

**INSTRUCTION MANUAL  
for  
CONDUCTED  
COMB GENERATOR**

Model: **CGC-105**  
(10 kHz/50 kHz Step Size)  
**10 kHz to 115 MHz**



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## 1.0 Introduction

This manual includes product specifications, safety precautions, warranty information, guidelines, and usage instructions for the CGC-105.

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## 2.0 Products Available from Com-Power



*Antennas*



*Antenna Kits*



*Absorbing Clamps*



*Coupling/Decoupling Networks (CDN)*



*Comb Generators*



*Current Probes*



*Emissions Test Systems*



*Conducted Immunity Test Systems*



*Impedance Stabilization Networks (ISN)*



*Line Impedance Stabilization Networks (LISN)*



*Antenna Masts*



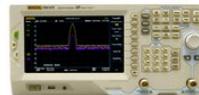
*Near-Field Probe Sets*



*Preamplifiers*



*Power Amplifiers*



*Spectrum Analyzers*



*Product Safety Test Equipment*



*Transient Limiters*



*Turntables*



*Antenna Tripods*



*Telecom Test Systems*

[www.com-power.com](http://www.com-power.com)

SECTION 2 - PRODUCTS AVAILABLE FROM COM-POWER

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Rev. 030326

## 3.0 Product Information

### 3.1 Incoming Inspection

Please check the contents of the shipment against the package inventory in section 3.2 to ensure that you have received all applicable items.

If shipping damage to the product or any accessories is suspected, or if the package contents are incomplete, contact Com-Power or your Com-Power distributor.

### 3.2 Package Inventory

#### *Standard Items:*

- ✓ **CGC-105** Conducted Comb Generator
- ✓ **LISN-PIN-SET** consisting of PP25A, PP50A and PP100A pins
- ✓ **G-PIN** Ground Pin (pre-installed)
- ✓ **CGCA-PIN-GWxx** Ground Wire
- ✓ **CGCA-PIN-NEMA** NEMA 5-15P Adapter
- ✓ **6 VDC, 500 mA Adapter** (Battery Charger)
- ✓ **CASE-CGC-PIN** Storage Case
- ✓ Conducted Output Reference Data

#### *Optional Items:*

- ✓ **CGCA-PIN-COAX** Coaxial Adapter
- ✓ **CGCA-PIN-SFP** Schuko F Plug Adapter

### 3.3 Product Overview

The CGC-series Comb Generators are reference signal sources for verifying conducted emissions measurement systems that incorporate Line Impedance Stabilization Networks (LISNs). They are designed for use in EMC laboratories to quickly detect measurement system problems that may otherwise go undetected. Full-site calibration, although more accurate, is time-consuming and impractical to perform at short intervals.

A Com-Power Conducted Comb Generator can be used to perform daily checks of your measurement setup. After spending just a few minutes performing the site validation test, you'll be able to proceed with your scheduled testing with a high degree of confidence that your lab is in proper working order and your measurements are accurate.

## 3.4 Theory

The conducted Comb Generators use an impulse to generate its step frequency output. Its signal-shaping circuit provides a stable signal output consisting of its fundamental [step-size] frequency and all harmonics thereof up to 115 MHz.

Com-Power Comb Generators operate on battery power. The battery output voltage is regulated by a circuit to provide stable power to the signal-generating circuit. The signal-generating circuit consists of a crystal oscillator, an impulse-wave-shaping circuit, and an impedance-matching circuit.

An ideal impulse in the time domain corresponds to a flat output across the entire frequency spectrum in the frequency domain. An ideal impulse, by definition, is an infinite magnitude pulse with zero rise and fall time and no duration. In practice, such a pulse is impractical; however, Com-Power Comb Generators use this principle to deliver their output across a wide frequency 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 to ensure stability, extend frequency response, and match its output impedance to 50 ohms.

## 3.5 Product Safety Information

### 3.5.1 Product Hazard Symbols Definitions

The hazard symbols appearing on the product exterior are defined below.



The yellow triangle with an exclamation mark indicates the presence of important operating and/or maintenance (servicing) instructions in the literature accompanying the product.



The yellow triangle with a lightning bolt alerts the user that uninsulated, **dangerous voltages** are present within the product enclosure and on output connectors. These voltages may be of sufficient magnitude to constitute a risk of electric shock to people.



The Ground symbol inside a circle indicates a terminal that is intended for connection to an external conductor for protection against electric shock in case of a fault, or the terminal of a protective earth (ground) electrode.



To indicate on the rating plate that the equipment is suitable for AC current. To indicate on the rating plate that the equipment is suitable for direct current.

### 3.5.1 General Safety Instructions

The following safety instructions have been included in compliance with product safety regulations. Please read them carefully.

- **READ AND RETAIN INSTRUCTIONS** - Read all safety and operating instructions before operating the instrument. Retain all instructions for future reference
- **HEED WARNINGS** - Adhere to all warnings on the instrument and operating instructions.
- **FOLLOW INSTRUCTIONS** - Follow all operations and use instructions.
- **WATER AND MOISTURE** - Do not use the instrument near water.
- **HEAT** - The instrument should be situated away from heat.
- **POWER SOURCES** - Connect the instrument only to the type of power source described in the operating instructions.
- **POWER CORD PROTECTION** - Place power supply cords so that they are not likely to be walked on or pinched by items placed on them or against them.
- **CLEANING** - Clean the instrument's outside surfaces of the device with a soft, lint-free cloth. If necessary, a mild detergent may be used.
- **NON-USE PERIODS** - Unplug the power cord of the instrument when it is left unused for an extended period of time.
- **DEFECTS AND ABNORMAL STRESS** - Whenever it is likely that the normal operation has been impaired, make the equipment inoperable and secure it against further operation.
- **ENVIRONMENTAL CONDITIONS** - This equipment is designed for indoor use.
- **STORAGE AND PACKAGING** - The device should only be stored at a temperature between -25 and +70 °C. During extended periods of storage, protect the device from dust accumulation. The original packaging should be used if the device is transported or shipped again. If the original packaging is no longer available, the device should be packed carefully to prevent mechanical damage.

### 3.5 Product Features



Figure 1 – Product Features

- 1 Power Indicator LED**  
When illuminated, it indicates that the Comb Generator is powered ON.  
  
**NOTE:** When battery voltage reaches a certain voltage, the Comb Generator will automatically power OFF, along with the power LED.
- 2 Power Switch**  
Toggles power ON and OFF.
- 3 Frequency Step Size Selector Switch**  
Toggles between 50 kHz and 10 kHz step sizes.
- 4 Charger Power Input Port**  
Port for connection to the battery charger.
- 5 Battery Low Indicator LED**  
When illuminated, it indicates that the battery voltage is running low, and charging is needed.

- 6 Comb Generator Output Port**  
RF output port of the Comb Generator, threaded to accommodate the provided PP25A, PP50A, or PP100A output pins.
- 7 G-PIN Ground Pin**  
4 mm banana plug for connection to LISN reference ground port jack. When no jack is available on LISN, it may be removed and replaced with the CGCA-PIN-GWxx (or similar) Ground Wire to establish an alternative reference ground connection (see section 4.2)
- 8 PP25A Output Pin**  
Screws into the Comb Generator's output port to facilitate connection to the EUT port socket receptacle of Com-Power LISNs having a current rating up to 25 amperes.
- 9 PP50A Output Pin**  
Screws into the Comb Generator's output port to facilitate connection to the EUT port socket receptacle of a 50 Ampere Com-Power LISNs having a current rating >25 amperes and ≤50 amperes.
- 10 PP100A Output Pin**  
Screws into the Comb Generator's output port to facilitate connection to the EUT port socket receptacle of Com-Power LISNs having a current rating >50 amperes and ≤100 amperes.

### 3.6 Product Specifications

Product	<b>Conducted Comb Generator</b>
Model	<b>CGC-105</b>
Frequency Range	<b>10 kHz to 115 MHz</b>
Frequency Step Size	<b>10 kHz or 50 kHz (user-selectable)</b>
Frequency Stability	<b>20 ppm</b>
Amplitude Stability	<b>±0.1 dB</b>
Time Stability	<b>&lt;1 dB (over 12 months)</b>
AC Adapter/Charger Output	<b>6 VDC (unregulated), 500 mA</b>
AC Adapter/Charger Output Connector	<b>2.5 mm [ID] x 5.5 mm [OD] (center-pin positive)</b>
Battery Type	<b>6V NiMH, 1 Ah</b>
Typical Operating Time	<b>&gt;23 Hours (with fully-charged battery)</b>
External LED Indicators	<b>Battery Low and Power On</b>
Dimensions (L x W x H)	<b>6.5 x 2.3 x 2.4 inches (165 x 58 x 61 mm)</b>
Weight	<b>0.5 lbs (0.22 kg)</b>
Standard Accessory Output Adapters	<b>PP25A, PP50A, PP100A Output Pins, CGCA-PIN-NEMA</b>
Optional Accessory Output Adapters	<b>CGCA-PIN-COAX, CGCA-PIN-SFP</b>

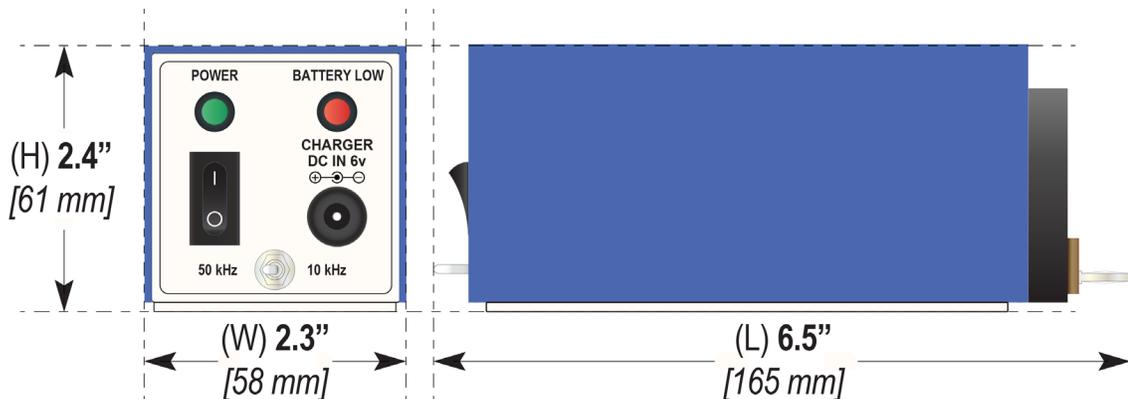


Figure 2 – Product Dimensions

#### SECTION 3 - PRODUCT INFORMATION

## 4. Product Configuration and Operation

### 4.1 Selecting the Output Pin and Adapter (if needed)

The Comb Generator is provided with (3) output pins: a 25 amp pin (PP25A), a 50 amp pin (PP50A), and a 100 Amp pin (PP100A). The CGCA-PIN-NEMA adapter (sold separately) adapts the generator output to a NEMA 5-15 Plug. The CGCA-PIN-COAX adapter (sold separately) adapts the generator output to a coaxial connector.

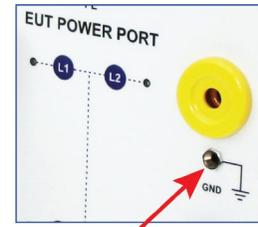
The following table may be used as a cross-reference to determine the appropriate output pin and adapter (if needed) for your LISN.

Com-Power LISN Model	OUTPUT PIN and ADAPTER (if needed)	Com-Power LISN MODEL	OUTPUT PIN and ADAPTER (if needed)
LI-125	PP25A	LI-325C	PP25A
LI-150	PP50A	LI-350	PP50A
LI-1100	PP100A	LI-3100	PP100A
LI-3P-116	PP25A	LI-400C	PP25A
LI-3P-132	PP50A	LI-4100	PP100A
LI-3P-163	PP100A	LI-3P-416	PP25A
LI-3P-1100	PP100A	LI-3P-432	PP50A
LIN-120C	PP25A and CGCA-PIN-NEMA	LI-3P-463	PP100A
LI-3P-216	PP25A	LI-3P-4100	PP100A
LI-3P-232	PP50A	LI-550C	PP50A
LI-3P-263	PP100A	LIP-0010	PP25A and CGCA-PIN-NEMA
LI-3P-2100	PP100A	LIP-120	PP25A and CGCA-PIN-NEMA
LI-220C	PP25A and CGCA-PIN-NEMA	LIP-1000	PP25A and CGCA-PIN-COAX
LI-325C	PP25A		
LI-350	PP50A		
LI-3100	PP100A		

SECTION 4 - PRODUCT CONFIGURATION AND OPERATION

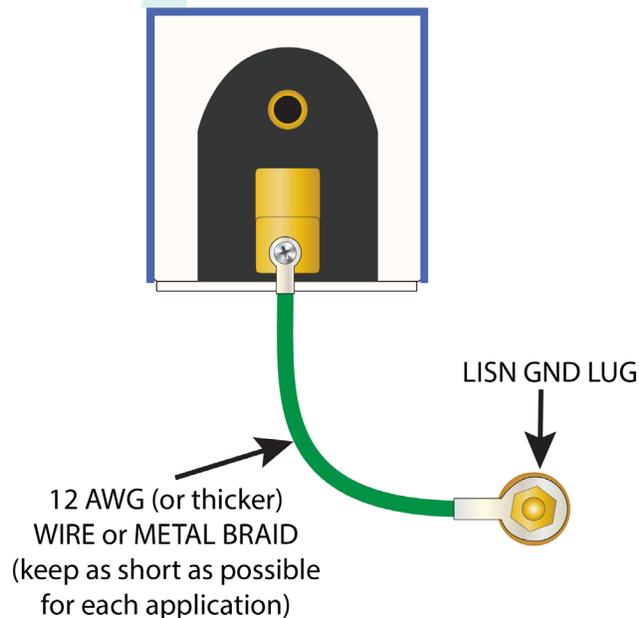
## 4.2 Ground Plug

The Comb Generator requires a reliable ground connection to operate properly. Refer to Item 7 in Section 3.4 (Product Features). Most Com-Power LISNs currently being manufactured are equipped with the reference ground jack (pictured to the right) to accommodate the ground pin.



For legacy or non-Com-Power LISNs without a reference ground jack, the G-PIN ground pin can be removed from the ground pin port of the Comb Generator, and an alternative ground connection, as illustrated in Figure 3, may be used to establish the reference ground.

The provided CGCA-PIN-GWxx ground wire is suitable for most applications. In cases where the ground wire is too short, or in cases where the ground wire is too lengthy, construct a similar wire to use in its place.



**Figure 3 – Alternative Reference Ground Connection**

**Use a #6-32 screw to attach the ground lead to the ground pin port.**

**NOTE:** Use of this alternative ground connection may not be sufficiently effective in all applications. In situations where a lengthy lead is necessary, either because the ground lug on the front panel is missing or because it is located too far from the EUT port, the ground connection may not provide a sufficient reference.

### 4.3 Connecting to the LISN

Once the Comb Generator is configured with the appropriate output pin (and adapter, if needed) for the LISN to which it will connect, simply plug the Comb Generator into the EUT port. An example is shown in Figure 4.



Figure 4 – Example Connection of Comb Generator to the EUT Port of the LISN

### 4.4 Charging the Comb Generator

To charge the comb generator, switch the power switch to the OFF position. Plug the charger into 120 VAC, 60 Hz, and connect the charger's output to the comb generator's power input port. The Comb Generator battery will be fully charged in less than eight hours.

**NOTE:** Disconnect the charger from the Comb Generator after charging. Leaving the charger plugged in continuously for extended periods may damage the battery and reduce its operating time.

## 5. Recommended Practice for Site Validations

While Com-Power Comb Generators can be used for many applications, the primary intended use is to periodically verify or validate conducted and radiated emission measurement systems.

In automated measurement systems, the entire frequency range is typically scanned. For manual systems, several individual signals over the frequency range are strategically selected for measurement.

Prior to site measurements, baseline measurements can be performed using the **CGCA-PIN-COAX** coaxial adapter, which is available separately. Using this adapter allows you to connect the comb generator directly to your measuring instrument and measure its output. This measurement data should be stored for possible future reference. Baseline measurements are not part of the site validation process, but can be very useful as a “sanity check” when troubleshooting, in case there is any question about whether the output of the comb generator has changed. The direct output measurements can be repeated and compared against the original baseline data.



The first step in the site validation process is to perform REFERENCE MEASUREMENTS, as described in section 5.1. Reference measurements of the comb generator output signals are performed when the measurement system is known to be in proper working order. Ideally, this is done soon after all components of the measurement system and test site have been individually calibrated.

Then, on a periodic or daily basis, the measurements are repeated on the same Comb Generator, and the results are then compared with the reference measurements. The measured signal amplitudes during the site checks should be consistent with the reference measurement amplitudes.

If the measured amplitudes are outside the defined acceptance criteria (see section 5.3), there is likely a problem with one or more components of the measurement system.

### SECTION 5 - RECOMMENDED PRACTICE FOR SITE VALIDATIONS

## 5.1 Reference Measurements

The reference measurements essentially serve as the “calibration” of your Comb Generator. It is recommended that the recorded amplitude values (in dB $\mu$ V) for the reference measurements, as well as site verification measurements, be “corrected” values (i.e.: all correction factors applied, such as insertion loss factors for the LISN, cables, attenuators, etc.). That way, if any of the system components are replaced at any time, it isn't necessary to repeat the reference measurements.

It is also recommended to perform at least 10 complete sets of reference measurements and use the calculated averages as the reference. The calculated average value ( $meas_{REF}$ ) of all 10 measurement values ( $RM_1$  through  $RM_{10}$ ) at each frequency is then compared with the site validation measurements (see section 5.3).

$$meas_{REF} = \frac{(RM_1 + RM_2 + RM_3 + RM_4 + RM_5 + RM_6 + RM_7 + RM_8 + RM_9 + RM_{10})}{10}$$

where...

$meas_{REF}$  = reference measurements against which site verification measurements are to be compared

$RM_x$  = reference measurement where x corresponds the measurement set with which the measurement was taken

EXAMPLE:  $RM_1$  indicates that the measurement is from the first set of reference measurements

The reference measurements should be performed at the same time intervals as the site validations (e.g., once per day).

It is recommended that photographs of the test setup be taken for reference. Software files for performing site validation reference readings and site validation should be clearly marked.

## 5.2 Defining Your Acceptance Criteria and Setting Limits

The acceptance criteria determine the maximum allowed deviation between the reference measurement values and the site validation measurement values. It is typically defined in  $\pm$ dB units.

The output of the Comb Generator will remain consistent. Still, other factors, such as the measurement equipment's amplitude tolerance, variations in cable loss with temperature, and other variables, necessitate a tolerance in the measured values during site validation measurements.

A reasonable acceptance criterion for conducted measurement systems would be  $\pm 1.0$  dB to  $\pm 1.5$  dB.

Consideration should be given to the variance observed in the measured values between the sets of reference readings.

With the reference measurements completed and the average values of the reference readings ( $meas_{REF}$ ) calculated, the limits can now be calculated based on your Acceptance Criteria. A lower limit ( $limit_{LOW}$ ) and an upper limit ( $limit_{HIGH}$ ) for each frequency are calculated as follows:

$$limit_{LOW} \text{ (in dB}\mu\text{V)} = meas_{REF} \text{ (in dB}\mu\text{V)} - \text{Acceptance Criteria (in dB)}$$

$$limit_{HIGH} \text{ (in dB}\mu\text{V)} = meas_{REF} \text{ (in dB}\mu\text{V)} + \text{Acceptance Criteria (in dB)}$$

## 5.3 Site Validation Measurements

The site validation measurements must be performed using the same setup as the reference measurements, including the physical equipment, software configuration, equipment settings, and correction factors.

As long as the measured values fall between (*limit<sub>LOW</sub>*) and (*limit<sub>HIGH</sub>*), then your measurement system has been validated and is ready for testing.

If any of your measured values are outside the defined limits, there may be a problem with your measurement system. Repeat the site validation measurements as necessary during troubleshooting to determine whether the issue has been resolved.

### 5.3.1 Possible Sources of Measurement System Problems

Listed below are some common measurement system problems:

- ✓ Loose or improper connections on measurement cables.
- ✓ Damaged attenuator or transient limiter.
- ✓ Damaged measurement cable(s).
- ✓ Damaged 50-ohm termination on one or more of the leads not currently being measured (e.g., on neutral lead when measuring line lead). This termination may be connected externally to the LISN measurement port or internal to the LISN.
- ✓ Damaged or partially damaged LISN.
- ✓ Loose or improperly connected output pin or ground pin on Comb Generator.
- ✓ Incorrect factors selected on the measurement software or measuring instrument.
- ✓ Problem with the measuring instrument.
- ✓ Damaged or malfunctioning Comb Generator.

## 6.0 Warranty

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

- Transport damages during shipment from your plant.
- Damages due to poor packaging.
- Products operated outside their specifications.
- Products Improperly maintained or modified.
- Consumable items such as fuses, power cords, cables, etc.
- Normal wear
- Calibration
- Products transported 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 representatives.

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 any other equipment.

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

For repair or complaint, please visit our website at [www.com-power.com](http://www.com-power.com) and complete the RMA form (<http://com-power.com/repairservicereq.asp>). Our technical assistance personnel will contact you with an RMA number. The RMA number should be displayed in a prominent location on the packaging and on the product, along with a description of the problem, and your contact information.

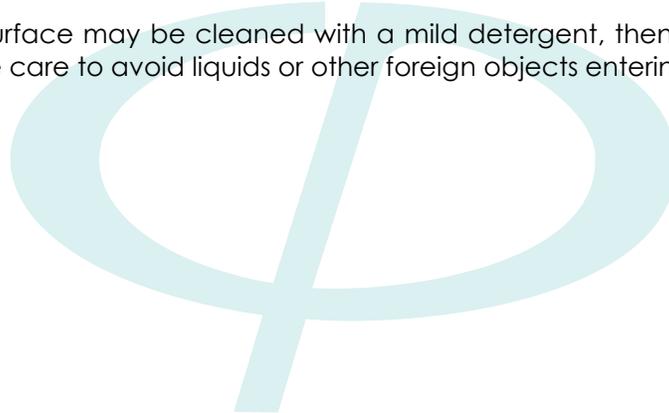
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### SECTION 6 - WARRANTY

## 7.0 Maintenance

This product contains no user-serviceable parts. If the unit is not operating or requires calibration, don't hesitate to contact Com-Power Corporation. Any modifications or repairs to the unit by persons other than an authorized factory-trained technician will void the warranty.

The exterior surface may be cleaned with a mild detergent, then wiped with a dry, lint-free cloth. Use care to avoid liquids or other foreign objects entering the chassis.



## 8.0 Typical Output Characteristics

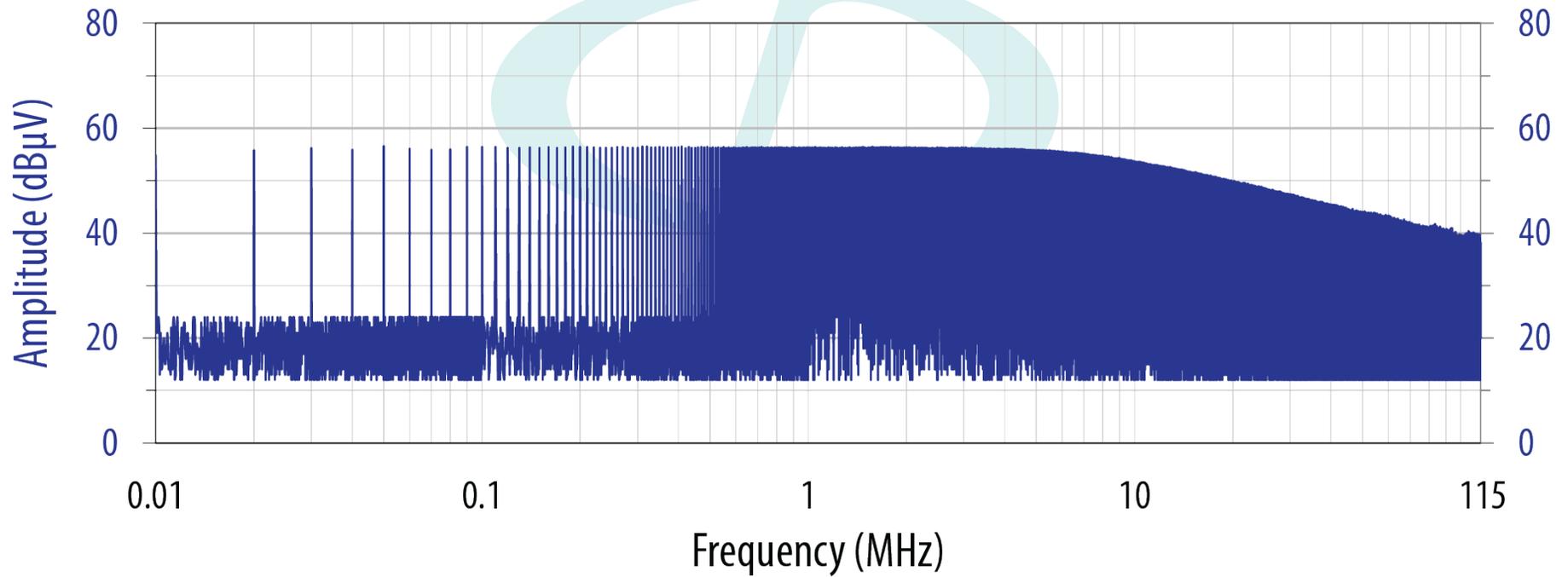


Figure 5 – Typical Conducted Output (10 kHz step)

### SECTION 8 - TYPICAL OUTPUT CHARACTERISTICS

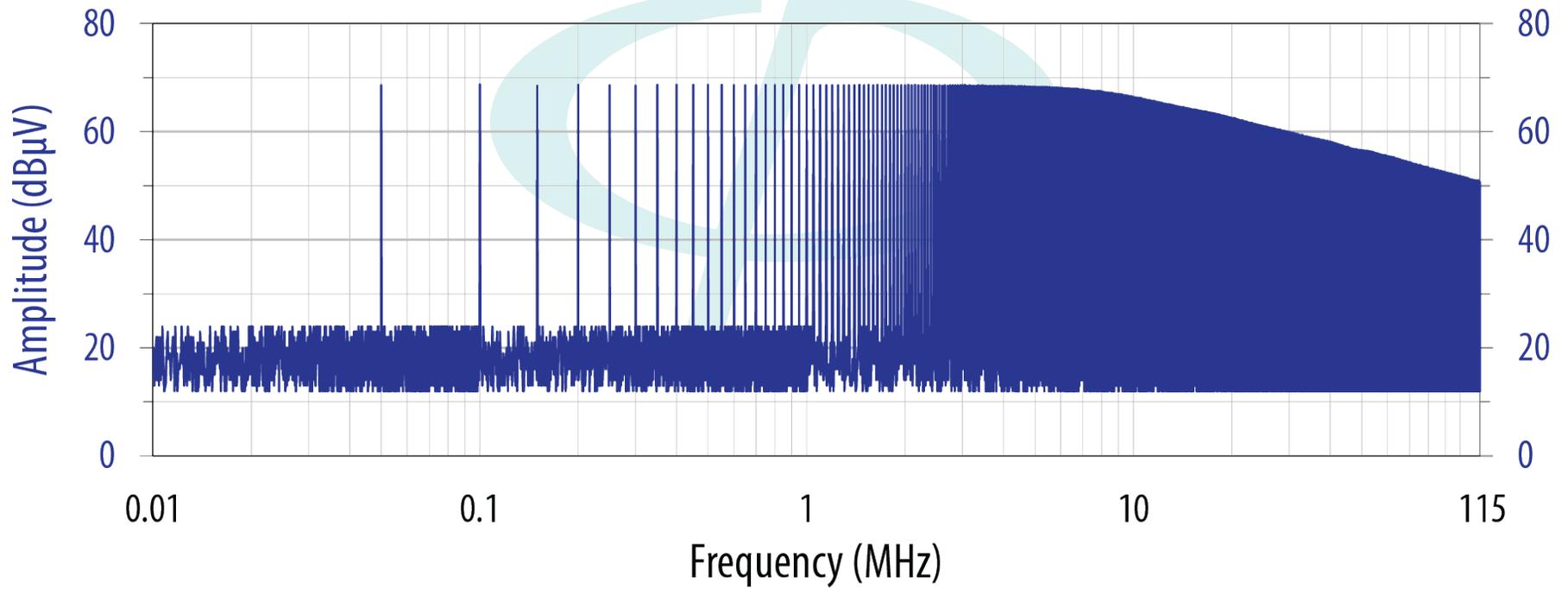


Figure 6 – Typical Conducted Output (50 kHz step)

SECTION 8 - TYPICAL OUTPUT CHARACTERISTICS