SG1000B Signal Generator

User's Manual

High Powered 1kHz to
10GHz Synthesized
Signal Generator

310-010111-004

PRAXSYM
DISTINCTIVE SOLUTIONS

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1.0 System Description

The SG1000B Signal Generator and PR1000A Preamplifier have been designed to simplify the measurement of shielding integrity of an RF shielded enclosure. When coupled with a high stability spectrum analyzer and an appropriate selection of test antennas, the SG1000B/PR1000A combination can measure shielding effectiveness at all of the NSA 94-106 (supersedes NSA 65-6) defined test frequencies from 1 kHz to 10 GHz.

1.1 SG1000B Signal Generator

The high stability of the SG1000B signal generator is sufficient to allow all measurements to be made with a companion spectrum analyzer operating at an IF resolution bandwidth as low as 10 Hz at 10 GHz. The narrow bandwidth coupled with a 3.5 dB preamplifier noise figure and the high signal generator output power, is sufficient to achieve measurement dynamic ranges of 160 dB or more.

The SG1000B generates output signals as outlined in DOD specification NSA 94-106. These frequencies include 1 kHz, 10 kHz, 100 kHz, 1 MHz, 10 MHz, 100 MHz, 400 MHz, 1 GHz and 10 GHz. Each frequency except 10 GHz can be varied up to +/- 5 percent in order to avoid interfering signals. The 10 GHz frequency can be varied up to +/- 2 percent.

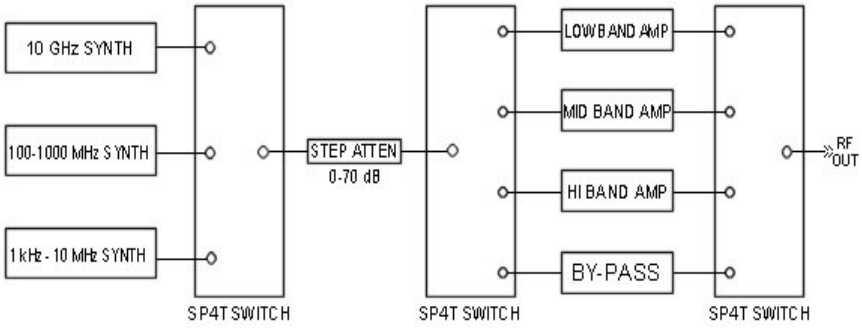


Figure 1 - Conceptual Block Diagram

The heart of the SG1000B consists of three synthesizers, one covering the 1kHz through 10 MHz, the second generating 100 MHz through 1 GHz, and the third generating 10 GHz. One of these three synthesizer outputs is switched to the 70dB step attenuator to generate the 9 target frequency bands. Output levels can be adjusted in 10 dB steps over a 110 dB range by either routing the signal to the appropriate nominal 30dB gain linear power amplifier or to the nominal 10dB attenuator by-pass. The output frequency, attenuator and amplitude settings are displayed via the front panel LCD.

Nominal output power levels are 10 watts from 1 kHz to 10 MHz, 1 watt from 100 MHz to 1 GHz, and 1 watt at 10GHz. To ensure operator safety during measurement setup periods, a front panel switch will disable the power amplifiers without turning off the synthesizer. The power amplifiers should be disabled whenever disconnecting the antenna or cables from the RF output connector.

The signal generator can be configured for bench top or rack mount operation. Power requirement is 230 watts at 110/220 VAC.

1.2 PR1000A Preamplifier

Praxsym recommends the use of a low noise preamplifier to achieve proper noise figure values during testing. The PR1000A amplifies the received signal from the test antenna and masks the high noise figure of the companion test receiver or spectrum analyzer. The PR1000A, when used with an Agilent 8562E spectrum analyzer (or equivalent) will ensure that the system noise figure will be less than 4.5 dB at all test frequencies from 1 kHz to 10 GHz. When used with a spectrum analyzer measurement bandwidth of 100 Hz, the system exhibits a sensitivity of –150 dBm at the test antenna output.

At frequencies from 1 kHz to 1 GHz, the test antenna is connected to the low band preamplifier. The preamp output is switched by an SPDT electro-mechanical coaxial switch to the test receiver.

To overcome high cable loss between the test antenna and the PR1000A assembly at 10 GHz, a remote low noise pre-amplifier (Praxsym PN 310-010091-001) is mounted directly onto the 10 GHz antenna.

A bias tee inside the PR1000A chassis powers the remote preamp through the coax cable interconnecting the PR1000A and the 10 GHz test antenna. Additional gain at 10 GHz is provided by a second pre-amplifier in the PR1000A chassis. The 10 GHz amplified signal is routed to the test receiver through the SPDT coaxial switch. Using this configuration, the PR1000A can be interfaced to the 10 GHz test antenna with cables having insertion loss as high as 20 dB without significantly degrading the overall system sensitivity.

The PR1000A is housed in a 19″ wide x 1.75″ high x 10″ deep chassis. The unit can be configured for bench top or rack mount operation. Its power requirement is 15 watts at 110/220 VAC.

1.3 System Noise Figure

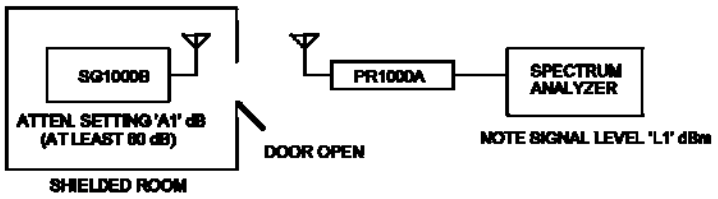
Several factors need to be considered when calculating the system noise figure of the receiver. The noise figure of a spectrum analyzer is the difference (in dB) between the theoretical value of noise power density in a 1 Hz bandwidth given by KTB (Boltzman's constant, temperature in degrees Kelvin, and bandwidth) which is –174 dBm/Hz at room temperature and the spectrum analyzer's displayed average noise level normalized to 1 Hz. For example if the spectrum analyzer has a specified noise level of –145 dBm in a 1 Hz bandwidth at a specified frequency, the difference between this and –174 dBm/Hz is 29 dB and is the noise figure of the spectrum analyzer at that frequency. The displayed average noise level specification requires that the input RF attenuator be set to 0 dB. Every dB that the input attenuator setting is increased from a setting of zero will add as many dB to the noise figure of the spectrum analyzer calculated above.

To achieve a 4.5 dB system noise figure at 10 GHz using a spectrum analyzer with a noise figure of 29 dB, the external LNA provides 26 dB of gain with a noise figure of less than 2.5 dB, followed by a transmission line with up to 20 dB of loss, followed by the PR1000A with 24 dB of gain with a noise figure of 3.5 dB.

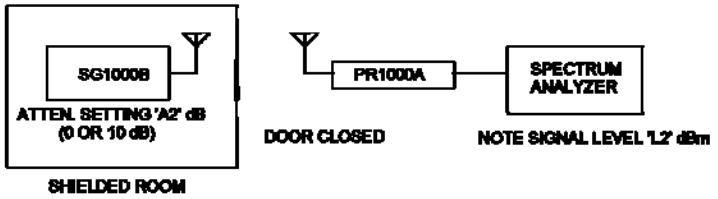
1.4 Shield Measurement Techniques

A typical test setup is shown in Figure 2. The shielding effectiveness measurement is made with RF substitution techniques.

CALIBRATION SETUP



MEASUREMENT SETUP



SHIELDING LEVEL = ((A1 - A2) + (L1 - L2)) dB

The SG1000B is installed inside the enclosure with the appropriate antenna. The PR1000A, spectrum analyzer, and receive antenna are located outside the enclosure. An initial measurement is made with the enclosure door in an open position. The transmit and receive antennas must be separated by the prescribed distance. The SG1000B attenuator is set to "A1" (at least 60 dB of attenuation), and a reference signal level, "L1", is measured on the spectrum analyzer and recorded.

With the door closed and the SG1000B attenuator set to "A2" (0 or 10 dB of attenuation), a new signal level, "L2", is measured on the spectrum analyzer. The addition of the change in the SG1000B attenuator setting (A1-A2) and the spectrum analyzer signal level (L1-L2) yields the shielding level offered by the enclosure between the two antennas. The antennas can then be relocated to check the shielding level at different locations in the enclosure.

2.0 Operating the SG1000B

Plug the SG1000B into 110/220 VAC 50/60 Hz power source. The instrument contains a universal power supply that automatically adjusts to any power source in this range.

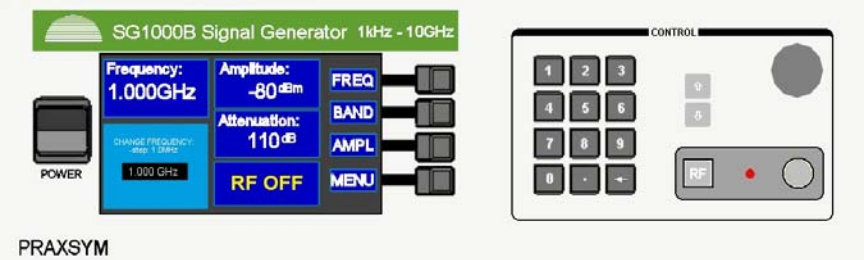


Figure 3—Front Panel

2.1 Power-On State

Toggle the power switch. The embedded light will illuminate. The Output Frequency readout will display '1.000 GHz,' the power-on default band. The Attenuation readout will show '110 dB', maximum attenuation. The RF output LED is not lit, indicating that the power amp is not powered.

Default Power-On Settings
Frequency 1.000 GHz
Amplitude -80 dBm
Attenuation 110 dB
RF Output OFF

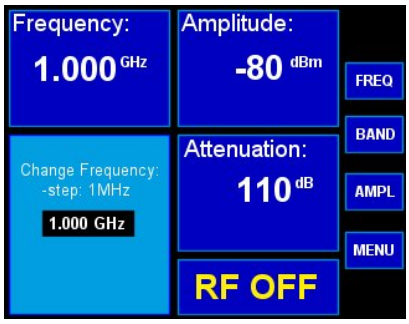


Figure 4—Power On State

Warm Up Period - The SG1000B contains an oven controlled crystal oscillator (OCXO) that is used as a reference for the synthesizer circuits. Once the generator is powered on, the user should wait five minutes to insure that the oven has stabilized. Once stabilized, the output frequency of the SG1000B will normally drift less than +/-0.2 ppm across the temperature range.

2.2 Menu structure & Control

Four menu selections may be made to adjust operating characteristics of the SG1000B. These are displayed vertically on the display as such:

FREQ – Frequency Fine-Tuning
BAND – Band Selection
AMPL – Power Output
MENU—Menu screen
By pressing the corresponding button, changes may be made to each setting.

Figure 5—On Screen Menu

Frequency, Amplitude and Attenuation are adjustable through the use of two control sets, either numerical entry or arrow keys/vernier control. When one control set is in use, the other is locked. An entry made with one control set must be completed before use of the other is available. A new band is selected using only the arrow keys/vernier control.

2.3 Frequency Fine-Tuning

Select FREQ from the on screen menu. 'Change Frequency' and the current frequency state are displayed in the active window. Arrow keys or the 'Vernier' knob adjust the frequency when tuning in the same band. A numeric entry may be made for any band by simply beginning a selection with the keypad. The on screen menu changes to kHz, MHz, GHz and Cancel. Entering the new frequency's suffix completes the command.

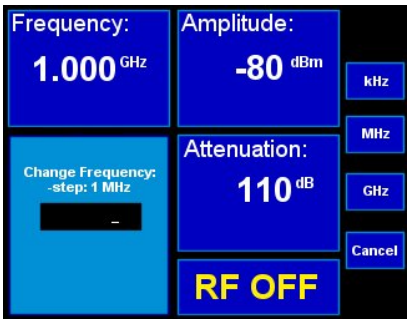


Figure 6—Change Frequency

Adjustment range & step sizes

Frequency Band	Adjustment Range	Step Size
1 kHz	.95 to 1.05 kHz (+/-5%)	1 Hz
10 kHz	9.5 to 10.5 kHz (+/-5%)	10 Hz
100 kHz	95 to 105 kHz (+/-5%)	100 Hz
1 MHz	.95 to 1.05 MHz (+/-5%)	1 kHz
10 MHz	9.5 to 10.5 MHz (+/-5%)	10 kHz
100 MHz	95 to 105 MHz (+/-5%)	100 kHz
400 MHz	380 to 420 MHz (+/-5%)	100 kHz
1 GHz	.95 to 1.05 GHz (+/-5%)	1 MHz
10 GHz	9.8 to 10.2 GHz (+/-2%)	1 MHz

2.4 Switching Bands

Select BAND from the on-screen menu. Use either the vertical arrow pushbuttons or vernier knob to move from band to band. A rectangular border denotes the selected band. The last selected target frequency in each band will be stored and recalled when that band is selected. At power-on the target frequency for each band defaults to the band -center frequency. Each changing of the band will cause the RF output to be disabled.

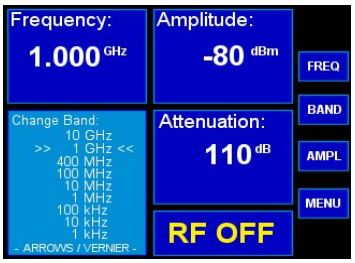


Figure 7—Change Band

2.5 Adjusting the Output Power

The output power level may be changed by adjusting either the amplitude or attenuation level. Changing either setting will result in adjustment of the other, by definition. To adjust the amplitude or attenuation, press 'AMPL' or 'ATTN'. These two settings may be adjusted by using the vertical arrows, vernier control or numerical keypad. When making a new amplitude entry via the numerical keypad, the on-screen menu changes to –dBm, +dBm and Cancel. When numerically entering an attenuation value, press dB to complete the entry or Cancel to abort. Entry of an unacceptable value in either case will return 'Entry Error'.

The attenuation or amplitude may also be adjusted by using the vernier knob or vertical arrow keys. The output signal may be attenuated up to 110 dB from the rated output of each power amplifier. Attenuation levels are available in 10 dB steps.

Maximum output & allowable attenuation range

Frequency Band	Maximum Power Output	Attenuation Range
1 kHz	10 W	0 to 110 dB
10 kHz	10 W	0 to 110 dB
100 kHz	10 W	0 to 110 dB
1 MHz	10 W	0 to 110 dB
10 MHz	10 W	0 to 110 dB
100 MHz	1 W	0 to 110 dB
400 MHz	1 W	0 to 110 dB
1 GHz	1 W	0 to 110 dB
10 GHz	1 W	0 to 110 dB

When switching bands, the attenuation setting will not change. For example, when switching from the 100 kHz band to the 10 kHz band, an attenuation level set at 100 dB will remain at 100 dB. When operating at attenuation levels greater than 70dB, the power amplifiers are disabled, and the signals are routed through the by-pass channel as shown in Figure 1. The RF output LED will remain lit to indicate to the operator that a valid RF signal is being applied to the OUTPUT connector.

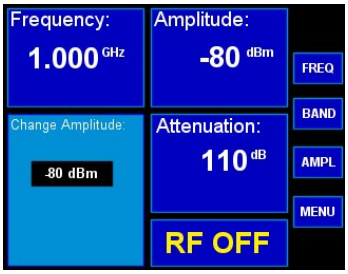


Figure 8—Change Amplitude

Figure 9—Change Amplitude on-screen menu

2.6 Enabling RF Output

Press the 'RF' button to enable the RF output for the band selected. Depending on the selected ATTENUATION, signal levels as high as 10 watts are directed to the OUTPUT connector.

A load must always be connected to the OUTPUT connector when the power amplifiers are enabled. Any change of band will cause the output to be disabled, requiring it to be manually enabled again.

When the 'RF' button is pressed, the RF output will immediately appear on the connector. The LED is lit during this time. Depressing the 'RF' button will immediately shut off the signal, extinguishing the LED.

2.7 Menu Options

Press the MENU button to access the on-screen menu options.

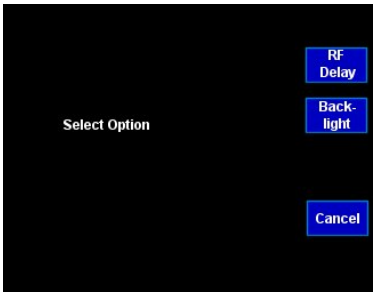


Figure 10—On-screen Menu

2.8 Display Backlight

Use the UP/DOWN arrows on the keypad to adjust the backlight level. Press OK when finished.

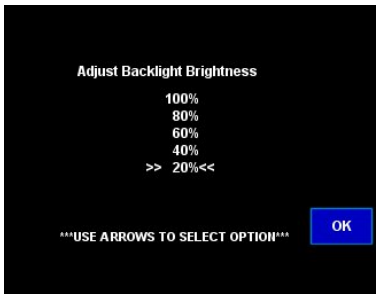


Figure 11-Backlight Options

2.9 Output Enable with Two Minute Delay

The SG1000B is capable of transmitting signals at levels which violate regulatory agencies' licensing policies. Thus, the SG1000B is equipped with the capability to delay engaging the output until the transmit location is securely shielded for test. Select the Menu option from the main screen. Two Minute RF Output Delay mode may be turned On or Off from this window. If the Two Minute RF Output Delay is turned on, the Output will be initiated accordingly when the 'RF' button is pressed. The LED assumes a slower blink rate in this mode. If the 'RF' button is depressed again during this two-minute period, the request for Output will immediately be terminated. Once the OUTPUT has been enabled via the 'two minute delay' mode, the output will remain on for ten minutes and will then be automatically disabled.

Figure 12—Two minute delay option menu

Note: All user inputs except the 'RF' button are disabled for the entirety of two minute mode, should it be activated.

2.10 Disabling RF Output

The RF output may be manually disabled at any time using the 'RF' button. Changing bands also disables the output automatically. The output will remain enabled during all other adjustments.

3.0 SG1000B Functions

3.1 Calibration and Remote Operation

The SG1000B has been calibrated at the factory to meet the specifications detailed in Section 4.0. A DB9 connector located on the instrument's rear panel allows a PC host or other equipment to communicate via RS232 with the embedded microcontroller for this purpose. This facility is documented in Praxsym document 010039ICD and is reserved for factory test and calibration.

3.2 Error Messages

UNLOCKED The synthesizer has come unlocked. The RF output for the frequencies generated by the unlocked synthesizer is disabled during this condition. Please contact Praxsym for service.

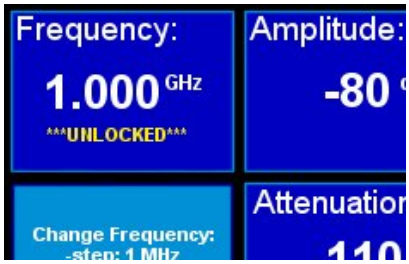


Figure 13—Synthesizer Unlocked

ENTRY ERROR A numeric entry has been made which is not within the operating parameters. An acceptable value may be entered from this screen. Pressing Cancel will return to the previous screen.

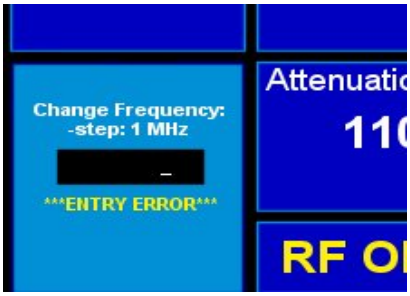


Figure 14—Entry Error

3.3 Proper Care and Use

The SG1000B normally operates in a dry environment. The SG1000B must be protected from sources of moisture. Adequate ventilation is imperative for proper function.

Regulations concerning unlicensed emissions must be observed.

4.0 Specifications

Attenuator Accuracy:	+/- 1.2 dB
Harmonic Spurious:	< - 20 dBc
Non-Harmonic Spurious:	< - 40 dBc
Phase Noise:	-90 dBc/Hz at 10kHz offset (1 GHz band) typical -115 dBc/Hz at 500 kHz (1GHz band) typical
Front Panel Fault Display:	Synthesizer unlock
Power Amplifier Disable:	Dedicated Front panel button
Power Output Adjustability:	10dB steps
Operating Temperature:	0 to + 40 degrees Centigrade
Operating Humidity:	95% relative humidity, non-condensing
Power Supply:	110/220 VAC (auto-adjusting), 48–63 Hz, 230 watts
Size:	19″ x 5.25″ x 20″ (Width x Height x Depth)
Weight:	33 pounds nominal
Enclosure:	3U Rackmount
RF Connector:	N-Type
Display:	5.7″ QVGA Color
Menu Option Control:	Four Pushbuttons
Keypad:	4x4 numeric
Rotary Vernier Control	

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