IBM 7080 Simulator Usage

01-May-2006

COPYRIGHT NOTICE

The following copyright notice applies to both the SIMH source and binary:

Original code published in 1993-2007, written by Robert M Supnik

Copyright (c) 1993-2007, Robert M Supnik

IBM 701 simulator written by Richard Cornwell

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL ROBERT M SUPNIK OR RICHARD CORNWELL BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

Except as contained in this notice, the name of Robert M Supnik or Richard Cornwell shall not be used in advertising or otherwise to promote the sale, use or other dealings in this Software without prior written authorization from both Robert M Supnik and Richard Cornwell.

Table of Contents

[1. Simulator Files 3](#__RefHeading___Toc2347_273995359)

[2. IBM 7080 Features 4](#__RefHeading___Toc2349_273995359)

[2.1 CPU 5](#__RefHeading___Toc2351_273995359)

[2.2 I/O Channels (CH0..CH6) 6](#__RefHeading___Toc2353_273995359)

[2.3 Unit record devices. 7](#__RefHeading___Toc2355_273995359)

[2.3.1 Inquiry Station (INQ) 7](#__RefHeading___Toc2357_273995359)

[2.3.2 711 Card Reader (CDR) 7](#__RefHeading___Toc2359_273995359)

[2.3.3 721 Card Punch (CDP) 8](#__RefHeading___Toc2361_273995359)

[2.3.4 716 Line Printer (LP) 8](#__RefHeading___Toc4457_273995359)

[2.4 Magnetic Tape devices 9](#__RefHeading___Toc4459_273995359)

[2.4.1 729 Magnetic Tape (MTA-D) 9](#__RefHeading___Toc4356_273995359)

[2.4.2 ChronoClock. 9](#__RefHeading___Toc4461_273995359)

[2.5 7908 Devices 10](#__RefHeading___Toc2363_273995359)

[2.5.1 1301/1302/2302/7320 Disk devices 10](#__RefHeading___Toc2365_273995359)

[2.5.2 Hypertape 7340 Tape drive (HTA) 11](#__RefHeading___Toc2367_273995359)

[2.5.3 7750 Communications Controller (COM and COML) 11](#__RefHeading___Toc2369_273995359)

[3 Symbolic Display and Input 12](#__RefHeading___Toc4463_273995359)

[4 Sim Load 12](#__RefHeading___Toc8842_273995359)

[5 Character Codes 13](#__RefHeading___Toc8844_273995359)

This memorandum documents the IBM 7080 simulator.

The IBM 7080 developed out of the IBM 702 which was a unique machine in that it had character addressed memory, however instructions had to be aligned on 5 character boundaries. Also it had to 256 character long accumulators which could be treated as variable length registers. IBM replaced this machine with the IBM 705, where the second accumulator was replaced with 15 fixed offset registers, given 14 16 digit registers and 1 32 character register. The 7080 enhanced this by adding in 3 more register sets that where used to talk to I/O devices. Instructions addressed the last location of an instruction or field and proceeded to lower memory. All instructions were 5 characters long consisting of a 4 character address and 1 character instruction. Data length was either determined by the length of the referenced accumulator or by a signed character indicating start of next data field.

# 1. Simulator Files

|  |  |  |
| --- | --- | --- |
| ***Subdirectory*** | ***File*** | ***Contains*** |
| **I7000** | i7000\_defs.h | IBM 7000 simulators general definitions |
|  | $0.00 | $0.00 |
|  | i7000\_chan.c | Generic channel interface. |
|  | i7080\_cpu.c | 7080 CPU, Channel, interface |
|  | i7080\_chan.c | 7080 Channel. |
|  | i7080\_sys.c | 7080 System interface |
|  | i7000\_cdr.c | 711 Card reader |
|  | i7000\_cdp.c | 721 Card punch |
|  | i7000\_com.c | 7750 Communications Controller |
|  | i7000\_con.c | Inquiry console. |
|  | i7080\_drum.c | Drum interface. |
|  | i7000\_dsk.c | 1301/2302 disk and 7238 drum controller. |
|  | i7000\_ht.c | 7340 Hypertape controller. |
|  | i7000\_lpr.c | 716 Line printer |
|  | i7000\_mt.c | 729 Tape controller. |
|  | i7000\_chron.c | Chrono Clock. |

# 2. IBM 7080 Features

The IBM 7080 simulator is configured as follows:

|  |  |
| --- | --- |
| **Device Name(s)** | **Simulates** |
| **CPU** | 7080 CPU with 160K of memory |
| **CH0** | Unit record devices |
| **CH1..4** | 754/7621 Tape controller channels |
| **CH5..7** | 7908 Disk, Hypertape, controller channels |
| **MTA** | 729 Magnetic Tape Controller (Channel 20) |
| **MTB** | 729 Magnetic Tape Controller (Channel 21) |
| **MTC** | 729 Magnetic Tape Controller (Channel 22) |
| **MTD** | 729 Magnetic Tape Controller (Channel 23) |
| **CHRON** | Chrono Clock |
| **HTA** | 7340 Hypertape, default not included. |
| **HTB** | 7340 Hypertape, default not included. |
| **INQ** | Inquiry Station |
| **CDR** | 711 Card Reader |
| **CDP** | 721 Card Punch |
| **LP** | 716 Line Printer |
| **DR** | Drum memory. |
| **DK** | 1301/2302/7304 disk. |
| **COM** | 7750 communications controller. |
| **COML** | 7750 Communications lines. |

Channels B through D, are mag tape channels 1,2,3,4.

Channels E & F, are 7908 channels for disk, hypertape or 7750.

The 7080 simulator implements several unique stop condition:

- undefined CPU instruction

- undefined channel instruction

- XEC nesting exceeds limit

- divide check on a divide and halt instruction

- select of a non-existent channel

- 7607 select of a 7909 channel

- write select of a write protected device

- invalid file control format

- invalid message to 7750

- no buffer storage available for input character on 7750

- no buffer storage available for output character on 7750

The LOAD command will load a card binary image file into memory.

## 2.1 CPU

The CPU options include setting memory size and CPU type.

|  |  |
| --- | --- |
| SET CPU 702 | Sets CPU to emulate 702. |
| SET CPU 705 | Sets CPU to emulate 705-I/II. |
| SET CPU 7053 | Sets CPU to emulate 705-III. |
| SET CPU 7080 | Sets CPU to emulate 7080. |
| SET CPU 10K | Sets memory to 10K |
| SET CPU 20K | Sets memory to 20K |
| SET CPU 40K | Sets memory to 40K |
| SET CPU 80K | Sets memory to 80K |
| SET CPU 120K | Sets memory to 120K |
| SET CPU 160K | Sets memory to 160K |
| SET CPU NO/EMU40K | Sets emulated memory limit to 40k |
| SET CPU EMU705 | Sets CPU to emulate a 705-I/II. |
| SET CPU EMU7053 | Sets CPU to emulate a 705-III. |
| SET CPU PROGRAM | Sets CPU to programmable stop mode. |
| SET CPU NONSTOP | Sets CPU to Non-stop mode. |

The 702 can support only 10k of memory. All 705's modes can support up to 40K of memory. The 7080 can support up to 160k of memory. When in 7080 mode the machine starts as either a 705-I/II or a 705-III depending on mode of EMU705/EMU7053 switch. Also the EMU40K fixes the maximum memory for the 7080 to 40K until it enters 80 mode with EEM instruction.

CPU registers include the visible state of the processor as well as the control registers for the interrupt system.

| ***Name*** | ***Size(digits)*** | ***Comments*** |
| --- | --- | --- |
| IC | 5 | Program Counter |
| A | 256 | Accumulator 1 |
| ASU1..15 | 256 | Accumulator 2 |
| SW | 6 | Switches |
| SW911..916 | 1 | Sense Switches 911 to 916 |
| STOP | 6 | Stop conditions |
| STOP0..5 | 1 | Individual Stop conditions |

If CPU set to PROGRAM and the stop flag is set to 1, and a 90x trigger is generated, the machine will stop. If flag is set to 0, no stop will occur. If CPU set to NONSTOP all errors must be checked by program.

The CPU can maintain a history of the most recently executed instructions.

This is controlled by the SET CPU HISTORY and SHOW CPU HISTORY commands:

|  |  |
| --- | --- |
| SET CPU HISTORY | clear history buffer |
| SET CPU HISTORY=0 | disable history |
| SET CPU HISTORY=n | enable history, length = n |
| SHOW CPU HISTORY | print CPU history |
| SHOW CPU HISTORY=n | print first n entries of CPU history |

Instruction history trace shows the Instruction counter, the symbolic operator, and memory address and the contents of the selected register.

## 2.2 I/O Channels (CH0..CH6)

The 7080 supports up to 11 channels.

|  |  |
| --- | --- |
| SET CHn UREC | Tapes are on unit record device. |
| SET CHn 7261 | Tapes are on Data Synchronizer. |
| SET CHn 754 | Tapes are standard 705 drives. |
| SET Chn HS | Set channel to High Speed. |

Channel 0 is for unit record devices.

Channels 1 through 4 are for tape drives. These support the option of

Channels 5-10 are for 7908 devices. For CPU channels are defined as:

|  |  |
| --- | --- |
| Channel | CPU address |
| 0 | 0-1999 |
| 20 | 2000 or 0200 |
| 21 | 2100 or 0210 |
| 22 | 2200 or 0220 |
| 23 | 2300 or 0230 |
| 40 | 4000 7908 high speed channel. |
| 41 | 4100 7908 high speed channel. |
| 44 | 4400 7908 channel. |
| 45 | 4500 7908 channel. |
| 46 | 4600 7908 channel. |
| 47 | 4700 7908 channel. |

Channels have the following registers:

| ***Name*** | ***Size(digits)*** | ***Comments*** |
| --- | --- | --- |
| ADDR | 5 | Channel Data Address |
| CMD | 1 | Channel Command. |
| FLAGS | 32 (binary) | Channel Flags |

For meaning of bits in FLAGS see i7000\_defs.h.

The command:

|  |  |
| --- | --- |
| SHOW CH | Print summary of devices on channel |

## 2.3 Unit record devices.

### 2.3.1 Inquiry Station (INQ)

The inquiry station allows for communications with the operating system. The station is half duplex and will either print or accept input. Whenever the computer sends a message it is prefixed with a ‘R’ character. When the station is ready to receive input it prompts with a ‘I’. Input is buffered until the return character is entered. Backspace will remove the last character typed. An <esc> will send an interrupt to the processor to request it read a record from the console. An <esc> while in input mode will cancel input mode and clear any typed message.

### 2.3.2 711 Card Reader (CDR)

The card reader (CDR) reads data from a disk file. Cards are simulated as ASCII lines with terminating newlines. Card reader files can either be text (one character per column) or column binary (two characters per column). The file type can be specified with a set command:

|  |  |
| --- | --- |
| SET CDR FORMAT=TEXT | Sets ASCII text mode |
| SET CDR FORMAT=BINARY | Sets for binary card images. |
| SET CDR FORMAT=BCD | Sets for BCD records. |
| SET CDR FORMAT=CBN | Sets for column binary BCD records. |
| SET CDR FORMAT=AUTO | Automatically determines format. |

or in the ATTACH command:

|  |  |
| --- | --- |
| ATTACH CDR <file> | Attaches a file |
| ATTACH CDR -f <format> <file> | Attaches a file with the given format. |

The card reader can be booted with the:

|  |  |
| --- | --- |
| BOOT CDR | Loads the first card into memory location 0.  Transfers to location 4. |

Error handling is as follows:

error processed as

not attached report error and stop

end of file out of cards

OS I/O error report error and stop

### 2.3.3 721 Card Punch (CDP)

The card reader (CDP) writes data to a disk file. Cards are simulated as ASCII lines with terminating newlines. Card punch files can either be text (one character per column) or column binary (two characters per column). The file type can be specified with a set command:

|  |  |
| --- | --- |
| SET CDP FORMAT=TEXT | Sets ASCII text mode |
| SET CDP FORMAT=BINARY | Sets for binary card images. |
| SET CDP FORMAT=BCD | Sets for BCD records. |
| SET CDP FORMAT=CBN | Sets for column binary BCD records. |
| SET CDP FORMAT=AUTO | Automatically determines format. |

or in the ATTACH command:

|  |  |
| --- | --- |
| ATTACH CDP <file> | Attaches a file |
| ATTACH CDP -f <format> <file> | Attaches a file with the given format. |

Error handling is as follows:

error processed as

not attached report error and stop

OS I/O error report error and stop

### 2.3.4 716 Line Printer (LP)

The line printer (LP) writes data to a disk file as ASCII text with terminating newlines. Currently set to handle standard signals to control paper advance.

|  |  |
| --- | --- |
| SET LP*n* NO/ECHO | Sets echoing to console of line-printer output. |
| SET LP*n* LINESPERPAGE=*lpp* | Sets number of lines per page on printer. |
| SET LP*n* SINGLE | Set printer to single spacing. |
| SET LP*n* DOUBLE | Set printer to double spacing. |
| SET LP*n* PROGRAM | Set printer to single spacing. |

If the printer is set to PROGRAM spacing the first character of the print record controls spacing.

|  |  |
| --- | --- |
| Character (Octal) | Action |
| 060 | Suppress spacing. |
| 020 | Single space |
| 012 | Double space |
| 003 | Skip to channel 3 (every 5th line) |
| 002 | Skip to channel 2 (every 8th line) |
| 001 & 009 | Skip to channel 1 (or 9), (top of form). |

Error handling is as follows:

error processed as

not attached report error and stop

OS I/O error report error and stop

## 2.4 Magnetic Tape devices

### 2.4.1 729 Magnetic Tape (MTA-D)

These come in groups of 10 units each.

Each individual tape drive support several options: MTA used as an example.

|  |  |
| --- | --- |
| SET MTA*n* REWIND | Sets the mag tape to the load point. |
| SET MTA*n* LOCKED | Sets the mag tape to be read only. |
| SET MTA*n* WRITEENABLE | Sets the mag tape to be writable. |
| SET MTA*n* LOW | Sets mag tape to low density. |
| SET MTA*n* HIGH | Sets mag tape to high density. |

Options: Density LOW/HIGH does not change format of how tapes are written. And is only for informational purposes only.

Tape drives can be booted with:

|  |  |
| --- | --- |
| BOOT MTxn | Read in record into location 0. |

### 2.4.2 ChronoClock.

Disabled by default. This is a special 729 tape drive which returns the current time. It supports the option of setting the channel and drive that it will occupy. Note: You must disable the real 729 drive that is is replacing. The clock responds to Read and Backspace commands. A read results in a 10 character buffer being generated that has the Month, Day, Hour, Minutes, Seconds and Milliseconds. This time is taken from the local computer time.

|  |  |
| --- | --- |
| SET CHRON CHAN=n | Set channel for chrono clock. |
| SET CHRON UNIT=n | Sets the unit for the chrono clock. |

Example: To set Chronoclock to unit A9 do the following:

|  |
| --- |
| SET MTA9 DISABLE |
| SET CHRON UNIT=9 CHAN=20 |

## 2.5 7908 Devices

These devices must be attached to a 7908 channel to work.

### 2.5.1 1301/1302/2302/7320 Disk devices

The 7631 file control supports up to ten devices, which can be 7320 drums, 1301 disks, 1302 disks, or 2302 disks. Unit types are specified with the SET command.

|  |  |
| --- | --- |
| SET DK*n* TYPE=7320 | Unit *n* is a drum |
| SET DK*n* TYPE=7320-2 | Unit *n* is a drum (two modules). |
| SET DK*n* TYPE=1301 | Unit *n* is a 1301 disk |
| SET DK*n* TYPE=130l-2 | Unit *n* is a 1301-2 disk (two modules). |
| SET DK*n* TYPE=1302 | Unit *n* is a 1302 disk |
| SET DK*n* TYPE=1302-2 | Unit *n* is a 1302-2 disk (two modules). |
| SET DK*n* TYPE=2302 | Unit *n* is a 2302 disk |

Units can be SET ENABLED or DISABLED. In addition, units can be set to enable or disable formatting:

|  |  |
| --- | --- |
| SET DK*n* FORMAT | Enable formatting |
| SET DK*n* NOFORMAT | Disable formatting |
| SET DK*n* HA2 | Enable writing of home address 2 |
| SET DK*n* NOHA2 | Disable writing of home address 2 |
| SET DK*n* MODULE=n | Sets modules for unit, modules can only be even. 0 to 8. |
| SET DK*n* CHAN=n | Sets channel for unit (A-H). |
| SET DK*n* SELECT=n | Sets select on channel (0 or 1). |

Formatting is disabled by default.

Error handling is as follows:

error processed as

not attached report error and stop

OS I/O error report error and stop

### 2.5.2 Hypertape 7340 Tape drive (HTA)

These come in groups of 10 units each. The controller defines which channel the devices will be on. By default these devices are not installed.

|  |  |
| --- | --- |
| SET HTA CHAN=*n* | Sets channel for unit (A-H). |
| SET HTA SELECT=*n* | Sets select on channel (0 or 1). |

Each individual tape drive support several options: HTA used as an example.

|  |  |
| --- | --- |
| SET HTA*n* LOCKED | Sets the mag tape to be read only. |
| SET HTA*n* WRITEENABLE | Sets the mag tape to be writable. |

NOTE: Hypertape drives may not be working correctly since there is very little documentation available on them.

### 2.5.3 7750 Communications Controller (COM and COML)

The 7750 is modeled as a terminal multiplexer with 33 lines. It consists of two device: COM is the multiplexer controller, and COML is the individual lines. For the first 32 lines, the 7750 performs input and output through Telnet sessions connected via a user-specified listening port; the 33rd line is permanently attached to the simulator console window. The ATTACH command specifies the port to be used for Telnet sessions:

|  |  |
| --- | --- |
| ATTACH COM <port> | set up listening port |

where port is a decimal number between 1 and 65535 that is not being used other TCP/IP activities.

Each line (each unit of COML) can be set to one of twp modes: KSR-35 and KSR-37. In KSR-35 mode, lower case input and output characters are converted automatically to upper case, and parity is ignored. In KSR-37 mode, lower case characters are left alone, and even parity is generated on input. KSR-37 is the default.

Once COM is attached and the simulator is running, the 7750 listens for connections on the specified port. It assumes that any incoming connection is a Telnet connections. The connections remain open until disconnected either by the Telnet client, a SET COM DISCONNECT command,or a DETACH COM command.

|  |  |
| --- | --- |
| SET COM DISCONNECT=*n* | Disconnect line *n* |
| SET COM CHAN=*n* | Set channel for com controller. |

The 7750 implements the following special SHOW commands

|  |  |
| --- | --- |
| SHOW COM CONNECTIONS | Displays current connections to the 7750 |
| SHOW COM STATISTICS | Displays statistics for active connections |

The 7750 implements the following special SET commands:

|  |  |
| --- | --- |
| SET COML*n* LOG=filename | Log output of line n to filename |
| SET COML*n* NOLOG | Disable logging and close log file |
| SET COML*n* KSR35 | Set line *n* to ksr-35 |
| SET COML*n* KSR37 | Set line *n* to ksr-37 |
| SET COML*n* 2741 | Set line *n* to 2741 |

The controller (COM) implements these registers:

|  |  |  |
| --- | --- | --- |
| *Name* | *Size* | *Comments* |
| ENABLE | 1 | Enable flag |
| STATE | 6 | Controller state |
| MSGNUM | 12 | Input message sequence number |

# 3 Symbolic Display and Input

The IBM 7080 simulator implements symbolic display and input. Display is controlled by command line switches:

|  |  |
| --- | --- |
| -c | Display/Enter as BCD character |
| -d/-s | Display as character dump. |
| -m | Display/Enter instruction mnemonics |
|  | Display/Enter as number. |

Instruction input uses standard 7080 assembler syntax.

* <opcode> <address>,<ASU>
* <opcode> <address>

# 4 Sim Load

The load command looks at the extension of the file to determine how to load the file. Based on extension the file is converted to characters and loaded based on the 7080 load format.

# 5 Character Codes

| Commercial | Scientific | ASCII | BCD | Card | Remark |
| --- | --- | --- | --- | --- | --- |
|  |  |  | 00 |  | Blank |
| 1 |  | 0 | 01 | 1 |  |
| 2 |  | 0 | 02 | 2 |  |
| 3 |  | 0 | 03 | 3 |  |
| 4 |  | 0 | 04 | 4 |  |
| 5 |  | 0 | 05 | 5 |  |
| 6 |  | 0 | 06 | 6 |  |
| 7 |  | 0 | 07 | 7 |  |
| 8 |  | 0 | 10 | 8 |  |
| 9 |  | 0 | 11 | 9 |  |
| 0 |  | 0 | 12 | 10 |  |
| # | = | = | 13 | 3-8 |  |
| @ | ' | '/@ | 14 | 4-8 |  |
| : |  | : | 15 | 5-8 |  |
| > |  | > | 16 | 6-8 |  |
| √ |  | " | 17 | 7-8 | Tape Mark |
| ƀ |  | \_ | 20 | 2-8 |  |
| / |  | / | 21 | 10-1 |  |
| S |  | S | 22 | 10-1 |  |
| T |  | T | 23 | 10-2 |  |
| U |  | U | 24 | 10-3 |  |
| V |  | V | 25 | 10-4 |  |
| W |  | W | 26 | 10-5 |  |
| X |  | X | 27 | 10-6 |  |
| Y |  | Y | 30 | 10-7 |  |
| Z |  | Z | 31 | 10-8 |  |
| # |  | # | 32 | 10-2-8 | Word Mark |
| , |  | , | 33 | 10-3-8 |  |
| % | ( | %/( | 34 | 10-4-8 |  |
| ` |  | ` | 35 | 10-5-8 |  |
| \ |  | \ | 36 | 10-6-8 |  |
| ⧻ |  | { | 37 | 10-7-8 | Segment Mark |

| Commercial | Scientific | ASCII | BCD | Card | Remark |
| --- | --- | --- | --- | --- | --- |
| - |  | - | 40 | 11 | also -0 |
| J |  | J | 41 | 11-1 |  |
| K |  | K | 42 | 11-2 |  |
| L |  | L | 43 | 11-3 |  |
| M |  | M | 44 | 11-4 |  |
| N |  | N | 45 | 11-5 |  |
| O |  | O | 46 | 11-6 |  |
| P |  | P | 47 | 11-7 |  |
| Q |  | Q | 50 | 11-8 |  |
| R |  | R | 51 | 11-9 |  |
| ! |  | ! | 52 | 11-2-8 |  |
| $ |  | $ | 53 | 11-3-8 |  |
| \* |  | \* | 54 | 11-4-8 |  |
| ] |  | ] | 55 | 11-5-8 |  |
| ; |  | ; | 56 | 11-6-8 |  |
| △ |  | ^ | 57 | 11-7-8 |  |
| & | + | &/+ | 60 | 12 | also +0 |
| A |  | A | 61 | 12-1 |  |
| B |  | B | 62 | 12-2 |  |
| C |  | C | 63 | 12-3 |  |
| D |  | D | 64 | 12-4 |  |
| E |  | E | 65 | 12-5 |  |
| F |  | F | 66 | 12-6 |  |
| G |  | G | 67 | 12-7 |  |
| H |  | H | 70 | 12-8 |  |
| I |  | I | 71 | 12-9 |  |
| ? |  | ? | 72 | 12-2-8 |  |
| . |  | . | 73 | 12-3-8 |  |
| ⌑ | ) | ) | 74 | 12-4-8 | Lozenge |
| [ |  | [ | 75 | 12-5-8 |  |
| < |  | < | 76 | 12-3-8 |  |
| ⧻\* |  | | | 77 | 12-7-8 | Group Mark |