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Digital Dev. Memo #399

To: Eldon Hall
From: Allen Harano
Date: 8 February 1968
Subj: Restarts Due to a Momentary Loss of Primary Power
Ref.: DDM #343 (Enclosed)

It has been found that multiple RESTARTS can occur due to a single momentary drop in primary (28 volt) power.

The input circuitry and relevant portions of the voltage fail circuitry of the AGC are shown in Fig. 1. Spacecraft power coming into the computer via the ABUSS or BBUSS passes through a blocking diode and 25 μh inductor to a point called + 28 COM (+ 28 common). + 28 COM is filtered directly by ~ 230 μf; in addition there are two L-C networks of 25 μh and 88 μf tied to + 28 COM.

The VFAIL comparator (contained in module B8) looks at + 28 COM and will alarm within microseconds if + 28 COM drops below 21.6 ± .2 volts. The signal VFAIL is digitally filtered (in module A13) and must remain present for a minimum of 146 μsec to cause a RESTART. The timing for this is shown in Fig. 2a. Flip-flop 1 is set by the coincidence of VFAIL and timing signal F05B (a 3200 pps, 10 μs wide pulse). The state of flip-flop 1 is interrogated by timing signal F05A (another 3200 pps, 10 μs wide pulse that is 180° out of phase with respect to F05B) which "jams" flip-flop 2 into the same state as flip-flop 1. The output of flip-flop 2 is the signal STRT1, which causes the signal GOJAM. GOJAM stops all computer activity, except for the AGC Scaler and a few continuous output signals (Master Clock, ISS timing, etc.), and forces the computer into T12 (time 12).

Due to hysteresis in the comparator VFAIL will remain at a logical "1" until + 28 COM increases somewhat above 21.6 volts. (In AGC ClM this point is .2 - .3 volts above the point where VFAIL turns on.) When VFAIL goes to a logical "0" flip-flop 1 is reset, and at the next F05A pulse flip-flop 2 is reset. Signal START2 has now disappeared, therefore signal GOJAM disappears and the computer begins program execution at location 4000_8.

It should be noted that from the time GOJAM comes on until the time GOJAM disappears is only <u>one</u> RESTART since program execution is suspended for the duration. RESTARTS caused by STRT1 are normally some multiple of 312 μs in duration since flip-flop 2 is set and reset by F05A.

It is possible, but very unlikely, for RESTARTS to occur at a 3200 pps rate due to VFAIL. The timing for this is shown in Fig. 2b. It requires that VFAIL be "1" during F05B and go from "1" to "0" during the 10 μs interval of F05A. In the case shown the first RESTART occurs 146 μs after VFAIL and each succeeding RESTART occurs 312.5 μs later.

Due to the digital filtering in A13, GOJAM will occur 146.25 - 458.75 μs after VFAIL turns on.

Because of the hysteresis in the VFAIL comparator it was felt unlikely that multiple RESTARTS would occur due to a single power transient since the Bus voltage would have to oscillate around the alarm voltage (22.3 ± .3). Closer

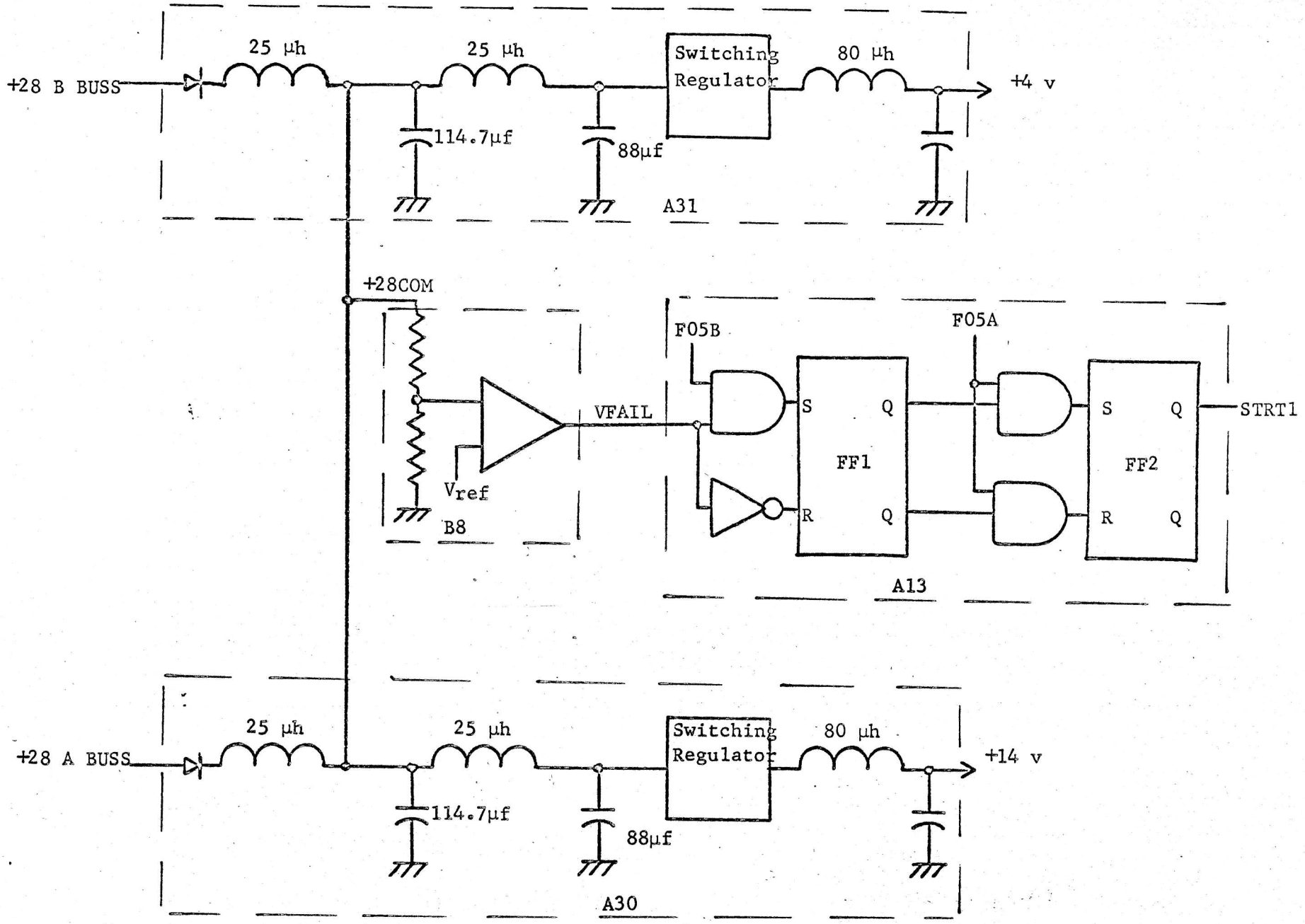
+28 B BUSS
25 µh
25 µh
Switching Regulator
80 µh
+4 v
114.7µf
88µf
A31
+28COM
F05B
F05A
VFAIL
S
Q
FF1
R
Q
S
Q
FF2
R
Q
STRT1
Vref
B8
A13
+28 A BUSS
25 µh
25 µh
Switching Regulator
80 µh
+14 v
114.7µf
88µf
A30

FIGURE 1

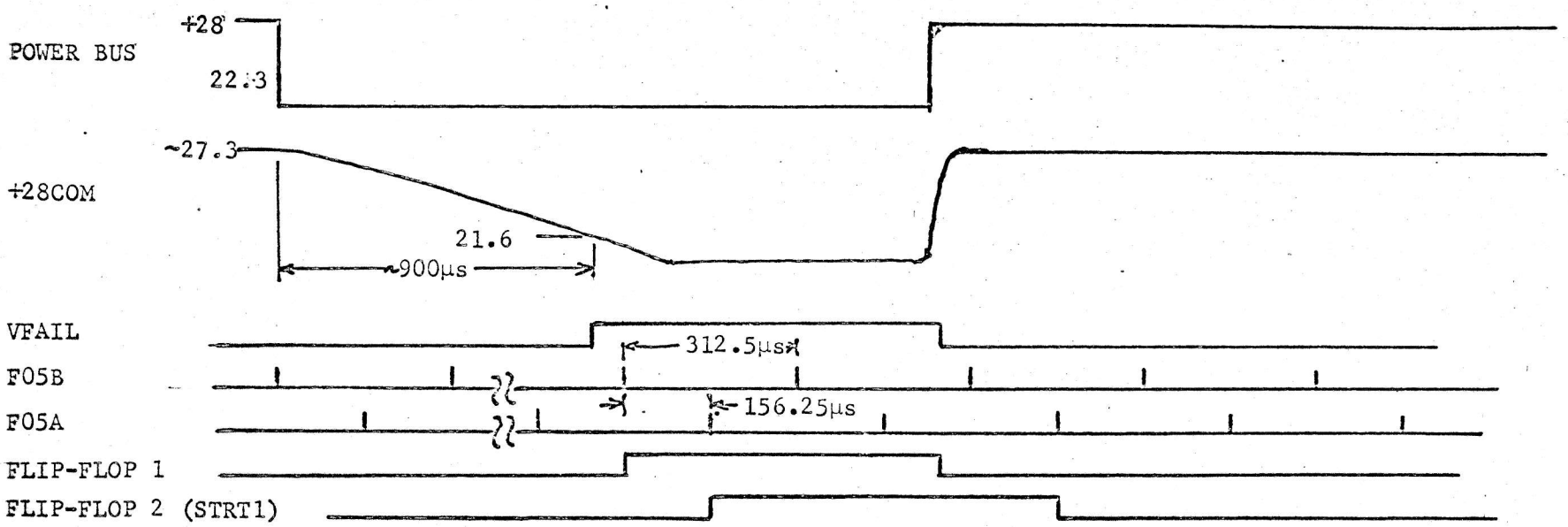

FIGURE 2a

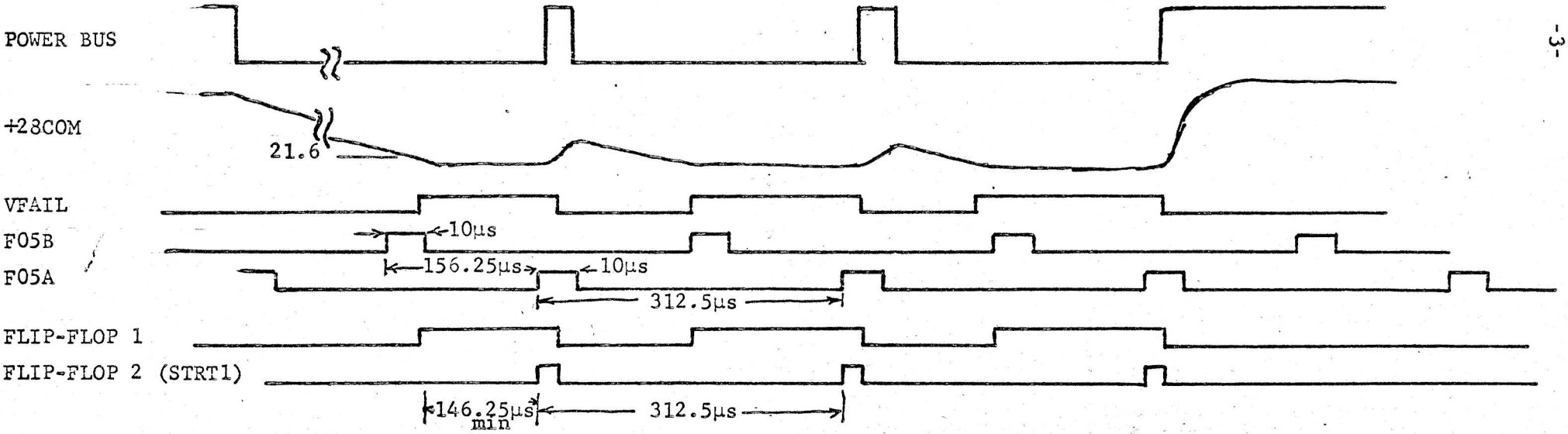

FIGURE 2b

examination of the AGC's power requirements, however, show that it is quite possible to obtain multiple RESTARTS. Tests performed using AGC-C1M and one DSKY show that as the 28 VBUS voltage is decreased, input current increased to ~ 3.0 amps until 22.7 volts is reached. At this point VFAIL occurs and the input current decreases to ~ 2.25 a since the computer is stopped. As the bus voltage is increased the current requirements remain constant until the voltage reaches 22.9 +, at which point VFAIL disappears and the computer resumes normal operation. The current requirement jumps up to ~ 2.95a. This corresponds to a negative resistance of ~ 1/3 Ω. Therefore a source resistance greater than 1/3 Ω can cause oscillation.

The oscillograph shown in Fig. 3a was taken using AGC-C1M and one DSKY. Power was applied from a well regulated supply through a 0.5 Ω resistor (see Fig. 3b). The wave shapes shown occurred with the power supply set at 24.1 volts. As the power supply voltage is varied the frequency and duty factor of VFAIL changes until VFAIL is always on (lower voltage), or always off (higher voltage).

To summarize, the affects of a momentary power loss are as follows:

1. Input power to the AGC drops below 22.3 ± .3V. + 28 COM slowly drops to 21.6 ± .2V at which time VFAIL turns on. (Reference D.D. Memo #343 for time constants involved with + 28 COM. NOTE: Line 3 of DDM #343 should be 22.3 instead of 23.3). After an additional delay of 146 - 458μs STRT1 occurs causing GOJAM.

2. If the transitions of the input power are sufficiently fast only one RESTART occurs. If the input power fluctuates near 23.3V for longer than ~500 μs after VFAIL turns on (due to slow transition times or the "steady state" value drops to ~ 22.3) multiple RESTARTS may occur.

From the results obtained in D.D. Memo #343, if the input power drops from 28 volts there is a minimum of ~ 1 ms before a RESTART occurs. Succeeding RESTARTS may occur (provided the input conditions are proper) at a maximum rate of 3200 pps.

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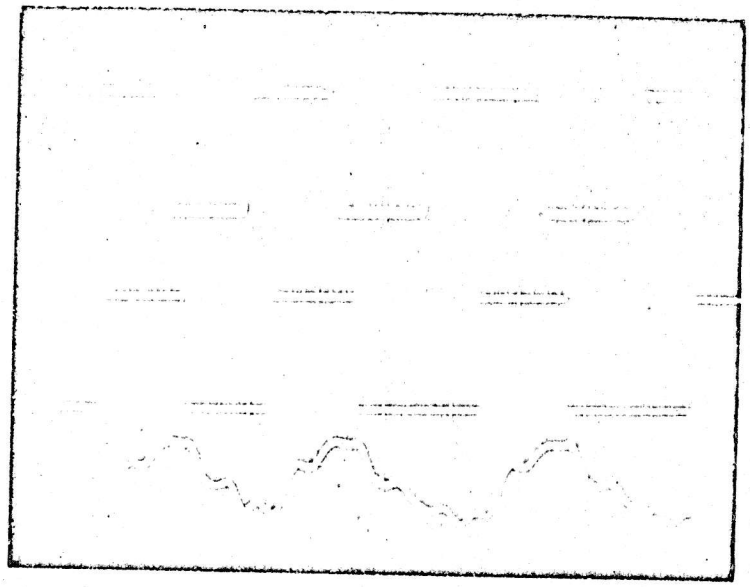

FIGURE 3a

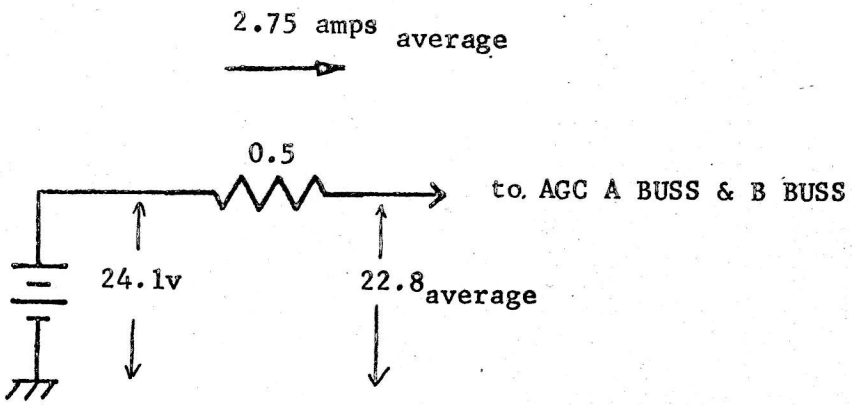

FIGURE 3b