SHAKDOWN Disk System Diagnostic

User's Guide

81-0000055 Rev. A

SHAKDOWN Floppy Disk System Daignostic
User's Guide

SHAKDOWN is a program for the IMSAI 8080 which exercises one floppy disk drive and all RAM (memory) from an address of about 1700 hex to the highest contiguous address installed in the machine. SHAKDOWN detects and reports disk errors detected by the hardware, incorrect data returned by the disk without a hardware error return, and RAM that doesn't hold data or that changes when RAM at other addresses is written. Becuase it tests RAM in direct memory access mode (as used by the disk interface) as well as under access by the main processor, SHAKDOWN has proven to be a more effective memory test than simple memory diagnostics.

SHAKDOWN is supplied with the IMSAI CP/M floppy disk operating system. It is designed to be loaded under the system, but it does not use the system after it is initialized. To use SHAKDOWN, you must have available a scratch diskette for SHAKDOWN to write on.

SHAKDOWN Operation

Figure 1 shows a typical SHAKDOWN run. With CP/M up and a diskette containing the file SHAKDOWN.COM in the drive, type "SHAKDOWN (carriage return)." Once SHAKDOWN starts typing, the diskette from which it was loaded may be removed. SHAKDOWN types a sign-on followed by an explanation of the switch options available to the operator. At this time, set all of the "Programmed input" switches down except switch 0, which should be set to the same position used in bootstrapping (cold-starting) the system. Answer "A", "B", "C", or "D" to the "DRIVE TO TEST" prompt, insert your scratch diskette in the selected drive, check the switch settings, then hit the carriage return key, as SHAKDOWN prompts you.

SHAKDOWN will print a message showing the disk drive and the range of RAM addresses it is going to test. If the upper RAM limit printed is not the maximum contiguous address installed in your machine, the RAM just above the address printed is probably defective.

SHAKDOWN should proceed to read and write on the disk (indicated by clicks from the disk drive and flashing lights on the disk panel.) If all is well, SHAKDOWN will occasionally print a message of the form "0 ERRORS IN nnn OPERATIONS"

SHAKDOWN has a number of tests it performs, which it selects in a pseudo-random sequence. Usually, it selects the reading or writing of a random disk track to or from a random RAM address. Each such track read or write is counted as one "operation" in

the printed messages. Occasionally, SHAKDOWN will choose a systematic reading of the entire diskette. This is indicated by the message "TEST OF ENTIRE DISK SELECTED" followed by "TEST OF ENTIRE DISK COMPLETE".

To terminate a SHAKDOWN run, stop the computer with the stop switch. Before doing this, we suggest that you request a summary by raising switch 6 as described in the next section.

Since SHAKDOWN does not test RAM below about 1700 hex, a complete test of your system requires that you reconfigure your system to move the RAM boards at 0 and 1000 hex to higher addresses, then run SHAKDOWN again.

```
IMSAI 16K CP/M VERS 1.31
A>SHAKDOWN

SHAKDOWN VERSION 1.1

SWITCHES:
 0 UP FOR MESSAGES ON CRT: DEVICE (PORT 4),
   DOWN FOR MESSAGES ON TTY: DEVICE (PORT 2)
 3 UP TO IGNORE ERRORS (USE WITH 6 TO SKIP TO SUMMARY)
 6 UP TO SUMMARIZE AND RESTART
1,2,4,5,7 SHOULD BE DOWN

DRIVE TO TEST (A/B)? B
SET SWITCHES, INSERT SCRATCH DISK IN DRIVE B, HIT RETURN_
TESTING DISK B, AND RAM 16D8-3FFF

0 ERRORS IN 253 OPERATIONS

TEST OF ENTIRE DISK SELECTED
TEST OF ENTIRE DISK COMPLETE

0 ERRORS IN 452 OPERATIONS

0 ERRORS IN 1053 OPERATIONS


SHAKEDOWN BEING RESTARTED
IMSAI 16K CP/M VERS 1.31
A>
```

Figure 1: SHAKDOWN Run Without Errors
(operator typing underlined)

SHAKDOWN Summary Printouts

SHAKDOWN prints summaries every few hundred operations, and also when the operator raises switch 6 (if an "Entire disk test" is in progress, SHAKDOWN will not respond to switch 6 until it is complete). If no errors have occured, the summary is merely a message of the form "0 ERRORS IN nnn OPERATIONS". If errors have been detected, the summary will also contain information on the errors, tabulated by RAM address and disk track, as described in following sections.

The summaries initiated by SHAKDOWN are cumulative; they include all operations since SHAKDOWN was started or since switch 6 was raised. However, after a summary initiated by the operator's raising switch 6, SHAKDOWN clears its tables and counters and restarts.

SHAKDOWN Error Printouts - Data Read From Disk Incorrect

Figure 2 is an example of a SHAKDOWN run in which SHAKDOWN is finding the data incorrect after reading the disk, yet the hardware is not indicating errors. Each time SHAKDOWN finds an incorrect byte in a block of data read from the disk, it prints a message of the form:

```
ERROR IN DATA READ FROM TRACK nn RAM hhhh-hhhh (OP nn)
RAM ADDRS            DATA:
WRIT READ   REL      IS SHOULDBE
hhhh hhhh   hhhh     hh hh
```

where the n's represent decimal numbers, and the h's represent hexadecimal numbers. The first line shows the track read, the RAM addresses read to, and the value of SHAKDOWN's operation counter. The last line shows the RAM address the particular byte was written from when the data was written to the disk, the RAM address it was read to, the relative address (number of bytes from the beginning of the disk track), the value read, and the correct value.

The last line is repeated for each incorrect byte, which can produce a lengthy printout if many bytes are bad. If the operator wishes to terminate such a printout, he/she may raise switch 3 for about a second.

```
...
TESTING DISK A, AND RAM 16D8-7FFF

ERROR IN DATA READ FROM TRACK 11 RAM 4775-5474 (OP 26)
RAM ADDRS           DATA:
WRIT READ   REL     IS SHOULDBE
3D13 4EF5   0780    50 58
3D14 4EF6   0781    10 18

ERROR IN DATA READ FROM TRACK 73 RAM 4E03-5B02 (OP 35)
RAM ADDRS           DATA:
WRIT READ   REL     IS SHOULDBE
2057 4EF5   00F2    12 1A
2058 4EF6   00F3    41 49

ERROR IN DATA READ FROM TRACK 22 RAM 4812-5511 (OP 67)
RAM ADDRS           DATA:
WRIT READ   REL     IS SHOULDBE
5123 4EF7   06E5    83 8B

5 ERRORS IN 89 OPERATIONS

RAM-4K    ---#ERRORS----      BAD
BLOCK    WRIT  READ  BKGD     BITS
2000        2     0     0      08
3000        2     0     0      08
4000        0     5     0      08
5000        1     0     0      08

DISK    WRONG    FIF
TRK     BYTES    ERRS
 11        2       0
 22        1       0
 73        2       0
```

Figure 2: SHAKDOWN Run with Incorrect Data Read From Disk
(Startup of SHAKDOWN omitted; summary initiated with switch 6)

While incorrect data read from the disk could indicate a disk problem, our experience has been that it normally indicates defective RAM. The bad RAM could be at the write address or at the read address; this must be inferred by noticing which address gets the most errors.

In addition to messages as errors occur, SHAKDOWN tabulates information on errors in its summary printout, as shown in the example in figure 2. Each incorrect byte of data detected adds one count to the "WRIT" and "READ" columns for the appropriate

memory address blocks, and one count to the "WRONG BYTES" column to the disk track from which it was read. The "BAD BITS" column is the "OR" of all incorrect bits in the address range. A reasonable interpretation of the example in figure 2 would be that RAM locations 4EF5, 4EF6, and 4EF7 hex are intermittently dropping bit 2 (hex value 8), as one of these locations appears in every error. bit 2 (hex value 8).

In the above example, the error occurred only during read operations. In general, the error might also be related to bad RAM at the address written from. In order to provide printouts that will help the operator localize the problem, after an error occurs during a read, SHAKDOWN will read the same track again, to the same RAM address. If the error recurrs, another message will be printed (in the above example, the error did not recurr). If the error persists, SHAKDOWN will try reading the track to other addresses in RAM. If it still persists (implying that the data on the disk is bad), it will try rewriting and rereading the track, first from the address previously written from, then from a different address. After such a rewrite and reread, one of the following messages will be printed:

TRACK THAT HAD ERROR OK AFTER REWRITE: nn
ERROR AGAIN AFTER REWITE ON TRACK nn

SHAKDOWN Error Printouts - Wrong Data Found in RAM after Write

SHAKDOWN occasionally checks the contents of the RAM area written to disk after writing. This check is not always made; it is selected occasionally on the basis of a pseudo-random number sequence. If the data is found to be incorrect, a message of the form

```
ERROR IN BUFFER AFTER WRITING TRACK nn RAM hhhh-hhhh (OP nn)
ADDR   REL    IS SHOULDBE
hhhh   hhhh   hh hh
```

is printed, with the last line repeated if multiple errors are found. Again, experience has shown that this is usually a RAM failure rather than a disk failure. An example of this message is shown in Figure 3. Errors of this type are counted in the "WRIT" column in the summary.

SHAKDOWN Error Printouts - Errors in RAM Outside Buffer

Another test is also performed by SHAKDOWN on some randomly-selected read operations: before reading, SHAKDOWN fills all of the RAM under test with known data; after reading, it checks the portions of RAM into which data was not read. If this RAM outside of the disk buffer does not contain the correct data, SHAKDOWN prints a message of the form:

```
ERR IN RAM OUTSIDE BUF AFTER READG TRACK nn RAM hhhh-hhhh (OP nn
ADDR   REL    IS SHOULDBE
hhhh   hhhh   hh hh
```

Again, this usually indicates a RAM failure. The "REL" column is the address relative to the base of the track buffer used; this information might be of use in identifying a bad bit in the floppy disk interface address drivers. Errors of this type are counted in the "BKGD" column in the summary; examples of this message are shown in Figure 3.

Figure 3 shows examples of this type of error message.

```
...
ERR IN RAM OUTSIDE BUF AFTER READG TRACK 1 RAM 185E-255D (OP 9)
ADDR   REL    IS SHOULDBE
2EF5   1697   ED E5

ERROR IN DATA READ FROM TRACK 2 RAM 2625-3324 (OP 11)
RAM ADDRS          DATA:
WRIT READ   REL    IS SHOULDBE
B626 2EF5   08D0   E9 E1

ERR IN RAM OUTSIDE BUF AFTER READG TRACK 1 RAM AE94-BB93 (OP 17)
ADDR   REL    IS SHOULDBE
2EF5   8061   ED E5

ERROR IN BUFFER AFTER WRITING TRACK 4 RAM 2E60-3B5F (OP 20)
ADDR   REL    IS SHOULDBE
2EF5   0095   7D 75

ERROR IN DATA READ FROM TRACK 4 RAM 2E60-3B5F (OP 21)
RAM ADDRS          DATA:
WRIT READ   REL    IS SHOULDBE
2EF5 2EF5   0095   7D 75

5 ERRORS IN 26 OPERATIONS

RAM-4K    ---#ERRORS----     BAD
BLOCK    WRIT  READ  BKGD    BITS
2000        2     2     2     08
B000        1     0     0     08

DISK    WRONG    FIF
TRK     BYTES    ERRS
2        1        0
4        1        0

SHAKEDOWN BEING RESTARTED
...
```

Figure 3: SHAKDOWN Run Showing Additional Error Printouts
(Resulting from bad RAM bit at address 2EF5 hex)

```
...
TESTING DISK B, AND RAM 16D8-BFFF
IRRECOVERABLE ERROR DISK B TRACK 53 SCTR 11 CODE 96
IRRECOVERABLE ERROR DISK B TRACK 58 SCTR 11 CODE 96
IRRECOVERABLE ERROR DISK B TRACK 55 SCTR 11 CODE 96
IRRECOVERABLE ERROR DISK B TRACK 54 SCTR 11 CODE 96

TEST OF ENTIRE DISK SELECTED
IRRECOVERABLE ERROR DISK B TRACK 56 SCTR 11 CODE 96
IRRECOVERABLE ERROR DISK B TRACK 57 SCTR 11 CODE 96
TEST OF ENTIRE DISK COMPLETE

66 ERRORS IN 352 OPERATIONS

DISK    WRONG    FIF
TRK     BYTES    ERRS
52        0       1
53        0      10   HAS HAD IRREC ERR(S)
54        0      10   HAS HAD INTERMITTENT IRREC ERR(S)
55        0      10   HAS HAD INTERMITTENT IRREC ERR(S)
56        0      10   HAS HAD INTERMITTENT IRREC ERR(S)
57        0      10   HAS HAD INTERMITTENT IRREC ERR(S)
58        0      10   HAS HAD INTERMITTENT IRREC ERR(S)
59        0       5
```

Figure 4: Floppy Disk Interface Error Printouts
(Produced using diskette with bad area)

SHAKDOWN Printouts - Errors Detected by Disk Interface

When the floppy disk interface gives an error indication to SHAKDOWN, SHAKDOWN tries the operation again up to 10 times. This is in addition to the retries initiated within the interface on certain types of errors. No message is printed at the time if the operation is ultimately successful; however, the number or error indications is accumulated and tabulated by disk track in the "FIF ERRS" column of the SHAKDOWN summary printout.

If the operation still fails after the 10th retry, SHAKDOWN prints a message of the form

IRRECOVERABLE ERROR DISK n TRACK nn SECTOR nn CODE hh

Examples of this message are shown in Figure 4.

"CODE" is the hexadecimal status code returned by the interface. These are documented in the Floppy Disk User's Guide. The most common ones are:

92	Can't find track
93	Can't find sector
94	CRC error in header
96	CRC error in sector data

Since each of SHAKDOWN's track operations actually consists of 26 sector operations at the disk interface level, up to 26 such messages can occur during one track operation.

If one or more "irrecoverable disk errors" occur while a track is being accessed, SHAKDOWN will complete the track operation then avoid further operations on that track. Also,the message

HAS HAD IRREC ERR(S)

will be added to that track's line in the summary printout, and each irrecoverable error will add 10 to the count of "FIF ERRS" for that track.

If SHAKDOWN is allowed to run long enough, it will eventually choose to retest the tracks that have had irrecoverable errors. This happens during the "ENTIRE DISK TEST" and is indicated by the message

RETESTING TRACKS THAT HAVE HAD IRREC ERRORS

After such a retest, the messages in the summary will be

HAS HAD PERSISTENT IRREC ERR(S) or
HAS HAD INTERMITTENT IRREC ERR(S)

The former means that every time SHAKDOWN attempted to operate on the track, at least one sector had an irrecoverable error; the latter, that the entire track was sometimes read or written successfully.

SHAKDOWN Crash Printouts

Occasionally a power line transient or hardware failure can cause program control to get to location 38 hex. If this happens, yet the hardware and the SHAKDOWN program are still sufficiently functional, SHAKDOWN will print a message of the form

********** CRASH hhhh hh

followed by a summary, then reinitialize and restart. The first hex number is the contents of the top two bytes of the stack; the second, the contents of the location addressed by the first.

Note that if the program fetches an instruction from non-existent memory, or a RAM board does not respond to an instruction fetch, the value executed will be hex FF, an RST-7 instruction, which will cause a CRASH message with the program counter as the first number printed.

Use of Switch 3

Switch 3, when raised, suppresses SHAKDOWN's data checking and data error printouts. Note that since the actual checking is suppressed, no errors will be detected or included in later summary printouts. If you wish to terminate a long error printout, we suggest that you raise switch 3 until disk activity resumes, then lower it.

Controlling the Pseudo-Random Test Sequence

The pseudo-random number generator used in selecting SHAKDOWN's test sequence is initialized by counting during the pause between the prompt

SET SWITCHES, INSERT SCRATCH DISK IN DRIVE n, HIT RETURN

and inputting the carriage return. Thus, if you hit return before the typeout completes, there will be no pause, and you will always obtain the same sequence of tests. Alternately, if you wait a second or two, you will obtain different tests each run, due to slight variations in the duration of the pause.

Using SHAKDOWN to Make an 8080 System Reliable

We have found the procedure described here valuable in testing new systems and in checking systems after service.

1)

Before running SHAKDOWN, make sure the dust cover is in place on the 8080 mainframe and the fan is operating and not blocked. If a voltmeter is available, check the "+8" voltage at the power supply and the "+5" voltage on each board. If any of these are low, you will probably get intermittent errors. In large systems (about 32K or more) in areas where the line voltage is a little low, it is frequently necessary to move the input to the power transformer to the "low line" tap.

2)

Now bring up CP/M and run SHAKDOWN. Use a hardcopy terminal, such as a teletype if available.

3)

If you immediately get error printouts other than "IRRECOVERABLE DISK ERROR", let SHAKDOWN run (aborting long printouts with switch 3) until you can infer where the problem is. Usually most errors will include particular bits in a particular range of RAM addresses, indicating a repair needed to a RAM board. Repair the board, or remove it and proceed without it if you have more than 16K.

Occasional random errors may also indicate a problem in the address drivers in the disk interface (causing it to write into the wrong RAM locations), or a low "+8" supply causing RAM to fail during slight dips in the power line voltage.

If you get a lot of "IRRECOVERABLE DISK ERROR" messages, try reFORMATting your scratch diskette, using a fresh scratch diskette, or using a different drive.

4)

Once the system will run SHAKDOWN successfully for about 15 minutes, re-address the RAM boards at 0 and 1000 hex to higher addresses and run SHAKDOWN again.

5)

If no errors are detected, run SHAKDOWN several hours, rearrange the RAM boards again, and run SHAKDOWN another several hours.