

Moving from a Tektronix AWG7000 to the Model 685

A series resistor or an in-line capacitor added at an AWG7082C output to suppress a secondary pulse and ringing is treating a reflection from a mismatched load. The Berkeley Nucleonics Model 685 has a DC-coupled 50 Ω output with up to 5 Vpp into 50 Ω and a ± 2.5 V offset, and it generates a double pulse as a native waveform when a test calls for one. Tektronix no longer sells the AWG7000C series.



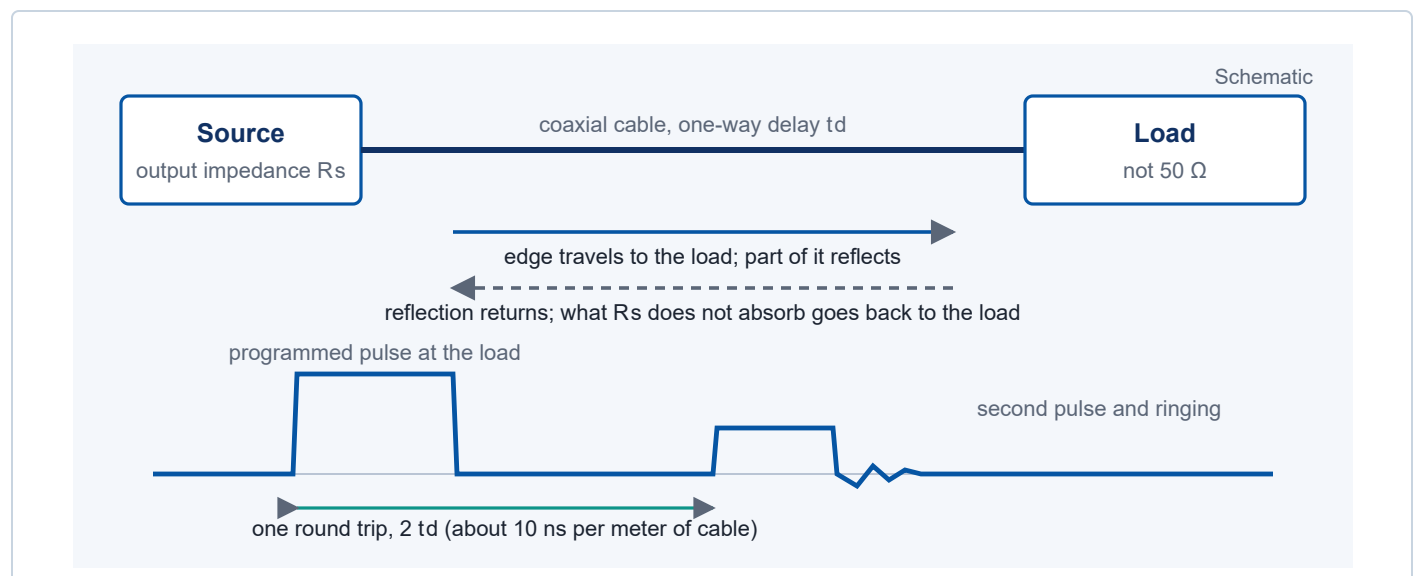
APPLICATION BRIEF · AWG · dc-62022201

THE PROBLEM

A second pulse after the programmed one

The symptom: one pulse is programmed and the device under test receives two, the intended pulse and a smaller copy of it a few nanoseconds later, with ringing (Figure 1). A series resistor or an in-line capacitor at the output damps the reflection and suppresses the second pulse. It also changes the edge, reduces the amplitude at the load, and places an uncalibrated part between the instrument and the device under test.

Tektronix no longer sells the AWG7000C series, which includes the AWG7082C, so units in service are supported from the used and rental market.



SCHEMATIC Figure 1. How a second pulse forms. Part of the edge reflects from a load that is not 50 Ω , returns along the cable and, where the source does not absorb it, is sent back toward the load, arriving one cable round trip later.

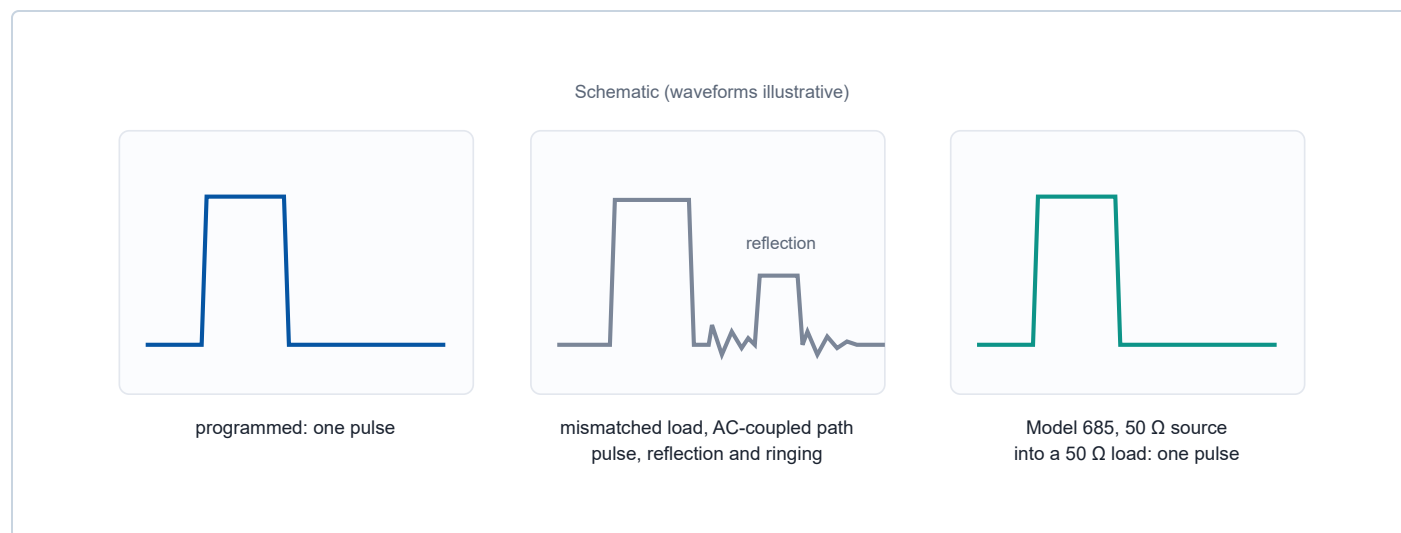
ROOT CAUSE

Why the second pulse shows up

A second pulse at a fixed delay after the first is the signature of a reflection. A fast edge launched into a load that is not $50\ \Omega$ partly reflects; the reflected edge travels back to the source, and whatever the source does not absorb is sent toward the load again. The second pulse arrives one cable round trip after the first, about 10 ns per meter of cable in solid-dielectric coax (velocity factor 0.66). Any fast source shows this into a mismatched load. The size of the second pulse depends on the load mismatch and on how closely the source matches $50\ \Omega$ across the bandwidth of the edge. If a blocking capacitor sits in the path, the drive is also AC-coupled, and the baseline shifts with the duty cycle of the pattern.

A series resistor attenuates both the pulse and its reflection; a series capacitor blocks DC and makes the baseline depend on duty cycle. Terminating the device under test in $50\ \Omega$, or keeping the cable short compared with the pulse width, removes the cause.

THE FIX



■ **SCHEMATIC** Figure 2. One programmed pulse (left), the output into a mismatched load through an AC-coupled path, with a second pulse and ringing (center), and the Model 685 DC-coupled $50\ \Omega$ output into a $50\ \Omega$ load (right). Waveforms illustrative.

The Model 685 output

The Model 685 single-ended output is DC coupled with a $50\ \Omega$ output impedance, and it delivers up to 5 Vpp into $50\ \Omega$ with a $\pm 2.5\ \text{V}$ hardware offset, so the baseline sits at the programmed level without a blocking capacitor. A reflection returning from the load is terminated in the $50\ \Omega$ source impedance instead of being sent back as a second pulse; the mismatch at the load itself remains, and a $50\ \Omega$ termination at the device under test removes it. In True Arb mode, rise and fall time is $\leq 110\ \text{ps}$ (20% to 80%) and $\leq 175\ \text{ps}$ (10% to 90%) at 1 Vpp single-ended, and random jitter on a clock pattern is $< 2\ \text{ps rms}$. In AFG mode, square and pulse edges are 300 ps (20% to 80%) and 400 ps (10% to 90%).

The 685 also generates a double pulse on purpose. In AFG mode the double pulse is a standard waveform up to 385 MHz, with the two pulse amplitudes summing to 10 Vpp ($|V_{pp1}| + |V_{pp2}|$) single-ended, alongside sine, square, ramp, pulse, Gaussian, noise and arbitrary waveforms. Vertical resolution is 16 bits in every mode: 65,536 levels, 64 times the 1,024 levels of a 10-bit converter, for fine steps and low-level detail in pulse and step shapes.

SIDE BY SIDE

AWG7082C and Model 685

Table 1.

Specification	Tektronix AWG7082C	BNC Model 685
Product status	No longer sold by Tektronix	Current production
Vertical resolution	10 bit (8 bit with markers)	16 bit
Sample rate	8 GS/s (16 GS/s interleaved, one channel, Option 06)	1 S/s to 6.16 GS/s (12.32 GS/s in RF mode)
Bandwidth	–3 dB modulation bandwidth, typical: 680 MHz amplified output, 3.2 GHz direct output, 3.5 GHz Option 02	≥ 2 GHz calculated (0.35 / rise time), single-ended
Rise / fall time, 20% to 80%	Typical: 350 ps amplified, 75 ps direct, 35 ps Option 02	≤ 110 ps True Arb at 1 Vpp single-ended; 300 ps AFG
Output level	Typical, single-ended: –22 dBm to 10 dBm amplified, –22 dBm to 4 dBm direct	0 to 5 Vpp into 50 Ω, single-ended, DC coupled
Offset	±0.5 V amplified output; none listed on the direct output	±2.5 V into 50 Ω
Random jitter, clock pattern, rms	Typical: 1.6 ps amplified, 0.9 ps direct	< 2 ps (typical)
Channels	2 (1 interleaved)	2, 4 or 8
Waveform length	32 M points (64 M with the record length option)	128 to 2 G samples per channel (4 G optional)

Model 685 values are from the Berkeley Nucleonics Model 685 datasheet. AWG7082C values are from the Tektronix AWG7000 Series datasheet, literature number 76W-22259-18, and are typical where that datasheet marks them typical. The AWG7082C leads on sample rate, direct-path bandwidth, edge time and jitter. The Model 685 leads on vertical resolution, output amplitude and offset into 50 Ω, channel count and waveform memory. For applications that need more than 6.16 GS/s, the Model 686 samples at up to 20 GS/s with 14-bit resolution.

WHAT YOU GAIN

More than a clean pulse

- **Resolution.** 16 bits, 64 times the levels of a 10-bit converter, for pulse shapes, fine steps and low-level detail.
- **A DC-coupled output.** Up to 5 Vpp into 50 Ω with a ±2.5 V offset, so a device whose input sits within that window is driven without an external resistor, capacitor or amplifier.
- **A current product.** Calibration, warranty and service from Berkeley Nucleonics.
- **Room to grow.** Two, four or eight channels, up to 2 G samples per channel (4 G optional), and a sequencer with up to 16,384 entries, loops, jumps and conditional branches.
- **The double pulse as a setting.** A double-pulse waveform in AFG mode when the test calls for one.

NEXT STEP

See it on your own pulse

Send us the waveform and the load you drive from an AWG7000. We will reproduce it on a Model 685 into the same load and compare the two edges on one oscilloscope. Let's look at the results together.

Request a Model 685 demo

or explore the Model 685 data sheet.

Berkeley Nucleonics Corp.

Test, Measurement and Nuclear Instrumentation since 1963

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Application Brief

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