This application note focuses on how to program and run fast frequency (or generalized list) sweeps using the Model 845 Series signal generators with the fast switching option FS.

The Model 845 Series (or the Model 855 Series multi-channel) signal generators with option FS allow extremely fast sweeps that, in combination with the trigger system, can generate very accurate and fast frequency and power ramps. In contrast to traditional analog sweeps, fast digital sweeps can be synchronized at any time during the sweep and yield precise frequencies throughout the sweep.
INTRODUCTION

The Model 845 Series and Model 855 series of signal generators can be programmed to execute sweeps by either the BNC graphical user interface (GUI) or by directly using the 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 us
- An output trigger shall provide a "signal valid" indication by changing to HIGH whenever the transient is completed and the signal becomes valid

TRIG OUT now remains high until $t=50 \mu s$ is reached and switching to the next frequency is initiated. Within $t_{\text{inv}}$ the switching transient is completed and TRIG OUT goes high again. The new frequency / power pair remain stable until $t=150 \mu s$ is reached. TRIG OUT goes low for a second time and the next frequency / power pair is programmed.

Note that the transient time $t_{\text{invN}}$ and the valid time $t_{\text{valN}}$ can vary from point to point, but the step time $t_{\text{step}}$ (= $t_{\text{invN}}$+$t_{\text{valN}}$) between frequencies is always 50 $\mu$s.

In particular, for the first frequency of the sweep, $t_{\text{inv1}}$ is zero and the $t_{\text{val1}}$ is 50 $\mu$s. TRIG OUT can be used to precisely synchronize sweeps to any external equipment.

Sweep Configuration

We configure this sweep in three steps:

1. Configure Trigger
   
   Trigger input
   
   TRIG:SEQ:TYPE POIN
   TRIG:SEQ:SOUR EXT
   TRIG:SEQ:DEL 0
   TRIG:SEQ:SLOP POS
   TRIG:SEQ:ECO 1

   Trigger output
   
   TRIG:OUTP:MODE VAL

2. Configure Sweep
   
   SOUR:SWE:COUNT 1
   SOUR:SWE:DWEL 50e-6
   SOUR:SWE:DEL 0
   SOUR:SWE:SPAC LIN
   SOUR:SWE:POIN 10
   SOUR:SWE:STAR 1e9
   SOUR:SWE:STOP 12e9
   SOUR:FREQ:MODE SWE

3. Arm trigger
   
   INIT:CONT ON

Figure 1: Timing diagram
In the GUI, the setup is straightforward. First, we configure the trigger system to wait for rising edge and run the entire sweep upon 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"
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 chose 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.

Figure 3: GUI sweep settings
MEASUREMENT RESULTS

Figure 4 shows the time domain measurements of the sweep. TRIG IN is applied approx every 990 microseconds from an external source (red trace).

Upon the rising edge, the "signal valid" (green trace) goes high almost instantly, indicating that first frequency RF (blue trace) is stable. After the ten consecutive frequencies, "signal valid" does low a last time and remains low until a new sweep starts upon new trigger rising edge.

Figure 2: 10 point sweep with 50 μs step time.
CONCLUSION

The option FS for the MODEL 845 SERIES allows extremely fast and precise digital sweeps that can be well synchronized to external equipment using input and output trigger.

INDUSTRY COMPARISON

RF / MICROWAVE SIGNAL GENERATORS

3 GHz, 6 GHz, 12 GHz, 20 GHz & 26.5 GHz AVAILABLE

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>MODEL 845-20</th>
<th>KEYSIGHT MXG N5183A</th>
<th>KEYSIGHT E8257D PSG W/OPTIONS</th>
<th>R&amp;S SMB B120L W/OPTIONS</th>
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</thead>
<tbody>
<tr>
<td>FREQ. RANGE RESOLUTION</td>
<td>100 kHz-20.5 GHz, 0.001 Hz</td>
<td>250 kHz-20 GHz, 0.01 Hz</td>
<td>250 kHz-20 GHz, 0.01 Hz</td>
<td>100 kHz-20 GHz, 0.001 Hz</td>
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<tr>
<td>SWITCHING SPEED OPTION FS</td>
<td>0.2 ms</td>
<td>5 ms (1.15 ms OPTION UNZ)</td>
<td>9 ms</td>
<td>3 ms</td>
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<tr>
<td>POWER RANGE</td>
<td>-30 TO +20 dBm, -190 TO +13 dBm, -20 TO +26 dBm, 0.01 dB</td>
<td>-90 TO +7 dBm, 0.01 dB</td>
<td>-135 TO +15 dBm, 0.01 dB</td>
<td>-20 TO +22 dBm, 0.01 dB</td>
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<tr>
<td>PHASE NOISE 10G OPTION LN</td>
<td>-108 dBc/Hz, &lt; 0.1 PPM, -117 dBc/Hz, 0.01 PPM</td>
<td>-98 dBc/Hz, &lt; 1 PPM</td>
<td>-115 dBc/Hz, &lt; 0.05 PPM</td>
<td>-108 dBc/Hz, &lt; 0.1 PPM</td>
</tr>
<tr>
<td>MODULATIONS</td>
<td>AM/FM/PM/PULSE TRAINS/CHIRPS</td>
<td>OPTIONAL</td>
<td>OPTIONAL</td>
<td>OPTIONAL</td>
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<tr>
<td>EXTRAS</td>
<td>PORTABLE INTERNAL BATTERY</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>WEIGHT, SIZE</td>
<td>2.5 kg, &lt; 15 W</td>
<td>12.8 kg, 250 W</td>
<td>22 kg, 250 W</td>
<td>6.9 kg, &gt;90 W</td>
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<tr>
<td>POWER CONSUMP.</td>
<td>$17,000.00 USD</td>
<td>$42,000.00 USD</td>
<td>$68,000.00 USD</td>
<td>$51,000.00 USD</td>
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ALL BENCHTOP MODEL FEATURES:
- LAN/USB/GPIB REMOTE CONTROL WITH SCPI 1999 COMMAND SET
- COMPLIMENTARY POWERFUL & EASY TO USE GUI
- COMPACT, ROBUST, LIGHTWEIGHT, PORTABLE & RUGGED DESIGN
- SEALED, FAN-LESS, ENCLOSURE (LOW POWER CONSUMPTION)
- INTERNAL RECHARGEABLE BATTERY OPTIONS
- FIELD CARRYING CASE AVAILABLE
- SINGLE AND DOUBLE RACKMOUNTS AVAILABLE