Fermi National Accelerator Laboratory

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Multiple Time Constant Pulse Shaper

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Multiple time constant pulse shaper

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We were asked to make a circuit that produces an output like that of a CsI crystal viewed by a PMT. This pulse is characterized by a rise time of 10ns, and a dual slope fall time with 80% of the pulse having a time constant of 25ns and 20% of the pulse having a time constant of 1us.

The circuit schematic is included on page 2. The circuit differentiates an input pulse giving a negative pulse out for positive transitions, and a positive pulse out for negative transitions. A low pass filter on the input sets the time constant for the leading edge of the pulse. The signal is then buffered and fed through two parallel high pass networks which set the time constant for the trailing edge of the pulse. A current buffer drives the capacitively coupled output. The ratio of the resistors in the high pass networks sets the proportions of the slow to fast components of the pulse. Additional time constants can be added to the trailing edge by paralleling additional high pass networks.

The Burr-Brown OPA660 operational transconductance amplifier (OTA) and buffer was ideal for this circuit. The buffer has low voltage noise density 4nv per root hertz, 700 mhz small signal bandwidth, and a slew rate of 3000v per usec. The OTA in its similarity of operation to a transistor was used as a common base transistor for a current buffer. Some notes on the OTA from the Burr-Brown data sheet :
"While the OTA is similar to a transistor, one essential difference is the sense of the collector output current. It flows out of the collector terminal for positive base to emitter voltage...The OTA is self biased, simplifying the design process and reducing component count. The OTA is far more linear than a transistor. Transconductance of a transistor is proportional to its collector current which is signal-dependent -- this implies a fundamental nonlinearity."

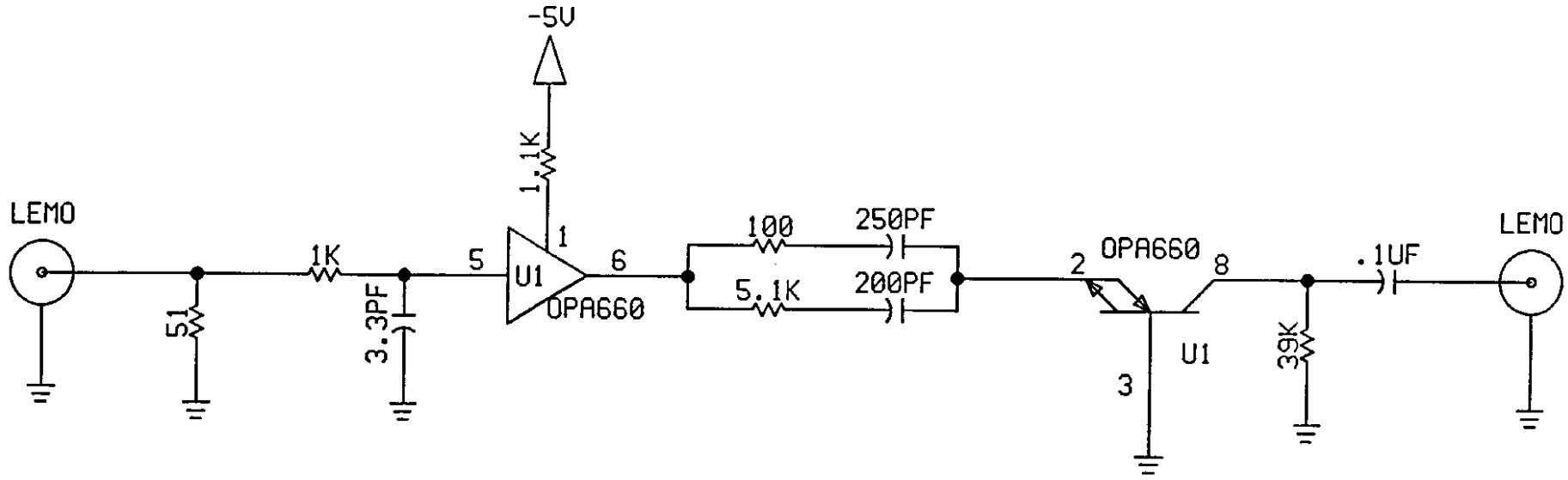
The time constants for the pulse were set by the following components.

leading edge time constant set by 1k ohm resistor and 3.3pF capacitor = 3.3n sec.
fast trailing edge time constant set by 100 ohm resistor and 250pF capacitor = 25n sec.
slow trailing edge time constant set by 5.1k ohm resistor and 200pF capacitor = 1.02u sec.

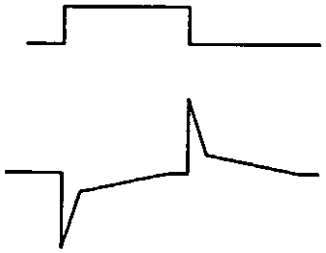
Input pulse : -2v to +2v maximum
output pulse: 0 to -500mv and 0 to +500mv for an positive input from 0 to 2v.

power supplies : -5v, +5v

Page 3 is a plot of a spice simulation of the circuit, which was found to be comparable with the actual circuit performance.



0 -> 2V 10uSec WIDE INPUT



0 -> ±500mV Out

UNLESS OTHERWISE SPECIFIED	ORIGINATOR	B. Tschirhart	
	DESIGNER	D. Graupman, S. Hansen	8-20-92
	DRAWN	D. Graupman	8-20-92
	CHECKED		

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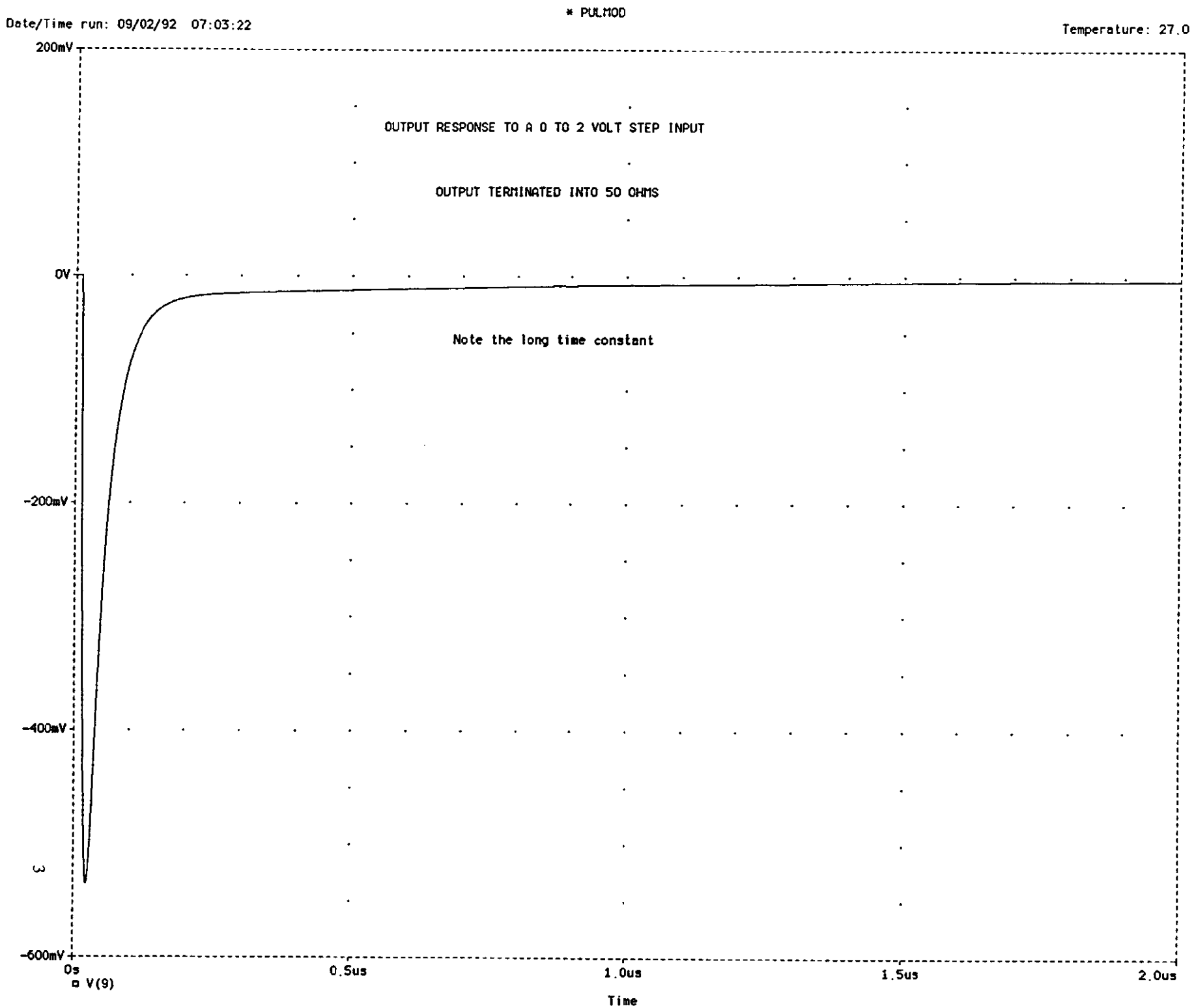
UNITED STATES DEPARTMENT OF ENERGY

MULTIPLE TIME CONSTANT PULSE SHAPER

TEST PULSE CIRCUIT FOR KTEV

DRAWING NUMBER	REV.

2


* PULMOD
Date/Time run: 09/02/92 07:03:22
Temperature: 27.0
OUTPUT RESPONSE TO A 0 TO 2 VOLT STEP INPUT
OUTPUT TERMINATED INTO 50 OHMS
Note the long time constant
200mV
0V
-200mV
-400mV
-600mV
0s
0.5us
1.0us
1.5us
2.0us
V(9)
Time