The DG535 Digital Delay/Pulse Generator provides four precisely-timed logic transitions or two independent pulse outputs. The delay resolution on all channels is 5 ps, and the channel-to-channel jitter is typically 50 ps. Front-panel BNC outputs deliver TTL, ECL, NIM or variable level (−3 to +4 V) pulses into 50 Ω or high impedance loads. The high accuracy, low jitter, and wide delay range make the DG535 ideal for laser timing systems, automated testing, and precision pulse applications.

**Delay Outputs**

There are four delay output channels: A, B, C and D. The logic transitions of these outputs can be delayed from an internal or external trigger by up to 1000 seconds in 5 ps increments. The T0 pulse, which marks the beginning of a timing cycle, is generated by the trigger signal. The insertion delay between an external trigger and the T0 pulse is about 85 ns.

Delays for each channel may be “linked” to T0 or any of the other delay channels. For instance, you can specify the delays of the four channels as:

\[
\begin{align*}
A &= T0 + 0.00125000 \\
B &= A + 0.00000005 \\
C &= T0 + 0.10000000 \\
D &= C + 0.00100000
\end{align*}
\]
In this case, when the A delay is changed, the B output will move with it. This is useful, for instance, when A and B specify a pulse and you want the pulse width to remain constant as the delay of the pulse is changed. Regardless of how the delay is specified, each delay output will stay asserted until 800 ns after all delays have timed out. The delays will then become unasserted, and the unit will be ready to begin a new timing cycle.

**Pulse Outputs**

In addition to the four delay outputs, there are four pulse output channels: AB, –AB, CD and –CD. The leading edge of the AB pulse coincides with the leading edge of the earlier of A or B, and the falling edge of the AB pulse coincides with the leading edge of the later of B or A. For instance, in the previous example, a 50 ns pulse would appear at the AB output and a 1 ms pulse at CD. Pulses as short as 4 ns (FWHM) can be generated in this manner. The complementary outputs (–AB and –CD) provide a pulse with identical timing and inverted amplitude.

**Output Amplitude Control**

Each delay and pulse output has an independently adjustable offset and amplitude which can be set between −3 V and +4 V with 10 mV resolution. The maximum transition for each output is limited to 4 V. In addition, you can also separately select 50 Ω or high impedance termination for each output. Preset levels, corresponding to standard logic families, can also be selected. TTL, NIM and ECL levels can each be set with a single key press.

**Triggering**

The DG535 can be triggered internally from 1 mHz to 1 MHz with 4-digit frequency resolution. External, single-shot and burst mode triggers are also supported. For power control applications, the DG535 can be synchronized to the AC line. An optional trigger inhibit input allows you to enable or disable triggering with a TTL level input signal.

**±32 Volt Outputs**

For applications requiring higher voltages, a rear-panel high voltage (±32 V) option is available. This option provides five rear-panel BNCs which output 1 μs pulses at the transition times of the front-panel T0, A, B, C and D outputs. The high voltage option does not affect the function or the timing of the front-panel outputs. The amplitude of the rear-panel outputs is approximately 8× the corresponding front-panel output, and the outputs are designed to drive 50 Ω loads. Since they can only drive an average current of 0.8 mA, charging and discharging the cable capacitance may be the most important
current limiting factor to consider when using them (assuming a high impedance load). In this case, the average current is: \( I = \frac{2Vtf}{Z} \), where \( V \) is the pulse step size, \( t \) is the length of the cable in time (5 ns per meter for RG-58), \( f \) is the pulse repetition rate, and \( Z \) is the cable’s characteristic impedance (50 \( \Omega \) for RG-58).

**Internal or External Timebase**

Both internal and external references may be used as the timebase for the DG535. The internal timebase can be either the standard 25 ppm crystal oscillator timebase, or the optional 1 ppm temperature-compensated crystal oscillator (TCXO). The internal timebase is available as a 1 Vpp square wave on a rear-panel BNC. This output is capable of driving a 50 \( \Omega \) load and can be used to provide a master timebase to other delay generators. Any external 10.0 MHz reference signal with a 1 Vpp amplitude can also be used as an external timebase.

**Fast Rise and Fall Time Modules**

External in-line modules are available to reduce the rise or fall time of the DG535 outputs to 100 ps. These modules use step recovery diodes to speed up the rise time (option O4A) or the fall time (option O4B). A bias tee (option O4C) allows these modules to be used with the optional rear-panel outputs to produce steps up to 15 V. For step amplitudes of less than 2.0 V, the fast transition time units should be attached directly to the front panel of the DG535.

**Easy to Use, Easy to Program**

All instrument functions can be accessed through a simple, intuitive, menu-based interface. Delays can be entered with the numeric keypad in either fixed-point or exponential notation, or by using the cursor keys to select and change individual digits. The backlit 20-character LCD display makes it easy to view delay settings in all lighting conditions.

The DG535 comes standard with a GPIB (IEEE-488) interface. All instrument functions can be queried and set via the interface. You can even display the characters the DG535 has received over the interface on the front-panel LCD display. This can be valuable when debugging programs which send commands to the instrument.

---

**Ordering Information**

- **DG535** Delay/pulse generator w/ GPIB
- **Option 02** \( \pm 32 \) V rear panel outputs
- **Option 03** 1 ppm TCXO timebase
- **Option 06** Trigger inhibit input
- **O4A** 100 ps rise time module
- **O4B** 100 ps fall time module
- **O4C** Bias Tee (for 02 & O4A or O4B)
- **O5** Dual rack mount tray

---

*[Image of DG535 Digital Delay/Pulse Generator]*

**DG535 rear panel (with opt. 02)**
ATE Applications

The DG535’s versatility, precision and accuracy make it ideal for a wide variety of test and measurement tasks. In this example, the DG535 is used to measure the setup times for the data, preset and clear inputs to a flip-flop. The measurements may be made with picosecond resolution. The 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 interface.

Precision Time Control Applications

A single DG535 can provide four transitions for precise system timing. Several DG535s may be used if more channels are needed. The 10 MHz reference may be daisy-chained between units so that each DG535 in an experiment uses the same time-base. All of the units may be controlled over the same GPIB bus. The flexible output levels and simple architecture of the pulse/delay generators make it simple and easy to rapidly reconfigure test systems.

Laser Timing Applications

The DG535’s four independent outputs make it ideal for laser timing applications. In this example, the T0 output of the DG535 fires the flashlamp of a pulsed laser. Its internal rate generator controls the repetition rate of the laser and the overall experimental repetition rate. The A delay output controls the firing of the laser Q-switch. The B delay output can be used to synchronize some aspect of the experiment to the laser pulse (e.g., the application of a voltage pulse) or the triggering of a discharge. Finally, the C delay is used to trigger the gated integrator looking at the detector output. Note that both the B and C delays can be specified relative to the A delay. In this way, as the laser pulse is moved by changing the A to T0 delay, the experimental trigger and the gated integrator trigger will stay fixed relative to the laser pulse.
**Delays**

- **Channels**: Four independent delay outputs
- **Range**: 0 to 999,999,999,999,995 seconds
- **Resolution**: 5 ps
- **Accuracy**: 1500 ps + timebase error × delay
- **Timebase**:
  - Standard: 25 ppm crystal oscillator
  - Optional: 1 ppm TCXO (opt. 03)
  - External: 10.0 MHz reference input
- **RMS jitter**: <100 ps + (10−8 × delay)
- **Trigger delay (typ.)**: 85 ns (ext. trigger to T0 output)

**External Trigger**

- **Rate**: DC to 1/(1 µs + longest delay)
- **Threshold**: ±2.56 VDC
- **Resolution**: 10 mV
- **Slope**: Trigger on rising or falling edge
- **Impedance**: 1 MΩ + 40 pF or 50 Ω

**Internal Rate Generator**

- **Rate**: Single shot, 0.001 Hz to 1.000 MHz, or line
- **Resolution**: Four digits, 0.001 Hz below 10 Hz
- **Accuracy**: Same as timebase
- **Jitter**: 1:10,000
- **Settling**: <2 seconds for any rate change
- **Burst mode**: 2 to 32766 pulses per burst at integer multiples (4 to 32767) of the trigger period

**Outputs**

- **Load**: 50 Ω or high impedance
- **Rise time**: 2 to 3 ns (typ.)
- **Slew rate**: 1 V/µs
- **Overshoot**: <100 mV + 10 % of pulse amplitude
- **Levels**:
  - TTL: 0 to 4 VDC (normal or inverted)
  - ECL: −1.8 to −0.8 VDC (normal or inverted)
  - NIM: −0.8 to 0.0 VDC (normal or inverted)
  - VAR: Adjustable offset and amplitude between −3 and +4 VDC with 10 mV resolution.
  - 4 V maximum transition.
- **Accuracy**: ±(50 mV + 3 % of pulse amplitude)
- **Option 02**: Rear panel 1 µs pulses corresponding to T0, A, B, C, D outputs with nominal amplitude of 8× the front-panel outputs (1 kHz rep. rate). Output level is reduced by 2V/µA of additional average output current.

**Fast Rise Time (opt. O4A)**

- **Output amplitude**: +0.5 to +2.0 VDC
- **Output offset**: −0.8 VDC (typ.)
- **Transition time**:
  - Rise (20/80 %): 100 ps (max.)
  - Fall (20/80 %): 2000 ps (max.)
- **Pulse aberrations**:
  - Foot: 4 % (typ.)
  - Ring: ±5 % (typ.)

**Fast Fall Time (opt. O4B)**

- **Output amplitude**: −0.5 to −2.0 VDC
- **Output offset**: +0.8 VDC (typ.)
- **Transition time**:
  - Rise (20/80 %): 2500 ps (max.)
  - Fall (20/80 %): 100 ps (max.)
- **Pulse aberrations**:
  - Foot: 4 % (typ.)
  - Ring: ±5 % (typ.)

**General**

- **Display**: backlit 20-character LCD
- **Computer interface**: GPIB (IEEE-488). All instrument functions and settings may be controlled over the interface bus. Interface queue can be viewed from the front panel.
- **Dimensions**: 8.5" × 4.75" × 14" (WHD)
- **Weight**: 10 lbs.
- **Power**: 70 W, 100/120/220/240 VAC, 50/60 Hz
- **Warranty**: One year parts and labor on defects in materials and workmanship