Application Note 218-4
Microwave Synthesizer Series

HEWLETT hp PACKARD

Synthesized Signals from 18 to 37.2 GHz using the 8672A

The frequency range of the HP 8672A Synthesized Signal Generator is 2 to 18 GHz with overrange to 18.6 (18.599997) GHz. To satisfy the increasing need for signal generation above 18 GHz, the 8672A may be used with the HP 938A and 940A Frequency Doublers (Figure 1) to generate frequencies from 18 to 37.2 (37.199994) GHz. Activity in this range includes satellite links, radars, calibration laboratories, and various electronic warfare applications. There is a need for highly stable synthesized signals in each of these areas. In many cases, this need will be satisfied through the use of the 8672A generator and the 938A/940A Frequency Doublers. This note describes the typical frequency, output level, and modulation characteristics available through the combined use of these instruments.

The 938A and 940A double input frequencies from 9 to 13.25 GHz and 13.25 to 20 GHz respectively. Except for this frequency range difference, the two doublers are identical. These instruments consist of broadband harmonic generators, a power monitor, a broad stopband low-pass filter, and a precision attenuator. They

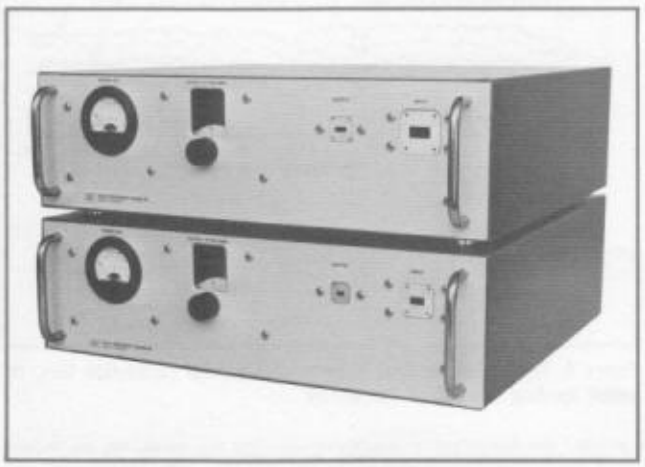

Figure 1. The HP 938A and 940A Frequency doublers.

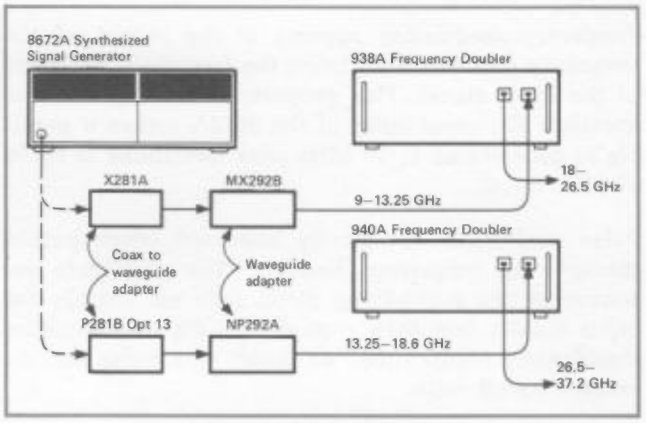

Figure 2. System configuration.

are passive devices and require no adjustment with changing input frequency.

System configuration is shown in Figure 2. The 8672A is connected to either of the frequency doublers through a short length of flexible or semi-rigid coax, a coax-to-waveguide adapter, and a waveguide-to-waveguide adapter. Output signals are then available from 18 to 26.5 GHz from the 938A doubler and from 26.5 to 37.2 GHz from the 940A doubler.

Typical Performance

Maximum Output Power

Power available at the outputs of the frequency doublers is a nonlinear function of the power delivered to their inputs. The standard 8672A is specified to deliver +3 dBm, but will typically provide several dB more than this over most of its 2 to 18 GHz frequency range. There are two options available for the 8672A which increase its maximum output level, thus increasing the power available from the doublers. Option 001 consists of deleting the final output attenuator from the 8672A. This provides a specified output level of +5 dBm from

2 to 18 GHz. Option 008 provides a leveled output of +8 dBm through the use of high-power microwave GaAs FETs. Options 001 and 008 may be combined to deliver the overall maximum output level possible from the 8672A. Figure 3 shows the typical maximum output level available from the frequency doublers when used with each of these 8672A configurations.

Output Flatness

Figure 4 indicates the typical output level of the doublers when driven by each of the 8672A configurations described above, operating at their maximum specified output levels. When operating at these levels, the 8672A output is leveled to within ±1.25 dB. The curves indicate overall system output flatness, and the conversion loss of the doublers for various input signal levels.

Modulation

Though the doubling process is nonlinear with amplitude variation of the input signal, shallow-depth AM is still possible with relatively low distortion. An AM depth of 10 percent typically yields less than 5 percent total harmonic distortion.

Frequency modulation appears at the output of the frequency doublers with twice the frequency deviation of the input signal. This property combined with the excellent FM capabilities of the 8672A makes it possible to generate up to 20 MHz peak deviations at up to 10 MHz rates.

Pulse modulation is actually improved when passed through the frequency doublers. The amplitude response of the multiplying diode falls off sharply for input signals less than −10 dBm. This characteristic significantly reduces the "off level" of a pulse and increases on/off ratio.

Spectral Purity

The frequency doublers affect phase noise and spurious signals as if they are modulation on the input carrier. An inherent 6 dB increase in the level of phase noise occurs due to doubling the deviation of this unwanted "modulation." Spurious signals may also be thought of as a combination of modulations, and will appear at the output of the doublers no more than 6 dBc higher than they were at the input. They will always appear with the same offset from the carrier as they had at the input, and might give rise to a smaller spurious signal on the opposite side of the carrier.

Feedthrough of the input frequency to the output of the doublers is minimized by the inherent high-pass filter characteristics of the waveguide used within the doublers.

Frequency Resolution

The resolution of the 8672A output frequency is 2 kHz in the 9 to 12.4 GHz range, and 3 kHz in the 12.4 to 18.6 GHz range. After doubling, this yields a resolution of 4 kHz from 18 to 24.8 GHz, and 6 kHz from 24.8 to 37.2 GHz. Application Note 218-2 describes a technique to achieve increased resolution from the 8672A, which will yield 0.004 or 0.006 Hz resolution to 37.2 GHz.

Summary

The 8672A is a broadband synthesized signal generator with extremely versatile frequency and modulation capabilities. Through use of the 938A and 940A Frequency Doublers, signals may be generated from 18 to 37.2 GHz with synthesizer accuracy, stability, and spectral purity. This combination of instruments should be considered for any application requiring synthesized signal generation above 18 GHz.

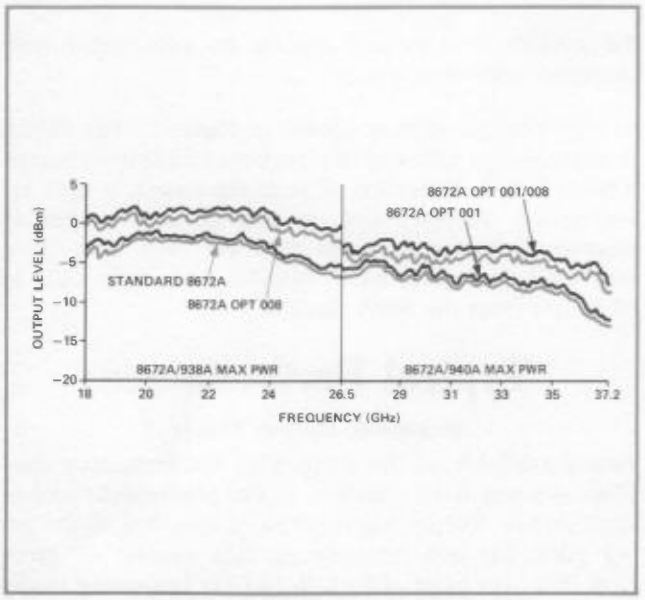

Figure 3. Typical maximum output power.

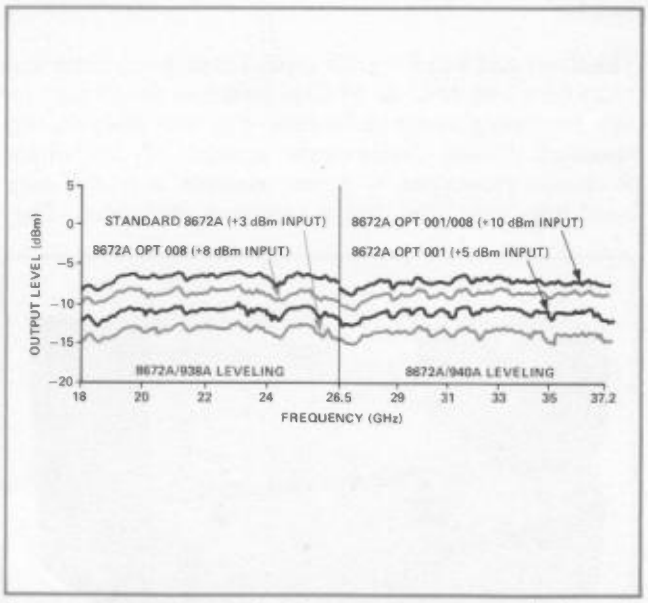

Figure 4. Typical output level flatness and doubler conversion loss. Internal leveling is used on the 8672A.

For more information, call your local HP sales office or East (301) 948-6370 • Midwest (312) 255-9800 • South (404) 955-1500 • West (213) 877-1282; Or write, Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, California 94304. **In Europe,** Hewlett-Packard S.A., 7, rue du Bois-du-lan, P.O. Box, CH-1217 Meyrin 2-Geneva, Switzerland. **In Japan,** Yokogawa-Hewlett-Packard Ltd., 29-21, Takaido-Higashi 3-chome, Suginami-ku, Tokyo, 168.

5952-8202 MARCH 1979 Printed in U.S.A.