

9200 Series, 300 MHz Programmable Pulse Generator

Main Features

- **Variable edge pulses (1 nsec to 1 msec) at rates to 250 MHz**
- **Fast 300 psec edges to 300 MHz**
- **Wide output swings to 32 V at pulse rates to 50 MHz**
- **Modular Architecture**
- **DC amplitude accuracy 1%**
- **Normal and complementary outputs**
- **5 year warranty**

Modular Architecture - Achieves an exceptionally wide range of pulse characteristics. Output modules can be mixed in any combination within the mainframe, making future upgrades as simple as plugging in a new module.

UNPARALLELED ACCURACY AND PRECISION

The 9210 features 10 psec resolution with $\pm(0.5\% + 200 \text{ psec})$ timing accuracy. DC amplitude accuracy is 1%. Accuracy is guaranteed by the built-in calibration system. Automatic load compensation delivers true programmed amplitudes even with non 50 Ohm loads.

EASY, INTUITIVE OPERATION -

Setting the operating parameters couldn't be easier! A bright CRT display shows all related settings at a glance. Pulse parameters and trigger settings are accessible with a single keystroke. Individual parameters are selectable from on-screen system or front-panel select keys. Displays automatically match installed modules. An on-screen graphical icon shows the pulse parameter being affected and setting conflicts are highlighted to prevent setup errors. Up to 16 setup configurations can be stored and recalled from non-volatile memory.

CONTROL WITHOUT COMPROMISE -

Choose the data entry method you prefer, digital or analog. Use the full-featured keypad to enter parameter values with digital precision and speed.

Use the concentric knob if you prefer the interactive analog feel. The analog knob provides both coarse range selection and vernier control, with key-selectable vernier sensitivity.

The 9210 is also fully GPIB compatible, with an easy-to-understand command set and syntax. A built-in command monitor aids in rapid debugging of your test programs.

PLUG-IN MODULARITY

The 9210's pulse output characteristics are determined by the selection of one of three available output modules. The mainframe performs all timing, triggering, interface, and control functions. In this way, the 9210 can meet a wide range of pulse generation applications... from the large amplitude requirements of analog device characterization to the sub-nanosecond transition times required by today's fast digital IC's.

STRAIGHTFORWARD, VERSATILE CONTROLS

1. Display: Large blue keys select the display of pulse, triggering, or control parameters for adjustment.

2. Select: the touch-screen CRT selects individual parameters (like pulse width) for adjustment.

3. Enter: Parameter values can be quickly entered using the numeric keypad, the 1-2-5- sequence rotary ring, or the fine analog rotary control knob.



Model 9211

250 MHz, 1 nsec output module

- 250 MHz, 1nsec output module
- Variable edged... 1nsec to 1 msec
- 5 volt swing into 50 Ohms
- Complementary outputs



Model 9213

50 MHz, 16 volt output module

- 50 MHz pulse repetition rate
- Variable edges... 6.5 nsec to 95 msec
- 16 volt p-p output into 50 Ohms
- 32 volts into high impedance



Model 9214

300 MHz, 300 ps output module

- 300 MHz pulse repetition rate
- 300 psec leading edge
- 5 volt swing into 50 Ohms
- Complementary outputs
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HIGHEST PRECISION & ACCURACY

The 9210 uses a 12-bit ADC and a high resolution TDC to make nearly 1000 calibration measurements to guarantee timing accuracies of <0.5% and edge placement resolution to 10 psec.

AUTOMATIC LOAD COMPENSATION

Test fixtures and jigs can often introduce slight variations in load impedance. The load compensation capability of the 9210 delivers the programmed pulse level to any load from 47 Ohms to 1M Ohm.

CONSTANT PHASE MODE

Constant Phase Mode on the 9210 maintains a constant phase relationship between two channels, even when varying the repetition rate during simultaneous clock and data simulation.

GPIB PROGRAMMABLE

Fully GPIB (IEEE 488.2) compatible with an easy-to-understand, plain English command set and syntax. A built-in GPIB command monitor aids in rapid debugging of automated test programs.

5 YEAR WARRANTY, BY DESIGN

The 9210 Pulse Generator has a unique five year warranty. It's not an extended warranty... it's the standard warranty. The 9210 is guaranteed to meet its specs, continuously and reliably, for five full years. This type of warranty is made possible by designing in plenty of margin in the 9210's components and specifications. Component and connector counts are low, cooling is generously provided, and automated testing routines are extensive.

ALL THIS AT A PRICE YOU CAN AFFORD -

Compare the cost of the Model 9210 with that of comparable instruments. Even with all its innovative features and high performance, the Model 9210 is competitively priced.

Functional Description

The LeCroy Series 9210 Pulse Generator is a high performance programmable pulse generator which uses a flexible modular architecture. The system can be performance matched to a wide range of pulse generator applications by the selection of the appropriate plug-in output modules. The modular architecture allows the pulse generator to be re-configured to match changing needs at minimum cost. The following three output modules are available, offering picosecond edges, high output swings, and wide rise time variability.

Model 9211 - 250 MHz Variable Edge Output Module

Model 9213 - 50 MHz Variable Edge Output Module

Model 9214 - 300 MHz 300 psec Edge Output Module

Plug-ins can be used in any combination and changed easily at any time. Pulse parameters for each output module, including delay, width, and transition times, are independently adjustable. The modules share a common timebase and trigger mode.

The timebase in the 9210 mainframe offers six operating modes including: normal (free run) mode; four triggered modes including single, burst, gated, and external width; and double pulse mode. The unit can be triggered by an external signal, front panel manual push-button, or via GPIB. External trigger threshold is user-programmable either manually or with an automatic trigger level adjustment. In externally triggered modes the external trigger frequency is measured by an internal frequency counter and displayed on the CRT.

An output trigger pulse, with programmable or preset TTL or ECL compatible levels, is available for synchronization.

The 9210 Series sets a new standard for accuracy and precision. It achieves 5 mV amplitude resolution with 1% DC accuracy. Its time resolution is 10 psec with a timebase accuracy of $\pm(0.5\% + 200 \text{ psec})$. Internal self-calibration using a built-in frequency counter and 12-bit analog-to-digital converter are combined with other accuracy related features, such as load compensation, to obtain these high levels of accuracy.

The front panel operation of the 9210 has been designed for intuitive error free setup. The friendly user interface is centered on a bright CRT display which shows all related setup parameters at a glance. The menu based display adapts automatically to match the installed output modules. A graphical icon is included to show the parameter being adjusted. Settings conflicts are highlighted and help messages appear on screen. Settings are changed by means of either a numeric keypad for precise numeric entry or by means of an analog knob for continuous variation of parameters. CRT touch-screen response allows the user to set and change parameters through the use of optical soft keys.

For added operational convenience, alternate settings formats can be selected. These include: duty cycle or pulse width, frequency or period, delay or phase, amplitude/median and amplitude/offset or Vhigh/Vlow, slew rate or rise time - all key selectable.

Fully programmable via GPIB, the 9210 pulse generator complies with the IEEE-488.2 interface standard. It uses a self-documenting, English-language based command set and features high-speed command execution.

Programmable Pulse Generators

The front panel operation of the 9210 has been designed for intuitive error free setup. The friendly user interface is centered on a bright CRT display which shows all related setup parameters at a glance. The menu based display adapts automatically to match the installed output modules. A graphical icon is included to show the parameter being adjusted. Settings conflicts are highlighted and help messages appear on screen. Settings are changed by means of either a numeric keypad for precise numeric entry or by means of an analog knob for continuous variation of parameters.

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Fully programmable via GPIB, the 9210 pulse generator complies with the IEEE-488.2 interface standard. It uses a self-documenting, English-language based command set and features high-speed command execution.

Important Note: At least one output module (9211, 9213, or 9214) must be installed in the 9210 Pulse Generator Mainframe in order to obtain a pulse output.

TIMING CHARACTERISTICS

Defined at 50% amplitude points and minimum transition times.

NOTE: The minimum values listed below refer to the mainframe only, and may not be achievable with all output modules.

Pulse period: 3.33 nsec to 450 msec.

Resolution: The greater of 0.1% of value or 10 psec.

Accuracy: $\pm(0.5\%$ of value + 0.2 nsec) from 3.33 nsec to 450 msec.

RMS jitter: < or equal to 0.035% (350 ppm) of value + 35 psec.

Temperature coefficient: < 250 ppm/°C typical with temperature compensation ON.

Frequency: Alternate format for period. Settable from 300 MHz to 2.2 Hz with 0.1% resolution.

Pulse width: 1.0 nsec to 450 msec.

For period setting < or equal to 8.0 nsec; max. width = period - 0.8 nsec.

For period setting > 8.0 nsec; max. width = period - 2.9 nsec.

Resolution: The greater of 0.1% of value or 10 psec.

Accuracy: $\pm(0.5\%$ of value + 0.3 nsec transition time error) from 1.6 nsec to 450 msec (see output module data for transition time accuracy specifications). RMS jitter: < or equal to 0.035% of value + 35 psec.

Temperature coefficient:
< 250 ppm/°C typical with temperature compensation ON.

Duty cycle: Alternate format for width. Settable from 1% to 99% in 0.01% steps. In this format, width is controlled as a percentage of period.

Pulse delay: 0 nsec to 450 msec, measured from leading edge of trigger out to *beginning* of leading edge of pulse output (relative to fixed offset).

For period setting < or equal to 8.0 nsec; max. delay = period -2.6 nsec.

For period setting > 8.0 nsec; max. delay = period -4.7 nsec.

Resolution: The greater of 0.1% of value or 10 psec.

Accuracy: $\pm(0.5\%$ of value + 1.0 nsec).

RMS jitter: < or equal to 0.035% of value + 35 psec.

Temperature coefficient: < (250 ppm + 50 psec)/°C typical with temperature compensation ON.

Match between output modules of the same type: 1.2 nsec.

Phase: Alternate format for delay. Settable from 0° to 359.9° with 0.1° resolution. In this format, delay = phase/360 x period.

Double pulse delay: 4 nsec to 450 msec.

Resolution: The greater of 0.1% of value or 10 psec.

Accuracy: $\pm(0.5\%$ of value + 0.3 nsec).

RMS jitter: < or equal to 0.035% of value + 35 psec.

Temperature coefficient: < 250 ppm/°C typical with temperature compensation ON.

INPUTS AND OUTPUTS

External Input

Input impedance: 10 kW or 50 W $\pm 5\%$, selectable.

Input range: ± 5 V into 50 W or ± 20 V into 10 kW.

Minimum detectable amplitude: 200 mV.

Threshold range and resolution: ± 2.5 V adjustable in 20 mV steps.

Threshold level accuracy: ± 100 mV.

Max. input frequency: 300 MHz.

Min. pulse width: 1.5 nsec.

Min. input slew rate: 10 V/sec.

Edge selection: Positive, negative, neither edge (disabled).

Trigger Output

Output levels: Nominal 1 V negative swing from base level into 50 W. Base level adjustable over ± 1.5 V range with 20 mV resolution. (Into Hi-Z: amplitude = -2 V. Base level of ± 3 V, 40 mV resolution.)

Output impedance: 50 W $\pm 5\%$.

Protection: Protected against application of ± 10 V.

Delay from trigger input: 21 nsec typical.

Width: Dependent on trigger mode.

Normal mode:

Period \leq or equal to 7.2 nsec:

Width = 1.8 nsec typical. 7.2 nsec $<$ period $<$ 50 nsec:

3.6 nsec \leq or equal to width \leq or equal to 7.2 nsec:

Period 50 nsec:

Width = 25 nsec typical.

Single mode:

Pulse width setting \leq or equal to 40 nsec:

Trigger output width = 1.8 nsec typical.

Pulse width setting $>$ 40 nsec:

Trigger output width = 25 nsec typical.

Burst mode:

Width = period \times (burst count - 1).

Gate and ext. width modes:

Trigger output width \times trigger input width.

PROGRAMMABILITY

All generator functions are programmable over GPIB. Command set conforms with IEEE 488.2-1987.

TRIGGERING MODES

Normal: Continuous pulse stream. Trigger output for each pulse output.

Single: Each external trigger input generates a single output pulse. One trigger output for each trigger.

Gated: Signal at external input enables period generator. The first output pulse is synchronized with the gate's leading edge. Last pulse is allowed to complete. One trigger output for each gate input; 20 nsec retrigger (dead) time between gate inputs.

Burst: Each external trigger input generates a pre-programmed number of pulses (3 to 4095). Minimum time between two bursts is 50 nsec. One trigger output for each trigger.

External width: The signal at the external input is reproduced with programmable transition times and output levels. Trigger output for each external trigger.

OPERATING FEATURES

Manual trigger: Front panel push-button generates an external trigger input. Each push provides one trigger pulse in single and burst modes. Output remains active as long as button is pressed in gate and external width modes.

Double pulse mode: When double pulse is set to ON, two pulses are produced for each trigger. The first pulse begins as soon as possible after the trigger (approximately the minimum pulse delay time). The delay parameter now specifies the time from the leading edge of the first pulse to the leading edge of the second pulse. One trigger output occurs for each pulse pair. Compatible with all trigger modes except external width.

ADDITIONAL CAPABILITIES

Limit: When enabled, the maximum high and low level settability of the pulse outputs is limited to protect the device under test.

Setups: 16 setup configurations can be stored and recalled using the store and recall keys on the front panel.

Change format: Enables the alternate representation of a parameter or enables an alternate mode of operation. Examples are amplitude/base or amplitude/median in lieu of Vhigh/Vlow, duty cycle instead of width, phase instead of delay, frequency instead of period, slew rate as opposed to transition time.

ENVIRONMENTAL

The following specifications apply to the 9210 mainframe and to all output modules (9211, 9213 and 9214).

Storage temperature: -40°C to 70°C (temp above 40 ° C may degrade battery life).

Operating temperature: 5°C to 40°C at rated specifications, operational from 0°C to 50°C.

Temperature & self-calibration: Generator and output modules will meet specifications over a ±5°C range without repeating self-calibration.

Humidity range: < 95% R.H from 5°C to 40°C.

POWER

115/220 VAC ±20%; 48 - 448 Hz, 300 Watts max. (180 typical).

MISCELLANEOUS

Battery backup life: 10 years typical.

The following specifications apply to the 9210 mainframe and to all output modules (9211, 9213 and 9214).

Recalibration interval: 1 year.

Warm-up time (to meet specs):

15 min, after which a new self-calibration must be performed.

MAINFRAME

Weight: 23 lbs. net, 34 lbs. shipping.

Dimensions: (HWD) 5 x 17 x 21 inches.

OUTPUT MODULES

Weight: 2 lbs. net, 4 lbs. shipping.

Dimensions: (HWD) 4.6 x 2.4 x 14.7 inches.

9211 - 250 MHz Output Module Specifications

TIMING CHARACTERISTICS

Maximum rep rate: 250 MHz.

Minimum pulse width: < or equal to 2.0 nsec.

Fixed delay from trigger out: 13 nsec \pm 4 nsec.

OUTPUT CHARACTERISTICS

Specified with both outputs terminated in 50.00 W. (Ratings in { } are when driving an open circuit.)

Outputs: Normal and complementary polarity.

Short circuit output current: \pm 260 mA.

DC output source impedance: 50 \pm 1.0 W.

Output protection: Protected against application of < or equal to \pm 15 V.

OUTPUT LEVELS

High level: -4.95 V to +5.00 V
{-9.90 V to +10.00 V}

Low level: -5.00 V to +4.95 V
{-10.00 V to +9.90 V}

Output voltage range: ± 5 Volts { ± 10 Volts}; max. amplitude of 5 V {10 V}; min. amplitude of 50 mV {100 mV}.

Resolution: 5 mV {10 mV}.

Level Accuracy

Normal output: $\pm(1\%$ of programmed value +1% of amplitude +40 mV) into 50.00 W.

Accuracy with load comp: The same accuracy as stated above will be maintained for user supplied load of 47 Ohms to 1 M Ohm when load compensation feature is enabled.

Complementary output: $\pm(1\%$ of programmed value +3% of amplitude +40 mV) into 50.00 W.

Accuracy with load comp: $\pm(3\%$ of setting times the ratio of the load on the complemented output to the load on the normal output). Measurements for the load compensating correction factors are made on the normal output.

PULSE PERFORMANCE

Variable transition times: (10% to 90%):

Leading edge: < or equal to 1.2 nsec min (1 nsec typical) to 10 msec.

Trailing edge: < or equal to 1.2 nsec min (1 nsec typical) to 10 msec.

Ranges: 7 ranges of 25:1. Minimum lead to trail dynamic range = 2.5:1, except 2:1 at first range break (see graph below).

Resolution: The greater of 1% or 100 psec.

Accuracy: $\pm(10\%$ of value + 300 psec).

Linearity: $\pm 3\%$ typical (10 - 90%) for transition times > 50 nsec.

Slew rate mode: Settable down to 0.1 V/msec with 0.1% resolution and $\pm 10\%$ accuracy (separately settable for leading and trailing edge). Max. rate determined by amplitude setting & transition time limits stated above.

Overshoot and ringing: The greater of $\pm 8\%$ of amplitude or ± 10 mV.

Settling time: < or equal to 10 nsec to 2% of amplitude change at fastest transition times.

Normal to complementary output skew: 200 psec max at fastest transition times (50 psec typical).

MODULE CONTROLS

The following controls are located on the front panel of the output module.

Invert: Inverts normal output pulse levels. Quiescent and active levels exchanged.

Disable: Output circuitry is disconnected via relay.

Display channel: Instructs mainframe to select and display the settings parameters for this module.

9213 - 50 MHz, 16 V
Output Module Specifications

TIMING CHARACTERISTICS

Maximum rep rate: 50 MHz.

Minimum pulse width: < or equal to 10.0 nsec.

Fixed delay from trigger out: 13 nsec \pm 4 nsec.

OUTPUT CHARACTERISTICS

Specified with output terminated in 50.00 W. (Ratings in { } are when driving an open circuit.)

Output: Normal polarity.

Short circuit output current: \pm 200 mA.

DC output source impedance: 50 \pm 2.0 W.

Output protection: Protected against application of < or equal to \pm 40 V.

OUTPUT LEVELS

High level: -7.98 V to +8.00 V
{-15.96 V to +16.00 V}

Low level: -8.00 V to +7.98 V
{-16.00 V to +15.96 V}

Output voltage range: \pm 8 Volts { \pm 16 Volts}; max. amplitude of 16 V {32 V}; min. amplitude of 20 mV {40 mV}.

Resolution: 5 mV {10 mV}.

Level accuracy: \pm (1% of programmed value +1% of amplitude +40 mV) into 50.00 W.

Accuracy with load comp: The same accuracy as stated above will be maintained for user supplied load of 47 W to 1 MW when load compensation feature is enabled.

PULSE PERFORMANCE

Variable transition times (10% to 90%):

Leading edge: < or equal to 6.5 nsec to 95 msec.

Trailing edge: < or equal to 6.5 nsec to 95 msec.

Ranges: 8 ranges of 25:1. Minimum lead to trail dynamic range = 2.5:1 (except for lowest range, see graph below).

Resolution: The greater of 1% or 100 psec.

Accuracy: $\pm(10\% \text{ of value} + 300 \text{ psec})$.

Linearity: $\pm 3\%$ typical (10-90%) for transition times > 100 nsec.

Slew rate mode: Settable down to 0.1 V/msec with 0.1% resolution and $\pm 10\%$ accuracy (separately settable for leading and trailing edge). Max. rate determined by amplitude setting and transition time limits stated above.

Overshoot and ringing: The greater of $\pm 8\%$ of amplitude or $\pm 10 \text{ mV}$.

Settling time: < 50 nsec to 2% of amplitude change for amplitudes < or equal to 10 V or to 3% of amplitude change for amplitudes > 10 V (at fastest transition times).

MODULE CONTROLS

The following controls are located on the front panel of the output module.

Invert: Inverts normal output pulse levels. Quiescent and active levels exchanged.

Disable: Output circuitry is disconnected via relay.

Display channel: Instructs mainframe to select and display the settings parameters for this module.

9214 - 300 MHz, 300 psec Output Module Specifications

TIMING CHARACTERISTICS

Maximum rep rate: 300 MHz.

Minimum pulse width: < or equal to 1.2 nsec .

Maximum pulse width:

For period setting < or equal to 8.0 nsec; max. width = period -1.4 nsec.

For period setting > 8.0 nsec; max. width = period -3.5 nsec.

Fixed delay from trigger out: 13 nsec \pm 4 nsec.

OUTPUT CHARACTERISTICS

Specified with both outputs terminated in 50.00 W. (Ratings in { } are when driving an open circuit.)

Outputs: Normal and complementary polarity.

Short circuit output current:

\pm 240 mA.

DC output source impedance:

50 \pm 1.0 W.

Output protection: Protected against application of < or equal to \pm 6 V.

OUTPUT LEVELS

High level: -4.50 V to +5.00 V

{-4.00 V to +5.00 V}

Low level: -5.00 V to +4.50 V

{-5.00 V to +4.00 V}

Output voltage range: \pm 5 Volts { \pm 5 Volts} (amplitude will double into a high impedance up to the 5 V level limit). Max. amplitude of 5 V {10 V}. Min. amplitude of 500 mV {1 V}.

Resolution: 5 mV {10 mV}.

Level Accuracy

Normal output: \pm (1% of programmed value +1% of amplitude +40 mV) into 50.00 W.

Accuracy with load comp: The same accuracy as stated above will be maintained for user supplied load of 47 Ohms to 1 M Ohm when load compensation feature is enabled.

Complementary output: \pm (1% of programmed value +3% of amplitude +40 mV) into 50.00 W.

Accuracy with load comp: \pm (3% of setting times the ratio of the load on the complemented output to the load on the normal output). Measurements for the load compensating correction factors are made on the normal output.

PULSE PERFORMANCE

Minimum transition time: < or equal to 300 psec guaranteed (20% - 80%).

Overshoot and ringing: The greater of $\pm 10\%$ of amplitude or ± 10 mV.

Settling time: $<$ or equal to 10 nsec to 2% of amplitude change.

Normal to complemented output skew: 100 psec max. (25 psec typical).

MODULE CONTROLS

These controls are located on the front panel of the output module.

Invert: Inverts normal output pulse levels. Quiescent and active levels exchanged.

Disable: Output circuitry is disconnected via relay.

Display channel: Instructs mainframe to select and display the settings parameters for this module.



Models 9211, 9213 and 9214 plug-ins