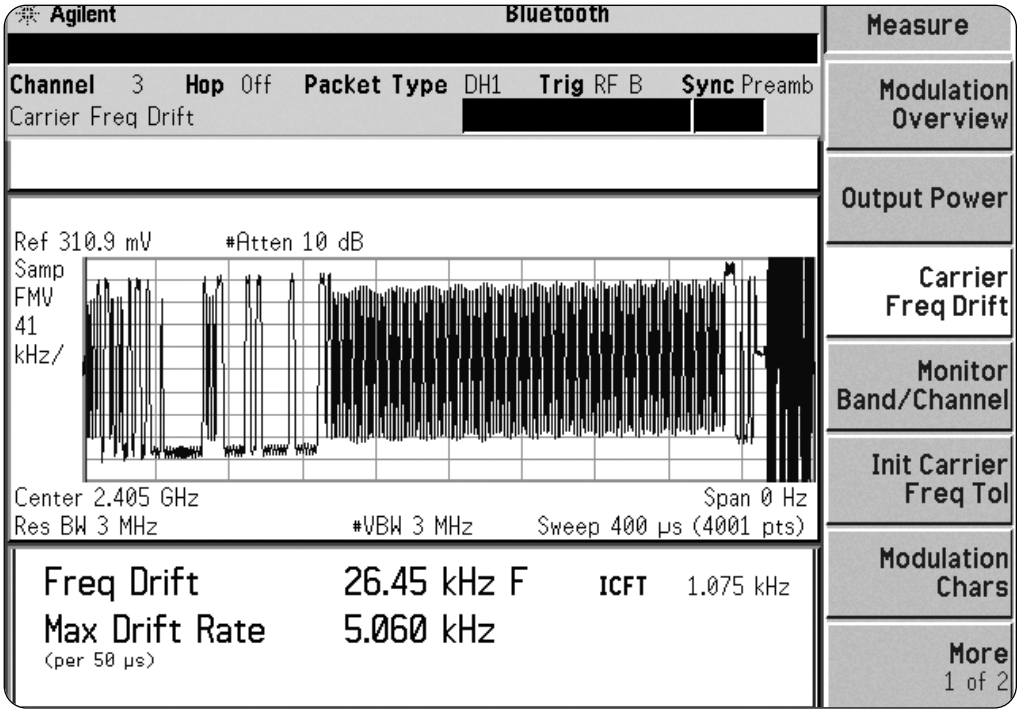
Agilent
ESA-E Series Spectrum Analyzer

Bluetooth™ Measurement Option
Self-Guided Demo

Application Note



Agilent Technologies

Table of Contents

What is *Bluetooth*?

Bluetooth is an open specification that allows simple wireless connectivity for computing, telecommunications and other devices. In other words, it permits the transmission of data between devices, such as computers, Personal Digital Assistants (PDAs) and mobile phones, without any cables or wires. *Bluetooth* signals support both voice and data connections. The operating range between the devices is from 10 cm to 10 m. With an amplifier, the maximum range increases 10 times, to 100 meters. Once the devices are separated beyond the specified range, the data transmission bandwidth drops off. The modulation format of the *Bluetooth* system is 2-level Frequency Shift Keying (2FSK) in which the modulated carrier shifts by plus or minus 157 kHz nominally to represent a binary "1" or "0". The frequency that data packets are transmitted on changes or hops within the range of 2.402 to 2.480 GHz. This method is called frequency hopping. A *Bluetooth* system can make up to 1600 hops/sec. This dramatically decreases the probability of interference from other devices operating in the same frequency range.

The *Bluetooth* system

The advantage of this technology is low power consumption, low cost, and robust operation in a crowded RF (Radio Frequency) environment.

Radio unit – sends and receives RF signals.

Baseband link control unit – determines the state of the devices and is responsible for connection, power efficiency, error encryption, and security.

Link management software – enables devices to communicate between each other.

For additional information on *Bluetooth* and *Bluetooth* measurements please refer to *Performing Bluetooth RF Measurements Today*, Application Note 1333, literature number 5968-7746E

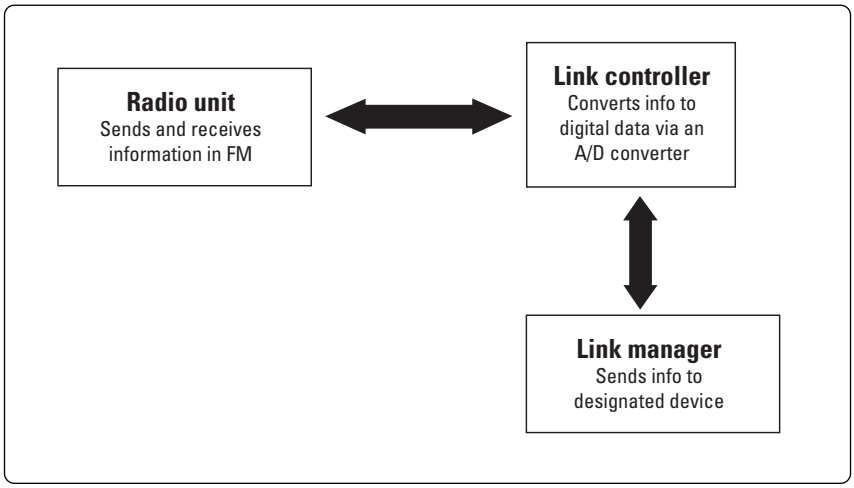


Figure 1. Block diagram of the *Bluetooth* system.

Making *Bluetooth* transmitter measurements with the ESA spectrum analyzer

The ESA-E Series spectrum analyzer provides one-button standard compliant *Bluetooth* transmitter measurement capability, all in a mid-priced package. This allows accurate design verification and troubleshooting of manufacturing devices. In the following examples, the ESG-D Series signal generator will be used to generate *Bluetooth* modulated signals. This may be useful in real test setups when the device is in loopback mode or is a passive component. The ESA will make measurements to let us analyze characteristics of those signals. The frequency range allocated with *Bluetooth* is 2.402 GHz to 2.480 GHz (with a few possible exceptions). The spectrum analyzer can determine whether the signals transmitted by a *Bluetooth* device is in the required frequency range. This will ensure the accuracy of transmitted data and compliance with international regulations, such as the Federal Communications Commission (FCC) regulations in the U.S. The ESA can also analyze the modulation of the signal and verify that the power of the signal meets its specifications.

Which measurements are we going to focus on?

Average/peak output power – power measurements in the frequency domain.

Modulation characteristics – frequency deviation measurement.

Initial carrier frequency tolerance – test accuracy of the transmitter's carrier frequency.

Carrier frequency drift – test frequency drift of signal.

Monitor band/channel – view specific channels or entire band.

Modulation overview – provides snapshot of overall modulation behavior.

Output Spectrum – 20 dB bandwidth measures occupied bandwidth of *Bluetooth* signal

Adjacent channel power (ACP) – measures emission power across entire *Bluetooth* operating band except for the main operating channel and its immediately adjacent channels.

What options does the ESA-E spectrum analyzer need?

To perform one-button standard compliant measurements of *Bluetooth* signal the ESA spectrum analyzer must have at least the following options; option 228 *Bluetooth* measurement personality, option 106 *Bluetooth* FSK demodulator, option AYX Fast zero span sweeps (provides ADC and DSP functions), option B72 Memory extension. This is the minimum option configuration and requires a trigger signal from the signal generator to measure a *Bluetooth* burst. Option AYX may be replaced with option B7E and option B7D, in which case the trigger signal from the signal generator is not required.

What options does the ESG-D signal generator need?

To source standard compliant *Bluetooth* signal bursts the ESG signal generator must have option UND and option UN8 installed.

How do we make those measurements?

Connecting the instruments:

Using a RF cable with an impedance of 50 Ω, connect the **RF Output 50 Ω** port on the ESG-D Series Signal Generator to the **RF Input 50 Ω** port on the ESA Series transmitter tester as shown. Connect a second cable between the Event 1 BNC on the rear of the signal generator and the Gate Trig / Ext. Trig In BNC on the rear of the spectrum analyzer.
Note: In the following keystrokes, **{ }** = soft key and **[ ]** = hard key.

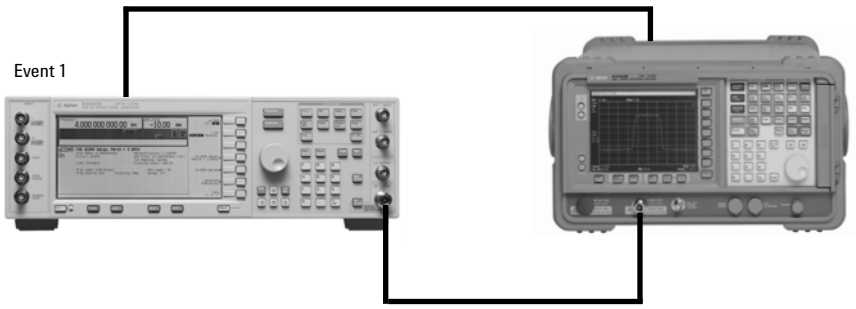


Figure 2. An ESG-D Series signal generator (left) connected to an ESA-E Series spectrum analyzer (right).

Bluetooth Setup

ESG-D Series signal generator

Instructions	Keystrokes
Activate mode menu.	Press [Mode]. You may press [Return] to return to previous menu.
Go to *Bluetooth* mode. Arb waveform generator is a predefined *Bluetooth* signal. We can also customize the *Bluetooth* signal by changing the packet, adding impairments or changing # Symbols/Ramp.	-For predefined signal: Press {Arb Waveform Generator}, then Press {Bluetooth} -To customize *Bluetooth* signal you may change the following parameters: Press {Packet}. If you press {BD_ADDR 000000 00 0008}, then you may use {A...F} to define new packet, then press {Enter}.
If you press {AM_ADDR), enter the number, Data},	then press {Enter}. If you press {Payload choose either {PN9} or {8 Bit Pattern} OR Press {Impairments}, you may choose {Freq Offset}, {Freq Drift} or {Mod Index}, enter the number, then press unit (soft key). OR Press {# Symbols/Ramp}, then enter number.
Set frequency to 2.402 GHz.	Press [Frequency], then enter 2.402, then press {GHz}
Set amplitude to 0 dBm.	Press [Amplitude], then enter 0, then press {dBm}
Activate *Bluetooth* mode.	Press {Bluetooth Off On} The "On" should be highlighted
Turn on signal bursts.	The "On" should be highlighted. If not, press {Burst Off/On}
Turn on RF.	Press [RF On/Off] The display should read "RF ON"
Turn on MOD.	The display should read "MOD ON". If not, press [MOD On/Off]

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Activate mode menu.	Press [Mode]
Choose *Bluetooth* mode.	Press {Bluetooth}

Optional: frequency/channel setup

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to Frequency mode menu.	Press [Frequency Channel]. Listed below are the various options.
Change channels. *Bluetooth* channel range is 0 - 78. Channel 0 is 2.402 GHz. Increasing the value of the channel, in turn, increases the center frequency by 1 MHz.	Press {Channel}. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Change center frequency.	Press {Center Freq}. Then you may: - enter number, then press {GHz}. OR - adjust the number by turning the knob.
Choose a low, mid or high channel. This mode automatically sets a channel value.	Press {L M H Channel}, then press either {Low 1}, {Mid 40} or {High 79}
Change packet type to either DH1, DH3 or DH5[1]. ESG UND only supports DH1 with internal FW at present.	Press {Packet Type}, then press either {DH1}, {DH3} or {DH5}
Automatically tune the ESA to center frequency / channel number of the transmit channel (a new enhancement)	Press {Auto Channel}

Optional: mode setup

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to mode setup.	Press [Mode Setup], listed below are the various options. Press [Return] after each measurement to return to Mode menu.
Select power class (1, 2 or 3) or frequency hopping mode. Default is power class 1 and hopping off.	Press {Radio}, then choose from {Power Class 1}, {Power Class 2} or {Power Class 3}. Press TAB to activate the frequency hopping parameter (it will be highlighted). Then either press {On} or {Off}.
Change input parameters. Default is auto. The following parameters are max total power, input attenuation, internal preamp, external gain and external attenuation.	Press {Input}, then press either {Auto} (automatic) or {Man} (manual). Within each choice, there are a few parameters that you may change by pressing TAB until the desired parameter is highlighted. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Go to the trigger menu. The following parameters are trigger delay, trigger level and trigger slope.	Press {Trigger}. There are a few parameters that you may change by pressing TAB until the desired parameter is highlighted. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Go to the demod menu. The following parameters are max deviation, burst search threshold and burst search pre-trigger.	Press {Demod}. There are a few parameters that you may change by pressing TAB until the desired parameter is highlighted. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Check the version of the *Bluetooth* personality you are using.	Press {Properties}
Go to the packet data menu. The following parameters are access code + header, DH1 payload header length (also for DH3 and DH5) and DH1 payload data length (also for DH3 and DH5).	Press {Packet Data}. There are a few parameters that you may change by pressing TAB until the desired parameter is highlighted. Then you may: Enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Go back to a previous menu.	Continue to press [Return] until you reach the desired menu

1. DH1, DH3, DH5 are high rate non-error protected data packets. Suffixes 1, 3 and 5 indicate the number of time slots occupied by the data burst.

Measurement 1: Average/Peak Output Power

Output power (average and peak):

Power measurements in the frequency domain ensure the output power is within the limits set in the *Bluetooth* specifications. Too little power will result in less range. Too much power and the device runs the risk of overcrowding other transmitters in the Industrial Scientific Medical (ISM) band.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
Measure output power.	Press {Output Power}

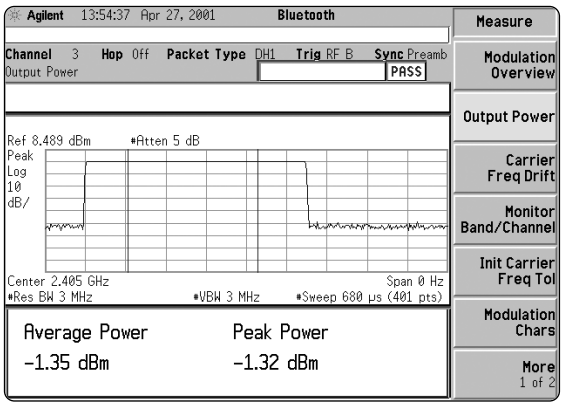


Figure 3. Output power measurement under measure menu.

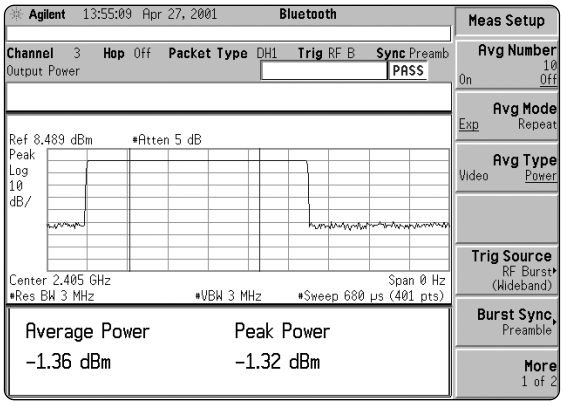


Figure 4. Measurement setup menu for output power.

Optional: measurement setup

This will allow you to customize the output power measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between exponential or repeat averaging.	Press {Avg Mode}, underlined word indicates active mode.
Switch between power or video averaging. Power averaging is the average of the total linear power over multiple sweeps. Video averaging is the average of the logarithmic value obtained from each sweep.	Press {Avg Type}, underlined word indicates active mode.
Select trigger source for the measurement. Default is RF burst (wideband). Free Run activates the trigger condition that allows the next sweep to start as soon as possible after the last sweep. External triggers the next sweep to start when positive-edge triggered. Video allows the next sweep to start if the detected RF envelope voltage rises to a level set by the display line.	Press {Trig Source}, then choose from {Free Run (Immediate)}, {External}, {RF Burst (Wideband)} or {Video}
Select how the measurement will synchronize with the correct part of the burst. Preamble mode uses p0 to define start. RF Amptd mode defines the duration of the burst as the time between the leading and trailing 3 dB points compared to average power.	Press {Burst Sync}, then choose from {Preamble}, {RF Amptd} or {None}
View additional measurement options	Press {More 1 of 2}
Turn limit checking on and off. The relevant PASS/FAIL annotation is displayed in the measurement bar	Press {Limit Test}, mode is active if "On" is underlined
Select a particular limit. This is not the same as limit lines – the numeric peak and average power results are checked against the peak upper limit, avg upper limit and avg lower limit parameters to see if they meet the limit requirements.	Press {Limits...}, then choose a parameter by pressing TAB. The active parameter will be highlighted on the display. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Go back to a previous menu.	Continue to press [Return] until you reach the desired menu
Start marker parameter is used to determine the point at which averaging of the power should begin. It is defined as a Percentage of the burst length, relative to a specific start point. Determining the start point and burst length is dependent on the current burst sync. The difference between the stop and start marker must be at least 1%. Attempting to input anything less than 1% will result in the start marker being moved to the requested % of the burst length and the stop marker moved to 1% greater than the start marker. If the stop marker is at 100% the start marker will be set to 99%.	Press {Start Marker}. Then you may: - enter number, then press {%}. OR - adjust the number by turning the knob.
Stop marker parameter is similar as above measurement except when attempting to input anything less than 1% will result in the stop marker being moved to the requested % of the burst length and the start marker moved to 1% less than the start marker. If the stop marker is at 0% the start marker will be set to 1%.	Press {Stop Marker}. Then you may: - enter number, then press {%}. OR - adjust the number by turning the knob.
Set predefined default values for the above measurement parameters.	Press {Restore Meas Defaults}
Go back to a previous menu.	Continue to press [Return] until you reach the desired menu

Measurement 2: Modulation Characteristics

Modulation characteristics:

The modulation characteristics test is a frequency deviation measurement. For modulation characteristics, there are two sets of repeating 8-bit sequences used in the payload. These are 11110000 and 10101010. The combination of the two sequences checks both the modulator performance and the pre-modulation filtering. The measurement is performed in 2 stages, each stage requiring a different packet: one carrying the 10101010 payload, the other 11110000.

Stage 1: using the '11110000' payload

For each 8-bit 'slot' of the payload the following procedure is followed; the frequency deviations of each bit in the 8-bit sequence are measured and averaged together to give a frequency average for the slot. Then, the deviation from the average for the 2^{nd}, 3^{rd}, 6^{th} and 7^{th} bits are examined, and the max deviation is recorded as F1 max for the slot. Finally, an average of the maximum deviations from each slot in the packet is computed (F1 avg).

The maximum and minimum values of F1 max over the entire packet, along with F1 avg, are displayed on the screen. Any values of F1 max outside the range 140 to 175 kHz are flagged as a fail.

Stage 2: using the '10101010' payload

For each 8-bit 'slot' of the payload the following procedure is followed; the frequency deviations of each bit in the 8-bit sequence are measured and averaged together to give a frequency average for the slot. Then, the deviation from the average for each of the 8 bits are examined, and the max deviation is recorded as F2 max for the slot. Finally, an average of the maximum deviations from each slot in the packet is computed (F2 avg).

The maximum and minimum values of F2 max over the entire packet, along with F2 avg, are displayed on the screen. Any values of F2 max lower than 115 kHz are flagged as a fail.

The ratio F2 avg/F1 avg is then computed using the stored values from stage 1 and stage 2, with any results lower than 80% flagged as a fail.

Note: *An ideal Gaussian filter will produce a ratio of 88% between the peak frequency deviation of a 10101010 and 11110000 signal. The Bluetooth radio specification calls at least 80% to be achieved.*

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
Measure modulation characteristics.	Press {Mod Char}

Optional: measurement setup

This will allow you to customize the modulation characteristics measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On"is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between exponential or repeat averaging.	Press {Avg Mode}, underlined word indicates active mode
Store the measurement result for either 'Δf_1 Avg' or 'Δf_2 Avg', depending on which result has been measured.	Press {Hold Result}, then choose from {Δf_1 Avg}, {Δf_2 Avg} or {Off}
Choose either a predetermined payload data pattern or let ESA auto-detect pattern.	Press {Payload Data}, then choose from {Auto-Detect}, {11110000} or {10101010}
Select trigger source for the measurement. Default is RF burst (wideband). Free run activates the trigger condition that allows the next sweep to start as soon as possible after the last sweep. External activates the trigger condition that allows the next sweep to start when positive-going external voltage passes through approximately 1.5 volts.	Press {Trig Source}, then choose from {Free Run (Immediate)}, {External} or {RF Burst (Wideband)}
Select how measurement will synchronize with the correct part of the burst. Preamble mode uses p0 to define start.	Press {Burst Sync}, then choose from {Preamble} or {None}
View additional measurement options.	Press {More 1 of 2}
Turn limit checking on and off, controlling whether or not the relevant PASS/FAIL annotation is displayed in the measurement bar.	Press {Limit Test}, mode is active is On is underlined
Select a limit parameter. The choices are $\Delta f_2/\Delta f_1$ Lower Limit, Δf_1 max Upper Limit, Δf_1 max lower limit, Δf_2 max Upper Limit and Δf_2 max Lower Limit.	Press {Limits}. Choose an option by pressing it's respective soft key, then enter the number, then press unit (soft key).
Set 1.3 MHz post detection filter on or off.	Press {1.3 MHz Filter} to toggle the filter to on or off.
Adjust the Resolution bandwidth filter that is used when calculating Δf_1 or Δf_2 results.	Press {Advanced}, press either {Δf_1 RBW} or {Δf_2 RBW}, then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Set predefined default values for the above measurement parameters.	Press {Restore Meas Defaults} Go back to a previous menu. Continue to press [Return] until you reach the desired menu

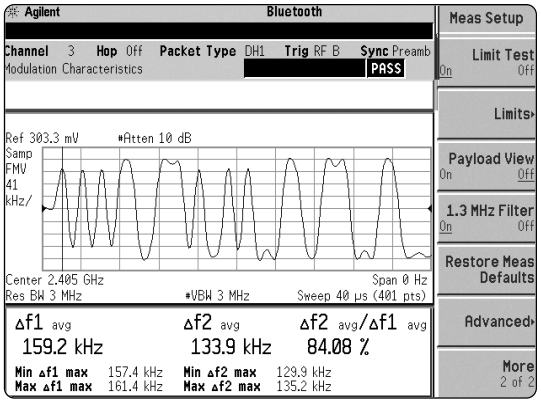


Figure 5. Measurement setup menu for modulation characteristics.

Measurement 3: Initial Carrier Frequency Tolerance

Initial carrier frequency tolerance:

The initial carrier frequency tolerance test verifies the accuracy of the transmitter's carrier frequency. A standard DH1 packet with a preamble[2], and with PRBS[3] as payload is used. The preamble bits are analyzed to determine the extent of the frequency deviation from center frequency. This measurement requires the signal to be demodulated to measure the frequency deviation of each symbol. After demodulation, the frequency offset of each of the preamble bits is measured and averaged. The transmitted initial center frequency accuracy must be ±75 kHz from the nominal center frequency (Fc).

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
Measure frequency tolerance.	Press {Init Carrier Freq Tol}

2. The initial four bits of a packet.
3. PseudoRandom bit sequence of period 2^9 - 1 bits.

Optional: measurement setup

This will allow you to customize the initial carrier frequency tolerance measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between exponential or repeat averaging.	Press {Avg Mode}, underlined word indicates active mode
Select trigger source for the measurement. Default is RF burst (wideband). Free run activates the trigger condition that allows the next sweep to start as soon as possible after the last sweep. External activates the trigger condition that allows the next sweep to start when positive-going external voltage passes through approximately 1.5 volts.	Press {Trig Source}, then choose from {Free Run (Immediate)}, {External}or {RF Burst (Wideband)}
Select how measurement will synchronize with the correct part of the burst. Preamble mode uses p0 to define start.	Press {Burst Sync}, then choose from {Preamble} or {None}
View additional measurement options.	Press {More 1 of 2}
Turn limit checking on and off, controlling whether or not the relevant PASS/FAIL annotation is displayed in the measurement bar.	Press {Limit Test}, mode is active is On is underlined
Select a limit parameter. The choices are ICFT upper limit and ICFT lower limit.	Press {Limits}, then choose from {ICFT Upper Limit} or {ICFT Lower Limit} Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Set 1.3 MHz post detection filter on or off.	Press {1.3 MHz Filter} to toggle the filter on or off.
Set predefined default values for the above measurement parameters.	Press {Restore Meas Defaults}
Go back to a previous menu.	Continue to press [Return] until you reach desired menu

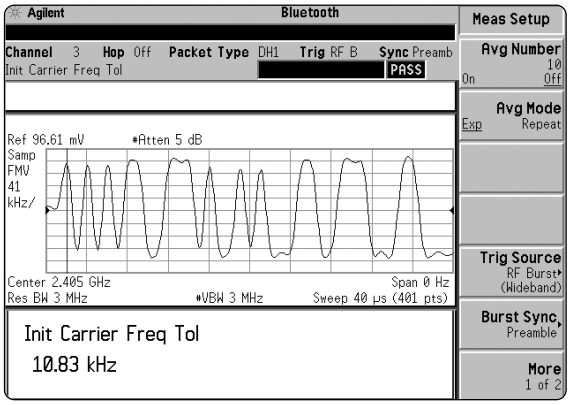


Figure 6. Measurement setup menu for initial carrier frequency tolerance.

Measurement 4: Carrier Frequency Drift

Carrier frequency drift: You will need to change the impairments in the ESG if you want to see a change in the display on the ESA.

Design or environmental considerations can cause the frequency of a *Bluetooth* signal to drift over the burst. This measurement checks the drift compared to the *Bluetooth* specification, checking that the overall drift is less than ±25 kHz for a single slot package, and less than ±40 kHz for larger payloads. In addition, it checks that maximum drift rate between any successive 10-bit sequences doesn't exceed 4 kHz.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
Measure frequency drift.	Press {Carrier Freq Drift}

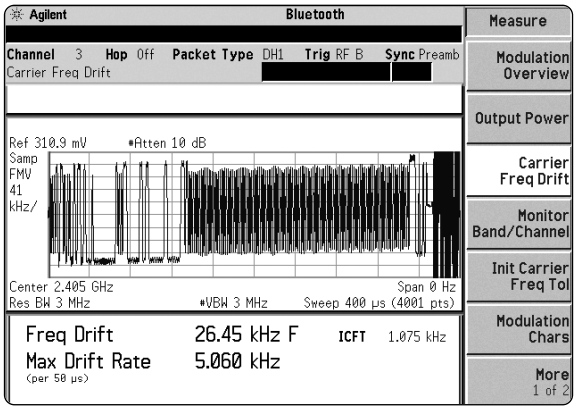


Figure 7. Carrier frequency drift measurement under measure menu

Optional: measurement setup

This will allow you to customize the carrier frequency drift measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between exponential or repeat averaging.	Press {Avg Mode}, underlined word indicates active mode
Select trigger source for the measurement. Default is RF burst (wideband). Free run triggers the next sweep to start as soon as possible after the last sweep.	Press {Trig Source}, then choose from {Free Run (Immediate)}, { External} or {RF Burst (Wideband)}
Select how measurement will synchronize with the correct part of the burst. Preamble mode uses p0 to define start.	Press {Burst Sync}, then choose from {Preamble} or {None}
Offset the trace displayed on the screen.	Press {View Offset}. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
View additional measurement options.	Press {More 1 of 2}
Turn limit checking on and off. The relevant PASS/FAIL annotation is displayed in the measurement bar.	Press {Limit Test}, mode is active is On is underlined
Select a limit parameter. The choices are max drift rate upper limit, max drift rate lower limit, freq drift upper limit and freq drift lower limit.	Press {Limits...}, then choose a parameter by pressing TAB. The active parameter will be highlighted on the display. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Set 1.3 MHz post detection filter on or off.	Press {1.3 MHz Filter} to toggle the filter on or off.
Set predefined default values for the above measurement parameters.	Press {Restore Meas Defaults}
Go back to a previous menu.	Continue to press [Return] until you reach the desired menu

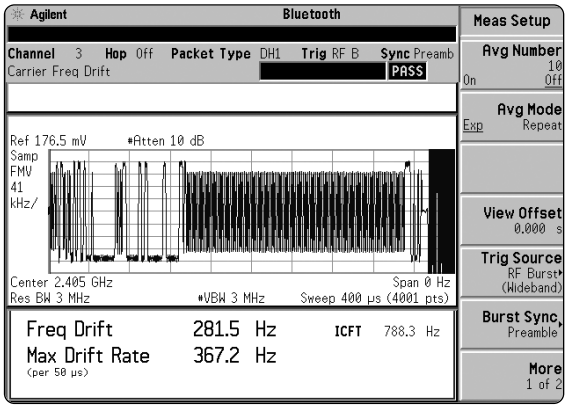


Figure 8. Measurement setup menu for carrier frequency drift.

Measurement 5: Monitor/Band Channel

Monitor band/channel:

This measurement is used as a quick, convenient means of looking at specific channels or the entire band.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
View channel/band.	Press {Monitor Band/Channel}

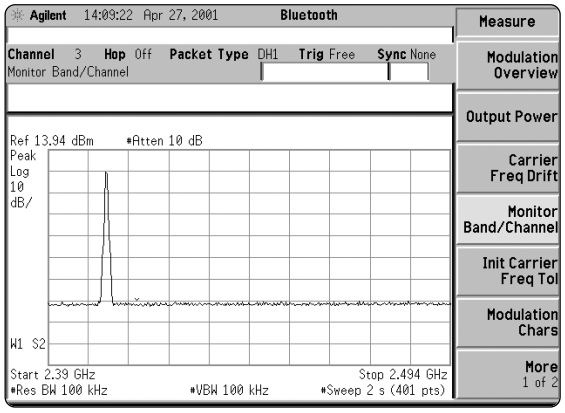


Figure 9. Monitor/band channel measurement under measure menu. The input signal stays at one channel.

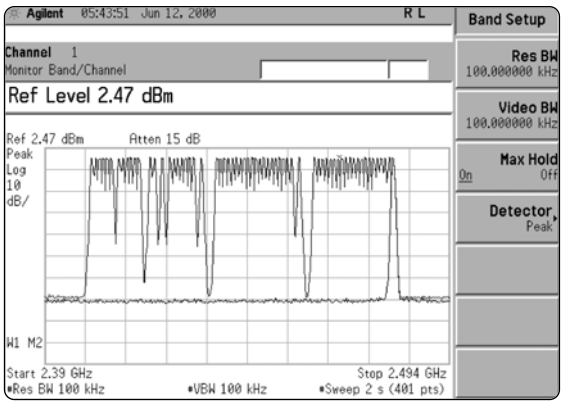


Figure 10. Measurement setup menu for monitor/band channel. The input signal is hopping across *Bluetooth* RF band.

Optional: measurement setup

This will allow you to customize the monitor band/channel measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between exponential or repeat averaging.	Press {Avg Mode}, underlined word indicates active mode.
Switch between the method used to monitor. The options are band or channel.	Press {Method}, the underlined word indicates active mode
Choose between monitoring the current channel by itself (one), or the channel and the channels on either side of it (three).	Channel span is only active when Method = Channel. Press {Channel Span}, underlined word indicates active mode.
View additional measurement options.	Press {More 1 of 2}
Go to channel setup menu. We can adjust the value of the resolution and video bandwidth. Max hold sets trace to hold maximum value over successive sweeps. Detector sets the detector mode. Peak detection is used primarily when measuring signals out of the noise floor. Sample detection is used primarily to display noise or noise-like signals.Negative peak detection functions the same as peak detection, but selects the minimum video signal.	*Channel Setup is only active when Method = Channel. Press {Chan Setup}, then you may do any of the following: Press {Res BW}, enter number, then press {kHz} OR Press {Video BW}, enter number, then press {kHz} OR Press {Max Hold}, underlined word indicates active mode OR Press {Detector}, then choose from {Peak}, {Sample} or {Neg Peak}
Go to band setup menu. Refer to channel setup (above) for measurement details.	*Band Setup is only active when Method =Band. Press {Band Setup}, then you may do any of the following: Refer to Channel Setup (above) for keystrokes.
Go to trace setup. Trace 1 sets to clear write, giving an instantaneous reading of what is happening in the band. Trace 2 sets to max hold, allowing us to see if the entire band is in use as the signal hops channels. Clear write sets trace to overwrite with new data on every sweep. Max/min hold holds the highest/minimum value recorded over all following sweeps. View enables the user to view a trace. Blank enables user to blank a trace. We can also perform Operations such as: 1 <-> 2 exchanges the contents of the trace 1 with 2 and puts 1 in view mode. 2-DL -> 2 subtracts the display line from 2 and places result in 2. 2 <-> 3 exchanges the contents of 2 with 3 and puts 2 in view mode. 1 -> 3 copies 1 into 3. 2 -> 3 copies 2 into 3. We can normalize trace data with respect to the normalized reference level. Norm ref lvl sets the normalized reference level. Norm ref posn offsets the displayed trace without affecting the instrument gain or attenuation settings.	Press {Trace}, then you may do any of the following: Press {Trace 1 2 3}, underlined number indicates trace number OR Press {Clear Write} OR Press {Max Hold} OR Press {Min Hold} OR Press {View} OR Press {Blank} Press {More 1 of 2}, then you may: Press {Operations}, then choose either {1 <-> 2}, {2-DL -> 2}, {2 <-> 3}, {1-> 3} or {2 -> 3}. OR Press {Normalize}, then you may: Press {Store Ref} OR Press {Normalize}, active if "On" is underlined Press OR Press {Norm Ref Lvl}, then enter number OR {Norm Ref Posn}, enter a number, then press {Enter}
Set predefined default values for the above measurement parameters.	-Press {Restore Meas Defaults}
Go back to a previous menu.	Continue to press [Return] until you reach the desired menu

Measurement 6: Modulation Overview

Modulation overview:

This measurement provides a quick snapshot of the overall modulation behavior of a *Bluetooth* packet. While not as accurate as the other measurements, which are, performed to the *Bluetooth* specifications, it is a useful tool to quickly gage the effects of real time adjustments made to a design. The first 8 bits of the payload are also displayed which is useful for identifying the different types of test signals (since they usually contain 8 bit repeating patterns).

We can verify if the measurements meet the *Bluetooth* specification by running the individual measurements. It will then show whether the results have passed or failed. This method provides results more quickly without having to change signal types (as in modulation characteristics) and is also convenient for making adjustments in real-time.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure]
View modulation of signal.	Press {Modulation Overview}

Optional: measurement setup

This will allow you to customize the modulation overview measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between Exponential or Repeat averaging. active mode	Press {Avg Mode}, underlined word indicates
Offset the trace displayed on the screen.	Press {View Offset}. Then you may: - enter number, then press unit (soft key). OR - adjust the number by turning the knob.
Select trigger source for the measurement.	Press {Trig Source}, then choose from
Default is RF burst (wideband).	{Free Run (Immediate)}, { External} or {RF Burst (Wideband)}
Select how measurement will synchronize with the correct part of the burst. Preamble mode uses p0 to define start.	Press {Burst Sync}, then choose from {Preamble} or {None}
View additional measurement options.	Press {More 1 of 2}
Set 1.3 MHz post detection filter on or off.	Press {1.3 MHz Filter} to toggle the filter on or off.
Turn on FM demodulation.	Press {FM Demod}, active if "On" is underlined.
Go back to a previous menu	Continue to press [Return] until you reach desired menu

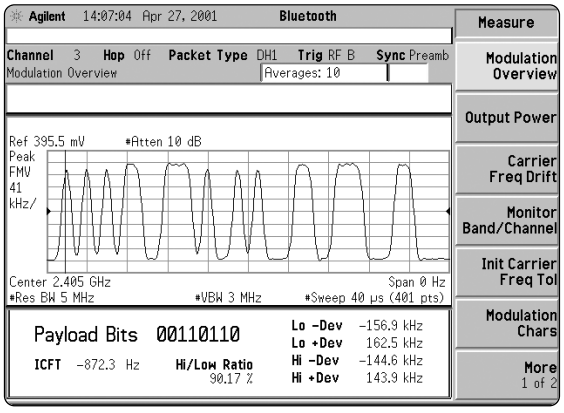


Figure 11. Modulation overview measurement is under measure menu.

Measurement 7: Tx Output Spectrum - 20 dB Bandwidth

Tx output spectrum - 20 dB bandwidth (new enhancement)

The *Bluetooth* RF Test Specification defines a 1 MHz channel spacing for *Bluetooth* signals. This measurement verifies that the power emissions at the main transmit channel are dwelling within the bandwidth.

The Test Specification also requires the input signals be DH1 packets with PRBS9 (Pseudo-Random Bit Sequence of 29-1) as payload. Therefore, make sure that the ESG-D Series signal generator is properly set so that its output *Bluetooth* RF signal is with a continuous PN9 sequence as the data payload. (Refer to the instructions for *Bluetooth* setup on page 5 of this product note.)

By finding the lowest frequency below and the highest frequency above the operating frequency at which transmit power drops 20 dB below its peak value, the measurement determines the 20 dB bandwidth.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure], then {More 1 of 2}
View modulation of signal.	Press {Output Spectrum BW}

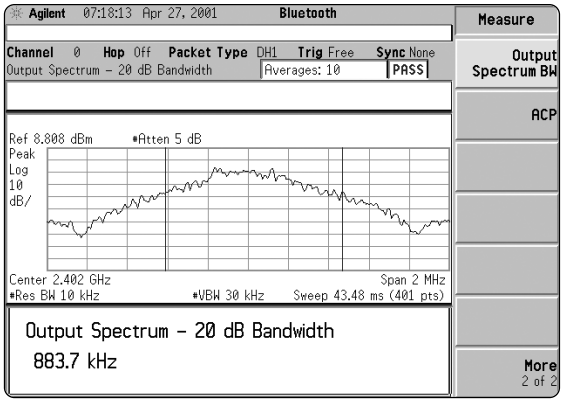


Figure 12. 20 dB bandwidth measurement is under measure menu (output spectrum BW).

Optional: measurement setup

This will allow you to customize the output spectrum bandwidth measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Turn averaging on and off. When on, you can set the number of averages performed.	Press {Avg Number}, averaging is on when "On" is underlined on display. Then you may: - enter number, then press {Enter}. OR - adjust the number by turning the knob.
Switch between Exponential or Repeat averaging.	Press {Avg Mode}, underlined word indicates active mode
Customize the criterion determining the output bandwidth.	Press {X dB}. Then you may: - enter number, then press {-dB}or {dB}. OR - adjust the number by turning the knob.
Customize bandwidth limits.	Under "Meas Setup" menu, press {More 1 of 2}, {Limits}, {Upper Limit}. Then you may: - enter number, then press {GHz} or {MHz} or {kHz} or {Hz}. OR - adjust the number by turning the knob.
Go back to a previous menu	Continue to press [Return] until you reach desired menu

Measurement 8: Adjacent Channel Power (ACP) Measurement

Adjacent channel power (ACP) measurement (new enhancement)

This measurement checks the spectral purity of a *Bluetooth* signal over the entire specified *Bluetooth* RF band (2.402 GHz - 2.480 GHz). It measures the absolute average emission power levels (in dBm) at all channels within the *Bluetooth* RF band except for the main transmit channel and its immediately adjacent channels.

The *Bluetooth* Test Specification requires the input signals be DH1 packets with PRBS9 as payload. Therefore, make sure that the ESG-D Series signal generator is properly set so that its output *Bluetooth* RF signal is with a continuous PN9 sequence as the data payload. (Refer to the instructions for *Bluetooth* setup on page 5 of this product note.)

If the average power levels are no greater than -20 dBm at the second upper and lower channels and no greater than -40 dBm at all other channels, the measurement will flag "PASS" at the upper right window.

ESA-E Series spectrum analyzer

Instructions	Keystrokes
Go to menu of measurements.	Press [Measure], then {More 1 of 2}
View modulation of signal.	Press {ACP}

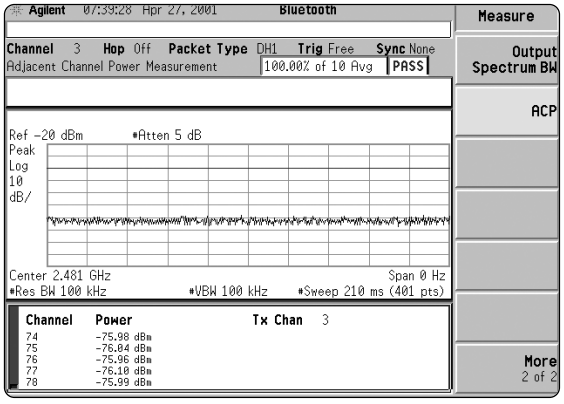


Figure 13. ACP measurement is under measure menu.

Optional: measurement setup

This setup allows you to customize the ACP measurement.

ESA-E Series spectrum analyzer

Go to measurement setup menu.	Press [Meas Setup]. Listed below are the various options. Press [Return] after each measurement to return to this menu.
Customize the test limits for absolute channel power, voltage or other energy levels.	Press {More 1 of 2}, then {Limits}, {Far Limit} or {Near Limit}. Then you may: - enter number, then press a proper softkey for unit (such as dBm, Watts, dBmV, or Gauss...) OR - adjust the number by turning the knob.
View the ACP measurements at time domain (Figure 13) or frequency domain (Figure 14).	Press [View/Trace], then {RF Envelope} for time domain display. OR Press [View/Trace], then {Spectrum} for frequency domain display.
View the numeric results of ACP measurement for all the channels.	Press [Next Window] so that the window for a numeric summary table is highlighted; then press [Meas Setup], {Table Index (Channel)}. Then you may: -enter the number, then press {Enter} to get the measurement result for the specified channel. OR - adjust the number by turning the knob.
View more channels simultaneously (Figure 15).	Press [Zoom] so that you can view readings for 21 channels altogether each time. Then press [Meas Setup], {Table Index (Channel)}. Then you may: - enter number, then press {Enter} OR - adjust the number by turning the knob.
Go back to a previous menu	Continue to press [Return] until you reach desired menu

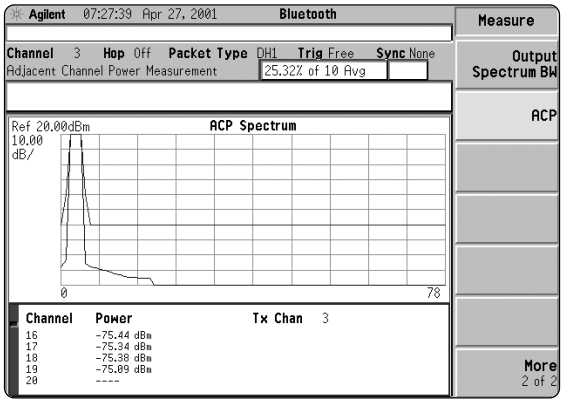


Figure 14. ACP measurement with spectrum display.

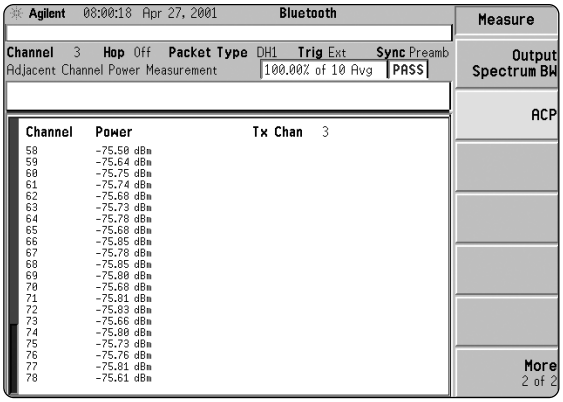


Figure 15. Zoom in on the numeric summary table for the ACP measurement. Notice a scroll bar at the left of the display window. Users can scroll up or down to view the channels of interest by pressing [⇑] or [⇓] hardkeys or by turning the knob.

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