APPENDIX B

Measuring Probe-Oscilloscope Response

The LT1394's 7ns response time and the circuitry it is used in will challenge the best test equipment. Many of the measurements made utilize equipment near the limit of its capabilities. It is a good idea to verify parameters such as probe and scope rise time and differences in delays between probes and even oscilloscope channels. Verifying the limits of wideband test equipment setups is a difficult task. In particular, the end-to-end rise time of oscilloscope-probe combinations is often required to assure measurement integrity. Conceptually, a pulse generator with rise times substantially faster than the oscilloscope-probe combination can provide this information. Figure B1 circuit does this, providing a 1ns pulse with rise and fall times inside 250ps. Pulse amplitude is 10V with a 50Ω source impedance. This circuit, built into a small box and powered by a 1.5V battery, provides a simple, convenient way to verify the rise time capability of almost any oscilloscope-probe combination.

The LT1073 switching regulator and associated components supply the necessary high voltage. The LT1073 forms a flyback voltage boost regulator. Further voltage step-up is obtained from a diode-capacitor voltage step-up network. L1 periodically receives charge and its flyback discharge delivers high voltage events to the step-up network. A portion of the step-up network's DC output is fed back to the LT1073 via the 10M-24k divider, closing a control loop.

The regulator's 90V output is applied to Q1 via the 1M-2pF combination. Q1, a 40V breakdown device, nondestructively avalanches when C1 charges high enough. The result is a quickly rising, very fast pulse across R4. C1 discharges, Q1's collector voltage falls and breakdown ceases. C1 then recharges until breakdown again occurs. This action causes free running oscillation at about 200kHz.[1, 2] Figure B2 shows the output pulse. A 12.4GHz sampling oscilloscope measures the double-terminated pulse at 4.8V high with about a 700ps base. Rise time is 216ps, with fall time 232ps. There is a slight hint of ring after the falling edge, but it is well controlled.

Note 1: This method of generating fast pulses borrows heavily from the Tektronix type 111 Pretrigger Pulse Generator. See References 17, 20, 22, 27 and 28.
Note 2: If desired, the avalanche pulse generator may be externally triggered. See Figure 75 and associated text. See also References 20 and 22.

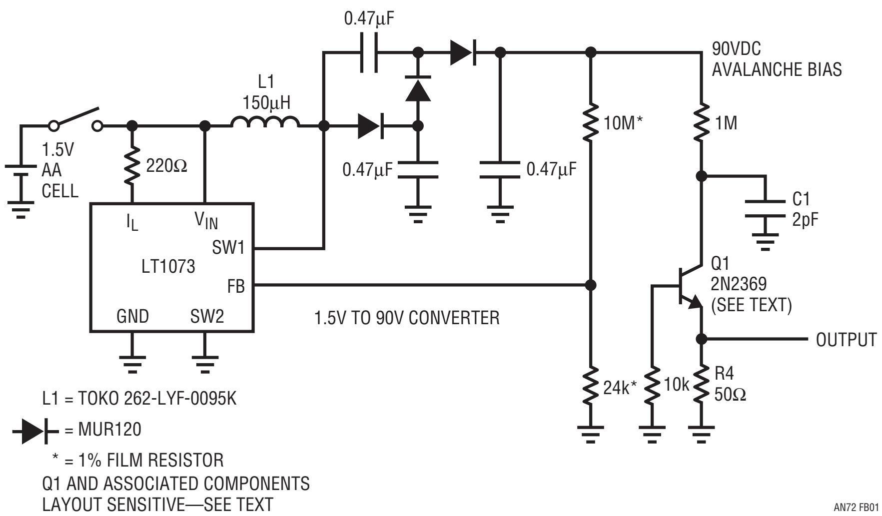

Figure B1. 250ps Rise/Fall Time Avalanche Pulse Generator

Q1 may require selection to get avalanche behavior. Such behavior, while characteristic of the device specified, is not guaranteed by the manufacturer. A sample of 50 Motorola 2N2369s, spread over a 12-year date code span, yielded 82%. All good devices switched in less than 650ps. C1 is selected for a 10V amplitude output. Value spread is typically 2pF to 4pF. Ground plane type construction with high speed layout techniques is essential for good results from this circuit. Current drain from the 1.5V battery is about 5mA.

Figure B3 shows the physical construction of the actual generator. Power, supplied from a separate box, is fed into the generator's enclosure via a BNC connector. Q1 is mounted *directly* at the output BNC connector, with grounding and layout appropriate for wideband operation. Lead length, particularly Q1's and C1's, should be experimented with to get best output pulse purity. Figure B4 is the complete unit.

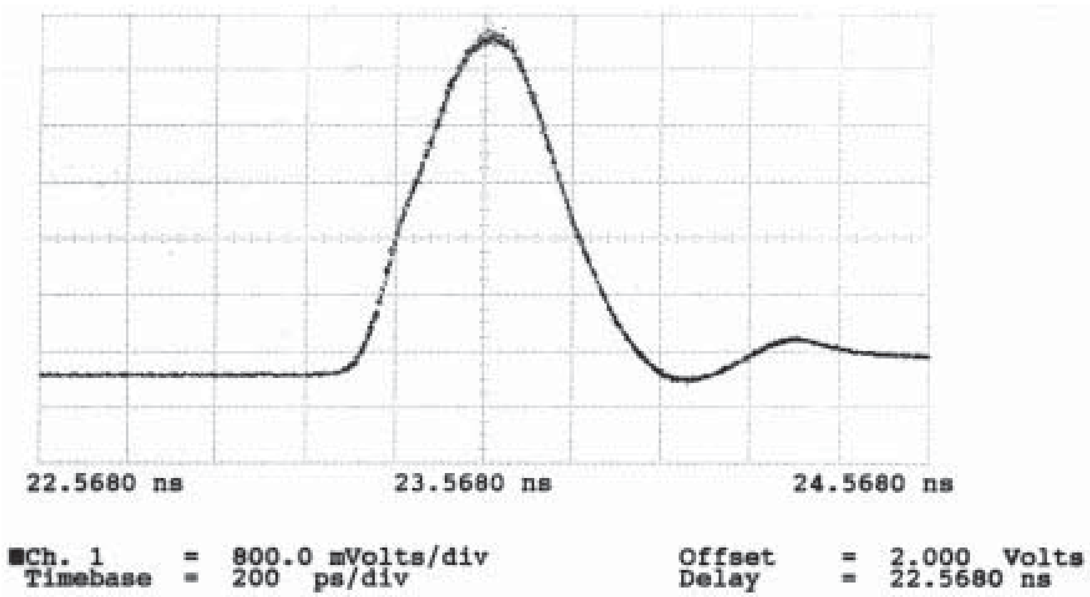

Figure B2. The Avalanche Pulse Generator's Output Monitored on a Hewlett-Packard 54120B 12GHz Sampling Oscilloscope. Double-Terminated Output Reduces Pulse Amplitude

(Courtesy of T. Hornak, Hewlett-Packard Laboratories)