

## INSTRUCTION MANUAL

*For the*  
**Comb Generators**  
**CGO Series**  
**Models CGO- 520**  
20 MHz step



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## Introduction

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This manual provides on how maintain and use the Comb Generator.

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### *Product Specifications*

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<b>Frequency step size:</b>	20 MHz
<b>Number of antennas included:</b>	Two
Antenna 1 Freq. range / height:	20 – 580 MHz / (12 inches / 30.4 cm)
Antenna 2 Freq. range / height:	580 to 4500 MHz / (2 inches / 5 cm)
<b>Output Variation:</b>	< ± 1 dB (at the antenna input)*
<b>Usable Frequency radiated:</b>	20 MHz - 4.5 GHz
<b>Internal Battery Type:</b>	6 V Rechargeable NimH
<b>Battery charger adapter specifications:</b>	
- Input:	115 / 230 VAC, 60 / 50 Hz
- Output:	6 VDC @ 500 mA (unregulated)
- Plug type:	2.5 ID x 5.5 OD mm (center pin positive)
<b>Output connector type:</b>	SMA (f)
<b>Operating temperature Range:</b>	5°C to 40°C
<b>Weight:</b>	2 lb. (max.)
<b>Circular base dimensions (W x H) :</b>	7 x 0.75 inches / 17.7 x 1.9 cm
<b>Weight (lb / kg):</b>	2 lb / 0.9 kg

\*This is conducted output variation with Comb Generator connected directly to EMI receiver or spectrum analyzer.

#### **Other Comb Generator models available from Com-Power**

- CGO-501      Comb Generator, 1 MHz step
- CGO-505      Comb Generator, 5 MHz step
- CGO-5100B    Comb Generator, 100 MHz step
- CGO-51000    Comb Generator, 1 GHz step
- CGC-510E      Conducted Comb Generator, 100 / 500 KHz step
- CGC-255E      Conducted Comb Generator, 50 / 250 kHz step

## Important precautions and Maintenance

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### Precautions:

A Comb Generator is an intentional radiator designed to produce signals over a wide frequency range. It was designed for use in EMI test laboratory to verify operation of EMI emissions test equipment. These radiated signals may cause unwanted radio frequency interference to other equipment operating in the vicinity. If you detect any interference, increase the separation between the Comb Generator and the other equipment.

### Maintenance:

There are no user serviceable parts inside the unit. User modifications to the Comb Generator will void warranty. The Comb Generator uses re-chargeable NiMH batteries. Call the factory if the battery needs replacement. Send the Comb Generator to an authorized Com-Power service center if it needs repair. Please visit our website at [www.com-power.com](http://www.com-power.com) to request a return merchandise authorization number (RMA) before you send the unit in for service.

### Battery care and instructions

#### To avoid any risk of explosion

- Replace batteries with the size and type specified in this manual.
- Do not dispose of batteries in a fire or trash incinerator, or leave batteries under direct sunlight.
- Do not immerse batteries in water or otherwise get them wet.
- Do not charge batteries that appear to be leaking, discolored, rusty, deformed; emit an odor.
- Use only the battery charger adapter supplied with the Comb Generator to charge the batteries.

### Environmental Conditions

This equipment is designed for indoor and outdoor use and is safe under the following environmental conditions:

- Temperature: 5° C to 40° C
- Maximum relative humidity: 80%

## Warranty

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Com-Power warrants to its Customers that the products it manufactures will be free from defects in materials and workmanship for a **period of 3 years**. This warranty shall not apply to:

- a) Transport damages during shipment from your plant.
- b) Damages due to poor packaging.
- c) Product operated outside their specification.
- d) Improperly maintained or modified.
- e) Consumable items, fuses, power cords, cables, etc.
- f) Normal wear
- g) Calibration
- h) Product is shipped outside the United States without the prior knowledge of Com-Power.

In addition, Com-Power shall not be obliged to provide service under this warranty to repair damage resulting from attempts to install, repair, service or modify the instrument by personnel other than Com-Power service representative.

Under no circumstances does Com-Power recognize or assume liability for any loss, damage or expense arising, either directly or indirectly from the use or handling of this product, or any inability to use this product separately or in combination with other equipment.

When requesting warranty services, it is recommended that the original packaging material be used for shipping. Damage due to improper packaging will void warranty.

In the case of a complaint, a label should be attached to the housing of the instrument which describes briefly the faults observed. If at the same time the name and telephone number (dialing code and telephone or direct number or department designation) is stated for possible queries, this helps towards speeding up the processing of warranty claims. In order to obtain service under this warranty, Customers must contact the Com-Power.

## Product Description

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### Overview

The CGO series Comb Generators are reference signal sources. They were designed for EMC laboratories use. It is ideal for quickly detecting malfunctioning equipment in the radiated emissions test setup in between full calibration intervals. These malfunctions may go undetected, unless it they are checked often. Full site calibration although more accurate is time consuming is not practical for a quick test. By comparing Comb Generator data taken at regularly, the EMI lab can ensure that all the test equipment and accessories are operating within the expected range. If any abnormality is detected, it can be quickly investigated and rectified before it causes measurement errors.

The Comb Generators can also used for comparing two or more sites with similar setup. They can also be utilized as conducted signal source for testing Line Impedance Stabilization Network (LISN), filters and cables.

### Items included with Comb Generators

Equipment, accessories, and documents supplied with CGO-520 Comb Generators are as follows:

- User's guide
- Custom wooden storage box
- Battery Charger adapter
- Two antennas
- Test data (optional reference data at extra cost)

## Controls and indicators

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### Power on Switch

This is located on the side of the Comb Generator. It not only powers unit on or off, it also enables or disables the signal output.

### Output connector

The comb generator output is available at the SMA (f) connector located on the top of the unit. This output can be used for radiated or conducted emissions testing. For radiated measurements, the monopole antenna is attached to this connector. There are two antennas with SMA male connectors provided to cover the Comb Generator radiated frequency range. Please refer to page 3 to determine the approximate frequency range of each antenna. The antenna can be disconnected for conducted emissions measurements. **Do not connect the Comb Generator conducted output to a Line Impedance Stabilization Network (LISN) that is connected to AC power. We also do not recommend connecting the Comb Generator conducted output directly to a preamplifier input.**

### Power On indicator

The green power on LED is lit, the Comb Generator is powered on and output is available for measurement.

### Battery Low indicator

When red battery Low LED is lit, the internal battery needs recharging. The output may not be reliable. Turn off Comb Generator and charge the battery with the supplied adapter. The approximate time to fully charge the battery is 8 hours. The Comb Generator can operate approximately 18 hours when fully charged. Please note however, that the operating time given in this manual is approximate and depends on the condition of battery, storage period and the number times it has been charged and discharged. If the operating time keeps decreasing, you may need to replace the battery.

## Theory

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The Comb Generator uses an impulse to generate its step frequency output. It uses a stable power supply and signal shaping circuit to obtain relatively stable signal output with frequency components extending beyond 1 GHz.

The Comb Generator operates on battery power. The battery output is controlled by a voltage the regulator circuit to provide stable power output to the signal generating circuit. The signal generating circuit consists of a clock generator, impulse generator, wave shaping circuit and output matching. The signal frequency is generated by a crystal oscillator.

An impulse in time domain corresponds to a flat output across the entire frequency spectrum in frequency domain. An ideal impulse, by definition is an infinite magnitude pulse with zero rise and fall time with zero duration. Such a pulse is not practical; however, the Model CGO-520 Comb Generators use this principle to get an output across a wide band. The highly stable frequency output from the oscillator is used to generate an impulse with very short duration and sharp rise and fall times. The shaping circuit was designed for improved stability, extended frequency response, and output impedance matching to 50 ohms.

The radiated reference signal is transmitted by the antennas affixed on top of the unit. An electrically short monopole antenna is an antenna that is short compared to the wavelength of the frequency it radiates. Such an antenna generates a radiated field proportional to its length. The radiated field, therefore, compensates for decreasing signal up to a frequency, where the antenna cannot be called electrically short. This theory describes the general behavior of the field, but each Comb Generator may behave slightly different than the other due to circuit variation. Since the Comb Generators were designed to provide a reference reading at a given frequency, this limitation is not a problem.



# Application

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## Radiated Emissions

EMI test sites such as Open Area Test Site (OATS) or Anechoic chambers are constructed with specific requirements and are calibrated in a precise manner to optimize the reliability of the emissions measurements. The time and expense incurred is considered essential to increase the repeatability of the data.

The data taken on the above sites are generally reliable. However, in some instances, discrepancies do occur, and the reliability of data is questionable. Such discrepancies could be discovered when either (a) data from two sites for the same equipment do not match, or (b) the data from two different occasions for the same equipment at the same OATS are not consistent. It is important to find the cause for such inconsistency. This is generally a very time consuming and difficult process because the reason could be one of four complex factors.

- (1) Equipment under test (EUT),
- (2) The Test Site
- (3) Instrumentation
- (4) Test personnel.

Each of these factors may have many possible causes. The EUT, for example, may have changed due to component variation, temperature, operating mode, wear and tear, design etc. The test site may be a cause due to a reflective object near the site, variation of ground saturation or ambient signal presence. It also could be due to malfunctioning test instrumentation.

By establishing simple measurement procedure similar to the one described below the test lab can reduce occurrence of these problems. There by increasing the reliability of measurements taken on the site. The procedure described is just a guide and can varied according to your needs.

## Measurement Procedure

As mentioned before, taking measurement more frequently is important. Create a log with frequency and levels that you would like to record. This can be daily, weekly or monthly log. We recommend taking Comb Generator measurement before to starting a radiated emissions test. Set up the Comb Generator with the appropriate antenna (see frequency range on page 3). Put the Comb Generator where the equipment under test (EUT) is normally placed during the test.

Make a measurement like you would on a EUT. We recommend using discrete frequency points rather than a wide frequency sweep. Such as 30 MHz, 40 MHz, 100 Hz, 900 MHz, etc. Record the level for each frequency.

Compare these levels with all subsequent measurements to make sure that the pattern does not have abrupt change from the established daily log at any frequency. The more higher the number of frequency points the higher the accuracy of the reference measurements.

This log is used to detect any test equipment or test site related problem as described below.

### **Problems Related to Test Equipment**

Variation on the log of the Comb Generator output data is dependent on the test equipment as well as site. The Comb Generator replaces the EUT. The Comb Generator not only generates the output simultaneously at all the harmonics, but it minimizes any variation of its output. This is achieved by utilizing a stabilized signal circuit as well as geometry of the radiator. The circuit stability is maximized by design, whereas the geometry of the radiated source is optimized by eliminating all cables during the Radiated Emission Mode. The typical variation of Comb Generator output at any frequency is less than  $\pm 1$  dB.

With the variations due to the EUT practically eliminated, only variations remaining are due to other factors, mainly the test instrumentation and the site. The variation due to test instrumentation is limited to the sum total of the tolerance on all test equipment used (spectrum analyzer, antenna, preamplifier, cables). A few days of data will establish the range of variation to be expected at a site. This is generally less than  $\pm 3$  dB. Any variation in the readings above normal variation indicates a potential problem.

After the daily log is established for a few days, any problem is easily detected as a larger variation. This procedure allows immediate detection of a major problem with the test equipment.

### **Problems Related to site**

The above procedure cannot distinguish the problems related to the test site. The Comb Generator can be used in two ways to detect any problem with a test site. One method is to start the daily log immediately after the test site is calibrated. This way, one is certain about the validity of the data taken on the test site. The second method is to calibrate the Comb Generator radiated output as absolute emission level. Such calibration is provided as an option with the Comb Generators.

In addition, when difficulty arises with any EUT data taken at two different sites, the Comb Generator can be used to determine if both sites give reliable results, just by comparing the data at the two sites with the Comb Generator. In this case, if the two sites do not produce comparable results, a Comb Generator with calibrated data is certainly required to determine the faulty site.

### **Problems Related to Test Personnel**

The Comb Generator cannot directly help to eliminate the test personnel related problems. However, by increasing the confidence level and establishing definite procedures for eliminating site and equipment related problems it helps tremendously to reduce the problems related to EMI measurements.

## Typical radiated output

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These are Comb Generator radiated output at 3 meter distance with the receiving antenna height varied from 1 to 4 meters taken in an open area test site.

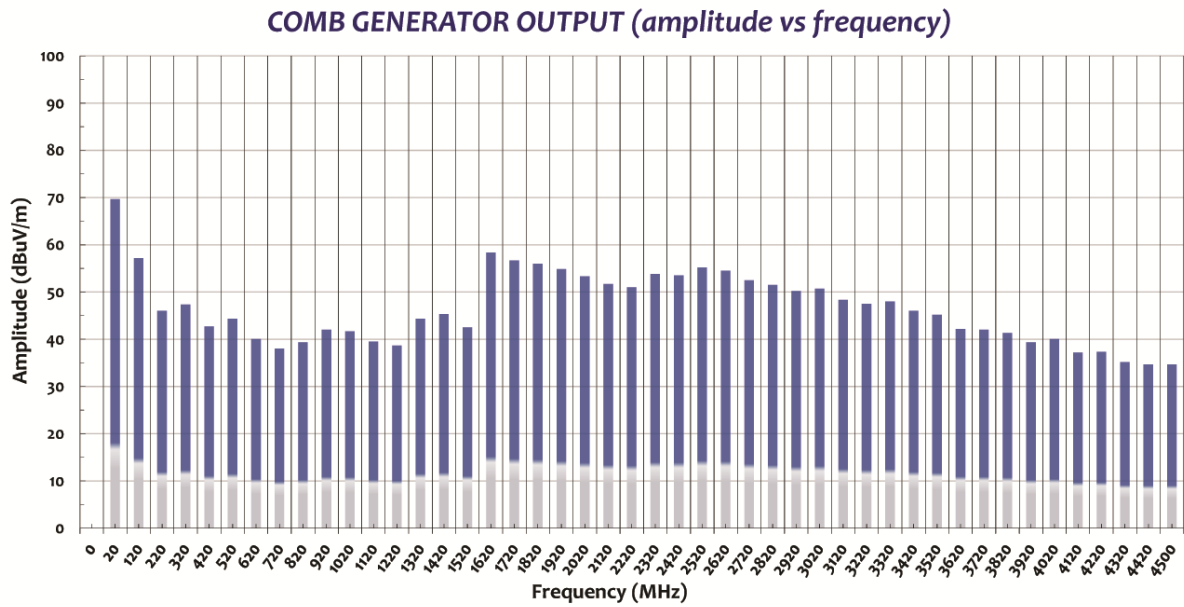


Figure 1: 20 MHz step size