

How to Use the Model 845 Series Trigger System to Perform Extremely Fast Digital Sweeps

This application note shows how to program and run fast frequency (or generalized list) sweeps on the Model 845 Signal Generator with the fast switching option FS, combining the sweep engine with the trigger system to produce frequency and power ramps with a 40 μ s minimum step time that stay synchronized to external equipment.

APPLICATION NOTE · BNC-AN-001 REV A · OCTOBER 2026 · dc-62022201

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The Model 845 Signal Generator (and the multi-channel Model 855B) with option FS steps through a sweep with a minimum step time of 40 μ s and a 30 μ s transient time (Model 845 datasheet, Sweeping & Switching). Combined with the trigger system, the sweep engine generates frequency and power ramps that external equipment can follow point by point. In contrast to an analog sweep, a digital sweep can be synchronized at any point during the sweep, and every point is a synthesized frequency with the generator's 0.001 Hz resolution.

1 Introduction

The Model 845 and Model 855B Signal Generators can be programmed to execute sweeps either from the BNC graphical user interface (GUI) or directly with SCPI commands.

In this application note, we describe the configuration for a frequency sweep with the following parameters:

- Linear sweep from 1 to 12 GHz in total 10 steps
- Execute entire sweep once on every external trigger rising edge

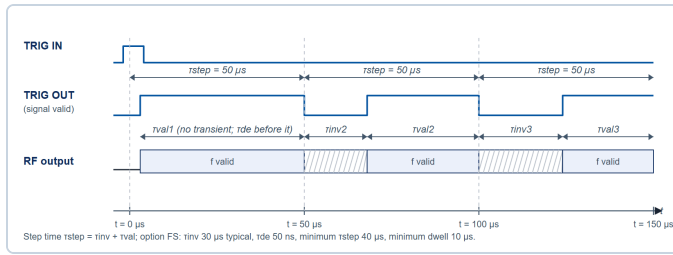
- Frequencies shall be switched every 50 μ s
- An output trigger shall provide a "signal valid" indication by changing to HIGH whenever the transient is completed and the signal becomes valid

2 Timing

TRIG OUT goes high as soon as the first frequency is valid and remains high until $t = 50 \mu$ s, when switching to the next frequency is initiated. Within the transient time τ_{inv} the switching transient completes and TRIG OUT goes high again. The new frequency and power pair remains stable until $t = 100 \mu$ s, when TRIG OUT goes low for a second time and the next frequency and power pair is programmed (Figure 1).

The transient time τ_{invN} and the valid time τ_{valN} can vary from point to point, but the step time $\tau_{step} (= \tau_{invN} + \tau_{valN})$ between frequencies is always 50 μ s. For the first frequency of the sweep, τ_{inv1} is zero and τ_{val1} is 50 μ s.

TRIG OUT synchronizes the sweep to external equipment with a timing accuracy of 5 ns per point (option FS).



SCHEMATIC Figure 1. Timing of TRIG IN, TRIG OUT (signal valid) and the RF output across consecutive 50 μ s steps. Each step is the transient interval τ_{inv} followed by the valid interval τ_{val} ; the first step has no transient.

3 Sweep Configuration

We configure this sweep in three steps:

1. Configure Trigger

Trigger input:

Table 1. Trigger input

Command	Value
TRIG:SEQ:TYPE	POIN
TRIG:SEQ:SOUR	EXT
TRIG:SEQ:DEL	0
TRIG:SEQ:SLOP	POS
TRIG:SEQ:ECO	1

Trigger output:

Table 2. Trigger output

Command	Value
TRIG:OUTP:MODE	VAL

2. Configure Sweep

Table 3.

Command	Value
SOUR:SWE:COUN	1
SOUR:SWE:DWEL	50e-6
SOUR:SWE:DEL	0

Command	Value
SOUR:SWE:SPAC	LIN
SOUR:SWE:POIN	10
SOUR:SWE:STAR	1e9
SOUR:SWE:STOP	12e9
SOUR:FREQ:MODE	SWE

3. Arm Trigger

Table 4.

Command	Value
INIT:CONT	ON

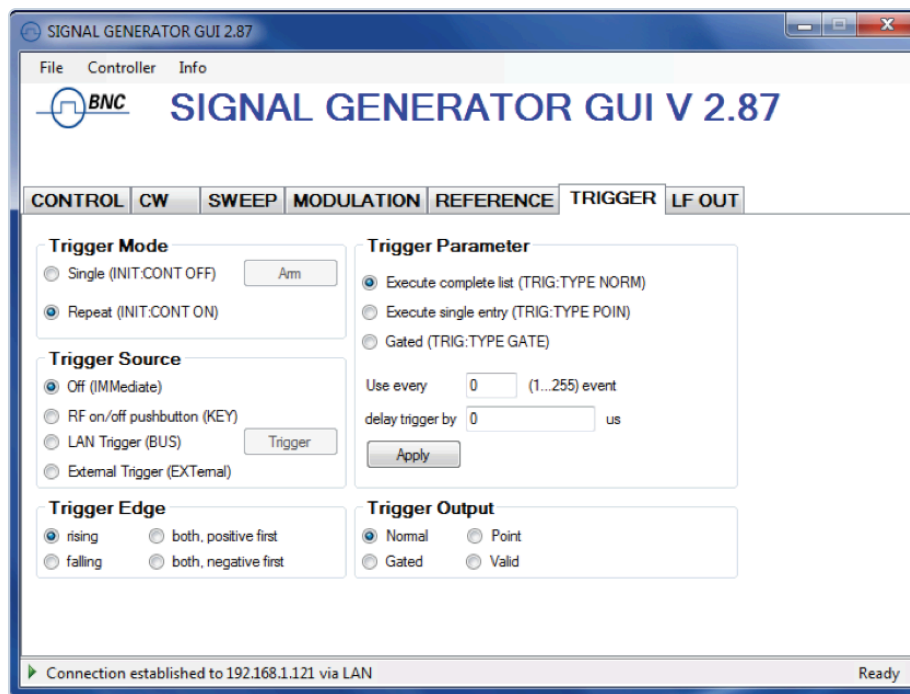
4 Key Specifications

- Output power -20 to +15 dBm standard; -90 to +13 dBm with option PE; up to +21 dBm (0.01 to 12 GHz) with option HP
- Frequency and amplitude setting time 30 μ s with option FS (200 μ s standard); minimum step time 40 μ s with option FS, minimum dwell time 10 μ s
- SSB phase noise -118 dBc/Hz typical at 4 GHz, 20 kHz offset
- Continuous, single, gated and gated-direction triggering; linear, logarithmic, random and list sweeps
- Models 845-12, 845-20 and 845-26 (100 kHz to 12, 20 or 26 GHz), desktop or 19 inch 1U rack mount (option 1URM)

5 Graphical User Interface (GUI) Setup

The same sweep can be set up in the GUI. First, we configure the trigger system to wait for a rising edge and run the entire sweep on each trigger.

We switch to the TRIGGER tab of the GUI as shown in Figure 2. We set trigger mode to "Repeat", Trigger source to "External Trigger", Trigger Edge to "Rising", and Trigger Parameter to "Execute complete List". In the trigger output setting we set "Valid".



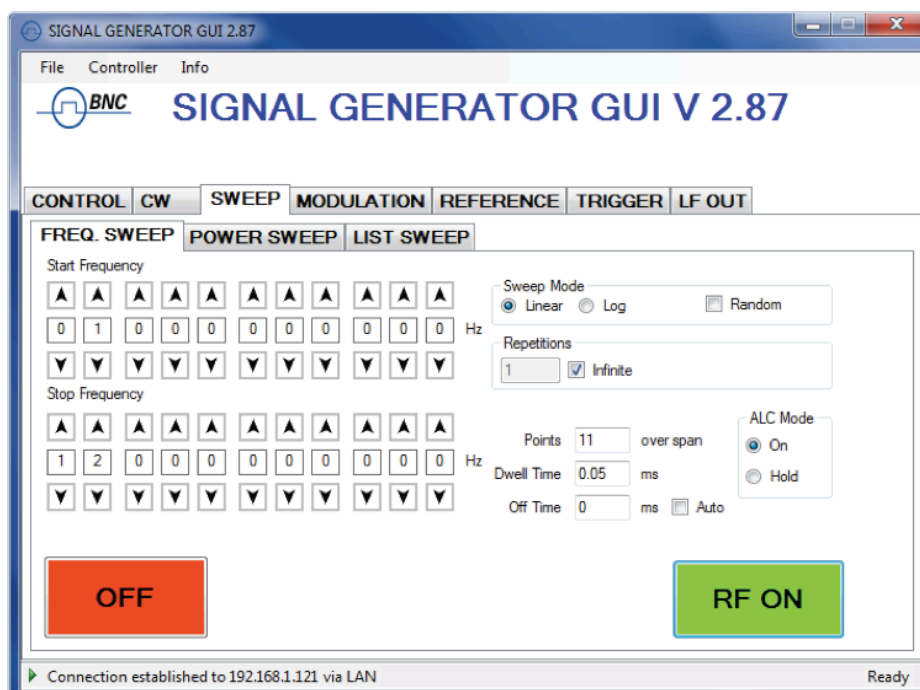
■ **MEASURED** **Figure 2.** The TRIGGER tab of the Signal Generator GUI with trigger mode Repeat, trigger source External, trigger edge Rising, trigger parameter Execute complete list and trigger output Valid.

Next, we switch to the SWEEP tab of the GUI as shown in Figure 3.

We set the start frequency to 1 GHz, and stop frequency to 12 GHz. The number of repetitions of the sweep we set to 1, number of points to 10, "Dwell time" to 0.05 ms, disable

the "Auto" and set the "Off time" to 0 ms.

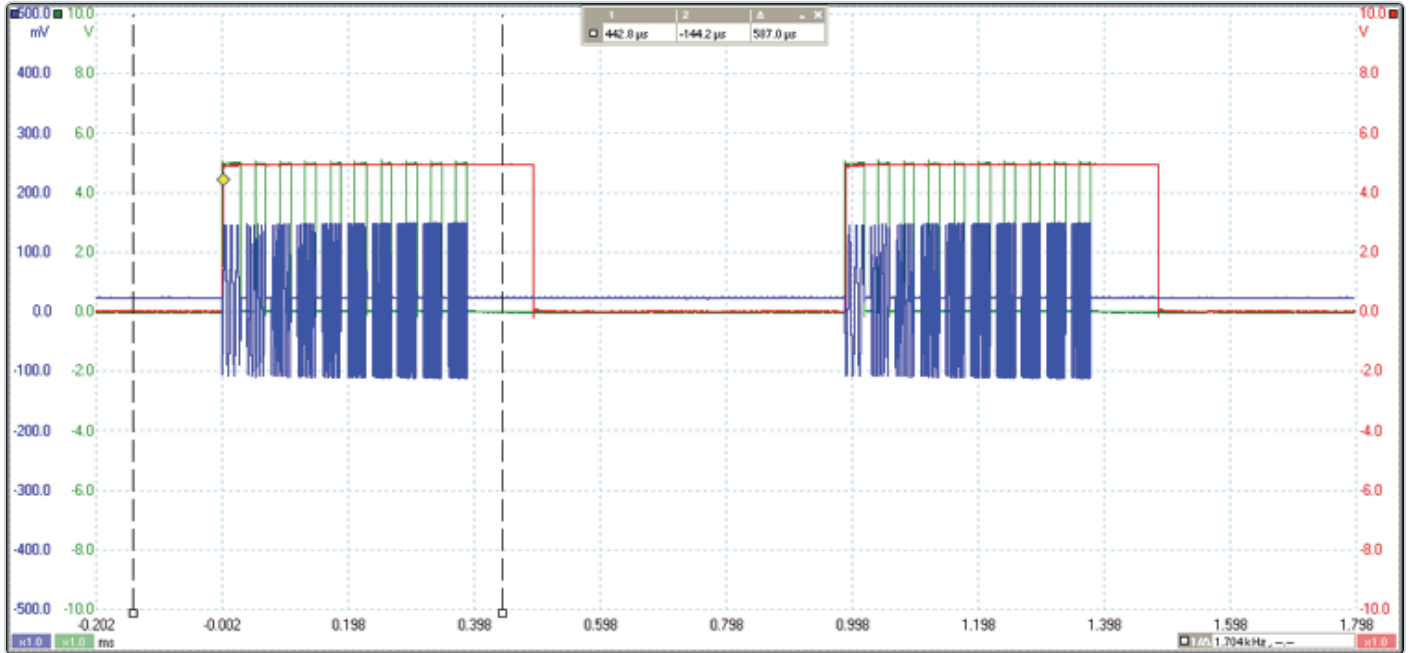
We can choose for the ALC (automatic level control) to operate in "on" or "hold" mode. We can start the sweep with the "on/off" button on the left.



■ **MEASURED** **Figure 3.** The SWEEP tab of the Signal Generator GUI with start and stop frequency, linear spacing, points over span, dwell time, off time and ALC mode controls.

6 Applications

- ATE
- R&D low noise signal source
- Production testing (fast switching, high dynamic range)
- Service and maintenance (battery operation with option EB6)
- Signal simulation (radar, UWB)
- Aerospace and defense (pulse modulator, chirps)



MEASURED Figure 4. Oscilloscope capture of a 10 point sweep with a 50 μ s step time, showing TRIG IN (red), signal valid (green) and the RF output (blue) for two successive externally triggered sweeps about 1 ms apart. The cursor readout at the top of the screen marks 587 μ s between the first cursor and the end of the first sweep.

7 Measurement Results

Figure 4 shows the time domain measurements of the sweep. TRIG IN is applied approximately every 990 microseconds from an external source (red trace). Upon the rising edge, the "signal valid" (green trace) goes high almost instantly, indicating that the first frequency RF (blue trace) is stable. After the ten consecutive frequencies, "signal valid" goes low a last time and remains low until a new sweep starts upon a new trigger rising edge.

8 Conclusion

Option FS on the Model 845 steps a digital sweep every 40 μ s or longer, and the TRIG IN and TRIG OUT signals keep that sweep synchronized to external equipment to within 5 ns per point.

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BNC-AN-001 Rev A

October 2026 | dc-62022201