios, make controlling the hospital spectrum mandatory. Conducting thorough site surveys provides the basis for resolving interference and determining compatibility of new equipment.

Figure 2. Antenna farm on roof of hospital

Handheld Spectrum Analyzer Features for Site Surveys

Hint:

Even if it is not being directly measured, a high power signal may be present when a spectrum measurement is being made, causing the spectrum analyzer to be "overloaded". If the spectrum analyzer is overloaded, this can create distortion products that appear as additional signals on the display. These signals may be incorrectly identified as signals present in the environment. A quick test for spectrum analyzer overload is to add input attenuation. If the analyzer is not overloaded, the signal on screen will not move (the microprocessor compensates for the attenuation and displays the signal at its true amplitude). If the signal displayed increases in amplitude, the analyzer is overloaded. To ensure accuracy, add enough attenuation that the signal stops moving, and then increase the attenuation by an additional 10 dB.

Keysight N934xC handheld spectrum analyzers enable, streamline, and ensure accurate and repeatable site surveys. Spectrum analyzer performance that was previously available only in benchtop or portable spectrum analyzers weighting 40 pounds or more is now standard in the affordable, light-weight family of N934xC handheld spectrum analyzers.

Key measurement specifications

In site surveys, a field engineer is frequently looking for low level signals. Each N934xC HSA has a displayed average noise level (DANL) as low as –151 dBm at 18 GHz, minimum resolution bandwidth of 10 Hz, residual responses below –85 dBm, and input-related spurious responses below –60 dBm. These capabilities make finding low level signals easy.

It is often necessary to make measurements on a smaller signal in the presence of a large signal. Third order intercept (TOI) as high as +13 dBm at 18 GHz means that users can make accurate measurements in the presence of high power transmissions.

Form factors

Many site surveys are conducted outdoors in a variety of weather conditions. Each N934xC handheld spectrum analyzer is MIL-rugged, meeting MIL-PRF-28800F Class 2, and is designed without fans or vents. In addition, the Keysight HSA weighs just seven pounds, including the battery, has a transflective display that enhances viewing in bright daylight, and back-lit keys for clear viewing in dim light. These attributes make the HSA ideal for site surveys in the most rugged and hostile environments, day or night.

GPS capability

Traditionally, a separate GPS unit was required to precisely note the location in the sector for each measurement in the site survey. The built-in GPS receiver and antenna on each N934xC HSA provides geo-location and time-stamped data to ensure the accuracy of an initial site survey, and the repeatability of measurements made at a later time. The internal frequency reference can also be locked to the received GPS signal increasing frequency accuracy to ±50 ppm.

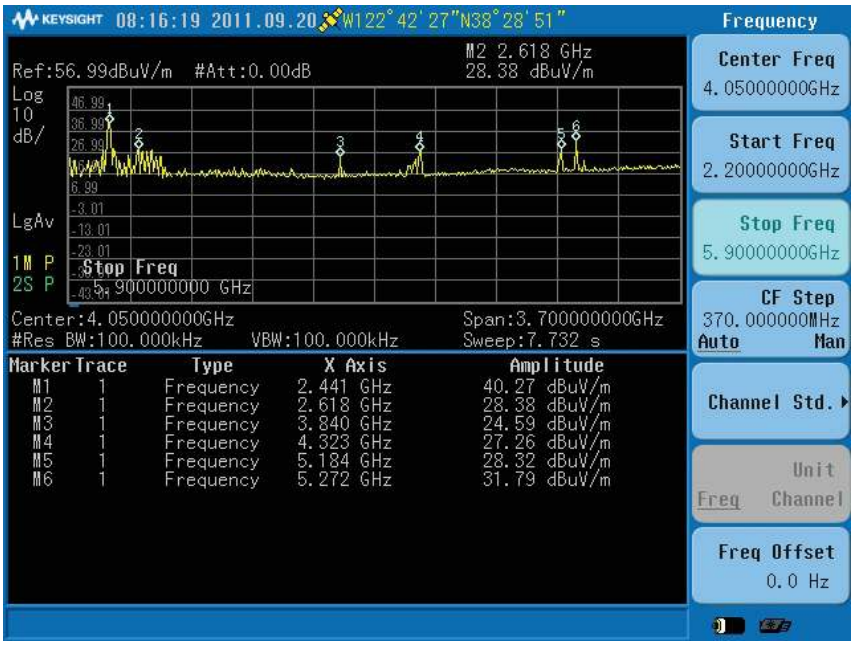


Figure 3. Spectral data using marker table with "zoom-in" showing data in dBµV/m, GPS coordinates

Task Planner

Figure 4 illustrates, the N934xC HSA's optional Task Planner feature which allows site survey project managers to create an exact measurement sequence to ensure that:

1. The measurements are always made in the same way, in the same order, using the same instrument settings. This makes survey data more uniform from sector to sector, and survey base-line data comparable to data previously obtained (for instance, before and after communication system installation).
2. Less skilled operators conduct site surveys with the same accuracy and repeatability as the site survey experts.
3. Measurement setup is simplified for the operator, saving up to 95% of the time normally required to prepare for testing in the field.

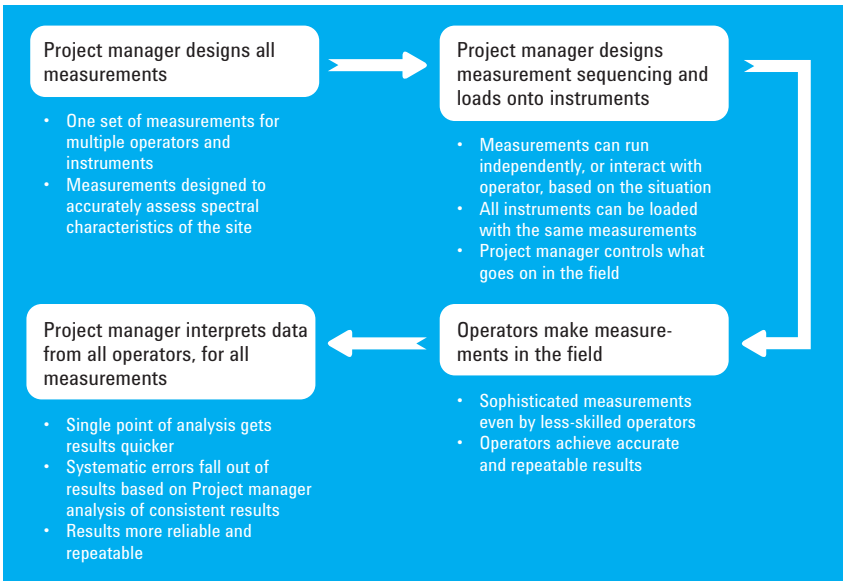


Figure 4. N934xC Task Planner advantages by stages of use

For more detail, refer to the Task Planner application note, *Streamlining Field Test with the Task Planner*, literature number 5990-6041EN.

Site Survey Example

This section provides a general description of how a site survey is performed using an N934xC handheld spectrum analyzer. *(Note: The key-stroke-specific process is detailed in* N9342C/N9343C/N9344C Handheld Spectrum Analyzer (HSA) User's Manual*, document number N9342-90002)*.

1. Load the channels of interest. This example uses five FM radio broadcast channels, highlighting the HSA's capability to support custom channel standards, although the instrument also has over 100 signal standards loaded for easy selection.

Figure 5. FM channels selected in a custom table

Hint:

.csv takes up less memory space and can easily be converted to .kml in the HSA PC software package.

2. Set the Channel Scanner for measurement interval. In this example, the site survey was conducted by walking around a set of buildings, so the interval was set to distance of 30 feet.
3. Once the built-in GPS receiver has established lock, select {Scan Start}, {Logging Start}, and file type .csv or .kml to initiate the data collection. Move through the coverage area of interest. Once the route has been covered, select {Scan Stop} to end data logging.

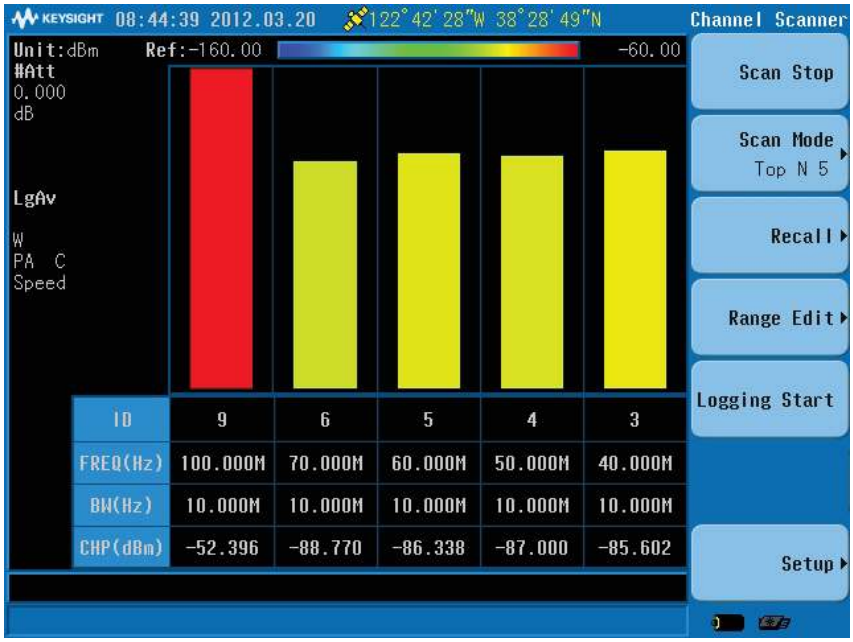


Figure 6. Channel Scanner logging data

4. Transfer the .csv file to a PC using a USB memory stick or USB cable connection, and start the HSA PC software. In the software controls, select Instruments, KML Convertor, and identify the .csv file to be converted. Once the conversion is complete, the .kml file will be added to the directory and file containing the .csv file. If the PC has Google Earth installed, double clicking the .klm file icon will open the mapping function and display your route with channel power indications at each measurement location.

Figure 7. Google Earth display of site survey

Site Survey Example (continued)

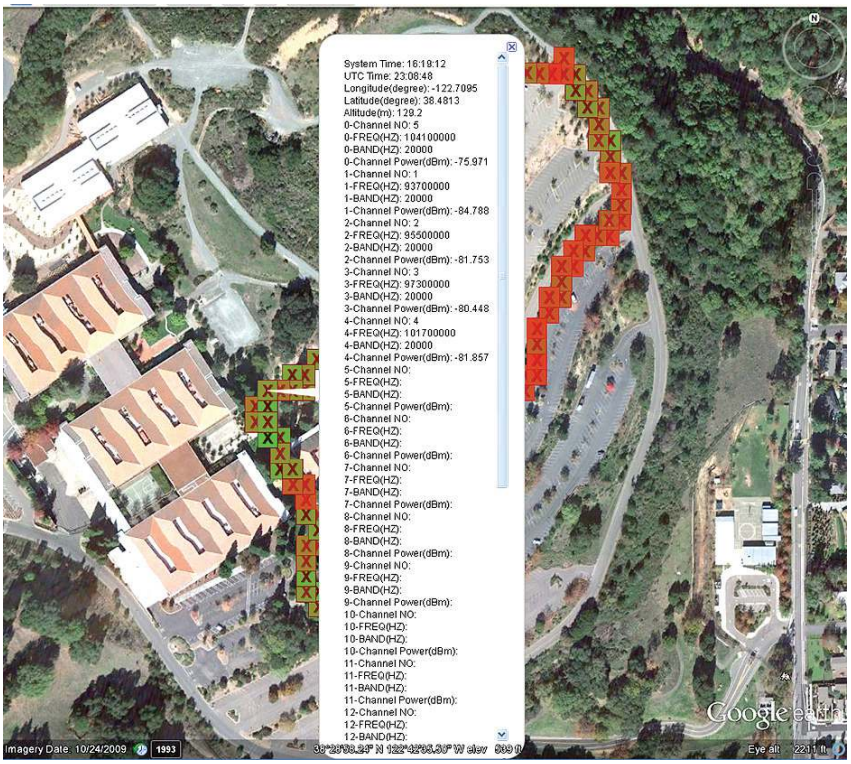


Figure 8. Site survey results available by mapped location point

5. Clicking on any one of the measurement icons on the map displays the measurement results including measurement time, GPS location, channel number, frequency, measurement bandwidth, and channel power.

Conclusion

Technological advancements have allowed the development of progressive handheld spectrum analyzers that are easy to use in the field, which has not always been the case with site survey equipment used in the past. The Keysight N934xC family, which includes the 20 GHz N9344C, the 13.6 GHz N9343C, and the 7 GHz N9342C, provides the measurement accuracy of a benchtop device, a light-weight and weather-resistant form factor, GPS capability, and the exclusive Task Planner feature. These features make each HSA easily capable of meeting the requirements of modern site surveys in a variety of locations such as military sites, hospitals, wireless sites, and government or commercial installations.

For more information

Visit any of the following handheld spectrum analyzer product pages and click on the "Document Library" tab to access additional application notes:

- www.keysight.com/find/n9344c
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