Troubleshooting

If the IBM 1401 Data Processing System fails to operate properly, the cause of the trouble must be found and corrected quickly to hold unproductive machine time to a minimum. Rapid and effective diagnosis depends upon thorough knowledge of machine logic and effective use of diagnostic tools available. Diagnostic programs, marginal checking, checking indicators and CE test panels are aids for troubleshooting the 1401 system.

Diagnostic Programming

The 1401 customer engineering tests are specifically designed to help the customer engineer in the field to test functional operations of the 1401 and its associated components.

These tests, when properly used, help the customer engineer to install the 1401 with a minimum of time and effort, thereby assuring efficient operation of the system before it is released to the customer.

A complete set of write-ups along with flow charts that describe the various tests are shipped with each 1401 system.

Marginal Checking

Marginal checking (MC) has two basic maintenance functions:

1. Scheduled maintenance – to increase system reliability.
2. Unscheduled maintenance – to minimize system down-time in troubleshooting for *intermittent* symptoms produced by degrading components. Marginal checking can force these into the region of solid failure.

In tube machines, marginal checking is of value in both of these functions. With the much higher reliability of solid-state machines, preventive maintenance becomes less important, and troubleshooting becomes the main purpose of marginal checking. Scheduled MC is required in order to clean up any bugs that excessively limit the MC range. This is necessary to ensure that adequate MC range will still be available when the next intermittent symptom occurs.

The marginal-checking scheme used in the 1401 system is an inherent part of the circuit design. Separate voltage busses are provided exclusively for marginal checking. Only those circuits which can benefit from marginal checking are connected to the MC bus. These connections to the MC bus are specifically designed to give each circuit approximately the same sensitivity to MC voltage variation. In every case, the MC connection to the circuit is designed so that good components cannot be damaged by the full ±3v marginal-check variation. The only possibility for component damage occurs with defective components that are already out-of-specification and on the brink of failure.

A ±3v variation on the +6M or −12M voltages will have very little effect on the steady state performance of normal circuits. Dynamically, the 3v MC shifts will cause about a 25 percent change in timing in most circuits.

The 1401 engineering specifications specify correct machine operation with a minimum variation of any marginal-check voltage by ±1.2v. This is a minimum variation. Many systems surpass this.

As soon as time permits after a new machine is installed, make a complete marginal check. Record the limits for future reference. Replace any out-of-specification cards that limit the MC range. After this, MC at two- or three-month intervals should be sufficient. If experience shows very little change in the limits, the MC interval can be increased. Make a complete MC check after installing any major machine changes.

When performing marginal checking, the combined 1401 CE diagnostic tests are to be used. These tests are arranged from the simple to the more complex operations. Refer to *Power Supplies* for a description of marginal checking.

Method of Performing Marginal Test

Note: Machines that have switches for selecting the gates to be marginal-checked have caused considerable trouble because of poor contacts. The marginal-check switches should be pushed in and left to eliminate the poor-contact problem. Future systems will eliminate these switches.

1. Select voltages to be biased by jackplug. Place the jackplug in the rest position when the marginal test is not being used.

The +6M voltage provides base bias on NPN inverters.

The −12M voltage provides base bias on PNP inverters.

The +12M voltage provides base bias on SDTDL circuits in TAU-9.

The +30M voltage provides base bias on current-source circuits for core storage by varying the +18v differential.

The remote hub provides bias to remote units. The voltage is selected at remote unit with another jackplug (Figure 13).

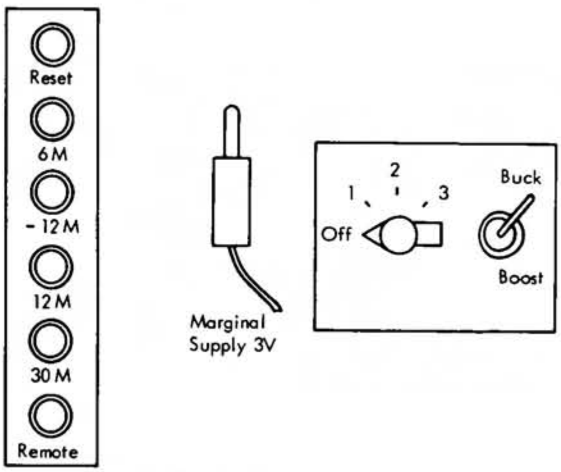

Figure 13. Marginal-Check Controls

2. Connect a meter to the supply selected with the jackplug. If the circuit breaker on the marginal 3v supply kicks out, no indication is made. The meter tells you exactly how much you are varying the supply being tested.
3. Set the buckboost switch.
4. Vary it with the Variac* switch.

VOLTAGE-LEVEL CHECKING

1. Periodic checking is recommended as a PM procedure.
2. Voltages should be exact; +12 variable is the exception.
3. Voltage should be measured at the place it is most likely to give trouble.
4. Voltage should be measured with the most accurate instrument available. A ½% dc meter is recommended.

PRECAUTIONS TO OBSERVE

1. The −12v supply is referenced to −6v. Therefore, it must be adjusted after the −6v supply.
2. The +12v fixed and variable supplies are developed from the +30v supply. Therefore, they must be adjusted after +30v.
3. Ripple on a supply can give a false meter reading.

PURPOSE OF SUPPLIES

−6v	Emitter voltage for NPN transistors.
+6v	Collector voltage for NPN transistors.
−12v	Collector voltage for PNP transistors.
+12v	Supplies base of transistors in core storage circuits.
+12v extender	Supplies the TAU-9 circuitry.
+18v differential	(+12 variable) Supplies current source circuits in core storage.
−20v	Supplies row-bit cores.
−20v filtered	Supplies bias for decode switches.
+30v	Supplies bias current for switch cores, collector voltage for decode switches.
−36v	Supplies TAU-2 circuits.

SEQUENCE FOR CHECKING VOLTAGES

+6v, −6v, and −12v for frame 1 are located in 02A4 and 02A5. Measure at gate 01B3: clock circuits and distribution.

+6v, −6v, and −12v for frame 2 are located in 02A3 and 02A6. Measure at gate 02B2 – TAU. If TAU is not on the machine, check at available optional-feature gate 02A7 or 02A8.

+30v measure at 02B2. If there is no TAU, measure at 01B3.

If there is TAU-2, measure −36 at 02B2.

−60v located in 1402. Model D location 01B4. Measure at 01B8 on −60v bus bar.

−20v located in 1402. Model D location 02A8. Measure at 01A2 A24Q.

Marginal Check Techniques

Studies have proven that marginal failures in solid-state circuitry are not all aggravated by any single marginal-check technique. Laboratory and field tests determined that base-voltage variation, the standard technique now in use, is primarily effective where failures are caused by transistor turn-on delays. Other known techniques have proved superior where intermittent failures were caused by noise, incorrect levels, or critical timing conditions.

*General Radio Corporation

When troubleshooting an intermittent failure, analyze the symptoms very carefully; note all console error lights, contents of registers, cycle lights, etc. Work with the customer's program at the start. Try inserting a branch op to define a failing loop. Often a failure that appears intermittent will fail solidly if the same data, or the same sequence of operations, is repeated.

If the problem cannot be duplicated with this approach, or with the diagnostic tests, try the marginal techniques listed here. The failure rate of most intermittent problems can be increased by one of these techniques. Branch offices already using this approach report a high degree of success.

Two cautions should be carefully noted:

1. Techniques described here are presented as troubleshooting tools *only*. Their use as preventive maintenance tools results in excessive service time and unwarranted parts replacement.
2. On any of the techniques, a difficult-to-diagnose failure, unrelated to the customer problem, may be introduced. This point can be within voltage limits specified here, particularly on older machines. If these problems cannot be resolved in a reasonable length of time, move on to another voltage or to the next technique.

   Base-voltage variation should be the first marginal technique tried. Other techniques can be applied in any convenient sequence. A detailed description of each technique follows.

BASE-VOLTAGE VARIATION

The +6M and −12M voltages supply transistors base potential throughout the 1401. The standard technique of varying these two voltages is known as *base-voltage variation*.

Vary these voltages toward their ±3.0 volt limits. Attempt to correct any failures that occur within these limits, or to the limit where the customer failure is duplicated.

Note: Some twin SMS cards, P/N 373000, will fail above ±1.2 volts bias unless capacitors announced in 1401 EC-CEM 579 are installed.

FREQUENCY VARIATION

Basic 1401 clock frequency is increased in this technique. It is most effective where failures are caused by marginal timing conditions (line delays, slow cards, etc.). Proceed as follows:

1. Set the scope as indicated in Figure 14. Display the output of the ±0 hub, located on the CE console with the machine in static condition. The output should appear as shown in Figure 14A.

SCOPE SETTING:
SYNC – INTERNAL +
VERTICAL DEFLECTION – 0.5V/DIV.
(EFFECTIVELY 5V/DIV)
HORIZONTAL DEFLECTION – 1 MICRO SEC/DIV

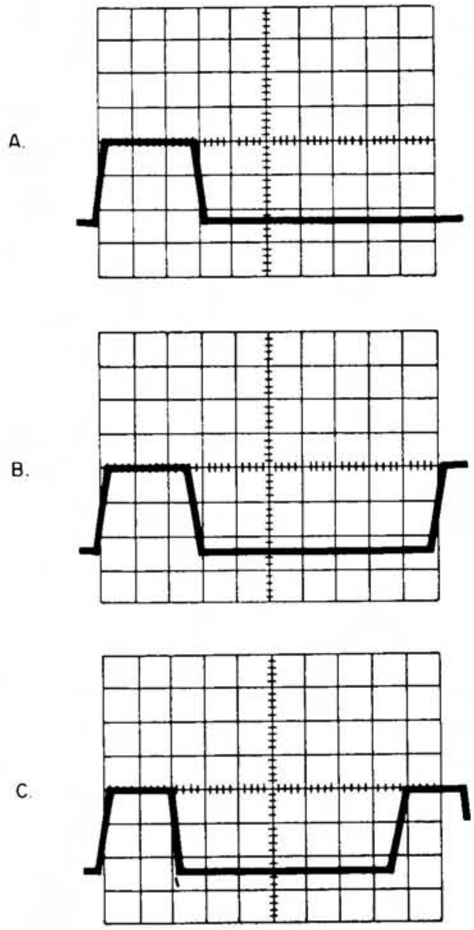

Figure 14. Clock Frequency Variation

2. By adjusting the time-per-division calibration knob counterclockwise, bring the positive-going portion of the next pulse onto the right side of the scope and line it up with the last vertical line on the scope face (Figure 14B).
3. Turn the power off and remove SMS card (RK –), P/N 371788, in location 01B3 A 26. Install variable oscillator SMS card, P/N 372561.
4. Turn the power on. Without changing the scope, adjust the pot on the variable oscillator card so that the scope picture is again identical to Figure 14B.
5. Run diagnostic tests. Vary the oscillator slowly so that the leading edge of the second pulse moves from the rightmost vertical line to a point 1⅓ horizontal divisions to the left (Figure 14C). This effectively increases the clock frequency from 11.5 to 10.0 microseconds.

CAUTION: The leading edge of the pulse should not be moved to the right of the last vertical line on non-print buffered systems. This *decreased* frequency causes hammer-driver fuses to blow on these systems when a print op is performed.

6. Troubleshoot all failures that occur within this range.
7. When limits have been met, drop the power and replace the oscillator card with a standard one.
8. On machines equipped with a print buffer, if machine failures are associated with a print operation:
   a. Rather than replace the basic block oscillator, observe the +U RO Time 000-030 pulse at 01A5 B14N, with the scope set as indicated in Figure 14.
   b. Adjust the scope as in Step 2, observing Figures 14A and B.
   c. Remove buffer clock oscillator SMS card (FT–), P/N 371405, from location 01A5 A07. Install variable oscillator SMS card, P/N 372561, using SMS card extender, P/N 451075.
   d. Follow the procedures as in Steps 4, 5, 6, and 7.

Note: Do not *decrease* frequency beyond 11.5 microseconds when printing.

MECHANICAL VIBRATION

Vibrating SMS cards is effective in showing failures caused by SMS socket contact resistance, cracked land patterns, or poor component connections.

With the palms up, run the backs of your fingers down the card rows, from top to bottom, while diagnostic tests are running. Vibrate the cards on any gate that may be associated with the machine problem.

CAUTION: Component damage can result from excessive vibration. If adjacent SMS cards contact, serious machine damage will result. To determine how hard to vibrate, a good rule to follow is: "If the vibration hurts your finger, slow down!" Vibrate the cards on all gates that may be associated with the failure.

COLLECTOR VOLTAGE VARIATION

This technique varies voltages (+6 and −12) that supply transistor collector potential. It is particularly effective in showing failures caused by electrical noise or bad levels.

From #22 gage (or larger) wire, make a jumper about 18 inches long. Solder spade clips to both ends. Proceed as follows:

1. Analyze the failure to determine the possible machine operation or unit involved.

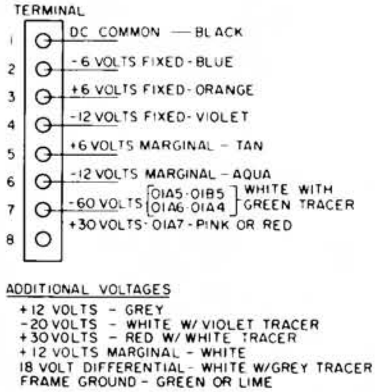

Figure 15. Voltage Terminal Block

2. Refer to the gate logic index pages in the front of Logic Book I. Select the gates containing the circuitry unique to this operation or machine function.

   As an example:

   a. Assume the failure appears to be a carriage problem. Logic indexes indicate Gates 01A5 and 01B1 contain this circuitry.
   b. If STAR-bit pickup is occurring, Gates 01A7, 01A8 (and 02B6, 02A7 if on the system) are affected.

   Note: TAU gates and memory gate 01A1 should not be collector-biased.

3. Select one of the affected gates. Drop the power and make the following changes at gate voltage terminal block. (Refer to Figure 15 located to the left of Row A.)
   a. Disconnect the external voltage (orange) wire from the +6v terminal and connect one end of the jumper to this terminal.

   CAUTION: Be certain the orange wire is positioned so that it does not short to frame, or the other connections.

   b. Connect the other end of the jumper to the +6M terminal (the terminal with the tan wire attached).

   Note: If no tan wire comes to this gate, connect the jumper to the terminal on the adjacent gate where this voltage is available.

   c. Connect a voltmeter to a +6v pin (Pin L) on the gate. Insert the marginal-voltage supply jack in the +6M hub (or set the marginal-supply switch to +6M on earlier machines).
4. For gates other than 01A4, 01A5, 01A6 and 01B5, proceed to Step 5. For Gates 01A4, 01A5, 01A6 and 01B5, disconnect −60v hammer-magnet return by

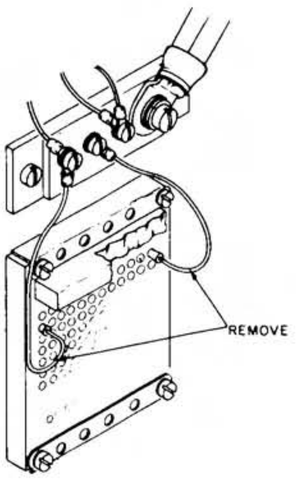

Figure 16. Relay Base Terminal Block

removing two black wires at the —60v return-relay, base-terminal block in 01B8 (Figure 16). Turn on the power. Begin by loading the print area with blanks and programming a simple print and branch loop. Observe the console-error lights and scope the output of the print-reset check latch at 01B5E01A to determine if errors occur. Now proceed to Step 6.

5. For gates other than 01A4, 01A5, 01A6 and 01B5:
   a. Turn on the power.
   b. Select the diagnostic tests applicable to failing machine function or operation.
   c. Run diagnostics and proceed to Step 6.
6. a. Vary the marginal-voltage supply. Collector voltages can be varied as much as +3.0 volts without causing machine damage. Vary the voltage to this limit in search of the trouble, if no other trouble occurs prior to this limit.

   Note: When biasing 01B7, a point is reached where all magnet drivers fire simultaneously. Do not continue to run the machine or bias beyond this point.

   b. Fix any failure that occurs before reaching the limits of 1.0v buck to 1.5v boost. If this trouble appears to be similar to the trouble, consider the machine fixed.
   c. When going beyond the limits of 1.0v buck to 1.5v boost, fix a trouble only if it appears to be the reported trouble. For future reference, it might be well to record the symptoms of failures in this area.

   Note: The trouble may appear somewhat different because the machine is undergoing a more severe test than it normally receives.
7. If customer-reported trouble has not been found, and the bias limits of the +6v on this gate have been reached:
   a. Drop the power and restore the voltage wires to normal.
   b. Disconnect the external voltage (violet) wire and connect one end of the jumper to the —12 volt terminal on the gate voltage terminal block (Figure 15). Be certain the violet wire is positioned so that it does not short to frame, or other connections.
   c. Connect the other end of the jumper to the —12v voltage terminal (the terminal with the aqua wire attached).

   Note: If no aqua wire comes to this gate, connect the jumper to the associated terminal on an adjacent gate.

   d. Connect a voltmeter to a —12v pin (Pin M) on the gate. Insert the marginal voltage-supply jack in —12M hub (set marginal check switch to —12M on early machines).
   e. Repeat Step 6.
8. If the trouble has not been found, and the —12v limits have been reached:
   a. Drop the power and restore gate voltages to normal.
   b. If other gates are involved, select one of these gates and continue, starting with Step 3.

DUAL BASE VOLTAGE VARIATION

Note: To utilize this technique, the machine must be equipped with a marginal-voltage jackplug receptacle. Obtain an additional marginal-voltage power supply. Plug the first supply into the +6M jack hub; plug the second supply into the —12 jack hub.

Vary marginal voltages ±1.5 volts separately or collectively, in any combination. Run diagnostic tests and follow this guide:

1. Set +6M to 4.5 volts; vary the —12M ±1.5 volts.
2. Set +6M to 7.5 volts; vary the —12M ±1.5 volts.
3. Set —12M to —10.5 volts, vary the + 6M ±1.5 volts.
4. Set —12M to —13.5 volts; vary the +6M ±1.5 volts.

A variable oscillator SMS card, P/N 372561, has been automatically shipped to each branch office, for use as an office tool.