Fermilab

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E-537 MWPC AMPLIFIER

R. Kephart and C. Kerns

September 17, 1979

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GENERAL

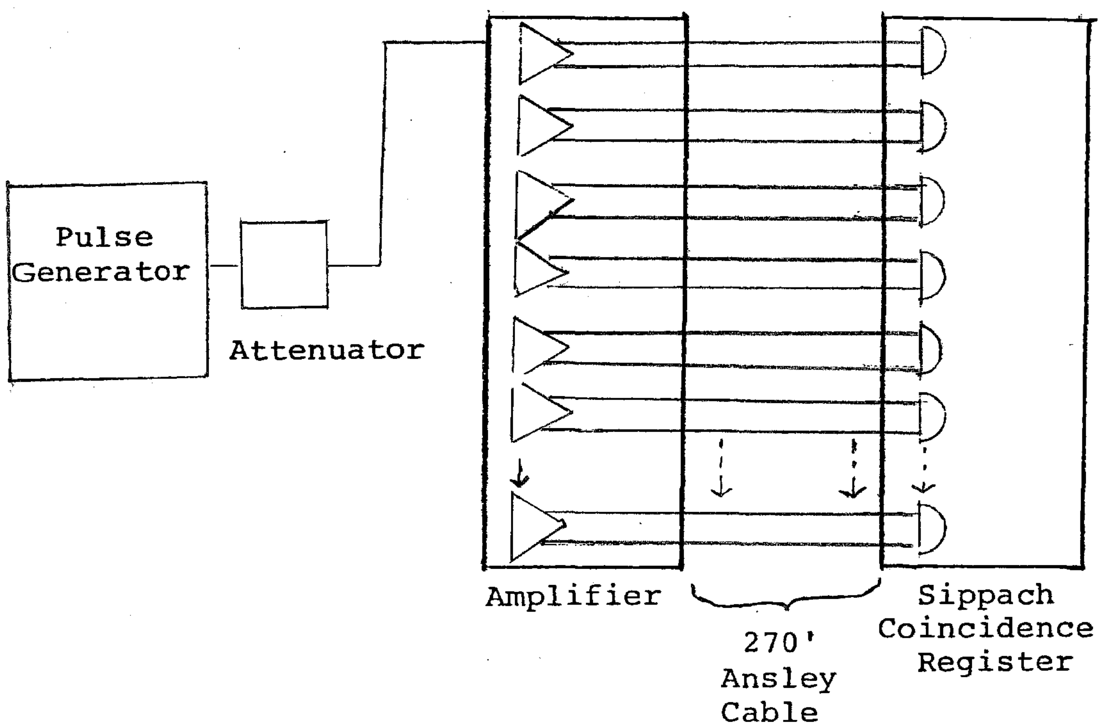
The design of a fast MWPC amplifier for the beam chambers and the absorber chamber is completed and all parts are on order. A prototype 16 channel board has been built and satisfactorily tested. Artwork is completed for the board and out to be photographed. The board fabrication contract has been let. Listed below is a summary of the amplifier characteristics as well as test results obtained with the prototype.

DESIGN

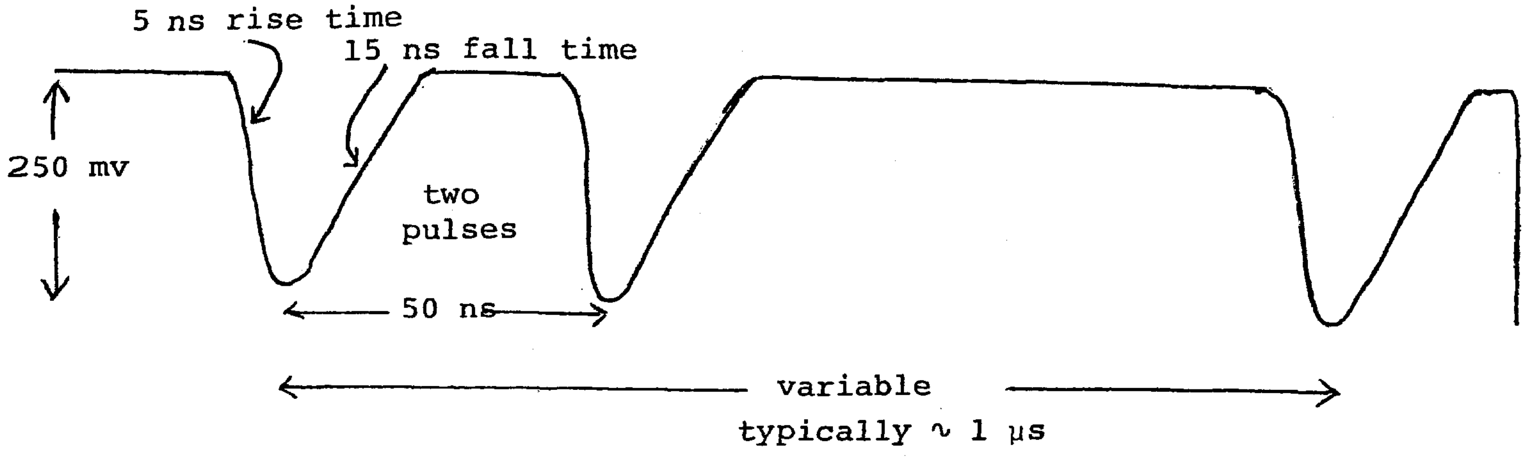
The amplifier is a version of the E-288 fast amplifier designed by Bill Sippach, modified and improved by C. Kerns in consultation with me. A circuit diagram is shown in Fig. 1. The amplifier is a "time over threshold" type consisting of a fast amplifier and pulse shaper followed by a μA-685 comparator with ECL differential outputs. The amplifier is consequently "dead-time-less" and capable of operation at very high rates (i.e., at high rates its simply stays "ON" continually). Although the original Sippach design was used successfully in E-288, its design had several short comings. The most serious was a tendency to oscillate unless very close attention was paid to the amplifier and output cable grounding and output cable geometry. This problem was traced to unbalanced currents flowing in the amplifier ground plane, and to stray capacitance feeding fast rise time ($\lesssim$ 1/2 ns) output signals back to the input. Thus in our amplifier design, Cordon took great care in reducing and balancing the currents flowing in the amplifier ground plane. In addition, since we are driving long flat line cables whose dispersion limits the fastest rise time one can obtain at the receiver to ∿ 7 ns, it did not make sense to drive them with 1/2 ns rise time signals. Thus the outputs of the μA-685 were slowed down with inductors to ∿ 5 ns rise time. The ECL "differential" outputs were balanced using a multifilar wound toroidal transformer to insure that they were truely differential. Finally extensive geometry changes and a bypass capacitor were added to reduce output to input coupling, and the original μA-687 dual comparator was replaced by 2 μA 685'5 to eliminate adjacent channel cross talk induced by the original chip.

PROTOTYPE TEST RESULTS AND SPECIFICATIONS

Test Setup



Test Pulse (seen at input of attenuator)



Pulse shape was chosen to simulate that expected from chambers.

Repetition rate was typically 1 MHz.

Results

Power Requirements	+ 6 V	875 ma	∿10.5 watts/card
	- 6 V	862 ma	

Sensitivity

Minimum Threshold:	Oscillation occurs at threshold corresponding to ∿ 100 μv.
Stable Operation Threshold:	For 60 db attentuation ⇛ 250 μv input signals stable operation well above oscillation with full efficiency is easily obtained (Threshold voltage applied 2.8 V).

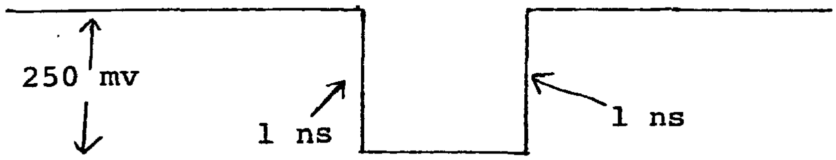
Time Slewing Test

(5 ns rise time test signal shown above)

(Threshold set at 3V ⇛ 125 μv).

Signal Size	Time	
250 μv	t = 0	consistent with signal rise time
2.5 mv	t = 5 ns	
2.5 mv	t = 6 ns	

(Change to 1 ns rise time signal)



(Threshold at 3v = 180 μv for this rise time)

Signal Size	Time
360 μv	t = 0
3.6 mv	t = 4ns (2 ns to 1/2 height)
36 mv	t = 6 ns (4 ns to 1/2 height)

Conclusion: Amplifier time slewing $\lesssim$ 5 ns.

Cross Talk (typical test)

Observe Channel #1 output with input floating, threshold = 3v ⇒ 125 μv sensitivity, inject signal into channel #2

Conclusion: Channel #1 Fires when signal into #2 exceeds 30 mV ⇒ dynamic range $\simeq \frac{30}{0.125} \sim \frac{240}{1}$

Same, but threshold = 5V ⇒ 180 μv

Channel #1 fires when signal into #2 exceeds 80 mV ⇒ $\frac{80}{0.2} = \frac{400}{1}$.

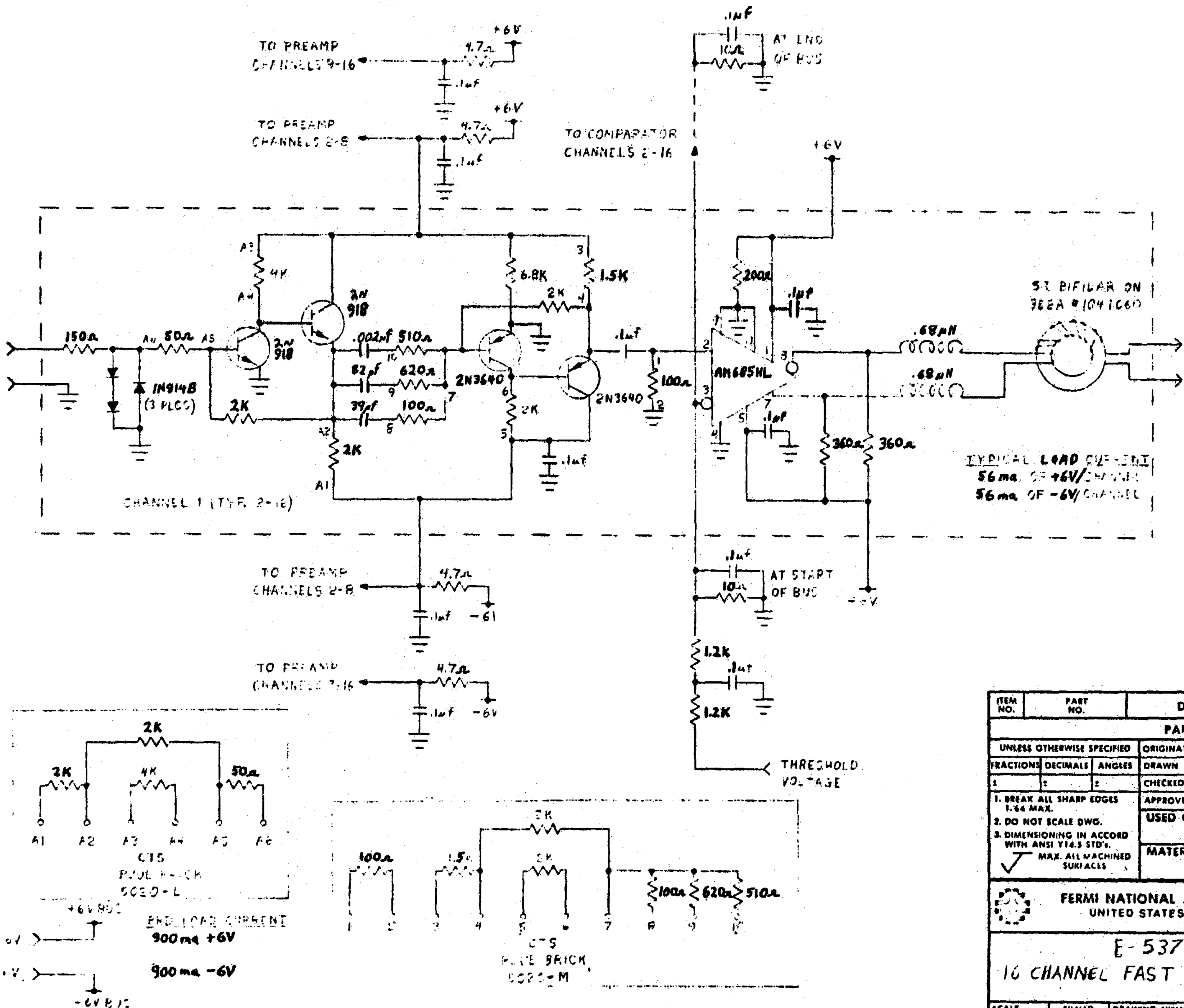
Numerous other similar cross talk tests were performed all looked quite reasonable.

<u>Magnetic Field Test</u>

Since amplifier contains ferrite inductors and toroid a test was made of the effects of fringe field etc.

<u>Conclusion:</u> a 1.5 Kg field lowers output pulse by $\lesssim$ 15% in "worst" orientation $\Rightarrow$ fringe fields are no problem. NOTE: Amplifier can be operated without toroids or inductor with reduced performance for operation in high magnetic fields.

REV.	DESCRIPTION	DRAWN	DATE
		APPD.	DATE



ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.

PARTS LIST

UNLESS OTHERWISE SPECIFIED					
FRACTIONS ±	DECIMALS ±	ANGLES ±	ORIGINATOR	C. KERNS	
			DRAWN		1-19-79
			CHECKED		
			APPROVED		

1. BREAK ALL SHARP EDGES 1/64 MAX.
2. DO NOT SCALE DWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5 STD'S.
√ MAX. ALL MACHINED SURFACES

USED ON

MATERIAL-

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

E-537
16 CHANNEL FAST MWPC AMP

SCALE	FILMED	DRAWING NUMBER	REV.
		5537-EC-114333	