SLAC-PUB-1296 (I) August 1973

A TIME COMPENSATOR FOR LARGE

SCINTILLATION COUNTERS*

J. Faust and R. S. Larsen

Stanford Linear Accelerator Center Stanford University, Stanford, California 94305

ABSTRACT

A circuit is described which develops time-invariant pulses for large scintillation trigger counters. For a 8.56 ft long counter, a unit capable of \pm 22 nsec range is described; the constancy of delay of output for this unit over the full delay range is typically \pm 400 psec.

* Work supported by the U. S. Atomic Energy Commission.

(Submitted to Nucl. Instr. & Methods.)

1. Introduction

One of the requirements for the solenoidal magnetic detector for the new Stanford Positron-Electron Storage Ring (SPEAR) was an electronic circuit to produce a time-invariant reference pulse from each of (48) 8.56 ft long scintillation counters. The counters are used in the topology selection portion of the trigger logic system, as shown in fig. 1. A detected particle produces pulses at each end of the long counter which are passed through discriminators; the 5 nsec FWHM discriminator outputs are then added in the time compensator circuit to produce a pulse which has constant delay with respect to the time, and independent of the position at which the particle impacts the scintillator. This time-compensated signal is then stored in a gated latch strobed by a narrow pulse derived from the rf synchronous trigger. The latches have fast (direct) outputs which are then fed to a MECL trigger logic system which makes a logical decision for the entire system in ≤ 50 nsec.

2. Principle of Operation

A tapped coaxial transmission line, of electrical length equal to the propagation time of the scintillator, conducts the two output pulses from the scintillatorphotomultiplier-discriminator combination (see fig. 2). In general, pulses enter each end of the coaxial line at different times and meet at some point along the line where their amplitudes add algebraically. The delay from the time the particle impacts the scintillator until the pulses combine and leave the coaxial line is a constant to within a fraction of a nanosecond and is equal to $(\Delta t_1 + \Delta t_2 + \Delta t_c)$, regardless of where the particle strikes the scintillator. When the two pulses add, the sum voltage is large enough to trigger a comparator connected to the OR-ed outputs of the cable taps.

- 2 -

3. Design Details

The detailed circuit is shown in fig. 3. The tapped coaxial line consists of (11) 2 nsec segments of RG-188 line with 12 taps. Each tap feeds a diode OR circuit, and each group of three diodes is then OR-ed through another series diode to a MECL 1692 Quad Line Receiver. The diodes provide a voltage threshold of about -800 mV, which is sufficiently high to reject a single pulse, but low enough to accept the sum of two pulses. The output from the MC 1692L is a 0 to -500 mV pulse which triggers one section of a MC 1650 comparator, thus improving the pulse rise-time and standardizing the amplitude.

The comparator in turn drives a current-switching pair with a clip-line pulse forming network to give a standard 5 nsec FWHM NIM level (0 to -700 mV min.) output pulse.

Waveforms of typical inputs and final outputs are shown in the photographs of figs. 4 and 5; the test circuit is shown in fig. 6. The pulse output for the full range of the delay line is shown in the photograph of fig. 7. Note that the total dispersion of the pulse leading edge is 800 psec, or \pm 400 psec for a delay range of \pm 24 nsec, which is slightly greater than the theoretical maximum delay range of \pm 22 nsec.

The unit is packaged as four independent channels in a single width NIM module (fig. 8). Measurements of the time dispersion from channel-to-channel at a particular delay setting for a NIM module typically shows a spread of 200 psec maximum among all four channels.

- 3 -

The overall specifications are summarized as follows:

SLAC 135-118 Time Compensator

Time shift: For ± 24 nsec input delay shift, ± 400 ps.

Inputs: Standard NIM logic pulse, 2 nsec ${\rm T}_{\rm R}^{},~{\rm T}_{\rm F}^{},~5$ nsec FWHM

from discriminator output.

Output Pulse:

Amplitude into 50 ohm: - 800 mV minimum

Risetime, 10% - 90%: 2 nsec

Pulse width: 5 nsec FWHM

Power required: - 6 volts at 240 mA dc for four channels

Package: Single width NIM with LEMO connectors

4. Conclusion

A circuit has been described which develops time-invariant pulses from large trigger counters. The constancy of the delay, exclusive of discriminator variations, is typically \pm 400 psec, over a \pm 24 nsec delay range.

5. Acknowledgement

The authors are indebted to G. Feldman and H. Lynch who initiated this development.





1



A CARLER AND



VERTICAL = 200 mV/cm HORIZONTAL = 2 nsec/cm

2267A 4

I

Fig. 4

1.1412



VERTICAL=200 mV/cm HORIZONTAL=2 nsec/cm

Mar March

2267A5

Fig. 5



I





VERTICAL=100 mV/cm HORIZONTAL=2 nsec/cm

2267A7



Fig. 8