AN5

Measuring RF Performance

Application Note 5
Sensor Node Software

Measuring GS1010 RF Performance

INTRODUCTION

THIS DOCUMENT describes a simple method for measuring GainSpan GS1010 RF performance. The method involves uploading GS1010 WFW (WLAN firmware) and forming an IBSS (independent BSS), also known as an *ad hoc* network. In an IBSS the device transmits periodic beacons that can be detected by any device capable of scanning for Wi-Fi networks. These beacons can be analyzed with an RF test equipment such as a spectrum analyzer or a power meter. The IBSS is initiated by using the GainSpan software configuration tool *WiLDConfigurator*.

This method involves interacting directly with the GS1010 WFW. This requires erasing any application firmware (AFW) that may be programmed into the device. Unfortunately, this also erases any application- or device-specific configuration, such as the device's unique MAC address. Care must be taken to restore this configuration information after reloading AFW.

UPLOAD WFW

Use *WiLDConfigurator* to upload WFW to the GS1010.

1. On a PC with a serial port, start *WiLDConfigurator*.
2. Ensure that *WiLDConfigurator* is using the correct COM port to talk to the GS1010 board (see the *WiLDConfigurator User Manual* for details).
3. Power off the GS1010.
4. Force the GS1010 to boot into BootROM:
   A. On the TLS board, short Test Point E13 to TP6.
   B. On the DB, set Switch 3 of INT2 to ON
5. Power on the GS1010.

The GS1010 should now be running from BootROM. Verify communication with BootROM by verifying that memory address `0x00000000` contains the BootCode reset vector (`0xEA000008`).

6. Select the Loader panel of *WiLDConfigurator*.
7. In the ROM debugging panel, read address `0x00000000`. The value read should be `0xEA000008`.
8. Erase WLAN, APP1, and APP2 firmware by checking their boxes and pressing the Erase Flash button. The *WiLDConfigurator* screen should appear as in Figure 1.

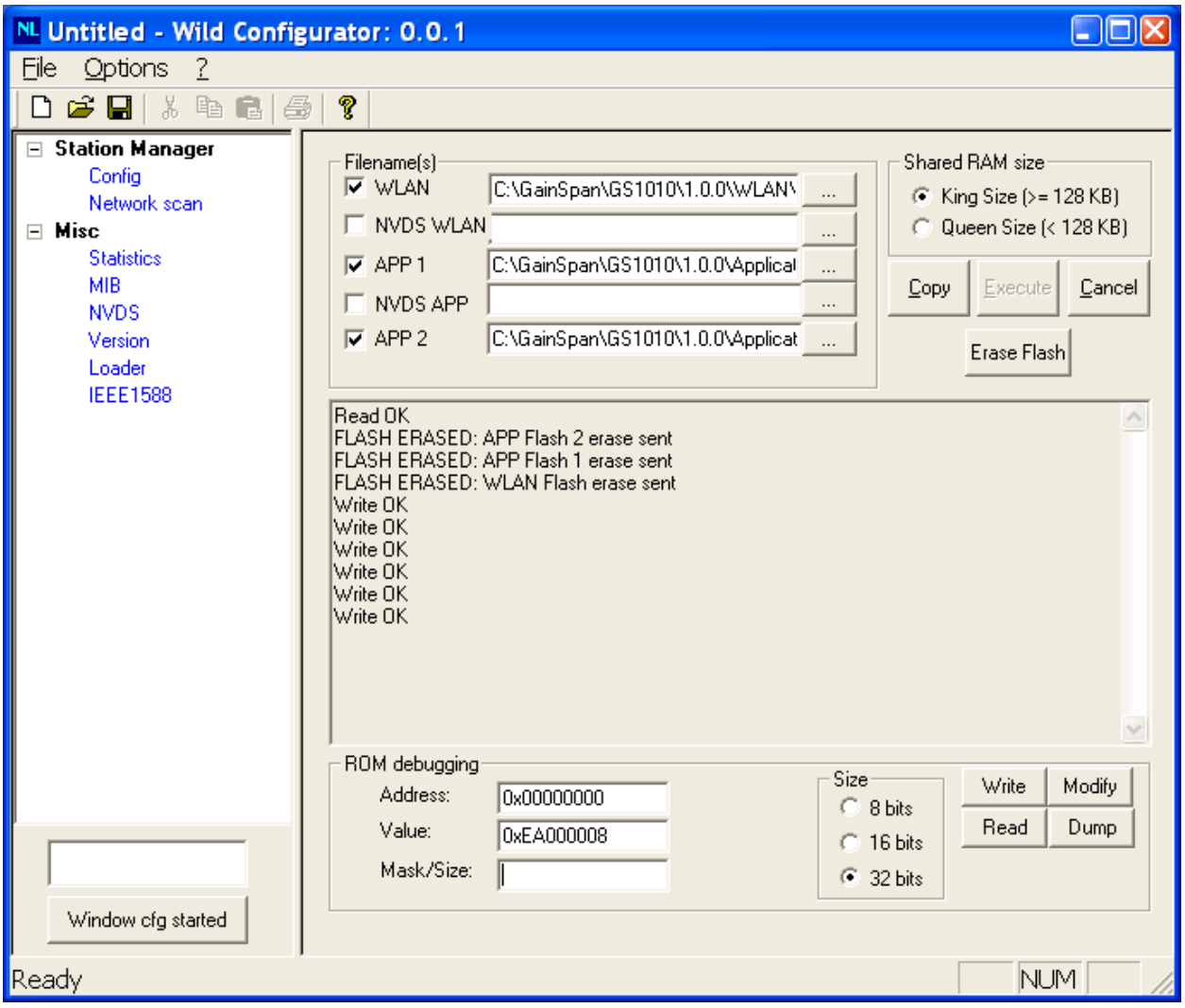


Figure 1: BootROM confirmed and all Flash erased.

Now, upload just the release version of WFW to WLAN flash.

9. Uncheck APP1 and APP2, but leave WLAN checked.
10. Select the WFW file to upload by clicking on the "…" button next to the WLAN box. The WFW file should have a name like WFW-A1-REL-DBBA-M_m_b.bin, where M_m_b means "Major Version _ Minor Version _ Build Number."
11. Upload the WFW image by clicking the Copy button (result shown in Figure 2).
12. Power off GS1010.
13. Force the GS1010 to boot into WFW:
    A. On the TLS board, remove short between Test Points E13 and TP6.
    B. On the DB, set Switch 3 of INT2 to OFF.
14. Power on the GS1010.
15. In the ROM debugging panel, read address `0x00000000`. The value read should now be `0xEA00000E`. This is the WFW reset vector.

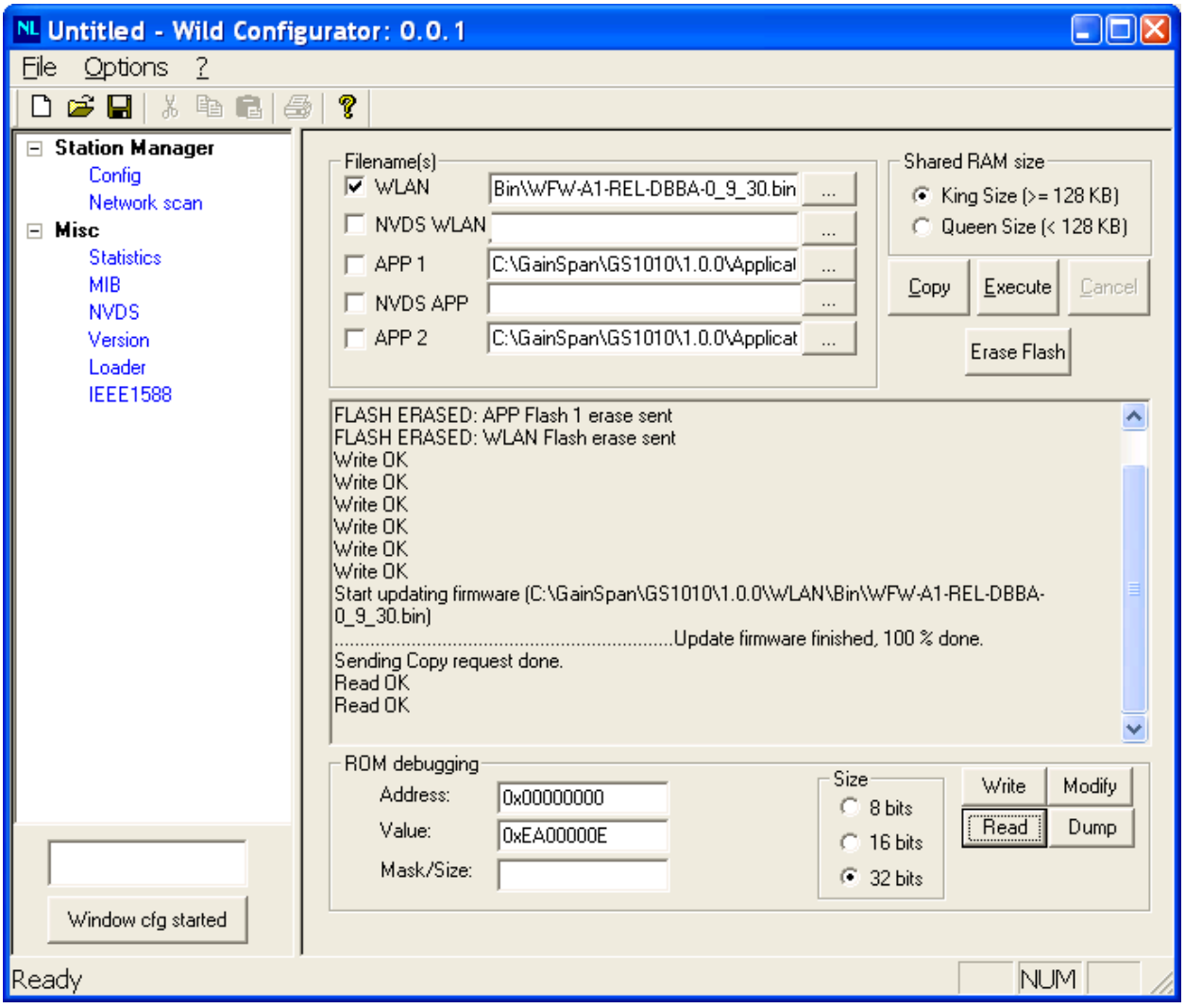


Figure 2: WFW uploaded to GS1010

SETTING GS1010 WFW MAC ADDRESS

Starting an IBSS is easy using *WiLDConfigurator*. When new WFW is uploaded into the GS1010, the default MAC address is 00:00:00:00:00:00. Unfortunately, most Wi-Fi devices will ignore IBSS beacons from a station with an all-zero MAC address. So, first a new WLAN MAC address must be stored in the GS1010 flash memory.

1. Select the MIB (Managed Information Base) frame of *WiLDConfigurator*.
2. Select the APP_CONF_MIB (application configuration MIB).
3. The MAC address is the dot11StationID MIB element. Double click to change its value to something like 00 1D C9 FF AB CD. 00 1D C9 is the OUI (Organizationally Unique Identifier) for GainSpan.

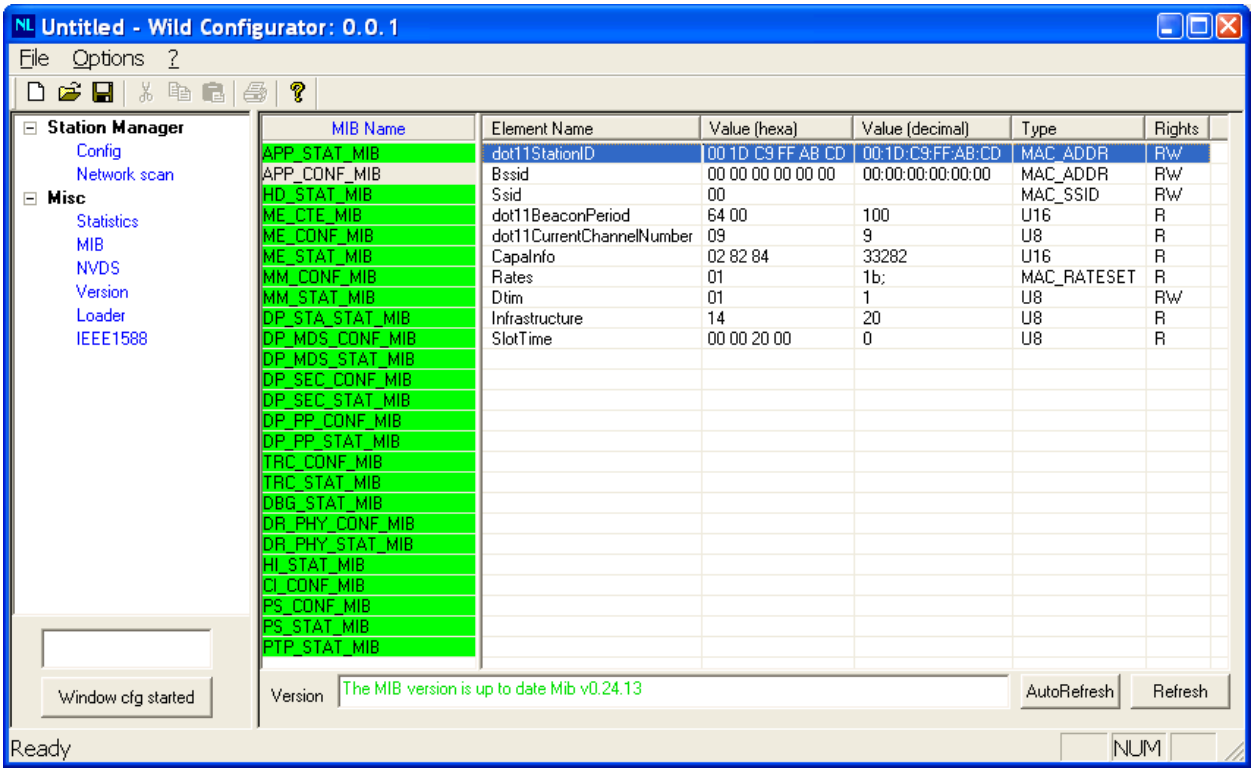


Figure 3: *WiLDConfigurator* MIB frame, showing MAC address (dot11StationID).

Changes to the WFW MIB via *WiLDConfigurator* are not written to the flash immediately. To force this change to become permanent, the GS1010 must be forced to Standby, which will cause any MIB changes to be flushed to the flash.

4. Select the IEEE1588 frame of *WiLDConfigurator*, shown in Figure 4.
5. Press the Standby Request button. This will write all MIB changes to the flash.

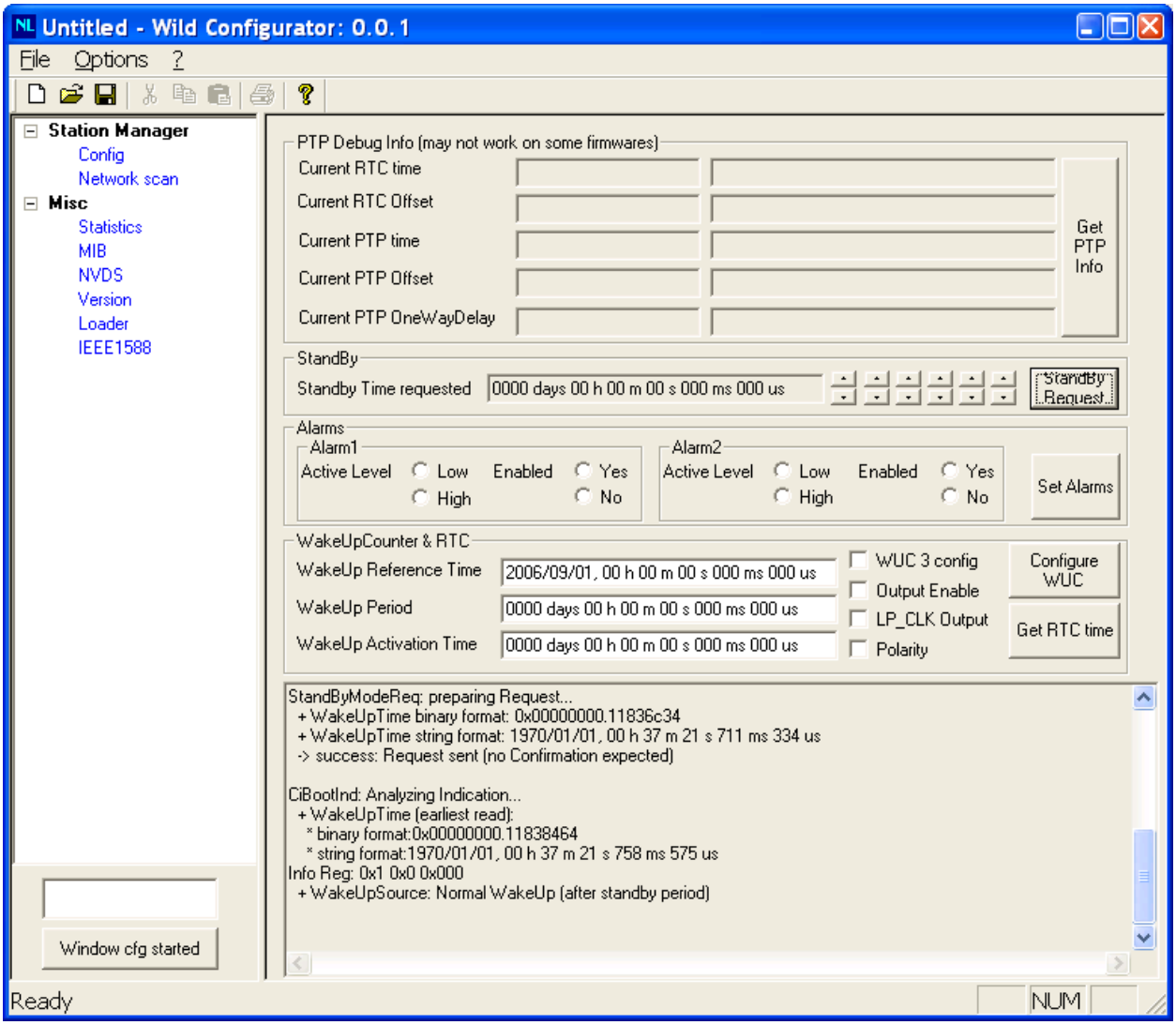


Figure 4: *WiLDConfigurator* IEEE1588 frame.

SCANNING FOR BSSS

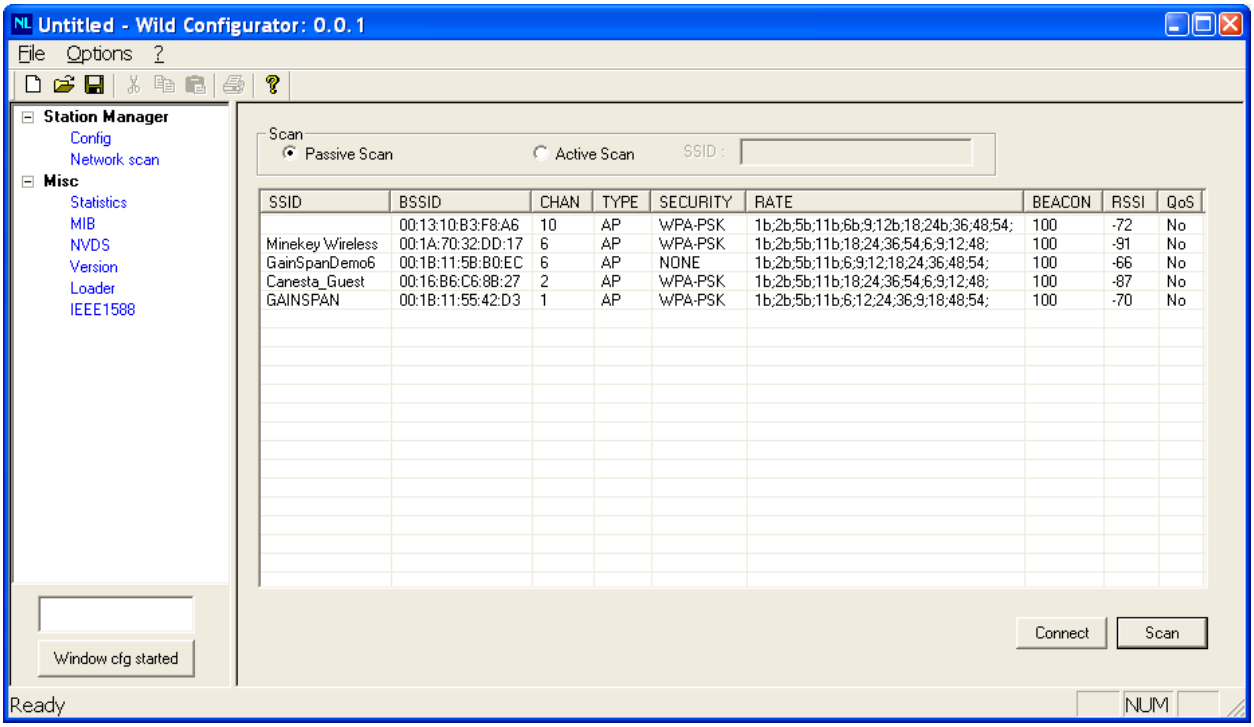


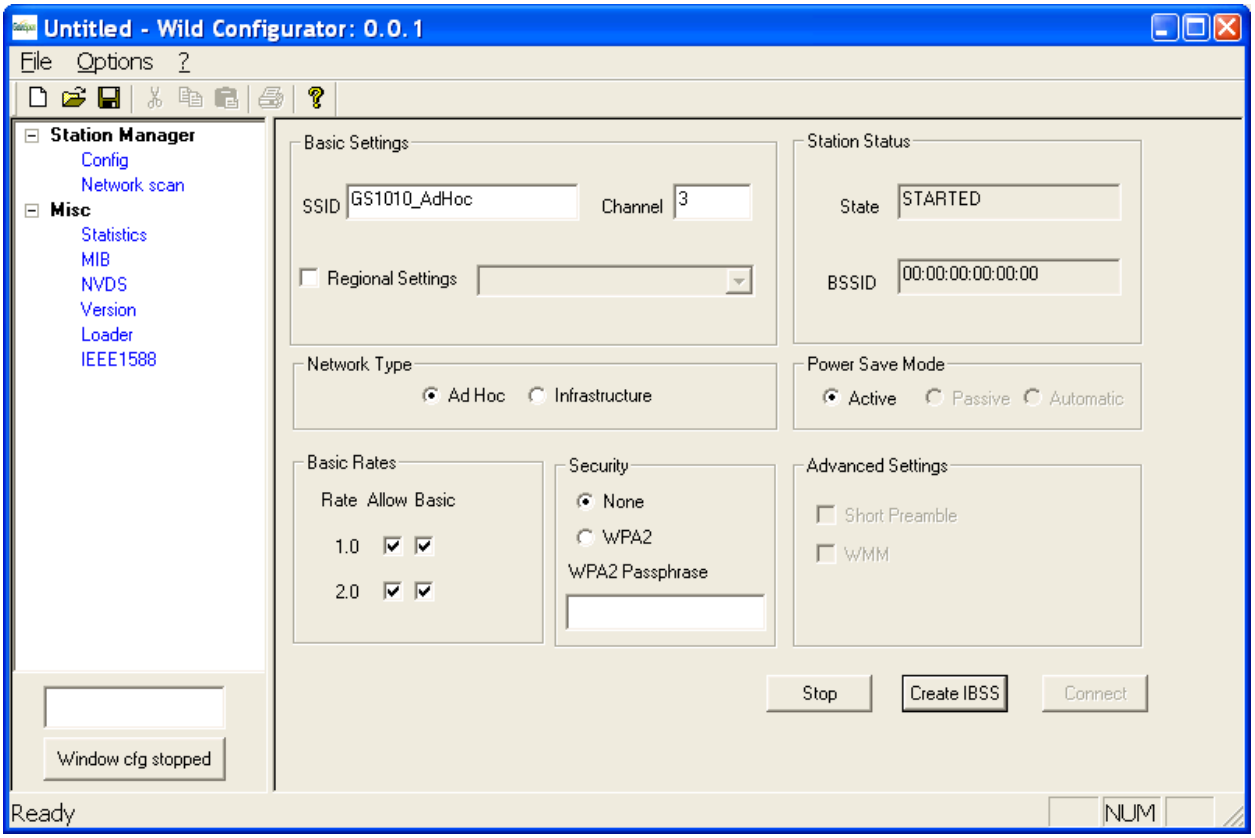
Figure 5: *WiLDConfigurator* Network Scan frame.

To verify that the WLAN radio is working, *WiLDConfigurator* provides a scan function. *WiLDConfigurator* supports both passive and active scanning. In passive scan, the GS1010 listens for beacon frames on each 802.11b/g channel for a fixed amount of time. It compiles a list of the first five beacons that it receives. For an active scan, the GS1010 first sends a Probe Request frame, and then compiles a list of the received Probe Response frames. It is also possible to active scan for a particular SSID. The Network scan frame of *WiLDConfigurator* is shown in Figure 5.

STARTING AN IBSS

The Config frame of *WiLDConfigurator* provides an interface for joining a BSS (either infrastructure or *ad hoc*) and also for starting an IBSS.

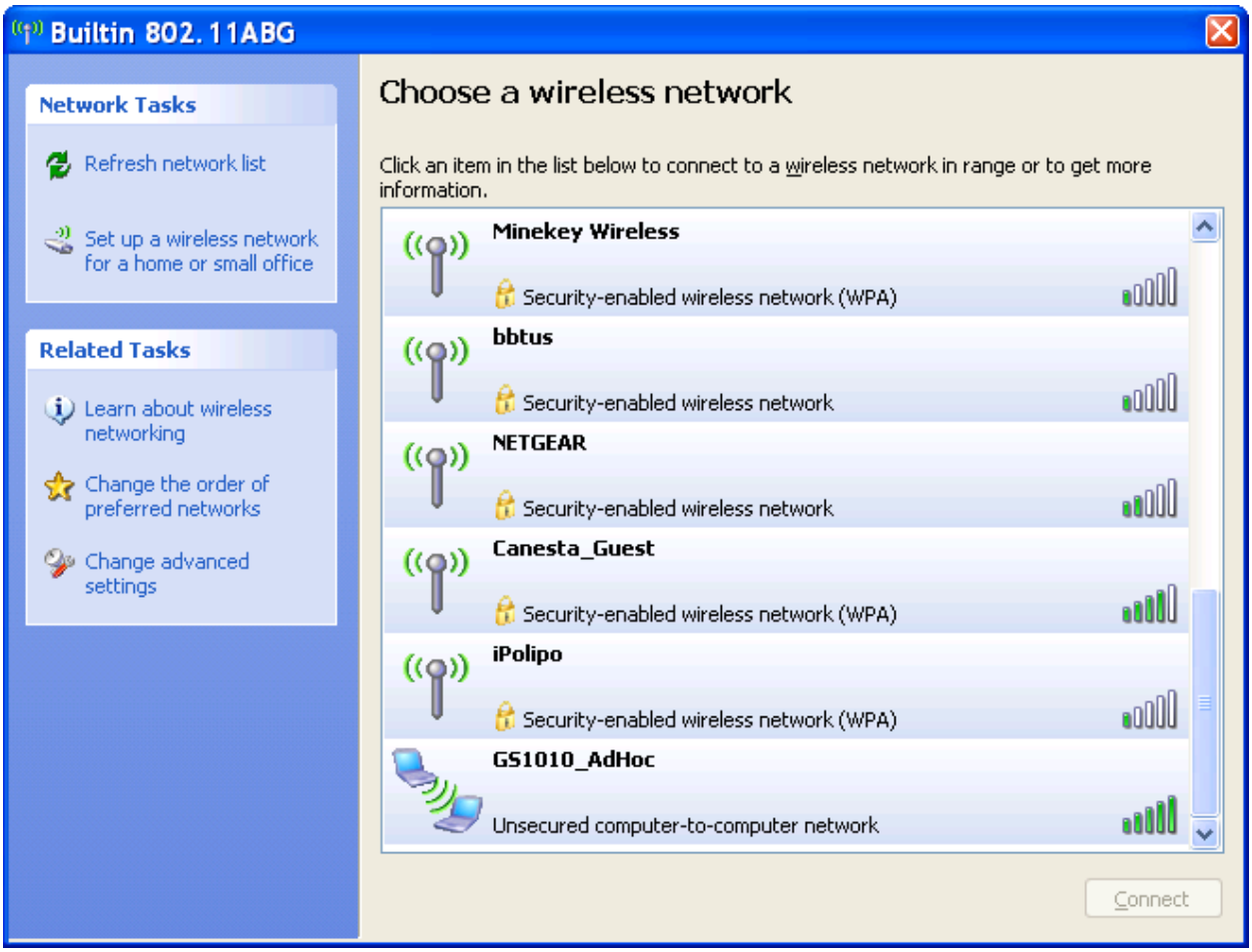
1. Select the Config frame of *WiLDConfigurator*.
2. Enter an SSID for the IBSS. For example, GS1010_AdHoc.
3. Select an 802.11b/g channel (1-14) on which to start the IBSS. For example, 3.
4. Select Ad Hoc for Network Type.
5. Select Basic Rates for the IBSS. Typically check both 1.0 and 2.0 for both Allow and Basic.
6. Click Create IBSS.



The Station Status will change to indicate that the IBSS has been STARTED.

DETECTING THE IBSS

Any device capable of scanning for Wi-Fi networks should be able to detect the IBSS. Ensure that the device is configured to detect and report *ad hoc* (IBSS) networks.



CONFIGURING BEACON INTERVAL

When the GS1010 WFW creates an IBSS, it periodically sends beacon frames with a period specified by a WFW MIB (DesiredBeaconPeriod). By default, DesiredBeaconPeriod is set to 100msec. For RF testing, it is often convenient to decrease this period to make beacons more frequent.

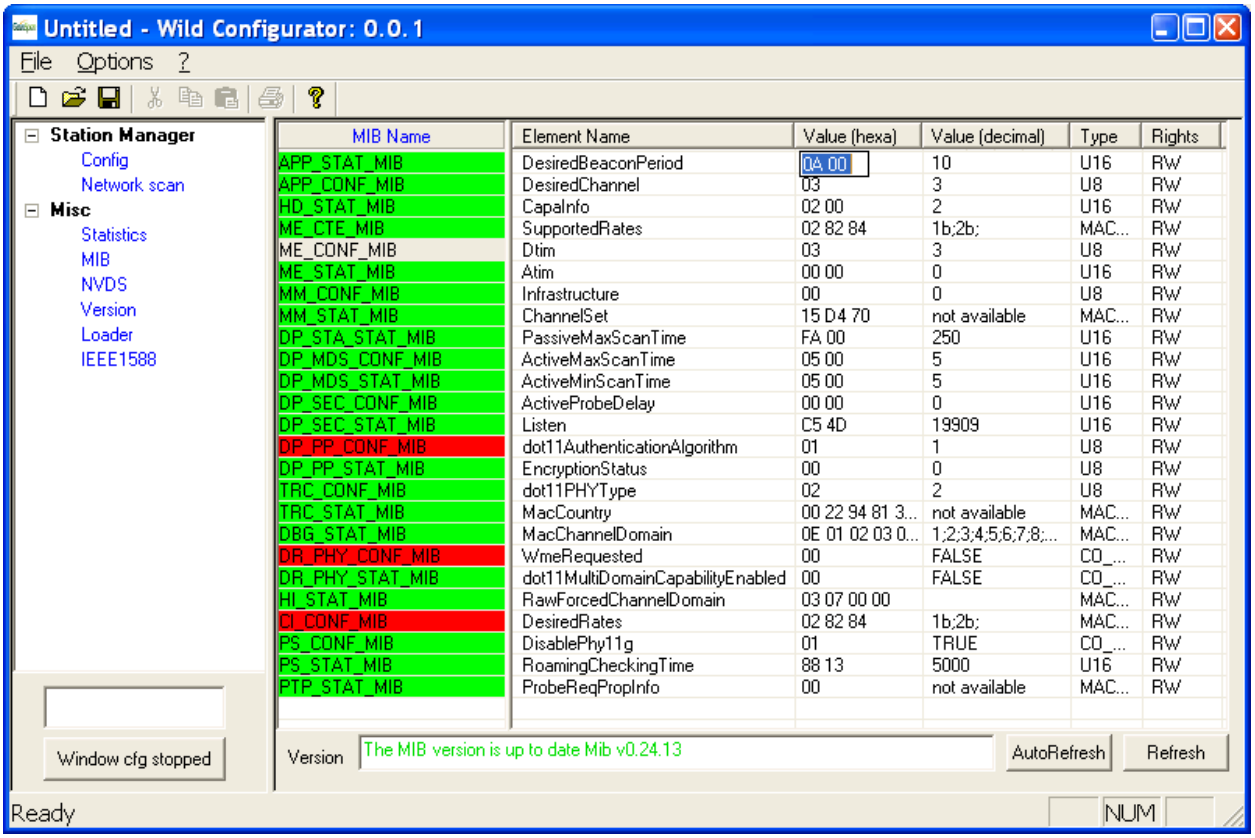


Figure 6: Setting DesiredBeaconPeriod in WFW MIB

1. Select the MIB frame of *WiLDConfigurator*.
2. Select ME_CONF_MIB.
3. Double click DesiredBeaconPeriod.
4. Set a new value. *NOTE: This unsigned 16-bit (U16) value is stored "little endian." In other words, enter the LSB MSB in hexadecimal. For example, for a 10msec period, enter 0A 00.*
5. Remember to enter Standby to make this MIB change permanent (see *Setting GS1010 WFW MAC Address*).

ENABLING THE EXTERNAL POWER AMP

By default, the WFW uses the internal power amp (IPA). On boards that include the external power amp (XPA) circuitry, such as the DB/BE, it is possible to enable XPA while sending IBSS BEACON frames by using *WildConfigurator*.

1. Select the MIB frame of *WiLDConfigurator*.
2. Select DR_PHY_CONF_MIB.
3. Set PAOffset = 00 to enable XPA. PAOffset = 08 enables IPA.
4. Remember to enter Standby to make this MIB change permanent (see *Setting GS1010 WFW MAC Address*).

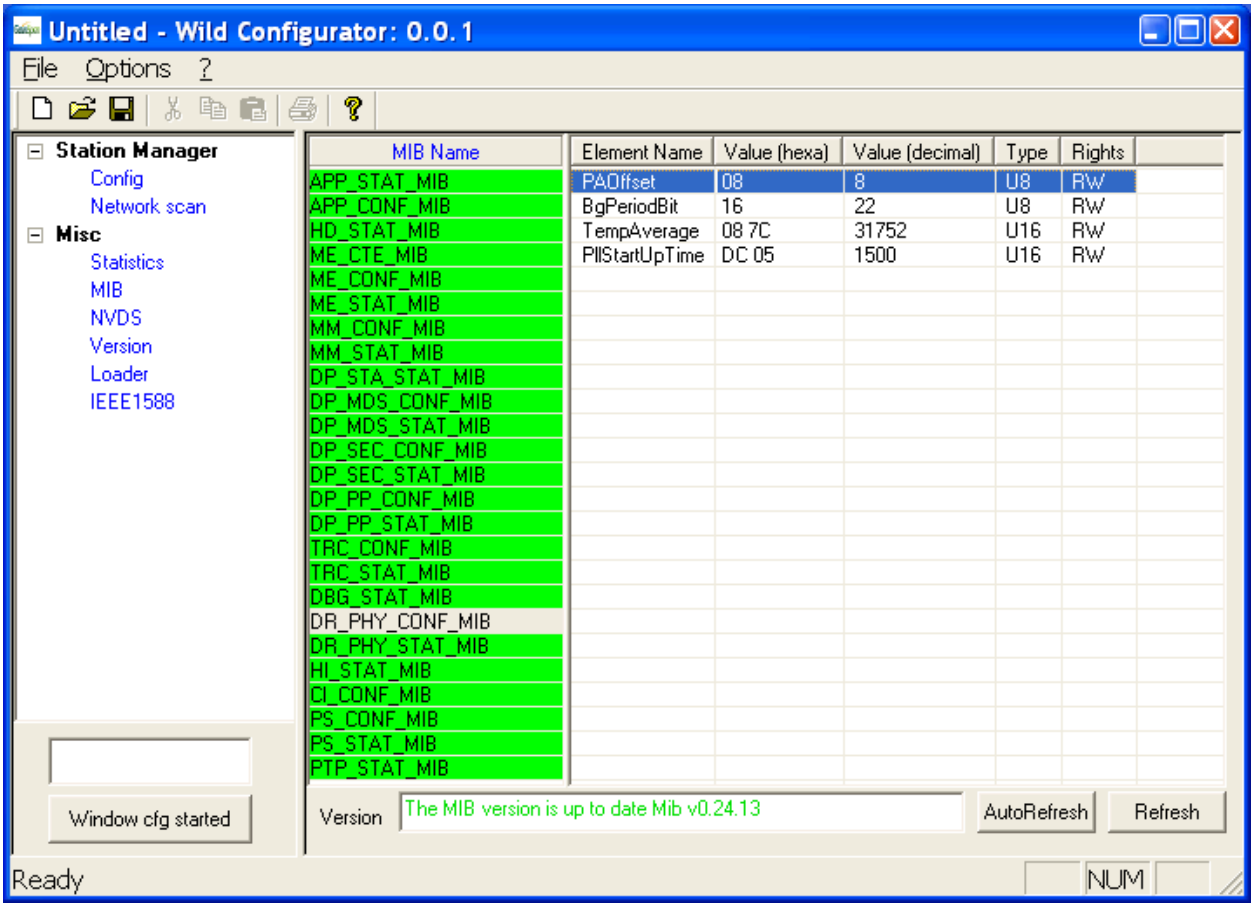


Figure 7: Set PAOffset = 0 to Enable XPA

MEASURING RF PERFORMANCE

Now that the GS1010 is pumping out IBSS beacons every 10msec, it is possible to attach the GS1010 directly to RF test equipment to measure such performance parameters as output power, spectrum, constellation, EVM, or power envelope. Below is a table relating the 802.11b/g channels numbers to their actual frequencies.

Channel	Start	Center	Stop	Regions
1	2.401	2.412	2.423	NA, ETSI, J
2	2.406	2.417	2.428	NA, ETSI, J
3	2.411	2.422	2.433	NA, ETSI, J
4	2.416	2.427	2.438	NA, ETSI, J
5	2.421	2.432	2.443	NA, ETSI, J
6	2.426	2.437	2.448	NA, ETSI, J
7	2.431	2.442	2.453	NA, ETSI, J
8	2.436	2.447	2.458	NA, ETSI, J
9	2.441	2.452	2.463	NA, ETSI, J
10	2.446	2.457	2.468	NA, ETSI, J

Channel	Start	Center	Stop	Regions
11	2.451	2.462	2.473	NA, ETSI, J
12	2.456	2.467	2.478	ETSI, J
13	2.461	2.472	2.483	ETSI, J
14	2.473	2.484	2.495	J

Figure 8: 802.11b/g Channels – NA = North America, ETSI = Europe, J = Japan

IEEE 802.11b

Frequency:	2.412 GHz	Ref Level:	3.2 dBm	External Att:	3 dB
Sweep Mode:	Continuous	Trigger Mode:	Power	Trigger Offset:	-10 µs
Preamble Type:	Long PLCP	Modulation:	1 Mbps DBPSK	PSDU Data Length:	1/4095 Bytes

Spectrum Emission Mask

Tx Channel:	Bandwidth	22 MHz	Power	-8.62 dBm

Start Freq. rel.	Stop Freq. rel.	RBW	Freq. at Delta to Limit	Pwr Abs.	Pwr Rel.	Delta to Limit	
-50.000 MHz	-22.000 MHz	100 kHz	2.368089744 GHz	-61.21 dBm	-52.60 dB	-2.60 dB	
-22.000 MHz	-11.000 MHz	100 kHz	2.400942308 GHz	-51.54 dBm	-42.92 dB	-12.92 dB	
11.000 MHz	22.000 MHz	100 kHz	2.423057692 GHz	-45.40 dBm	-36.79 dB	-6.79 dB	
22.000 MHz	50.000 MHz	100 kHz	2.434115384 GHz	-60.85 dBm	-52.23 dB	-2.23 dB	
...	...	...	...	...	...	...	
...	...	...	...	...	...	...	
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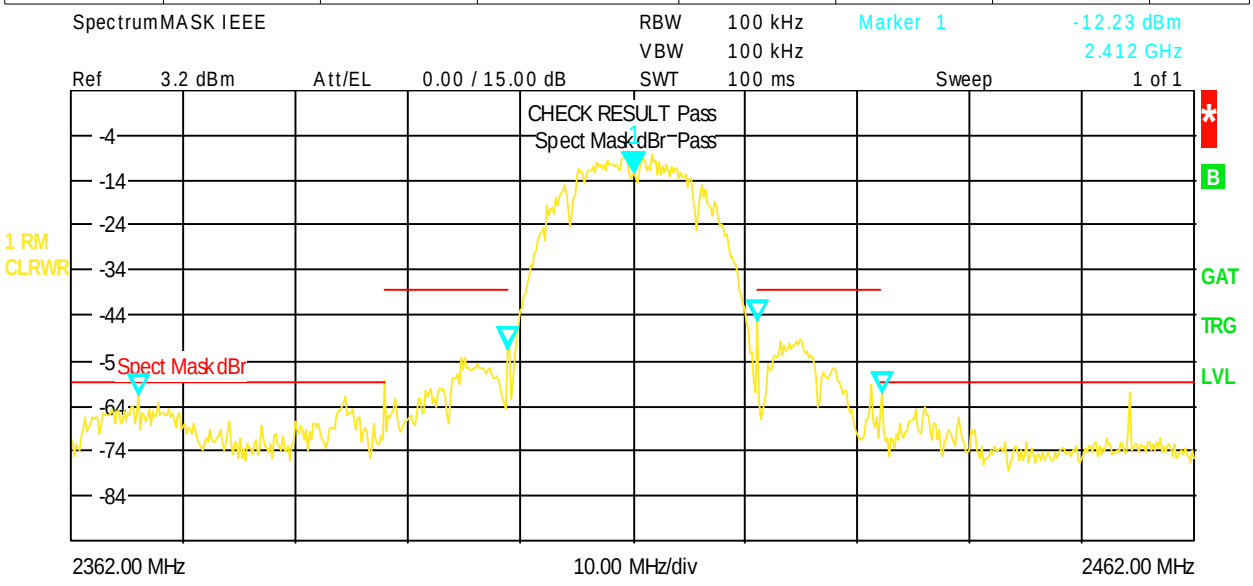

Figure 9: Spectrum Mask Test Using a Rohde & Schwarz FSG Spectrum Analyzer

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