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Programmable DC Output with the DDS9m or 409B
AN004

Introduction:

The Models DDS9m and 409B provides four synchronized sinewave outputs which can be independently controlled in frequency, phase, and amplitude. The frequency of each channel is programmable with 32-bits of resolution (0.1Hz using default clock) and phase can be controlled with 14-bits of resolution (0.022°), along with 10-bits of amplitude resolution. These features can be used to generate a variable DC output voltage.

Setting the Output Voltage:

Each of the four sinewave output channels on the DDS9m and 409B is direct coupled to the DDS (direct digital synthesizer). Since a frequency of zero Hertz (DC) can be programmed, there are two ways to set a programmable level on the outputs.

The output set by the DDS generator is:

$$Vo = Va*\sin(2*\pi*F*t+P)$$

where Va is the maximum amplitude in volts, F is the output frequency, P is the output phase, with time, t, as the variable. If F is set to zero:

$$Vo = Va*\sin(P)$$

Va is programmable over a 10-bit range by the "Vn N" command and P is controlled over a 14-bit range by the "Pn N" command. Either can be chosen as your control variable. Since the absolute phase is needed, the "M a" command must be sent before using these techniques.

Example using Va, via the "Vn N" command:

To use the control of Va to set a DC output, the frequency needs to be set zero and the value of the sin(P) term must be maximized. This requires setting the mode to auto and the phase to 90°. The phase must be set to 4096 to get +90° for positive outputs. The command sequence to set up a channel to output a DC voltage in this example is (shown for channel 0):

```
M a
F0 0
P0 4096
```

That will set the output to approximately +1 Volt. The "Vn N" command is then issued to scale the output:

```
V0 512
```

will result in a half scale output, or approximately 0.5V into an open circuit. For negative outputs, the

command sequence would be (setting -90°):

```
M a
F0 0
P0 12288

V0 512
```

to get approximately -0.5 Volt.

Note that is isn't necessary to resend the mode, frequency or phase commands after the channel is configured for a DC output. This method provides 10-bits of control over the full positive scale and full negative scale range, or approximately 1mV. The output is linear with the setting method.

Example using P, via the "Pn N" command:

Finer resolution control of the DC voltage can be obtained by using the phase command, which provides a 14-bit range. The trade-off is now the output voltage follows the sine of the input phase. As before, the mode must be set to auto and the frequency to zero Hertz:

```
M a
F0 0
```

Now, however, the "Pn N" command provides the control. Recall that the output is:

$$Vo = Va*\sin(P)$$

with Va=1 V into an open circuit by default. So this reduces to:

$$Vo = \sin(P)$$

which shows that the amplitude follows the sine of the input phase. If the same half scale outputs were desired ($\sin(30^\circ)=0.5$):

```
P0 1365
```

for +0.5 Volts, and:

```
P0 15019
```

for -0.5 Volts ($\sin(330^\circ)=-0.5$). This is based upon a full 360° being equal to 16,384 (14-bits).
The user must calculate the appropriate angle and scale it to fit into the 14-bit range of the phase command.

The DDS9m and 409B are designed as frequency synthesizers, so the DC accuracy of the output is not "calibrator" accurate or stable, but these DC outputs can be used with an offset is needed.

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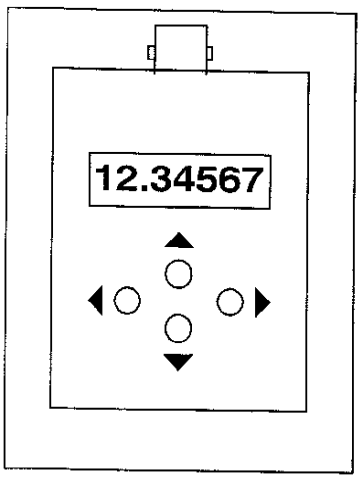
12MHz DDS Signal Generator Module
Model 101A



The Model 101A is a modular signal generator using Direct Digital Synthesis (DDS) to produce a sine or square wave up to 12.99999MHz. The output is programmable using four front panel cursor push buttons and an eight character liquid crystal display (LCD). The output frequency can be set with 10Hz resolution over the full frequency range. The output amplitude of 0.5Vrms into 50Ω is suitable for most applications. An LVCMOS output at the same frequency as the sine wave is also available by moving a jumper. The Model 101A can be powered continuously by two LR6 (AA) cells for 8 hours, or can use 2.8V for embedded applications. The frequency range of the Model 101A facilitates audio and baseband RF testing, as well as acting as a digital clock source.

Specifications:

OUTPUT

TYPES: Sine or LVCMOS Square wave.
IMPEDANCE: 50Ω.
RANGE: 10Hz to 12.99999MHz with 10Hz resolution in one continuous range.
AMPLITUDE: Sine: approximately $0.5V_{rms}$ into 50Ω @1MHz ($1.41V_{pp}$). LVCMOS: $3V_{pp}$ OC, $1.5V_{pp}$ into 50Ω. t_r, t_f <1ns.

CONTROL

Front panel push buttons and display allow setting of output. LCD shows frequency in MHz. RS232 (±3 V levels) serial port at 9600 Baud can also be used without the display for embedded applications. The Save button, or serial Save command, stores instrument settings in EEPROM. This allows the 101A to be pre-programmed for embedded applications.

ACCURACY AND STABILITY

Accuracy of ±0.005% at 20°C and a stability of ±0.0025% from +5 to +40°C.

SPECTRAL PURITY (50Ω load, span 25MHz, Sine Output)

Phase Noise:<-100dBc, 10kHz offset, 1MHz output.

Spurious:	<-50dBc below 1MHz
	<-30dBc below 10MHz
Harmonic:	<-40dBc below 1MHz
	<-25dBc below 12MHz

POWER REQUIREMENTS

DC Input: Nominal $+2.8V_{dc}$ ($2.0\text{-}3.0V_{dc}$) at <100mA. Two LR6 (AA) alkaline cells will power the Model 101A for at least 8 hours of operation (operates down to less than 1.0V per cell). Two-cell LR6 battery holder with attached connector provided.

SIZE

80mm L, 61mm W, 12mm H. excluding connectors. An additional 10mm is added to the height when the display is attached. Mounting holes and rubber feet provided.

ENVIRONMENTAL

Temperature: +5°C to +50°C operating. Humidity: 80% to 31°C, decreasing linearly to 50% at 40°C.

CONNECTORS

BNC for output. Jumper to select Sine or LVCMOS. 2-pin friction-lock header for DC input. 3-pin friction-lock header for RS232. A connector free version is available for OEM applications (101A/01).

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NOVATECH INSTRUMENTS, INC.
P.O. Box 55997
Seattle, WA 98155-0997
United States of America
http://www.novatech-instr.com/
sales@novatech-instr.com
206.363.4367 FAX/206.301.8986 Voice