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Digital Dev. Memo #379

To: Eldon Hall
From: R. Howie and W. Prince
Date: 22 August 1967
Subj: Night Watchman Noise Problems II

Experiments with the Block I system at MIT/IL on 15 March 1967 showed that the night watchman module is sensitive to input noise when the input is a logical one (i.e., the G&N fail light should be illuminated). As explained in Digital Dev. Memo #359 it was found that "a 0.01μf capacitor inserted between +13 VDC and the input point (E 3) reduced the noise to a level which would not trigger the circuit."

Since this capacitor is under consideration as a retrofit for the two remaining Block I systems, verification of the value 0.01μf was requested.

Experiments on the Block I system on 11 August 1967 established an upper limit of 0.08μf at which the filtering effect was sufficient to filter out the 24μ sec pulses for the night watchman program. This condition would cause the G&N fail lamp to be illuminated at all times. The value 0.01μf was confirmed as sufficient to greatly reduce input noise and allow proper operation of the night watchman program. The type of noise under consideration here is high frequency ringing noise (1 to 2 volts at 10 to 20 MH_z) as generated by relay switching transients. The .01μf capacitor will have a negligible effect on low frequency (400 H_z) noise.

The capacitor across the input does two things to the 24μs programmed pulse:

a. It slows down the rise and fall times of the pulse, and

b. It reduces the final amplitude of the pulse at the end of the 24μs interval.

This is shown in the series of oscillographs in Fig. 1. These photos were taken at 1 volt/division vertical and 5μ sec/division horizontal with the night watchman program running and the Telemetry Fail Light ON.[1] The first photo shows the "normal" pulse with no capacitor, and succeeding photos show the effect of increasing capacitance.

The night watchman module operated normally with all of the values of capacitance except the last value of .078μf. As can be seen in the last photo, the final amplitude of the pulse at the end of the 24μ sec interval was less than 700 millivolts.

A natural question which now arises is whether the failures at .078μf are due to the low amplitude of the programmed pulse or the slow rise and fall wave-shape of

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[1] Worst case for this test is when the T.L. Fail Light is ON. The photos show that the rise time of the 24μsec pulse is about 10 times as long as the fall time because of a 2K resistor in the collector drive circuit of the computer and only 200 ohms pull-up resistor in the N.W. Module. With the T.L. Fail Light OFF, the input pulse is inverted and the slow rise time of the pulse would be insignificant compared to the total on time of .75 seconds.

the pulse. To investigate this a modified night watchman program was loaded which extended the programmed pulse width to 10 milliseconds. This allows the input pulse to reach its maximum value even with an extremely slow rise time. Figure 2a shows this 10 millisecond pulse with no capacitor and Fig. 2b shows the pulse with a 1.0μf capacitor across the input. (1.0μf is 100 times the value we recommend.) The night watchman module operated normally with a .75μf capacitor and did not fail until a 1.0μf capacitor was placed across the input. We conclude, therefore, that the module is not sensitive to rise time, but rather to pulse amplitude which must exceed 700 millivolts.

Voltage margin tests were run on the system with the 24μsec night watchman program running. The module operated normally with a .068μf capacitor at all voltages tested (B^+ = 10.5 volts $\longrightarrow$ B^+ = 13.75 volts).[2] The module failed to operate at the same voltages with a .078μf capacitor. We therefore conclude that the maximum failure capacitance threshold level (between .068μf and .078μf) does not change with changes in the +13 VDC supply.

It is our opinion that a .01μf capacitor between E 2 and E 3 on the night watchman module will eliminate the noise problem without jeopardizing proper operation of the night watchman program.

Dist.

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[2] Unfortunately our computer fails at 13.75 volts. Worst case for the N.W. module should be at <u>low</u> B^+ since less base drive is available at low B^+.

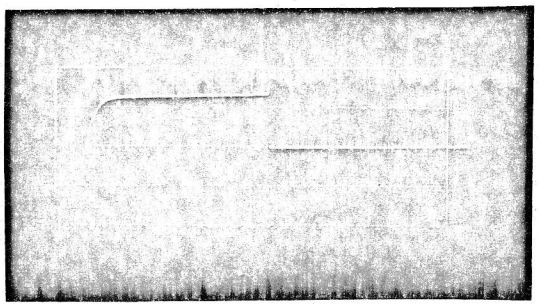

Fig. 1a. Normal Pulse (No Capacitor).

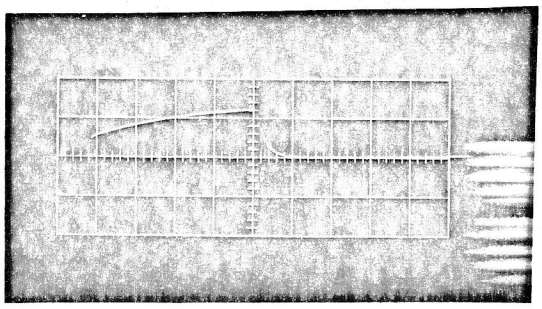

Fig. 1b. .01μf Capacitor.

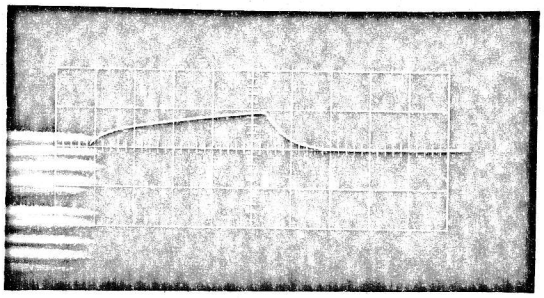

Fig. 1c. .022μf Capacitor.

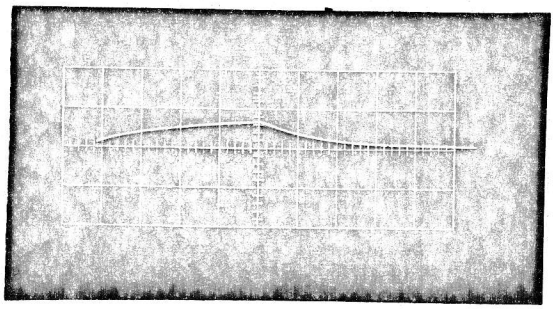

Fig. 1d. .068μf Capacitor.

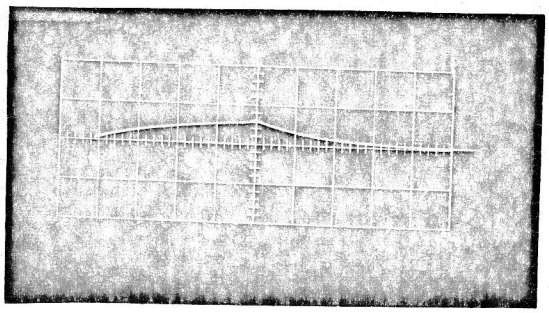

Fig. 1e. .078μf Capacitor (N.W. Module Failed).

Fig. 1 (a,b,c,d,e). Input pulse to night watchman module with different capacitors. Night watchman program running. Telemetry Fail Light ON. Horizontal scale 5 μsec/div.; Vertical scale 1 volt/div., Baseline = 11.7 volts. G&N Fail Light OFF in all cases except Fig. 1e.

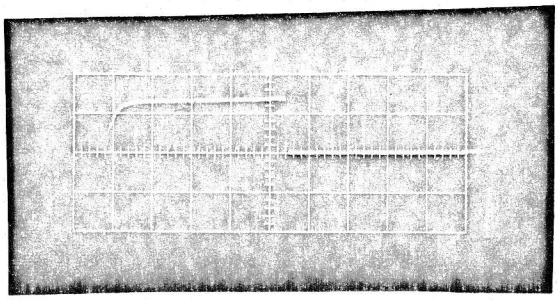

Fig. 2a. 10 Millisecond Pulse
No Capacitor.

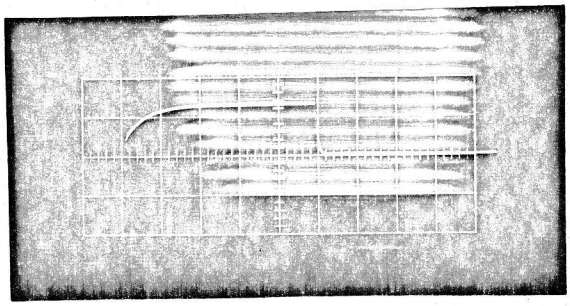

Fig. 2b. 10 Millisecond Pulse
1.0μf Capacitor.

Fig. 2 (a and b). Input pulse to night watchman module with "Modified" night watchman program (10 millisecond pulses). Horizontal scale 2 millisecond/div., Vertical scale 1 volt/div., Baseline = 11.7 volts.