

NOVATECH INSTRUMENTS

171 MHz Four Channel Signal Generator Model 409C



The 409C is a small signal generator with four output channels. Each channel can be programmed to generate a frequency from 0.1Hz to 171MHz. The frequencies of the four outputs can be independently set and can be offset from each other by 14-bits (0.02°) of programmable phase. The sine wave amplitudes are 10-bit programmable.

The 409C is programmed by sending it simple text commands using a USB serial interface. All settings can be stored in non-volatile memory. A windows program is included and provides a graphical interface for generating the serial commands, allowing simple control of the 409C.

The 409C uses a single master clock for all four output channels. The master clock can be an internal TCXO oscillator or the user can supply an external master clock. Using a precision external 10MHz signal and the /R option, the user can generate very accurate output signals with frequency uncertainties in the 10^{-11} ppm range.

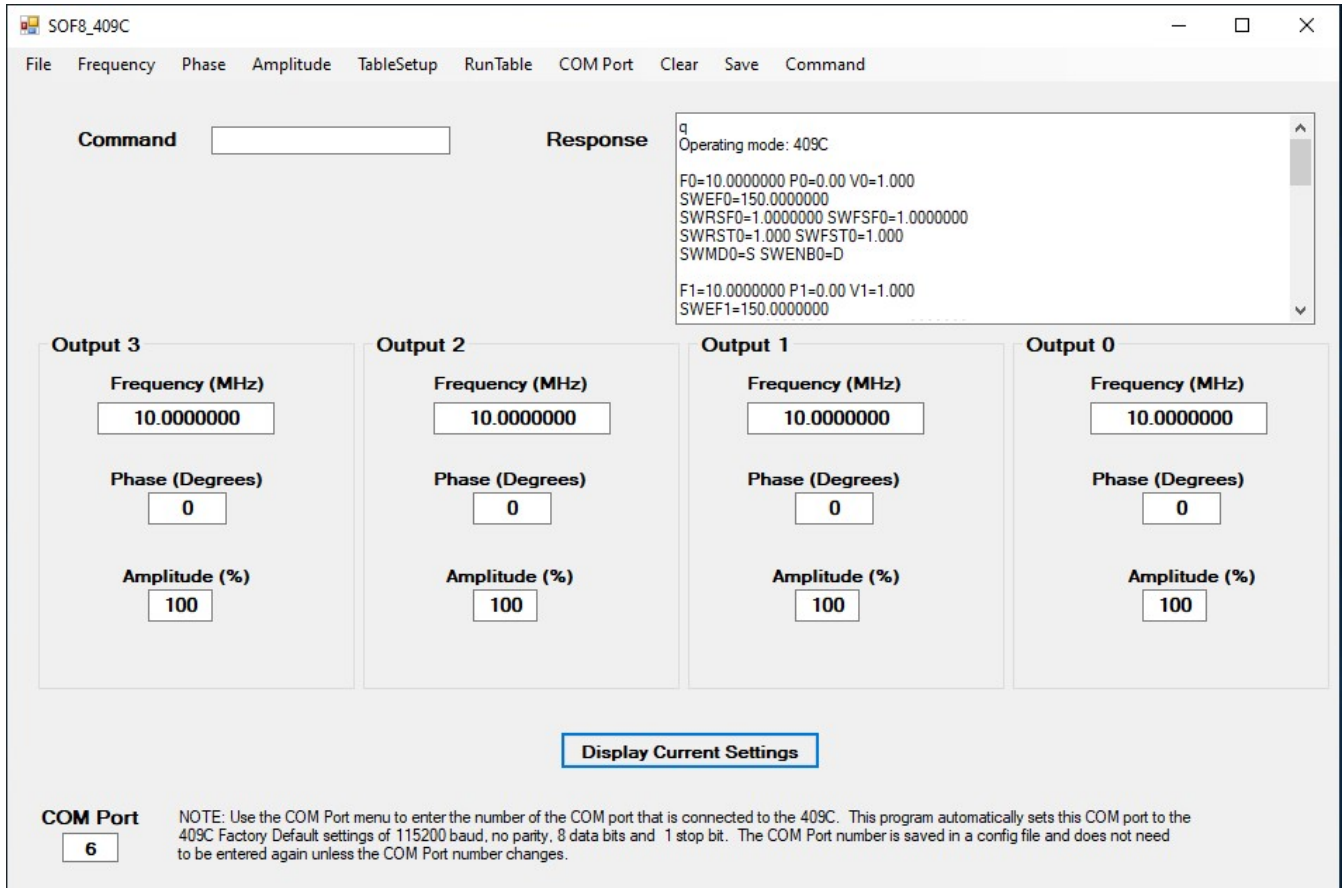
Model 409C Table Mode

The 409C has flash memory, configured as a Table, to enable agile frequency, phase and amplitude modulation and hopping.

The 409C can move through the table as fast as one row every 13 microseconds. Stepping through the Table can also be controlled using external customer supplied hardware triggers.

Model 409C Frequency Sweeping

The 409C can be programmed to automatically perform CHIRP frequency sweeping. The user enters a beginning frequency, ending frequency, frequency step size and a time duration for each step. The 409C can then automatically do the sweep using these parameters. The time for each frequency step can be as short as 9 nanoseconds and the frequency step size can be as short as 1Hz.



SOF8_409C Windows Software

The Model 409C comes with a free copy of the SOF8_409C Software on a USB Memory Stick. The SOF8_409C Software is a Microsoft Visual Basic application that runs in all versions of Microsoft Windows. It provides drop down menus to make it easy for users to control most functions of the 409C.

The File menu enables the user to load data from external text files to run scripts and to upload data into the 409C Table. The Frequency, Phase and Amplitude menus make it easy to set these parameters. The Table Setup menu makes it easy to create a Table and then run it using the RunTable menu.

The COM menu enables the display of all the available COM ports on the computer and makes it easy to select the port connected to the 409C. Multiple copies of the SOF8_409C can be run at the same time by setting each copy to a different COM port. This enables one computer to control multiple 409C.

The Command menu is used for sending commands as text strings to the 409C. Display fields show the 409C settings including the frequency, phase and amplitude of each output channel.

USB Serial Control of the 409C

The frequency, Amplitude and Phase of each of the four 409C output channels can be independently controlled by sending text commands to the 409C using the 409C USB serial interface. Commands are also able to control the source for the master 409C clock, to save settings to flash memory and perform a number of other functions. The list of serial commands is shown below.

409C Serial Commands (Not case sensitive)

Command	Function	Command	Function
Fn xxx.xxxxxxx	Set Frequency of output “n” in MHz to nearest 0.1Hz. n=0, 1, 2 or 3. Decimal point not required. 0.00 sets a channel to DC. Maximum setting: 171.1276031 MHz. Single tone mode.	R	Reset. This command resets the 409C to the same state as after power-up or cycling power, except the baud rate remains unchanged (cycling power will reset the baud rate to 115.2KBaud).
Fd	Stores the External Direct Input frequency in MHz. Used with the C D command. Valid entries are 1.000000 to 500.000000.	CLR	Clear. This command resets all factory default values except for the values stored in table memory. Use the TCLEAR command to reset the table to an empty state.
Fr	Stores the External Reference Input frequency in MHz. Used with C E command. Valid entries are 10.000000 to 125.000000.	S	Save. Saves Frequency, Amplitude, Amplitude Scale Factor, Relative Phase, Phase Reset Mode, Update Mode, Active Table Range, Table Dwell Scaling and Echo settings to flash memory. Does not save the Table Rows. Use TSAVE to save Table Rows. Saved values will be the default settings upon next power up or reset. Use the “CLR” command to return to factory default values.
C x	Select Clock Source. Set x=i for internal clock (the default). Set x=e for external reference. Set x=d for direct input.	Q	Returns the current values of the non-volatile settings and the firmware version.
Pn xxx.xx	Set Relative Phase of output “n” in degrees. n=0,1,2 or 3. N= 0.00 to 359.99. Single tone mode.	M x	Phase Mode. x=N means the phase will not be reset with every update. This is the default mode. x=A means the phase will be reset on every update. x=S will force a manual update.
Vn x.xxx	Set the Amplitude of output channel “n”. n=0,1,2 or 3. The amplitude indicates the signal level in Vpp when driving a 50 ohm load. Maximum amplitude setting is 1.000 . The default amplitude is set to the maximum. If the amplitude scale factor is not 1, the Vn command specifies the output amplitude before the amplitude scale factor is applied.	I x	I/O Update (IOUD). If x=a, then an IOUD update pulse is automatically sent at the end of each serial command. This is the default. If x=m, then an IOUD update pulse must be sent manually. If x=p a manual IOUD update pulse is sent. If x=e, then the IOUD is changed from an output to an input. If x=s, then external TS inputs are enabled. If x=d the external TS inputs are disabled.
Vs n	Set the output Amplitude Scale Factor . n=1 for full scale, n=2 for one half scale, n=4 for one quarter scale and n=8 for one eighth scale. All channels are scaled equally		
E x	Serial Echo control. x=D for Echo Disable, x=E for Echo Enable		

409C /R Option, Lock to Reference

Option /R changes the function of the rear mounted BNC connector and adds a /R option daughter board inside the 409C. The daughter board detects when a 10MHz signal has been applied to the rear BNC connector and then phase locks the oscillator

on the daughter board to the externally applied 10MHz signal. This improves the accuracy and stability of the 409C so that it is equal to the accuracy of the supplied 10MHz signal. Improvements in frequency accuracy by factors of better than 10,000 are achievable using option /R.

409C Frequency Sweeping

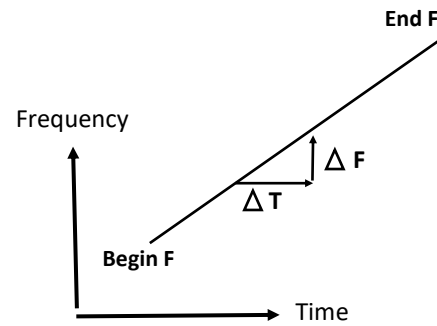
The 409C Models with firmware version 1.6 or higher have a sweep feature that enables the user to set a begin frequency, an end frequency a frequency step size and a frequency step time for each output channel. The frequency step time can be as small as 9 nanoseconds and as large as 2.2 seconds. There are two types of sweep modes as follows:

Single Mode, where a software command or hardware trigger will cause the 409C to sweep from the begin frequency to the end frequency and then step back down to the begin frequency.

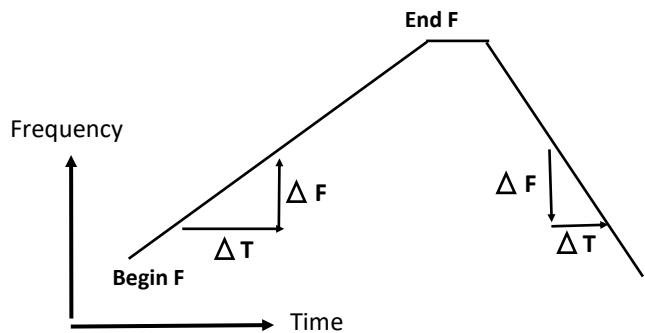
Dual Mode, where a software command or hardware trigger will cause the 409C to sweep from the begin frequency to the end frequency and then pause to wait for a second trigger. After the second software or hardware trigger is executed, the 409C will sweep from the end frequency back down to the begin frequency. The frequency and step sizes for the sweep up and the sweep down are independently programmed for each channel.

FREQUENCY SWEEP MODES

Single Mode



Dual Mode



Frequency Sweep Serial Commands.

Command	Frequency Sweep Function
SWENBn x	Enable Sweeping. n = Output channel number, x = E for enable or x = D for disable
SWMDn x	Sweep Mode. n = Output channel number, x = S sets single ramp up step down, x = D sets dual ramp up and ramp down.
SWEFn xxx.xxxxxxx	Ending Frequency. n = Output channel number, xxx.xxxxxxx = Ending frequency in MHz. (Beginning frequency is set by the Fn xxx.xxxxxxx command)
SWRSFn xxx.xxxxxxx	Rising Frequency Step Size. n = Output channel number, xxx.xxxxxxx = Frequency step size in MHz
SWFSFn xxx.xxxxxxx	Falling Frequency Step Size. n = Output channel number, xxx.xxxxxxx = Frequency step size in MHz
SWRSTn t	Rising Time Step Size. n = Output channel number, t = Step size in Microseconds
SWFSTn t	Falling Time Step Size. n = Output channel number, t = Step size in Microseconds
PPn x	Set Trigger Logic Level. n = Output channel number, x = 0 sets trigger Low or x = 1 sets trigger high, x = x enables external hardware triggers.

409C Table Feature

The Model 409C contains flash memory capable of storing up to 14,249 rows of data in a table format. Each row contains the frequency, phase and amplitude setting for one or up to four output channels. Commands are provided to enable the user to load data into the table and define a set of rows and then automatically step through them one time or continuously cycle through them. Each row also stores a dwell time that is used when automatically moving through the table in order to control how long the parameters in the row are maintained before stepping to the next row. The user can also move through the table a single step at a time by sending a command or using a hardware logic input to trigger the table to move to the next row. The Table commands are shown below.

409C Table Commands (Not Case Sensitive)

Command	Table Function ([...] indicates optional parameters)
T r d c f p a [c f p a][c f p a][c f p a]	T Command. Enters a row into the table. Where r=row, d=dwell, c=channel, f=frequency, p=phase and a=amplitude. One channel set consisting of 'c f p a' values is required. Up to three additional channel sets as indicated by [...] is optional. The entire T command must be on one line.
TSCALE x	Dwell Scaling Command. 'x' can be 1 or 4. x=1 is the default and sets the maximum dwell time to 8191.875 microseconds. If x=4 then all the dwell times are multiplied by 4 and the maximum dwell time becomes (4 x 8191.875 = 32.7675) milliseconds. Parameter 'x' is saved using the 'S' command.
TSAVE	Save to Flash Command. The T Command creates table data in RAM memory. The TSAVE command saves this RAM table data to flash memory. The table only operates on data that is in flash memory.
D x y	Display Table. Reads and displays the table values from row x to row y.
TRNG x y	Table Range Command. Makes a range of rows in the table Active . The TRUN and TONCE commands only operate on the Active rows. The active rows start at row x and include all rows up to and including row y. Default is the entire table from row 0 to 14249. The parameters x and y are saved using the 'S' command.
TRUN [x y]	Run Table Command. Saves all table rows to flash memory if they have been entered but not saved and starts the table continuously looping through the active table rows. If the optional x and y parameters are entered then the table will loop from row x to row y. Also sets the IOUD signal to an output and disables the TS hardware inputs.
TONCE [x y]	Run Table Once Command. Saves all table rows that have been entered but not saved and causes the table to run once through the active table rows. If the optional x and y parameters are entered then the table will run once from row x to row y. Also sets the IOUD signal to an output and disables TS hardware inputs.
TTRIG [row row]	Run Table Once Hardware Trigger. After this command is run the instrument waits for a trigger input on the external TS pin. Each rising edge on the TS pin will cause the table to be run once. A TSTOP command is required to exit this mode. The range of table rows is specified with the TRNG command or with the optional start and ending row numbers.
TSTOP	Stops the table from running. The state of the channels will be the same as they were when the table was stopped.
TS [x]	Table Step Command. Causes the table to move to the next active row. Does not save table data in RAM to flash memory. You must use the TSAVE command to save to RAM. If the optional 'x' parameter is included it causes the table to go to row x.
TCLEAR	Clear Table Command. Resets all table rows in the table flash memory to the empty state.



409C Rear Panel

409C SPECIFICATIONS

OUTPUTS

TYPES: Four Sine simultaneously (four independent, phase synchronous outputs.)

IMPEDANCE: 50Ω

RANGE: 0.0Hz to 171MHz in 0.1 Hz steps (Sine out, int. clock).

SINE AMPLITUDE: Programmable from 0.000 to 1.000 Vpp into 50Ω (4 dBm)

PHASE: Programmable from 0 to 359.99 degrees

FLATNESS: ±3dB from 1kHz to 150MHz referenced to amplitude at 35 MHz, full scale.

TABLE

Stores up to 14,250 rows each containing row number, dwell time and from 1 to 4 channels of frequency, phase, and amplitude.

CONTROL

All output frequencies (32-bits), amplitudes (10-bits) and phases (14-bits) are independently controlled by sending commands to the USB serial port or by executing rows saved in the 409C table. All outputs and other settings can be saved in non-volatile memory.

FREQUENCY ACCURACY AND STABILITY

Accuracy: $\leq \pm 1.5\text{ppm}$ at 10 to 40°C. Stable to an additional ±1ppm per year, 18 to 28°C. (Internal Clock)

EXTERNAL CLOCK IN

LEVEL: 0.2 to 0.5Vrms sine or square wave. 50Ω.

FREQUENCY: 10MHz to 125MHz with Clock set to External Reference (C e) or 1MHz to 500MHz with Clock set to direct input (C d).

/R OPTION: LOCK TO 10MHz EXTERNAL INPUT

Accepts only 10.00 MHz, ±5ppm on rear panel BNC. Automatically detected. Internal clock locks to and tracks this value. Level must be 0.2 to 0.5 Vrms, sine or square wave into 50Ω.

SPECTRAL PURITY (Typ. 50W load, internal clock, full-scale output)

Phase Noise: <math>< -120\text{dBc}</math>, 10kHz offset, 5MHz out.

Spurious:

<math>< -60\text{dBc}</math> below 10MHz

<math>< -60\text{dBc}</math> below 40MHz

<math>< -55\text{dBc}</math> below 80MHz

<math>< -50\text{dBc}</math> below 160MHz

Harmonic:

<math>< -65\text{dBc}</math> below 1MHz

<math>< -55\text{dBc}</math> below 20MHz

<math>< -45\text{dBc}</math> below 80MHz

<math>< -35\text{dBc}</math> below 160MHz

(channel-channel isolation: <math>< -60\text{dBc}</math>)

POWER REQUIREMENTS

+5.25Vdc (+5.0 to +5.5V)@<math>< 750\text{mA}</math>.

SIZE

39mm H, 107mm W, 172mm L, not including connectors.

CONNECTORS

BNC for Sine Outputs and 10MHz IN. Type B Female for USB Serial control. 2.5mm center positive power receptacle for +5VDC power. 14 pin header for logic I/O (J8), SMA for -AC logic I/O.

LOGIC I/O

Voh >= 2.4V and Vol <= 0.4V when series terminated. Output rise and fall times approximately 100 ns.