HEWLETT hp PACKARD

FREQUENCY SYNTHESIZER

model 5103A

TENTATIVE DATA 1/15/65

DUAL RANGE
DC TO 1 MC AND DC TO 10 MC

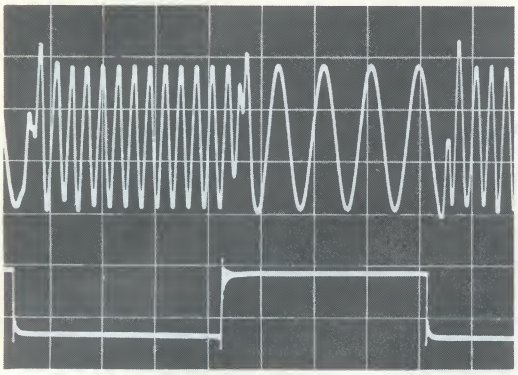
DIGITAL FREQUENCY SELECTION

SWEEP 0 TO 10 MC

SPURIOUS 70 DB DOWN

20 MICROSEC SWITCHING SPEED

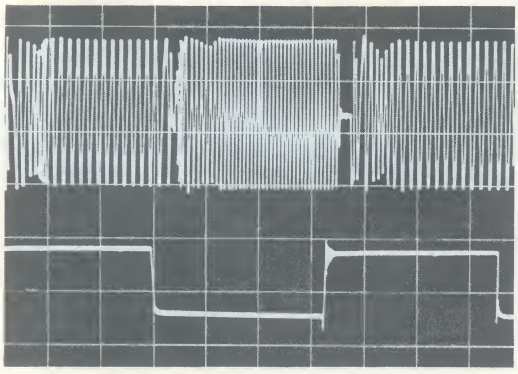
ALL SOLID STATE



220 Kc to 660 Kc, 25 Kc switching rate, 5 μsec/cm
1 MC RANGE

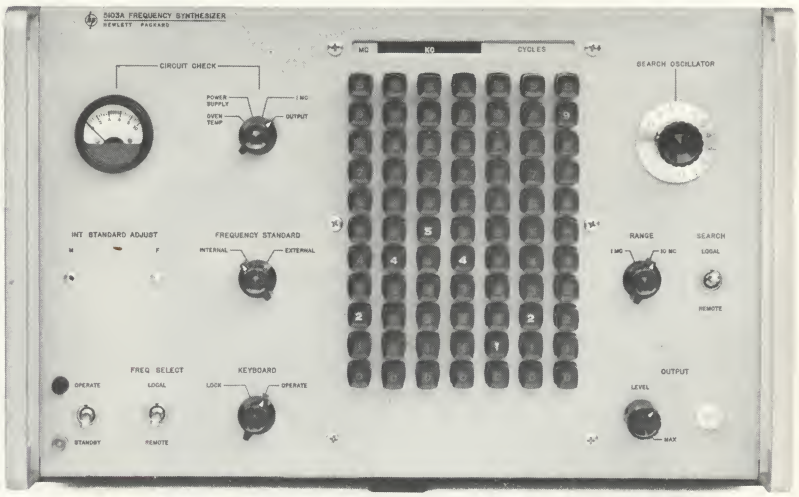
HIGH SPEED SWITCHING

1.2 Mc to 2.7 Mc, 30 Kc switching rate, 5 μsec/cm
10 MC RANGE



The HEWLETT-PACKARD MODEL 5103A FREQUENCY SYNTHESIZER provides any output frequency from 1 cps to 10 Mc, selectable in steps as small as 1 cps OR from 0.1 cps to 1 Mc in steps as small as 0.1 cps. The 1 Mc or 10 Mc maximum frequency output is selectable by a front panel RANGE switch. The output frequencies are digitally selected by front panel push-buttons, remote control or a combination of the two. Each significant column may be continuously varied over its range by local or remote use of the SEARCH oscillator.

A level control is provided to allow adjusting the voltage output level between 300 mv and 1 volt RMS. The output frequency is derived from a precision single frequency source through direct synthesis, a technique which translates the stability of the frequency source to the selected output. A precision quartz oscillator provided in the instrument or an external 1 Mc (or 5 Mc) frequency standard may be used as the frequency source.



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DESIGN FEATURES

Solid state modular construction has been used throughout the 5103A. The modular concept enhances serviceability and enables the system to meet the stringent demands regarding spurious signals. Careful design and quality control insure that all modules are interchangeable from one instrument to another.

Particular care has been taken to insure an extremely clean output signal over the entire frequency range of the 5103A. This high order of spectral purity (and stability) is essential for accurate doppler measurements, spectroscopy, narrow band telemetry, or communication work and similar applications. The design and construction of the HEWLETT-PACKARD FREQUENCY SYNTHESIZER make it possible to obtain output signals with spurious content at least 70 db below the selected output, dc to 1 Mc, in the 1 MC RANGE position and at least 50 db below the selected output, dc to 10 Mc in the 10 MC RANGE position.

The extremely good signal-to-phase noise characteristics of a typical 5103A synthesizer, in both the 1 MC RANGE position and the 10 MC RANGE position are shown in Figure 1 and Figure 2. Figure 3 shows a log plot of the single-side phase noise.

These typical plots show the performance of the 5103A in applications requiring low noise; for example, local oscillator control in VLF Receiver/Transmitter work.

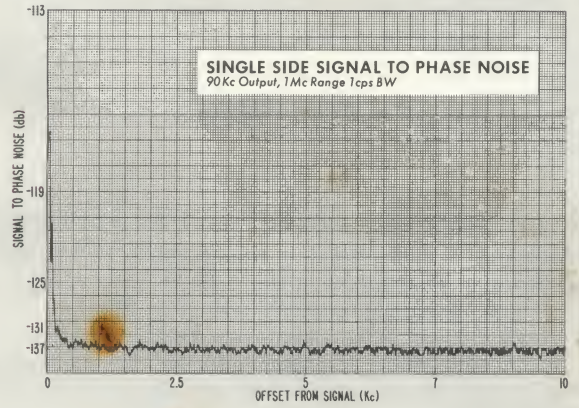
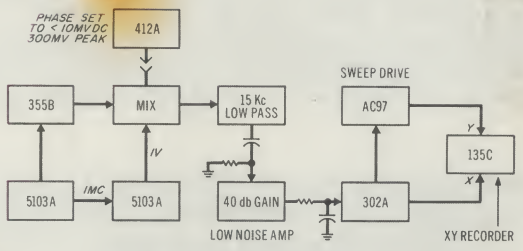


Figure 1.



MEASUREMENT SET-UP FOR NOISE PLOTS

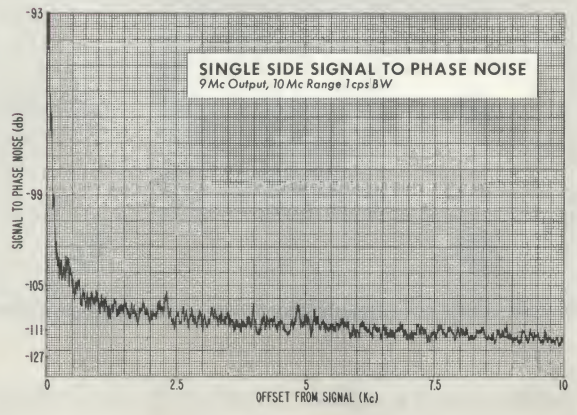


Figure 2.

05103-C-1

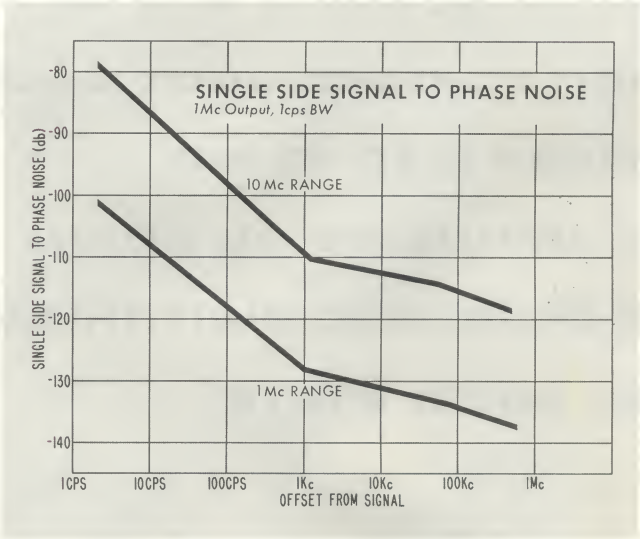


Figure 3.

OPERATIONAL FEATURES

Remote control is a standard feature on the 5103A. Any frequency or search oscillator position that can be selected by front panel push-buttons may also be remotely selected. Connectors located on the 5103A rear panel provide pins corresponding to each front panel push-button position, a ground connection, and a — 12.6 volt line for use in remote control. The — 12.6 voltage is available in two arrangements: continuous and switched (present when REMOTE mode is selected at front panel). This lends additional versatility since it enables the use of a combination of remote and local control. The combination of local and remote control can be used with the FREQUENCY SELECT switch in LOCAL. In this switch position, any column not selected locally by depressing a push-button in that column may be remotely controlled. Since no phase-locked loops are involved, switching from one output frequency to another can be accomplished very rapidly, either from the front panel push-buttons or remotely. Less than 20 μ seconds is required to change the output frequency. The two oscilloscope trace reproductions on the cover of this data sheet are typical results. For the 20 μs switching speed the controller must provide a low impedance connection to the — 12.6 volts for the "on" condition and + 1.5 volts for the "off" condition.

The search oscillator provides continuous tuning in any selected column plus an external sweep capability. This is an L-C oscillator which allows the operator to continuously "search" any significant column from 1 Mc to 0.1 cps either manually by a front panel control or remotely by application of a suitable voltage. The typical voltage vs. frequency characteristic is shown in Figure 4. The approximate slope is 10% of the selected column's range per volt.

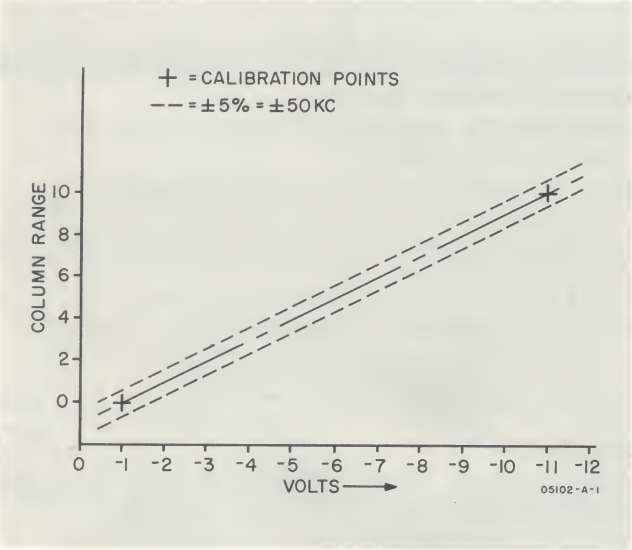


Figure 4.

If the search oscillator is used the stability of the Synthesizer output is determined by either that of the standard instrument or that of the search oscillator—depending on the column which is "searched." The search oscillator has a root-mean-square deviation of approximately 1 cycle (one second average) if used in the most significant column that can be searched (1 Mc steps). This Δf_{rms} is reduced by a factor of 10 for each less significant column that is searched. As an example, consider that the search oscillator is used in the 10 Kc column, at an output frequency of 1 Mc. The instability in the output frequency due to the search oscillator is then:

$$\frac{\Delta f_{rms}}{f_{out}} = \frac{0.1 \text{ cps}}{1 \times 10^6 \text{ cps}} = 1 \times 10^{-7}$$

At this output frequency, and using one second averaging, the short term stability of the Synthesizer itself is on the order of 1×10^{-10}. Consequently, the search oscillator governs in this case, but this is very stable for a sweep oscillator application.

The search oscillator may be frequency modulated from an external source at a maximum sine wave rate of 1 Kc while retaining the voltage control calibration.

SPECIFICATIONS

OUTPUT FREQUENCY: 1 MC RANGE—50 cps to 1 Mc. 10 MC RANGE—50 cps to 10 Mc.

OUTPUT LEVEL: Continuously adjustable from 300 mv to 1 volt RMS, ± 1 db, into a 50 ohm resistive load, source impedance 50 ohm nominal (front panel OUTPUT BNC).

AUXILIARY OUTPUTS:

LO LEVEL; 1 MC RANGE—DC to 1 Mc (f_o). 10 MC RANGE—DC to 10 Mc. (Output on rear panel.)

f_o + 30 MC; 30 to 31 Mc range simultaneously available at rear output BNC. (f_o is selected frequency, DC to 1 Mc, independent of RANGE setting.)

FREQUENCY STANDARD; 1 Mc buffered output available continuously at rear BNC.

LEVELS, AUXILIARY OUTPUTS:

LO LEVEL, 20 millivolts RMS (minimum, ± 1 db, plus capacitive loading effects) open circuit. Source impedance 10,000 ohms with approx. 70 pf shunt capacitance.

f_o + 30 MC; 1 volt RMS, ± 2 db into a 50 ohm resistive load.

FREQUENCY STANDARD; 1 volt RMS, ± 1.5 db into a 50 ohm resistive load.

FREQUENCY RESPONSE: Output flat within ± 0.5 db over the entire frequency range at any output level setting on 1 MC RANGE. Flat within ± 1 db over the entire frequency range at any output level setting on 10 MC RANGE.

DIGITAL FREQUENCY SELECTION: 1 MC RANGE; 0.1 cps through 100 Kc per step. 10 MC RANGE; 1 cps through 1 Mc per step. (OUTPUT, LO LEVEL and f_o + 30 Mc.) Selection by front panel pushbuttons or through appropriate rear panel connection.

SWITCHING TIME: < 20 μ seconds for any change in frequency.

SEARCH OSCILLATOR: A search oscillator provides continuously variable frequency selection in any desired column (by depressing the "S" button in that column) over the complete range of that column. Manual coverage by a front panel control or control by an externally applied voltage (— 1 to — 11 volts). The SEARCH OSCILLATOR range may be externally swept up to a 1 Kc rate (with a sinewave input to a rear BNC) with retention of calibration. Linearity is ± 5% of full range in column selected. (See Figure 4.)

SIGNAL-TO-PHASE NOISE RATIO (OUTPUT):*

1 MC RANGE; > 64 db. 10 MC RANGE; > 54 db.

SIGNAL-TO-AM NOISE RATIO (OUTPUT):*

1 MC RANGE; > 74 db for frequencies above 100 Kc. 10 MC RANGE; > 74 db for frequencies above 100 Kc.

SIGNAL-TO-PHASE NOISE RATIO (f_o + 30 Mc):*

> 60 db.

SIGNAL-TO-AM NOISE RATIO (f_o + 30 Mc):*

> 80 db.

RMS FRACTIONAL FREQUENCY DEVIATION (OUTPUT):

1 MC RANGE		10 MC RANGE	
Ave. Time	1 Mc Output Frequency	Ave. Time	10 Mc Output Frequency
10 ms	1×10^{-8}	10 ms	3×10^{-9}
1 sec	1×10^{-10}	1 sec	3×10^{-11}

RMS FRACTIONAL FREQUENCY DEVIATION (f_o + 30 Mc):

Ave. Time	Output Frequency
10 ms	6×10^{-10}
1 sec	1×10^{-11}

SPURIOUS SIGNALS: 1 MC RANGE; > 70 db. 10 MC RANGE; > 50 db. Below selected output, for nonharmonically related signals.

HARMONIC SIGNALS: 1 MC RANGE; > 35 db. 10 MC RANGE; > 35 db. Below selected output, with proper termination.

** In a 30 Kc band centered on the carrier, excluding a 1 cps band centered on the carrier.*

INTERNAL FREQUENCY STANDARD

TYPE: 1 Mc Quartz Oscillator.

AGING RATE: Less than $\pm$ 3 parts in 10^9 per 24 hours.

STABILITY: As a function of ambient temperature: $\pm$ 2 x 10^{-10} per °C from 0°C to + 55°C.

As a function of line voltage: $\pm$ 5 x 10^{-11} for a $\pm$ 10% change in line voltage (rated at 115 or 230 volts rms line voltage).

RMS FRACTIONAL FREQUENCY DEVIATION:

Ave. Time	1 Mc Output Frequency
10 millisec	6 x 10^{-10}
1 sec	1 x 10^{-11}

SIGNAL-TO-PHASE NOISE RATIO:* > 85 db.

SIGNAL-TO-AM NOISE RATIO:* > 80 db.

HARMONIC SIGNALS: > 40 db below the output (with proper termination).

PHASE LOCKING CAPABILITY: A voltage control feature allows 5 parts in 10^8 frequency control for — 5 to + 5 volts applied externally.

EXTERNAL FREQUENCY STANDARD

INPUT REQUIREMENTS: 1 Mc or 5 Mc, 0.2v rms minimum, 5v maximum across 500 ohms. Stability and spectral purity of 5103A FREQUENCY SYNTHESIZER will be partially determined by the characteristics of the external standard if used.

** In a 30 Kc band centered on the carrier, excluding a 1 cps band centered on the carrier.*

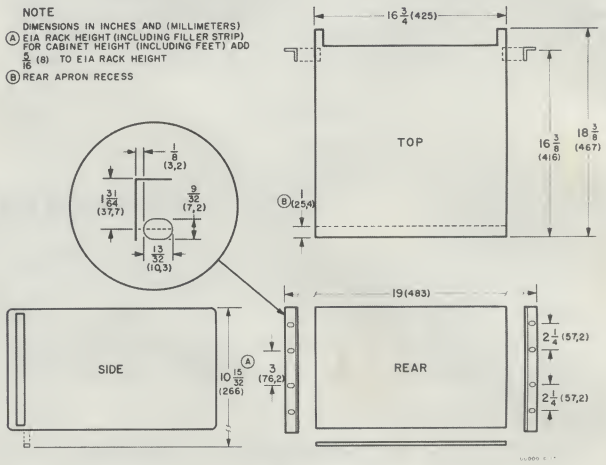
GENERAL

OPERATING TEMP. RANGE: 0 to + 55°C.

INTERFERENCE: Sample tested to MIL-I-6181D; MIL-I-26600, class 1 and 3.

CONNECTORS: 2 ea. 50 pin Amphenol number 57-40500, REMOTE CONTROL. 1 ea. BNC for the following: 1 Mc frequency standard output, rear; Phase locking control input, rear; 1 or 5 Mc frequency standard input, rear; Search Oscillator input, rear; f_o + 30 Mc output, rear; DC to maximum frequency output (LO LEVEL), rear; 50 cps to maximum frequency output, rear (through access hole covered by plug-button), or front.

DIMENSIONS:



WEIGHT: Net, 75 lbs. *(34 kg)*. Shipping, 127 lbs. *(58 kg)*.

Prices f.o.b. factory
Data subject to change without notice

HEWLETT hp PACKARD

FREQUENCY SYNTHESIZER

model 5102A

TENTATIVE DATA 1/15/65

DUAL RANGE
DC TO 100 KC AND DC TO 1 MC

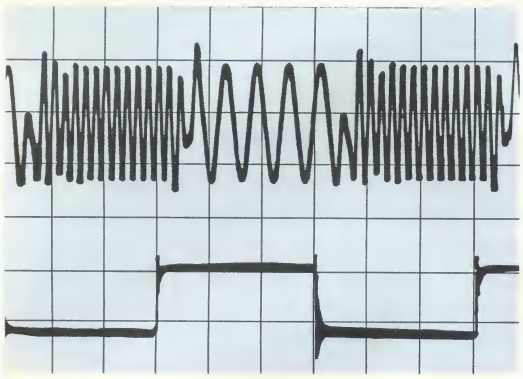
DIGITAL FREQUENCY SELECTION

SEARCH OSCILLATOR

SPURIOUS 70 DB DOWN

20 MICROSEC SWITCHING SPEED

ALL SOLID STATE



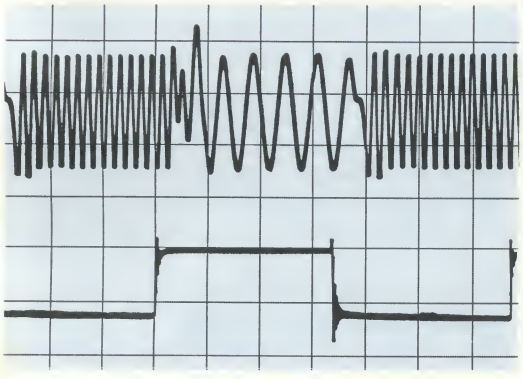
999.9 Kc to 333.3 Kc, 30 Kc switching rate, 5 μsec/cm

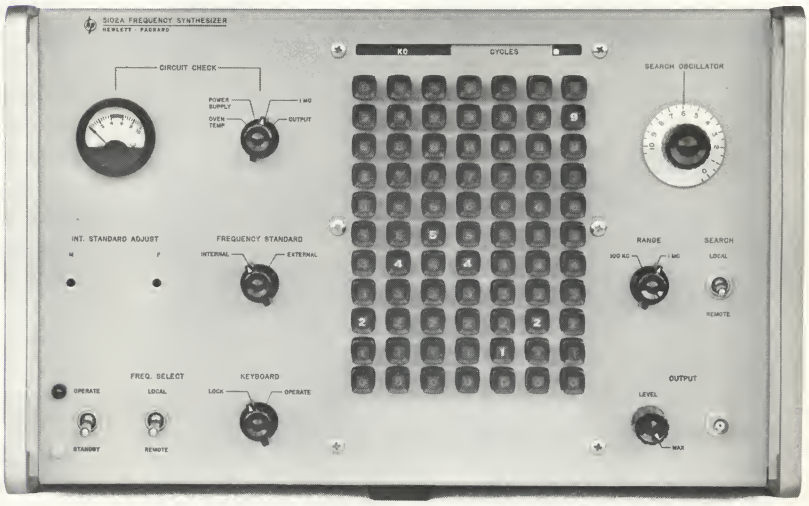
The HEWLETT-PACKARD MODEL 5102A FREQUENCY SYNTHESIZER provides any output frequency from 0.1 cps to 1 Mc, selectable in steps as small as 0.1 cps OR from 0.01 cps to 100 Kc in steps as small as 0.01 cps. The 100 Kc or 1 Mc maximum frequency output is selectable by a front panel RANGE switch. The output frequencies are digitally selected by front panel push-buttons, remote control, or a combination of the two. Each significant column may be continuously varied over its range by local or remote use of the SEARCH oscillator.

A level control is provided to allow adjusting the voltage output level between 300 mv and 1 volt RMS. The output frequency is derived from a precision single frequency source through direct synthesis, a technique which translates the stability of the frequency source to the selected output. A precision quartz oscillator provided in the instrument or an external 1 Mc (or 5 Mc) frequency standard may be used as the frequency source.

HIGH SPEED SWITCHING

990 Kc to 330 Kc, 30 Kc switching rate, 5 μsec/cm





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Printed in U.S.A.

DESIGN FEATURES

Solid state modular construction has been used throughout the 5102A. The modular concept enhances serviceability and enables the system to meet the stringent demands regarding spurious signals. Careful design and quality control insure that all modules are interchangeable from one instrument to another.

Particular care has been taken to insure an extremely clean output signal over the entire frequency range of the 5102A. This high order of spectral purity (and stability) is essential for accurate doppler measurements, spectroscopy, narrow band telemetry, or communication work and similar applications. The design and construction of the HEWLETT-PACKARD FREQUENCY SYNTHESIZER make it possible to obtain output signals with spurious content at least 70 db below the selected output, dc to 1 Mc, in the 1 MC RANGE position, and at least 90 db below the selected output, dc to 100 Kc, in the 100 KC RANGE position.

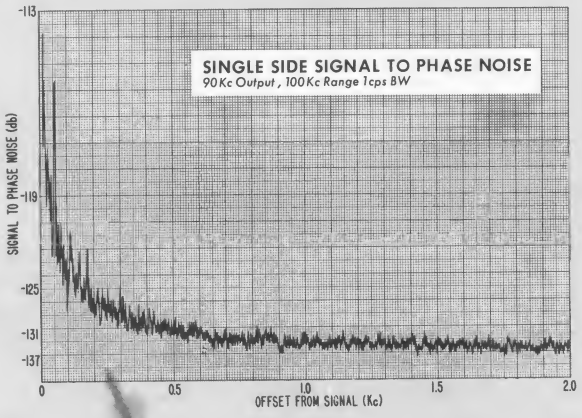
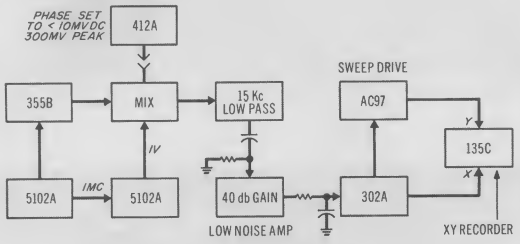


Figure 1.



MEASUREMENT SET-UP FOR NOISE PLOTS

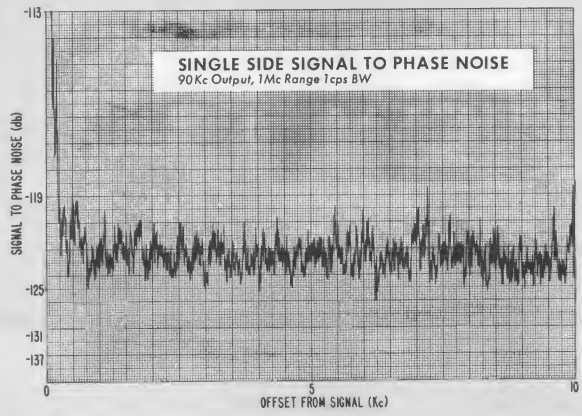


Figure 2.

05102-C-1

The extremely good signal-to-phase noise characteristics of a typical 5102A synthesizer, in both the 100 KC RANGE position and the 1 MC RANGE position are shown in Figure 1 and Figure 2. Figure 3 shows a log plot of the single side phase noise.

These typical plots show the performance of the 5102A in applications requiring low noise; for example, local oscillator control in VLF Receiver/Transmitter work.

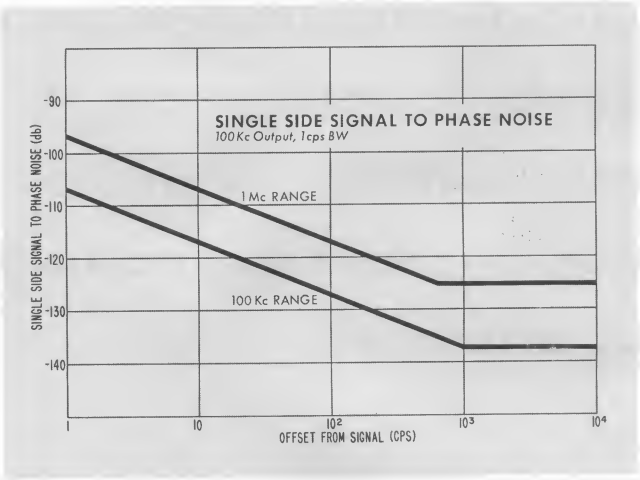


Figure 3.

OPERATIONAL FEATURES

Remote control is a standard feature on the 5102A. Any frequency or search oscillator position that can be selected by front panel push-buttons may also be remotely selected. Connectors located on the 5102A rear panel provide pins corresponding to each front panel push-button position, a ground connection, and a — 12.6 volt line for use in remote control. The — 12.6 voltage is available in two arrangements: continuous and switched (present when REMOTE mode is selected at front panel). This lends additional versatility since it enables the use of a combination of remote and local control. The combination of local and remote control can be used with the FREQUENCY SELECT switch in LOCAL. In this switch position, any column not selected locally by depressing a push-button in that column may be remotely controlled. Since no phase-locked loops are involved, switching from one output frequency to another can be accomplished very rapidly, either from the front panel push-buttons or remotely. Less than 20 μ seconds is required to change the output frequency. The two oscilloscope trace reproductions on the cover of this data sheet are typical results. For the 20 μs switching speed the controller must provide a low impedance connection to the — 12.6 volts for the "on" condition and + 1.5 volts for the "off" condition.

The search oscillator provides continuous tuning in any selected column plus an external sweep capability. This is an L-C oscillator which allows the operator to continuously "search" any significant column from 100 Kc to 0.01 cps either manually by a front panel control or remotely by application of a suitable voltage. The typical voltage vs. frequency characteristics is shown in Figure 4. The approximate slope is 10% of the selected column's range per volt.

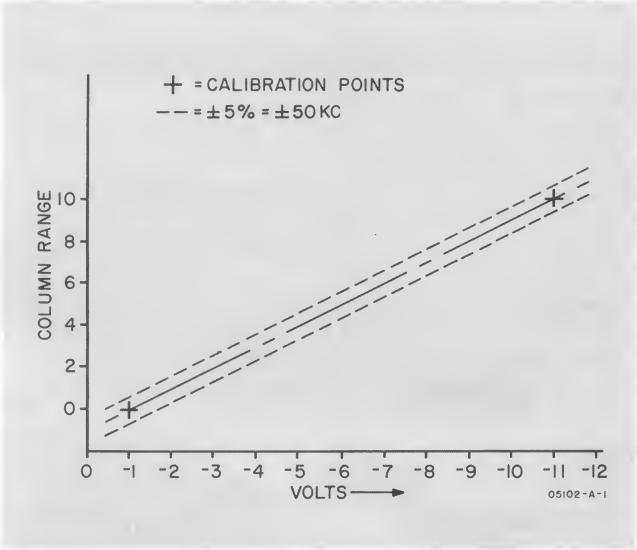


Figure 4.

If the search oscillator is used, the stability of the Synthesizer output is determined by either that of the standard instrument or that of the search oscillator—depending on the column which is "searched." The search oscillator has a root-mean-square deviation of approximately 1 cycle (one second average) if used in the most significant column that can be searched (100 Kc steps). This Δf_{rms} is reduced by a factor of 10 for each less-significant column that is searched. As an example, consider that the search oscillator is used in the 10 Kc column, at an output frequency of 1 Mc. The instability in the output frequency due to the search oscillator is then:

$$\frac{\Delta f_{rms}}{f_{out}} = \frac{0.1 \text{ cps}}{1 \times 10^6 \text{ cps}} = 1 \times 10^{-7}$$

At this output frequency, and using one second averaging, the short term stability of the Synthesizer itself is on the order of 1×10^{-10}. Consequently, the search oscillator governs in this case, but this is very stable for a sweep oscillator application.

The search oscillator may be frequency modulated from an external source at a maximum sine wave rate of 1 Kc while retaining the voltage control calibration.

SPECIFICATIONS

OUTPUT FREQUENCY: 100 KC RANGE—50 cps to 100 Kc. 1 MC RANGE—50 cps to 1 Mc.

OUTPUT LEVEL: Continuously adjustable from 300 mv to 1 volt RMS, ± 1 db, into a 50 ohm resistive load, source impedance 50 ohm nominal (front panel OUTPUT BNC).

AUXILIARY OUTPUTS:

LO LEVEL; 100 KC RANGE—DC to 100 Kc. 1 MC RANGE—DC to 1 Mc (f_o). (Output on rear panel.)

f_o + 30 MC; 30 to 31 Mc range simultaneously available at rear output BNC. (f_o is selected frequency, DC to 1 Mc, independent of RANGE setting.)

FREQUENCY STANDARD; 1 Mc buffered output available continuously at rear BNC.

LEVELS, AUXILIARY OUTPUTS:

LO LEVEL; 80 millivolts RMS (minimum, ± 1 db, plus capacitive loading effects) open circuit. Source impedance 1000 ohms with approx. 70 pf shunt capacitance.

f_o + 30 MC; 1 volt RMS, ± 2 db into a 50 ohm resistive load.

FREQUENCY STANDARD; 1 volt RMS; ± 1.5 db into a 50 ohm resistive load.

FREQUENCY RESPONSE: Output flat within ± 0.5 db over the entire frequency range at any output level setting.

DIGITAL FREQUENCY SELECTION: 100 KC RANGE; 0.01 cps through 10 Kc per step. 1 MC RANGE; 0.1 cps through 100 Kc per step. (OUTPUT, LO LEVEL and f_o + 30 Mc.) Selection by front panel push-buttons or through appropriate rear panel connection.

SWITCHING TIME: < 20 μ seconds for any change in frequency.

SEARCH OSCILLATOR: A search oscillator provides continuously variable frequency selection in any desired column (by depressing the "S" button in that column) over the complete range of that column. Manual coverage by a front panel control or control by an externally applied voltage (— 1 to — 11 volts).

The SEARCH OSCILLATOR range may be externally swept up to a 1 Kc rate (with a sinewave input to a rear BNC) with retention of calibration. Linearity is ± 5% of full range in column selected. (See Figure 4.)

SIGNAL-TO-PHASE NOISE RATIO (OUTPUT):* 100 KC RANGE; > 74 db. 1 MC RANGE; > 64 db.

SIGNAL-TO-AM NOISE RATIO (OUTPUT):* 100 KC RANGE; > 80 db for frequencies above 30 Kc. 1 MC RANGE; > 74 db for frequencies above 100 Kc.

SIGNAL-TO-PHASE NOISE RATIO (f_o + 30 Mc):* > 60 db.

SIGNAL-TO-AM NOISE RATIO (f_o + 30 Mc):* > 80 db.

RMS FRACTIONAL FREQUENCY DEVIATION (OUTPUT):

100 KC RANGE		1 MC RANGE		
Ave. Time	100 Kc Output Frequency	Ave. Time	100 Kc Output Frequency	1 Mc Output Frequency
10 ms	3×10^{-8}	10 ms	1×10^{-7}	1×10^{-8}
1 sec	3×10^{-10}	1 sec	1×10^{-9}	1×10^{-10}

RMS FRACTIONAL FREQUENCY DEVIATION (f_o + 30 Mc):

Ave. Time	Output Frequency
10 msec	6×10^{-10}
1 sec	1×10^{-11}

SPURIOUS SIGNALS: 100 KC RANGE; > 90 db down. 1 MC RANGE; > 70 db down (non-harmonically related signals).

RANGE; > 70 db down.

HARMONIC SIGNALS: > 35 db below the selected frequency (with proper termination).

** In a 30 Kc band centered on the carrier, excluding a 1 cps band centered on the carrier.*

INTERNAL FREQUENCY STANDARD

TYPE: 1 Mc Quartz Oscillator.

AGING RATE: Less than $\pm$ 3 parts in 10^9 per 24 hours.

STABILITY: As a function of ambient temperature: $\pm$ 2 x 10^{-10} per °C from 0°C to + 55°C.

As a function of line voltage: $\pm$ 5 x 10^{-11} for a $\pm$ 10% change in line voltage (rated at 115 or 230 volts rms line voltage).

RMS FRACTIONAL FREQUENCY DEVIATION:

Ave. Time	1 Mc Output Frequency
10 millisec	6 x 10^{-10}
1 sec	1 x 10^{-11}

SIGNAL-TO-PHASE NOISE RATIO:* > 85 db

SIGNAL-TO-AM NOISE RATIO:* > 80 db

HARMONIC SIGNALS: > 40 db below the output (with proper termination).

PHASE LOCKING CAPABILITY: A voltage control feature allows 5 parts in 10^8 frequency control for — 5 to + 5 volts applied externally.

EXTERNAL FREQUENCY STANDARD

INPUT REQUIREMENTS: 1 Mc or 5 Mc, 0.2 v rms minimum, 5 v maximum across 500 ohms. Stability and spectral purity of 5102A FREQUENCY SYNTHESIZER will be partially determined by the characteristics of the external standard if used.

** In a 30 Kc band centered on the carrier, excluding a 1 cps band centered on the carrier.*

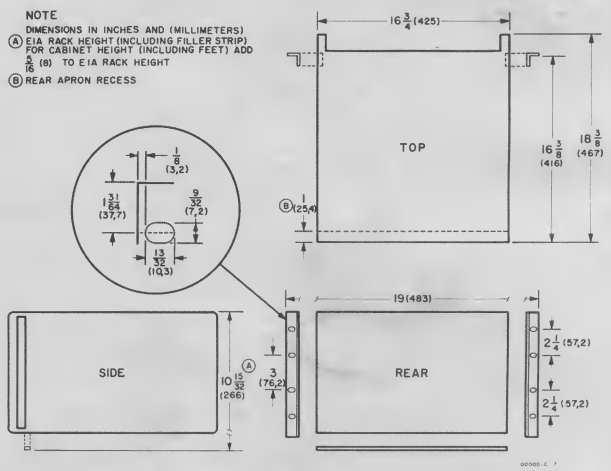
GENERAL

OPERATING TEMP. RANGE: 0 to + 55°C.

INTERFERENCE: Sample tested to MIL-I-6181D; MIL-I-26600, Class 1 and 3.

CONNECTORS: 2 ea. 50 pin Amphenol number 57-40500, REMOTE CONTROL 1 ea. BNC for the following: 1 Mc frequency standard output, rear; Phase locking control input, rear; 1 or 5 Mc frequency standard input, rear; Search Oscillator input, rear; f_o + 30 Mc output, rear; DC to maximum frequency output (LO LEVEL), rear; 50 cps to maximum frequency output, rear (through access hole covered by plug-button), or front.

DIMENSIONS:



WEIGHT: Net, 75 lbs. *(34 kg).* Shipping, 127 lbs. *(58 kg).*

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