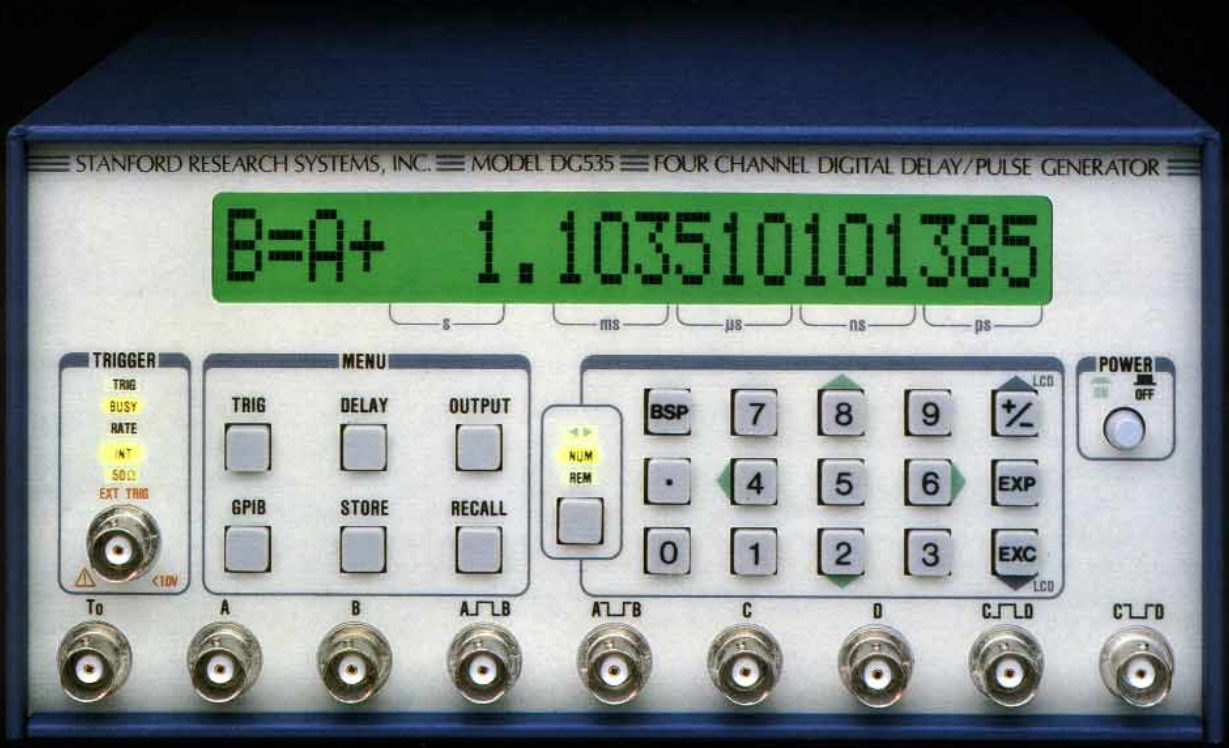
STANFORD RESEARCH SYSTEMS

DG535
Precision Digital Pulse & Delay Generator



New Precision Pulse Generator and Digital Delay Generator

Four Channels, 5 ps Resolution, & GPIB Interface

Triggering

Internal, external, single-shot and burst mode triggers. The trigger rate may be set to four digits, or the trigger threshold, slope, and input termination may be specified for external triggers.

GPIB Interface

The instrument may be completely controlled via the GPIB. The address is set from the front panel, and GPIB transactions may be viewed on the backlit LCD.

Delays

The four programmable delays may be set from 0 to 1000 s with 5 ps resolution. These delays also specify the position and width for the AB and CD pulse outputs.

Store and Recall

Up to nine instrument settings may be stored in the battery backed-up RAM. When recalled, all the instrument settings (including delays, output levels and trigger conditions) will be restored.

Outputs

Each output may be set to TTL, NIM, or ECL levels. The outputs are also continuously adjustable and may drive either 50 Ohm or high impedance loads.

Data Entry

Instrument settings may be entered numerically, or individual digits may be incremented or decremented with carrys and borrows.

The Instrument

The DG535 Digital Delay and Pulse Generator is both a four channel digital delay and a two channel precision pulse generator.

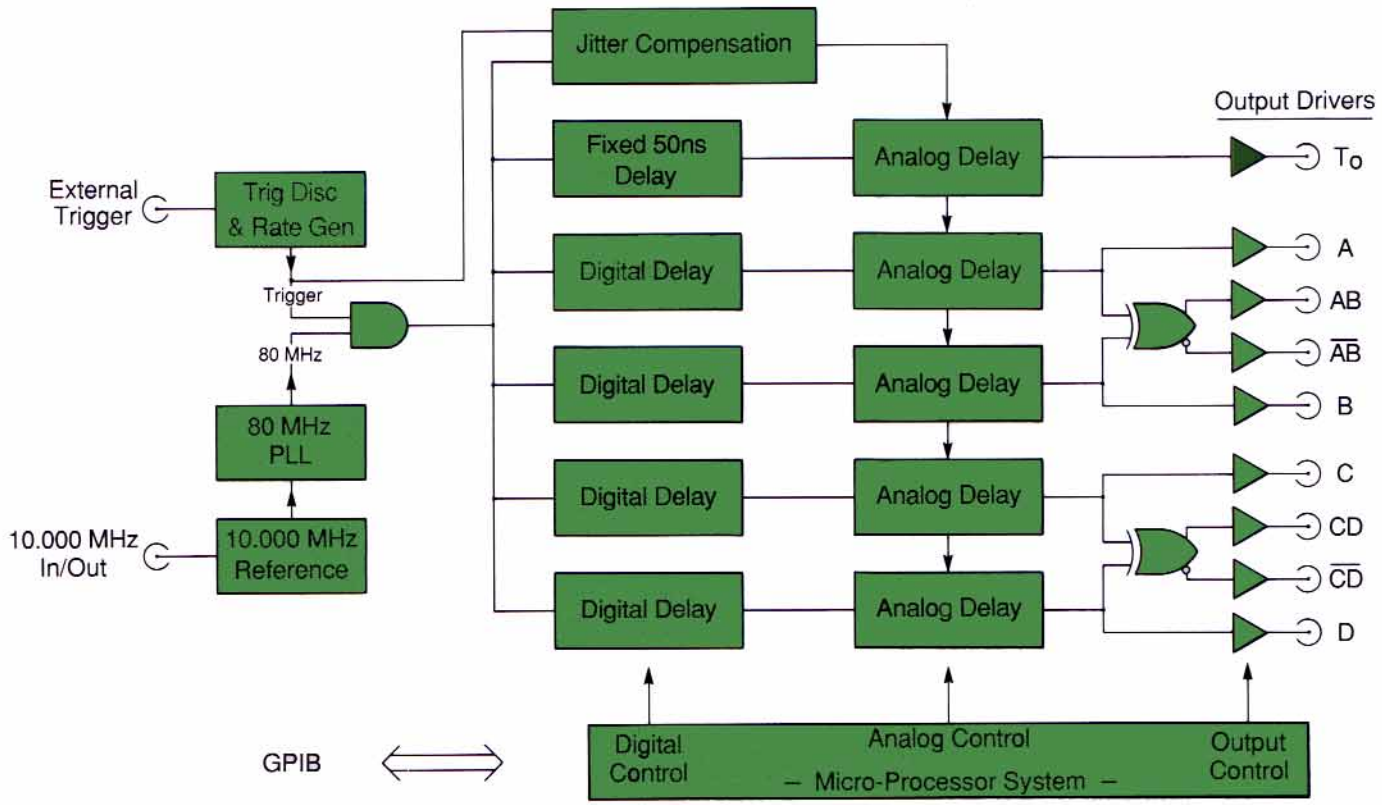
Digital Delay Generator

As a digital delay generator, the four outputs, A, B, C and D, may be programmed for any interval between 0 and 1000 s with 5 ps of resolution. The standard timebase provides 25 ppm accuracy, and option 03 provides 1 ppm accuracy. The jitter of any output is less than 50 ps plus 1 part in 10^8 of the programmed delay. All outputs return to their pre-trigger levels approximately 800 ns after the longest delay.

Precision Pulse Generator

As a precision pulse generator, the four time intervals define two pulses for applications that require precisely controlled pulse widths. The position and width of each pulse may be programmed from the front panel or via the GPIB. Front panel BNCs provide fast outputs at TTL, NIM, ECL or continuously adjustable levels. These pulses and their complements are available from separate front panel outputs. The outputs may be set to drive either 50 Ohm or high impedance loads.

The high accuracy, precision, wide range, and low jitter make the DG535 the solution to many difficult timing problems in science and industry.



Block Diagram

The DG535 has four identical timing channels, A, B, C and D. Each channel has a range of 1000 seconds and a resolution of 5 picoseconds. The T0 output, which occurs at a fixed time of 85 ns after the unit is triggered, is the t=0 reference for all of the delay channels.

Trigger

The unit may be triggered internally or externally. The external trigger slope and threshold is specified in the TRIG Menu. Internal trigger modes include single shot, burst, and fixed rate triggers. A PLL frequency synthesizer is used to generate trigger rates from 0.001 Hz to 1.000 MHz with four digits of resolution.

Time Base

The timing reference for the instrument is an 80 MHz oscillator which is phase locked to a 10 MHz crystal oscillator. When this internal timebase is being used, the 10.000 MHz is available at a rear panel BNC connector. An external 10.000 MHz timebase may also be used.

Delay Channels

Each timing channel has a digital delay which can count from 1 to 80,000,000,000 cycles of the 80 MHz clock. When the digital delay is complete, an analog delay is initiated. Each analog delay has a range of 25 ns and a resolution of 5 ps: half of this delay range is used to interpolate between the 12.5 ns cycles of the 80 MHz clock, the other half of the delay range is used to compensate for the time interval between the trigger and the first cycle of the 80 MHz clock. This time interval is measured by the jitter compensation circuits which reduce all of the analog delays so as to eliminate the one clock cycle indeterminacy which is common in other digital delay generators.

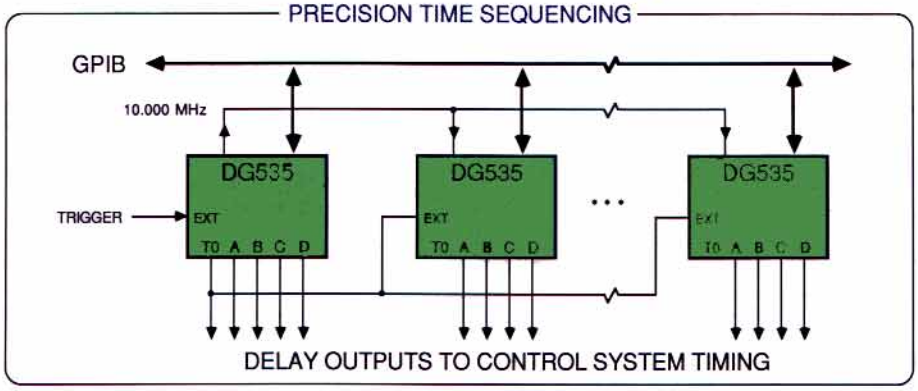
Outputs

The pulse outputs AB and CD are asserted for the time interval between A and B and between C and D respectively. Each of the outputs, T0, A, B, C, D, AB , –AB, CD and –CD, have output drivers which can drive 50 Ohm or high impedance loads to TTL, NIM, ECL or continuously adjustable levels. Inverted or normal polarities for each output may be specified in the OUTPUT Menu. Transition times are 2 ns for the NIM and ECL levels, and 3 ns for TTL levels.

Microprocessor

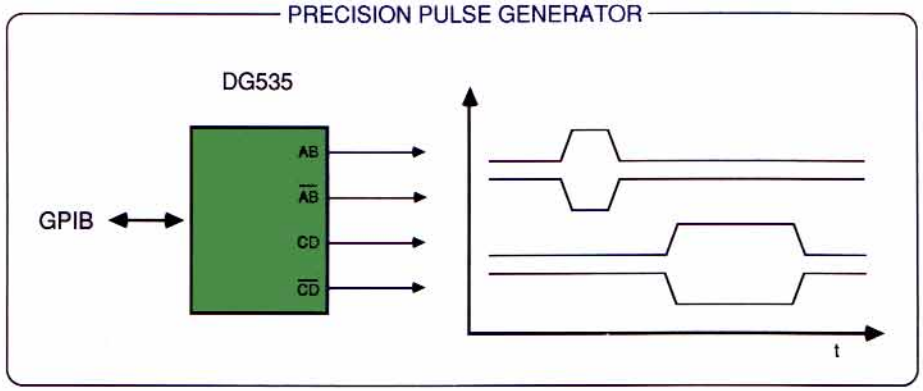
All instrument functions are controlled by a microprocessor system. The processor is also used to interface the instrument to computers over the GPIB.

Applications



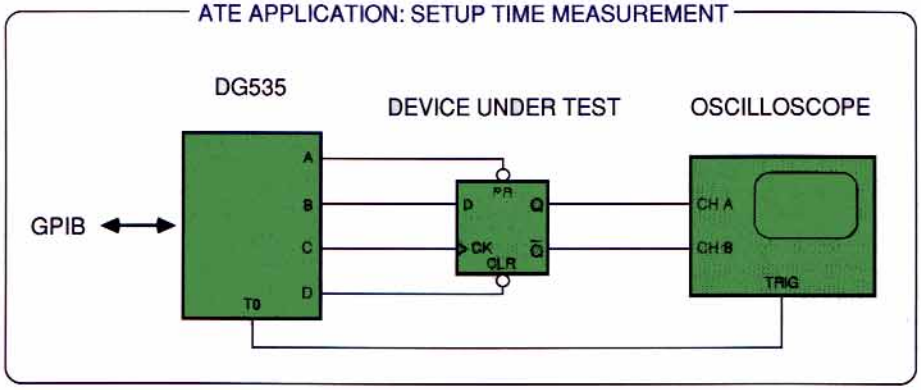
Precision Time Control

A single DG535 can provide four transitions for precise system timing. Several DG535s may be used if more channels are needed. The 10.000 MHz reference may be daisy-chained between units so that each DG535 will use the same timebase. All of the units may be controlled over the GPIB. The versatile outputs of the DG535 can trigger TTL, NIM, or ECL circuits and optional rear panel outputs can provide pulses with amplitudes up to 35 volts with either polarity.



Pulse Generator

The DG535 is a versatile pulse generator with two precisely controlled complementary pulse pairs. The output levels are continuously adjustable or may be set for TTL, NIM, or ECL levels. High impedance or 50 Ohm loads may be driven with 2–3 ns transition times. Pulse timing may be specified with start and stop positions, or with a start position and a pulse width.



ATE Applications

The instrument's versatility, precision, and accuracy recommend it for a wide variety of test and measurement tasks. In this example, the DG535 is used to measure setup times for the data, preset, and clear inputs to a flip-flop. The measurements can be made with subnanosecond accuracy. Logic thresholds for the device under test may be measured using the DG535's adjustable output levels. All measurements may be controlled from the front panel or by a computer via the GPIB.

Options

Rear Panel Outputs (Option 02)

The rear panel outputs for T0, A, B, C and D have adjustable output amplitudes from −32 to +32 volts. The pulse width is 1 μs, and the leading edge has a transition time of 2–3 ns. The outputs are designed to drive 50 Ohm loads, however, if the cable is terminated into a high impedance load, the pulse amplitude will double (i.e., up to 70 volts) for a duration equal to the round-trip cable delay. The amplitude of the output pulse is reduced by 2 volts per mA of average output current: the average current is only 0.8 mA for a 32 volt output into 50 Ohms at a 1 kHz repetition rate.

High Accuracy Timebase (Option 03)

The standard crystal timebase has an accuracy of 25 ppm over the temperature range of 0° to 50°C. If better accuracy is desired (to reduce the error and improve the stability of long delays), a 1 ppm temperature compensated crystal oscillator (TCXO) may be specified. The delay jitter is the same for either timebase, however, both the absolute error and stability are improved by the TCXO. Also, the TCXOs frequency may be set from the front panel to a few parts in 10^8, while the standard timebase cannot be adjusted. The 10.000 MHz TCXO from one DG535 may be daisy-chained to other units in a system.

Rack Mounting (Option 05)

A dual rack mount is available to mount one or two DG535s in a standard 19-inch rack.

Ordering Information

DG535 digital delay generator
Option 02 rear panel 32V outputs
Option 03 1 ppm TCXO Timebase
Option 04A fast risetime module
Option 04B fast falltime module
Option 04C bias tee
Option 05 rack mount

DG535 Specifications

Delays

Channels	Four independent delays: A, B, C and D
Range	0 to 999.999,999,999,995 seconds
Resolution	5 pS
Error	<1500 ps + timebase error x delay
Timebase	Standard: ±25 ppm crystal (0–50°C) Optional: ±1 ppm TCXO (0–50°C) External: User provides 10.0 MHz reference Rear panel output of internal timebase: 1 V
RMS Jitter	Ext Trig to any output: 60 ps+10^{-8} x delay T0 to any output: 50 ps+10^{-8} x delay
Trig Delay	Ext trig to T0 output: 85 ns
Indeterminacy	None

External Trigger

Rate	<1/(1μs + longest delay)
Threshold	−2.56 V to +2.56 V (10 mV resolution)
Slope	Trigger on rising or falling edge
Impedance	1 MOhm + 40 pF or 50 Ohm

Internal Rate Generator

Rate	Single shot or 0.001 Hz to 1.00 MHz
Resolution	0.001 Hz below 10 Hz, 4 digits above 10 Hz
Accuracy	Same as timebase
Rate Jitter	1:10,000
Settling	<2 seconds for any rate change
Burst Mode	2 to 32766 pulses per burst at an integer (4-32767) sub-multiple of the trigger rate

Outputs T0, A, B, C, D, AB, −AB, CD and −CD

Load	50 Ohm or nigh impedance
Transition	<2 ns for ECL, <3 ns for TTL
Overshoot	<100 mV +10% of pulse amplitude
Levels	TTL: 0 to 4 VDC, normal or inverted ECL: −1.8 to −.8 VDC, normal or inverted NIM: −.8 to 0 VDC, normal or inverted VAR: Adjustable offset and amplitude between −3 and +4 VDC with 4V maximum step
Accuracy	± (50 mV +3%)
Options	Rear panel outputs for T0, A, B, C and D Pulse: 1 μs nominal with amplitude 10x the corresponding front panel output: -32 to +32 VDC in 0.1 V steps into 50 Ohms Leading edge transition time: 2–3 ns

Computer Interface

GPIB	IEEE-488 STD All instrument functions and settings may be controlled over the interface bus. SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP0, DC1, DT1, C0 and E1.

Firmware Features

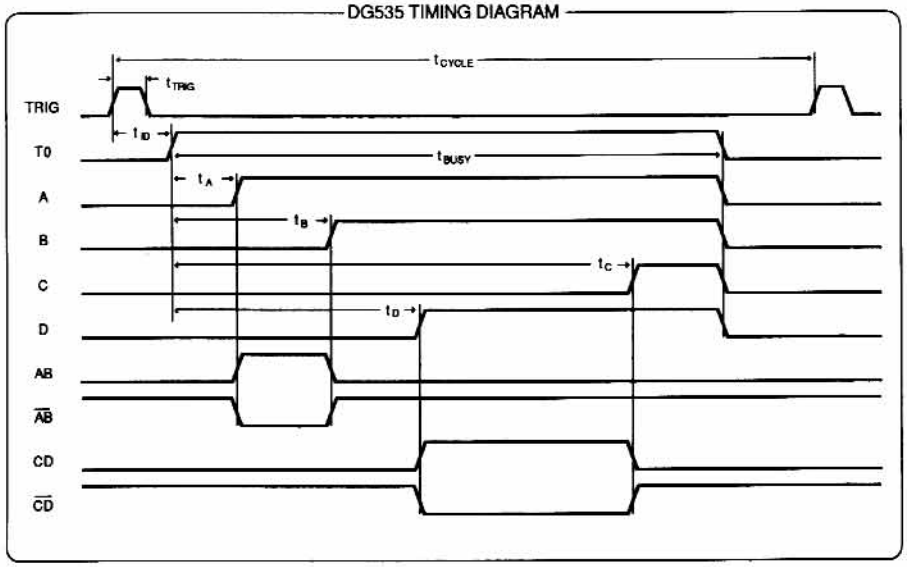
Menus	Front panel keys allow quick access to Trigger, Delay, Output, GPIB, Store and Recall.
Data Entry	Numeric mode allows direct entry of data. Cursor mode allows particular digit to be incremented or decremented with automatic carry and borrow from more significant digits. Continuous increment mode allows one or more delays to be scanned. Delays may be linked together so that as one moves the other follows.
Store/Recall	Up to nine complete instrument settings may be saved in the nonvolatile RAM.
GPIB	The GPIB address is set from the front panel and GPIB data may be seen on the LCD.

General

Displays	Electroluminescent backlit LCD
Dimensions	14"x8.5"x4.75"
Weight	10 lbs.
Power	70 Watts from 100, 120, 220 or 240 VAC, 50 or 60 Hz.
Temperature	0° to 50°C

All specifications and prices are subject to change (01/03)

DG535 Timing Diagram



Each timing cycle is initiated by either an internal or external trigger. The T0 output goes high immediately; the other outputs, A, B, C and D go high after their programmed delays. The delays may be specified with respect to T0, or may be linked to another channel so as one delay moves the other follows. All of the outputs go low about 800 ns after the last delay. The pulse outputs, AB and CD, go high for the time interval between the corresponding channels.

t_{TRIG}	>5 ns
t_{CYCLE}	>1 μs + longest delay
t_{ID}	<85 ns
t_{BUSY}	800 ns + longest delay
$t_{A, B, C, D}$	0 to 999.999999999995 s

Abridged Command List

Initialization

CL	Clear instrument.
GT {i, j, k}	Specify one to three ASCII codes to terminate each response.

Delays

DT i {, j, t}	Delay Time of channel i is set to t seconds relative to channel j. Example: DT 3, 2, 1.2E-6 will set B=A+000.000,001,200,000 seconds.

Outputs

TZ i {, j}	Configure Output i to drive a 50 Ohm (j=0) or a high-Z load (j=1).
OM i {, j}	Output i for TTL, NIM, ECL, or variable.
OA i {, v}	Amplitude of output i is set to v volts.
OO i {, v}	Offset of output i is set to v.
OP i {, j}	Output Polarity of channel i is inverted (j=0) or normal (j=1) for TTL, ECL or NIM.

Trigger

TM {i}	Trigger Mode to Int, Ext, Ss or Burst.
TR i {, f}	Int Trigger Rate to f Hz.
TZ 0 {, j}	Trigger input impedance to 50 Ohms (j=0) or to high impedance (j=1).
TL {v}	Set External Trigger Level to v Volts.
TS {i}	Trigger Slope set to falling (i=0) or Rising Edge (i=1).
SS	Single-Shot trigger.
BC {i}	Burst Count of i pulses per burst.
BP {i}	Burst period of i triggers per burst.

Display

DL {i, j, k}	Select Display menu, submenu, and line.
CS {i}	Select cursor mode or number mode.
SC {i}	Move cursor to column i.
MC i	Move cursor left or right.
IC i	Increment or decrement the digit at the cursor location.
DS string	Display a string of 1–20 characters.

Store and Recall

ST i	Store settings to location 1 to 9.
RC i	Recall settings to location 1 to 9.

Status

ES	Returns the Error Status.
ES i	Returns bit i of the Error Status.
IS	Returns the Instrument Status.
IS i	Returns bit i of the Instrument Status.
SM {i}	Set Status Mask for service request to i.

Notes:

In all of the commands listed above, i, j and k are integer values and f, t and v may be integer, floating point or exponential notation. Optional parameters are enclosed in curly brackets. In general, if optional parameters are omitted then the current value of those parameters will be sent back to the GPIB controller. For example, the command "TM 3" sets the Trigger Mode to mode 3 (burst mode) while the command "TM" will return the response "3."

Ordering Information

DG535 digital delay generator
Option 02 rear panel 32V outputs
Option 03 1 ppm TCXO Timebase
Option 04A fast risetime module
Option 04B fast falltime module
Option 04C bias tee
Option 05 rack mount

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