

# I/O DEVICE CODES

5

| OCTAL<br>DEVICE<br>CODE | MEMONIC | PRIORITY<br>MASK BIT | DEVICE NAME                              |
|-------------------------|---------|----------------------|------------------------------------------|
| 00                      | ----    | --                   | Unused                                   |
| 01                      | MDV     | --                   | Multiply/Divide                          |
| 02                      | MMU     | --                   | Memory Management Unit                   |
| 03                      | MMU1    | --                   |                                          |
| 02                      | MMPU    | --                   | Memory Management and Protection Unit    |
| 02*                     | MAPO    |                      |                                          |
| 03                      | MAP1    | --                   | Memory Allocation and Protection         |
| 04                      | MAP2    |                      |                                          |
| 05                      |         |                      |                                          |
| 06                      | MCAT    | 12                   | Multiprocessor Adapter Transmitter       |
| 07                      | MCAR    | 12                   | Multiprocessor Adapter Receiver          |
| 10                      | TTI     | 14                   | TTY Input                                |
| 11                      | TTO     | 15                   | TTY Output                               |
| 12                      | PTR     | 11                   | Paper Tape Reader                        |
| 13                      | PTP     | 11                   | Paper Tape Punch                         |
| 14                      | RTC     | 13                   | Real-time Clock                          |
| 15                      | PLT     | 12                   | Incremental Plotter                      |
| 16                      | CDR     | 10                   | Card Reader                              |
| 17                      | LPT     | 12                   | Line Printer                             |
| 20                      | DSK     | 9                    | Fixed Head Disc                          |
| 21                      | ADC     | 8                    | A/D Converter                            |
| 22                      | MTA     | 10                   | Magnetic Tape                            |
| 23                      | DACV    | --                   | D/A Converter                            |
| 24                      |         |                      |                                          |
| 25                      | DCM     | 0                    | Data Communications Multiplexor          |
| 26                      |         |                      |                                          |
| 27                      |         |                      |                                          |
| 30                      | QTY     | 14                   | Asynchronous Hardware Multiplexor        |
| 30                      | SLA     | 14                   | Synchronous Line Adapter                 |
| 31*                     | IBM1    |                      |                                          |
| 32                      | IBM2    | 13                   | IBM 360/370 Interface                    |
| 33                      | DKP     | 7                    | Moving Head Disc                         |
| 34                      | CAS     | 10                   | Cassette Tape                            |
| 34*                     | MX1     |                      |                                          |
| 35                      | MX2     | 11                   | Multiline Asynchronous Controller        |
| 36                      | IPB     | 6                    | Interprocessor Bus--Half Duplex          |
| 37                      | IVT     | 6                    | Interprocessor Bus--Watchdog Timer       |
| 40                      | DPI     | 8                    | Interprocessor Bus--Full Duplex Input    |
| 41                      | DPO     | 8                    | Interprocessor Bus--Full Duplex Output   |
| 40***                   | SCR     | 8                    | Synchronous Communication Receiver       |
| 41***                   | SCT     | 8                    | Synchronous Communication Transmitter    |
| 42                      | DIO     | 7                    | Digital I/O                              |
| 43                      | DIO     | 6                    | Digital I/O Timer                        |
| 44                      | MXM     | 12                   | Modem Control for MX1/MX2                |
| 45                      |         |                      |                                          |
| 46                      | MCAT1   | 12                   | Second Multiprocessor Transmitter        |
| 47                      | MCAR1   | 12                   | Second Multiprocessor Receiver           |
| 50                      | TTI1    | 14                   | Second TTY Input                         |
| 51                      | TTO1    | 15                   | Second TTY Output                        |
| 52                      | PTR1    | 11                   | Second Paper Tape Reader                 |
| 53                      | PTP1    | 13                   | Second Paper Tape Punch                  |
| 54                      | RTC1    | 13                   | Second Real-time Clock                   |
| 55                      |         |                      |                                          |
| 56                      | PLT1    | 12                   | Second Incremental Plotter               |
| 56                      | CDR1    | 10                   | Second Card Reader                       |
| 57                      | LPT1    | 12                   | Second Line Printer                      |
| 60                      | DSK1    | 9                    | Second Fixed Head Disc                   |
| 61                      |         |                      |                                          |
| 62                      | MTA1    | 10                   | Second Magnetic Tape                     |
| 63                      |         |                      |                                          |
| 64*                     | FPU1    |                      |                                          |
| 65                      | FPU2    | 5                    | Alternate Location for Floating Point    |
| 66                      | FPU     |                      |                                          |
| 67                      |         |                      |                                          |
| 70                      | QTY1    | 14                   | Second Asynchronous Hardware Multiplexor |
| 70                      | SLA1    | 14                   | Second Synchronous Line Adapter          |
| 71*                     |         |                      |                                          |
| 72                      |         | 13                   | Second IBM 360/370 Interface             |
| 73                      | DKP1    | 7                    | Second Moving Head Disc                  |
| 74                      | CAS1    | 10                   | Second Cassette Tape                     |
| 74*                     |         |                      |                                          |
| 75                      |         | 11                   | Second Multiline Asynchronous Controller |
| 74*                     | FPU1    |                      |                                          |
| 75                      | FPU2    | 5                    | Floating Point                           |
| 76                      | FPU     |                      |                                          |
| 77                      | GPU     | --                   | Central Processor and Console Functions  |

\* Code returned by INTA.  
 \*\* Can be set up with any even device code equal to 40 or above.  
 \*\*\* Can be set up with any odd device code equal to 41 or above.

# ASCII CHARACTER CODES

6

| Decimal | Octal | Hex | Character | To Produce<br>On TTY mod 33,35<br>Ctrl Shift Char | Even parity<br>8-bit Code |
|---------|-------|-----|-----------|---------------------------------------------------|---------------------------|
| 0       | 000   | 00  | NUL       | x x                                               | P 00                      |
| 1       | 001   | 01  | SOH       | x                                                 | A 01                      |
| 2       | 002   | 02  | STX       | x                                                 | B 02                      |
| 3       | 003   | 03  | ETX       | x                                                 | C 03                      |
| 4       | 004   | 04  | EOT       | x                                                 | D 04                      |
| 5       | 005   | 05  | ENQ       | x                                                 | E 05                      |
| 6       | 006   | 06  | ACK       | x                                                 | F 06                      |
| 7       | 007   | 07  | BEL       | x                                                 | G 07                      |
| 8       | 010   | 08  | BS        | x                                                 | H 08                      |
| 9       | 011   | 09  | HT        | x                                                 | I 09                      |
| 10      | 012   | 0A  | NL        |                                                   | line feed 0A              |
| 11      | 013   | 0B  | VT        | x                                                 | J 0A                      |
| 12      | 014   | 0C  | FF        | x                                                 | line feed 8A*             |
| 13      | 015   | 0D  | CR        | x                                                 | K 8B                      |
|         |       |     |           | x                                                 | L 0C                      |
|         |       |     |           | x                                                 | return 8D                 |
|         |       |     |           | x                                                 | M 8D                      |
|         |       |     |           | x                                                 | return 0D*                |
| 14      | 016   | 0E  | SO        | x                                                 | N 8E                      |
| 15      | 017   | 0F  | SI        | x                                                 | O 0F                      |
| 16      | 020   | 10  | DLE       | x                                                 | P 90                      |
| 17      | 021   | 11  | DC1       | x                                                 | Q 11                      |
| 18      | 022   | 12  | DC2       | x                                                 | R 12                      |
| 19      | 023   | 13  | DC3       | x                                                 | S 93                      |
| 20      | 024   | 14  | DC4       | x                                                 | T 14                      |
| 21      | 025   | 15  | NAK       | x                                                 | U 95                      |
| 22      | 026   | 16  | SYN       | x                                                 | V 96                      |
| 23      | 027   | 17  | ETB       | x                                                 | W 17                      |
| 24      | 030   | 18  | CAN       | x                                                 | X 18                      |
| 25      | 031   | 19  | EM        | x                                                 | Y 99                      |
| 26      | 032   | 1A  | SUB       | x                                                 | Z 9A                      |
| 27      | 033   | 1B  | ESC       |                                                   | esc 1B                    |
|         |       |     |           | x x                                               | K 1B                      |
| 28      | 034   | 1C  | FS        | x x                                               | L 9C                      |
| 29      | 035   | 1D  | GS        | x x                                               | M 1D                      |
| 30      | 036   | 1E  | RS        | x x                                               | N 1E                      |
| 31      | 037   | 1F  | US        | x x                                               | O 9F                      |
| 32      | 040   | 20  | SP        |                                                   | space A0                  |
| 33      | 041   | 21  | !         | x                                                 | 1 21                      |
| 34      | 042   | 22  | "         | x                                                 | 2 22                      |
| 35      | 043   | 23  | #         | x                                                 | 3 A3                      |
| 36      | 044   | 24  | \$        | x                                                 | 4 24                      |
| 37      | 045   | 25  | %         | x                                                 | 5 A5                      |
| 38      | 046   | 26  | &         | x                                                 | 6 A6                      |
| 39      | 047   | 27  | '         | x                                                 | 7 27                      |
| 40      | 050   | 28  | (         | x                                                 | 8 28                      |
| 41      | 051   | 29  | )         | x                                                 | 9 A9                      |
| 42      | 052   | 2A  | *         | x                                                 | : 2A                      |
| 43      | 053   | 2B  | +         | x                                                 | ; 2B                      |
| 44      | 054   | 2C  | ,         |                                                   | , AC                      |
| 45      | 055   | 2D  | -         |                                                   | - 2D                      |
| 46      | 056   | 2E  | .         |                                                   | . 2E                      |
| 47      | 057   | 2F  | /         |                                                   | / AF                      |
| 48      | 060   | 30  | 0         |                                                   | 0 30                      |
| 49      | 061   | 31  | 1         |                                                   | 1 B1                      |
| 50      | 062   | 32  | 2         |                                                   | 2 B2                      |
| 51      | 063   | 33  | 3         |                                                   | 3 B3                      |
| 52      | 064   | 34  | 4         |                                                   | 4 B4                      |
| 53      | 065   | 35  | 5         |                                                   | 5 B5                      |
| 54      | 066   | 36  | 6         |                                                   | 6 B6                      |
| 55      | 067   | 37  | 7         |                                                   | 7 B7                      |
| 56      | 070   | 38  | 8         |                                                   | 8 B8                      |
| 57      | 071   | 39  | 9         |                                                   | 9 B9                      |
| 58      | 072   | 3A  | :         |                                                   | : 3A                      |
| 59      | 073   | 3B  | ;         |                                                   | ; BB                      |
| 60      | 074   | 3C  | <         | x                                                 | < 3C                      |
| 61      | 075   | 3D  | =         | x                                                 | = BD                      |
| 62      | 076   | 3E  | >         | x                                                 | > BE                      |
| 63      | 077   | 3F  | ?         | x                                                 | ? 3F                      |
| 64      | 100   | 40  | @         | x                                                 | @ 40                      |
| 65      | 101   | 41  | A         |                                                   | A 41                      |
| 66      | 102   | 42  | B         |                                                   | B 42                      |
| 67      | 103   | 43  | C         |                                                   | C 43                      |
| 68      | 104   | 44  | D         |                                                   | D 44                      |
| 69      | 105   | 45  | E         |                                                   | E 45                      |
| 70      | 106   | 46  | F         |                                                   | F 46                      |
| 71      | 107   | 47  | G         |                                                   | G 47                      |
| 72      | 110   | 48  | H         |                                                   | H 48                      |
| 73      | 111   | 49  | I         |                                                   | I 49                      |
| 74      | 112   | 4A  | J         |                                                   | J 4A                      |
| 75      | 113   | 4B  | K         |                                                   | K 4B                      |
| 76      | 114   | 4C  | L         |                                                   | L 4C                      |
| 77      | 115   | 4D  | M         |                                                   | M 4D                      |
| 78      | 116   | 4E  | N         |                                                   | N 4E                      |
| 79      | 117   | 4F  | O         |                                                   | O 4F                      |
| 80      | 120   | 50  | P         |                                                   | P 50                      |
| 81      | 121   | 51  | Q         |                                                   | Q 51                      |
| 82      | 122   | 52  | R         |                                                   | R 52                      |
| 83      | 123   | 53  | S         |                                                   | S 53                      |
| 84      | 124   | 54  | T         |                                                   | T 54                      |

\* On even parity TTY's these codes are odd parity.

# ASCII CHARACTER CODES (Cont.)

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| Decimal | Octal | Hex | Character | To Produce<br>On TTY mod 33,35<br>Ctrl Shift Char | Even Parity<br>8-bit Code |
|---------|-------|-----|-----------|---------------------------------------------------|---------------------------|
| 85      | 125   | 55  | U         |                                                   | U 55                      |
| 86      | 126   | 56  | V         |                                                   | V 56                      |
| 87      | 127   | 57  | W         |                                                   | W 57                      |
| 88      | 130   | 58  | X         |                                                   | X 58                      |
| 89      | 131   | 59  | Y         |                                                   | Y 59                      |
| 90      | 132   | 5A  | Z         |                                                   | Z 5A                      |
| 91      | 133   | 5B  | [         | x                                                 | K 5B                      |
| 92      | 134   | 5C  | \         | x                                                 | L 5C                      |
| 93      | 135   | 5D  | ]         | x                                                 | M 5D                      |
| 94      | 136   | 5E  | ^         | x                                                 | N 5E                      |
| 95      | 137   | 5F  | _         | x                                                 | O 5F                      |
| 96      | 140   | 60  | `         |                                                   | 60                        |
| 97      | 141   | 61  | a         |                                                   | E1                        |
| 98      | 142   | 62  | b         |                                                   | E2                        |
| 99      | 143   | 63  | c         |                                                   | E3                        |
| 100     | 144   | 64  | d         |                                                   | E4                        |
| 101     | 145   | 65  | e         |                                                   | E5                        |
| 102     | 146   | 66  | f         |                                                   | E6                        |
| 103     | 147   | 67  | g         |                                                   | E7                        |
| 104     | 150   | 68  | h         |                                                   | E8                        |
| 105     | 151   | 69  | i         |                                                   | 69                        |
| 106     | 152   | 6A  | j         |                                                   | 6A                        |
| 107     | 153   | 6B  | k         |                                                   | 6B                        |
| 108     | 154   | 6C  | l         |                                                   | 6C                        |
| 109     | 155   | 6D  | m         |                                                   | 6D                        |
| 110     | 156   | 6E  | n         |                                                   | 6E                        |
| 111     | 157   | 6F  | o         |                                                   | 6F                        |
| 112     | 160   | 70  | p         |                                                   | 70                        |
| 113     | 161   | 71  | q         |                                                   | 71                        |
| 114     | 162   | 72  | r         |                                                   | 72                        |
| 115     | 163   | 73  | s         |                                                   | F3                        |
| 116     | 164   | 74  | t         |                                                   | 74                        |
| 117     | 165   | 75  | u         |                                                   | F5                        |
| 118     | 166   | 76  | v         |                                                   | F6                        |
| 119     | 167   | 77  | w         |                                                   | 77                        |
| 120     | 170   | 78  | x         |                                                   | 78                        |
| 121     | 171   | 79  | y         |                                                   | F9                        |
| 122     | 172   | 7A  | z         |                                                   | FA                        |
| 123     | 173   | 7B  | {         |                                                   | 7B                        |
| 124     | 174   | 7C  |           |                                                   | FC                        |
| 125     | 175   | 7D  | }         |                                                   | 7D                        |
| 126     | 176   | 7E  | ~         |                                                   | 7E                        |
| 127     | 177   | 7F  | DEL       |                                                   | rubout FF                 |

## OCTAL AND HEXADECIMAL CONVERSION

To convert a number from octal or hexadecimal to decimal, locate in each column of the appropriate table the decimal equivalent for the octal or hex digit in that position. Add the decimal equivalents to obtain the decimal number.

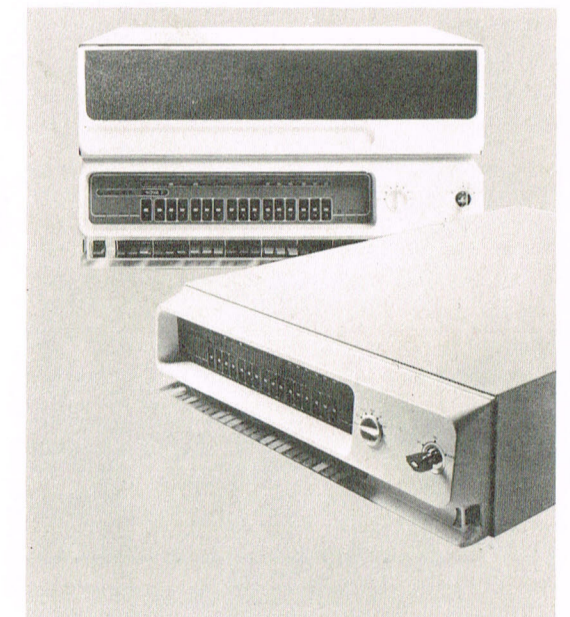
To convert a decimal number to octal or hexadecimal:

1. Locate the largest decimal value in the appropriate table that will fit into the decimal number to be converted.
2. Note its octal or hex equivalent and column position.
3. Find the decimal remainder.

Repeat the above steps on each remainder. When an octal or hex equivalent has been taken from the right-most column, the process is finished.

|                 | 8 <sup>5</sup> | 8 <sup>4</sup>  | 8 <sup>3</sup>  | 8 <sup>2</sup>  | 8 <sup>1</sup>  | 8 <sup>0</sup>  |
|-----------------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 0               | 0              | 0               | 0               | 0               | 0               | 0               |
| 1               | 32,768         | 4,096           | 512             | 64              | 8               | 1               |
| 2               | 65,536         | 8,192           | 1,024           | 128             | 16              | 2               |
| 3               | 98,304         | 12,288          | 1,536           | 192             | 24              | 3               |
| 4               | 131,072        | 16,384          | 2,048           | 256             | 32              | 4               |
| 5               | 163,840        | 20,480          | 2,560           | 320             | 40              | 5               |
| 6               | 196,608        | 24,576          | 3,072           | 384             | 48              | 6               |
| 7               | 229,376        | 28,672          | 3,584           | 448             | 56              | 7               |
| 16 <sup>5</sup> |                | 16 <sup>4</sup> | 16 <sup>3</sup> | 16 <sup>2</sup> | 16 <sup>1</sup> | 16 <sup>0</sup> |
| 0               | 0              | 0               | 0               | 0               | 0               | 0               |
| 1               | 1,048,576      | 65,536          | 4,096           | 256             | 16              | 1               |
| 2               | 2,097,152      | 131,072         | 8,192           | 512             | 32              | 2               |
| 3               | 3,145,728      | 196,608         | 12,288          | 768             | 48              | 3               |
| 4               | 4,194,304      | 262,144         | 16,384          | 1,024           | 64              | 4               |
| 5               | 5,242,880      | 327,680         | 20,480          | 1,280           | 80              | 5               |
| 6               | 6,291,456      | 393,216         | 24,576          | 1,536           | 96              | 6               |
| 7               | 7,340,032      | 458,752         | 28,672          | 1,792           | 112             | 7               |
| 8               | 8,388,608      | 524,288         | 32,768          | 2,048           | 128             | 8               |
| 9               | 9,437,184      | 589,824         | 36,864          | 2,304           | 144             | 9               |
| A               | 10,485,760     | 655,360         | 40,960          | 2,560           | 160             | 10              |
| B               | 11,534,336     | 720,896         | 45,056          | 2,816           | 176             | 11              |
| C               | 12,582,912     | 786,432         | 49,152          | 3,072           | 192             | 12              |
| D               | 13,631,488     | 851,968         | 53,248          | 3,328           | 208             | 13              |
| E               | 14,680,064     | 917,504         | 57,344          | 3,584           | 224             | 14              |
| F               | 15,728,640     | 983,040         | 61,440          | 3,840           | 240             | 15              |

# NOVA<sup>®</sup> LINE COMPUTERS Instruction Reference Card



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CODING CONVENTIONS

Symbols listed in upper case are to be coded exactly as shown.

The symbols < > and      are not coded. They act only to indicate how an assembly language instruction may be written. Their general definition is given below:

< > Indicates optional operands. The operand enclosed in the brackets (e.g. <#>) may be coded or not, depending on whether or not the associated option is desired.

     Indicates specific substitution is required. Substitute the indicated accumulator, address, name, or number.

ABBREVIATIONS

|                                   |                               |
|-----------------------------------|-------------------------------|
| AC = Accumulator                  | ACS = Source Accumulator      |
| FPAC = Floating Point Accumulator | ACD = Destination Accumulator |

In instructions that utilize an effective address, the following coding conventions are used:

The indirect bit (bit 5) is set by coding the symbol @ somewhere in the operand string.

The index bits (bits 6-7) are set by coding a comma followed by one of the digits 0-3 as the last operand of the operand string. If no index is coded, the bits are set to 00.

The displacement is coded as a signed number in the current assembler radix. If no sign is coded, the number is assumed to be positive. The character "period" (.) can be used to set the index bits to 01. "Period" can be read to mean "address of the current instruction". When the period is used, it is followed by either a plus or a minus sign followed by the displacement (e.g. ".+7" or ".-2").

The instructions that use the two accumulator-multiple operation format have several options that can be obtained by coding optional operands. The characters to be coded are given below with their results.

| CLASS        | CODED     |      |  |                                                                                               |  |
|--------------|-----------|------|--|-----------------------------------------------------------------------------------------------|--|
| ABBREVIATION | CHARACTER | BITS |  | OPERATION                                                                                     |  |
| c            | (omitted) | 00   |  | Do not initialize the carry bit.                                                              |  |
|              | Z         | 01   |  | Initialize the carry bit to 0.                                                                |  |
|              | 0         | 10   |  | Initialize the carry bit to 1.                                                                |  |
|              | C         | 11   |  | Initialize the carry bit to the complement of its present value.                              |  |
| sh           | (omitted) | 00   |  | Leave the results of the operation unaffected.                                                |  |
|              | L         | 01   |  | Combine the carry bit and the 16-bit result into a 17-bit number and rotate it one bit left.  |  |
|              | R         | 10   |  | Combine the carry bit and the 16-bit result into a 17-bit number and rotate it one bit right. |  |
|              | S         | 11   |  | Exchange the two 8-bit halves of the 16-bit result without affecting the carry bit.           |  |
| #            | (omitted) | 0    |  | Load the result of the shift operation into ACD.                                              |  |
|              | #         | 1    |  | Do not load the result of the shift operation into ACD.                                       |  |

the following operands initiate operations that test the result of the shift operation. If the condition is true, the next sequential instruction is skipped.

|      |           |     |                                        |
|------|-----------|-----|----------------------------------------|
| skip | (omitted) | 000 | Never skip.                            |
|      | SKP       | 001 | Always skip.                           |
|      | SZC       | 010 | Skip if carry = 0.                     |
|      | SNC       | 011 | Skip if carry not = 0.                 |
|      | SZR       | 100 | Skip if result = 0.                    |
|      | SNR       | 101 | Skip if result not = 0.                |
|      | SEZ       | 110 | Skip if either carry or result = 0.    |
|      | SBN       | 111 | Skip if both carry and result not = 0. |

The instructions that use the I/O format can set bits 8-9 by coding optional operands. The characters to be coded are given below with their results.

|   |           |    |                                        |
|---|-----------|----|----------------------------------------|
| f | (omitted) | 00 | Do not affect the Busy and Done flags. |
|   | S         | 01 | Set Busy to 1 and Done to 0.           |
|   | C         | 10 | Set Busy and Done to 0.                |
|   | P         | 11 | Pulse the I/O bus control line.        |
| t | BN        | 00 | Skip if Busy not = 0.                  |
|   | BZ        | 01 | Skip if Busy = 0.                      |
|   | DN        | 10 | Skip if Done not = 0.                  |
|   | DZ        | 11 | Skip if Done = 0.                      |

For I/O instructions to device code 77 (CPU), the f and t fields have different meanings. The characters to be coded are given below with their results.

|   |           |    |                             |
|---|-----------|----|-----------------------------|
| f | (omitted) | 00 | Has no effect.              |
|   | S         | 01 | Set ION to 1.               |
|   | C         | 10 | Set ION to 0.               |
|   | P         | 11 | Has no effect.              |
| t | BN        | 00 | Skip if ION not = 0.        |
|   | BZ        | 01 | Skip if ION = 0.            |
|   | DN        | 10 | Skip if Power Fail not = 0. |
|   | DZ        | 11 | Skip if Power Fail = 0.     |

STANDARD INSTRUCTION SET

Mnemonic and Operands

|                             |                |
|-----------------------------|----------------|
| ADC<e><sh><#>               | acs,acd<,skip> |
| ADD<e><sh><#>               | acs,acd<,skip> |
| AND<e><sh><#>               | acs,acd<,skip> |
| CON<e><sh><#>               | acs,acd<,skip> |
| DSZ <@>displacement<,index> |                |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1

acs

acd

1 0 0

sh

c

#

skip

|                                |                |
|--------------------------------|----------------|
| INC<e><sh><#>                  | acs,acd<,skip> |
| ISZ <@>displacement<,index>    |                |
| JMP <@>displacement<,index>    |                |
| JSR <@>displacement<,index>    |                |
| LDA ac,<@>displacement<,index> |                |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1

acs

acd

0 1 1

sh

c

#

skip

|                                |                |
|--------------------------------|----------------|
| MOV<e><sh><#>                  | acs,acd<,skip> |
| NEG<e><sh><#>                  | acs,acd<,skip> |
| STA ac,<@>displacement<,index> |                |
| SUB<e><sh><#>                  | acs,acd<,skip> |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

1

acs

acd

0 1 0

sh

c

#

skip

INPUT/OUTPUT

|        |           |
|--------|-----------|
| DIA<f> | ac,device |
| DIB<f> | ac,device |
| DIC<f> | ac,device |
| DOA<f> | ac,device |
| DOB<f> | ac,device |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 0 1

f

device

|        |           |
|--------|-----------|
| DOC<f> | ac,device |
| NIO<f> | device    |
| SKP<t> | device    |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

1 1 0

f

device

MULTIPLY/DIVIDE

|     |  |
|-----|--|
| DIV |  |
| MUL |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 1 0 1 1 0 0 1 0 0 0 0 0 1

NOVA 3 EXTENDED INSTRUCTIONS

|         |  |
|---------|--|
| NFFP ac |  |
| NFSP ac |  |
| NTFP ac |  |
| NTSP ac |  |
| POPA ac |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 0 0 1 0 0 0 0 0 0 1

|                       |  |
|-----------------------|--|
| PSHA ac               |  |
| RET                   |  |
| SAV                   |  |
| TRAP acs,acd,trap no. |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 1 1 0 0 0 0 0 0 0 1

FLOATING POINT INSTRUCTION SET

Mnemonic and Operands

|         |  |
|---------|--|
| .FABS   |  |
| .FAD ac |  |
| .FAS ac |  |
| .FATD   |  |
| .FATS   |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 0 0 0 0 0 1 1 1 1 1 0 0

|         |  |
|---------|--|
| .FCLR   |  |
| .FDD ac |  |
| .FDS ac |  |
| .FDTD   |  |
| .FDTS   |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 0 0 0 0 0 0 1 1 1 1 0 0

|          |  |
|----------|--|
| .FHMV ac |  |
| .FLDD ac |  |
| .FLDS ac |  |
| .FLJX ac |  |
| .FMD ac  |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 0 1 0 0 1 1 1 1 0 0

|         |  |
|---------|--|
| .FMFT   |  |
| .FMS ac |  |
| .FMTD   |  |
| .FMTF   |  |
| .FMTS   |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 0 0 0 0 0 1 1 1 1 1 0 1

|          |  |
|----------|--|
| .FNEG    |  |
| .FNRM    |  |
| .FRST ac |  |
| .FSCL ac |  |
| .FSD ac  |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 0 0 0 0 0 1 0 1 1 1 0 0

|          |  |
|----------|--|
| .FSN ac  |  |
| .FSRD ac |  |
| .FSRS ac |  |
| .FSTD    |  |
| .FSTS    |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 1 0 0 1 1 1 1 1 0 0

|          |  |
|----------|--|
| .FWST ac |  |
|----------|--|

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1

ac

0 1 0 0 0 1 1 1 1 0 0

FLOATING POINT STATUS REGISTER

|     |     |     |     |     |     |     |     |          |   |    |    |     |     |     |    |
|-----|-----|-----|-----|-----|-----|-----|-----|----------|---|----|----|-----|-----|-----|----|
| any | ovf | unf | dvz | mof | gtz | eqz | ltz | reserved |   |    |    | ind | ppm | dmd |    |
| 0   | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8        | 9 | 10 | 11 | 12  | 13  | 14  | 15 |

FLOATING POINT NUMBER FORMAT

|     |          |          |
|-----|----------|----------|
| s   | exponent | mantissa |
| 0 1 | 7 8      | 31       |

|     |          |          |
|-----|----------|----------|
| s   | exponent | mantissa |
| 0 1 | 7 8      | 63       |

BOOTSTRAP LOADER

For ITY, -- = 10. For PTR, -- = 12. Start at BSTRP.

|       |        |        |       |         |
|-------|--------|--------|-------|---------|
| X7757 | 126440 | GET:   | SUBO  | 1,1     |
| X7760 | 0636-- |        | SKPDN | --      |
| X7761 | 000777 |        | JMP   | .-1     |
| X7762 | 0605-- |        | DIAS  | 0.--    |
|       |        |        |       |         |
| X7763 | 127100 |        | ADDL  | 1,1     |
| X7764 | 127100 |        | ADDL  | 1,1     |
| X7765 | 107003 |        | ADD   | 0,1,SNC |
| X7766 | 000772 |        | JMP   | GET+1   |
| X7767 | 001400 |        | JMP   | 0,3     |
|       |        |        |       |         |
| X7770 | 0601-- | BSTRP: | NIOS  | --      |
| X7771 | 004766 |        | JSR   | GET     |
| X7772 | 044402 |        | STA   | 1,+.2   |
| X7773 | 004764 |        | JSR   | GET     |

X=0 for 4K systems; 1 for 8K; 2 for 12K; etc.

CPU INSTRUCTIONS

|          |  |
|----------|--|
| HALT     |  |
| INTA ac  |  |
| INTDS    |  |
| INTEN    |  |
| IOBST    |  |
|          |  |
| NSKO ac  |  |
| READS ac |  |

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

0 1 1 0 0 1 1 0 0 0 1 1 1 1 1 1

ASSEMBLER OPERATING PROCEDURE

- IN:
- TTY reader without parity checking.
  - TTY reader with parity checking.
  - Paper tape reader without parity checking.
  - Paper tape reader with parity checking.
  - TTY keyboard without parity checking.
- LIST:
- TTY model 33.
  - TTY model 35.
  - Line printer.
  - Paper tape punch (for ASR 33).
  - Paper tape punch (for ASR 35).
- BIN:
- TTY punch without local symbols.
  - Paper tape punch without local symbols.
  - TTY punch with local symbols (relo. assembler only).
  - Paper tape punch with local symbols (relo. assembler only).
- MODE:
- Pass 1.
  - Pass 2--put out object tape.
  - Pass 2--put out listing.
  - Pass 2--put out object tape, listing, and symbol list.

RELOCATABLE LOADER

- Load a relocatable binary or relocatable library tape from ITY.
- Load a relocatable binary or relocatable library tape from PTR.
- Force a load address for normally relocatable code.
- Complement the load all symbols switch.
- Print current memory limits.
- Print a loader map.
- Reinitialize the loader.
- Terminate the loading process.
- Print a loader map of undefined symbols (ext. relo. loader only).

UNSIGNED INTEGER COMPARISONS

|       |             |                                           |
|-------|-------------|-------------------------------------------|
| SUB#  | acs,acd,SZR | Skip if contents of ACS = contents of ACD |
| SUB#  | acs,acd,SNR | Skip if contents of ACS ≠ contents of ACD |
| ADCZ# | acs,acd,SNC | Skip if contents of ACS < contents of ACD |
| SUBZ# | acs,acd,SNC | Skip if contents of ACS ≤ contents of ACD |
| SUBZ# | acs,acd,SZC | Skip if contents of ACS > contents of ACD |
| ADCZ# | acs,acd,SZC | Skip if contents of ACS ≥ contents of ACD |

SIGNED COMPARISONS TO ZERO

|       |             |                              |
|-------|-------------|------------------------------|
| MOV#  | acs,acs,SZR | Skip if contents of ACS = 0. |
| MOV#  | acs,acs,SNR | Skip if contents of ACS ≠ 0. |
| MOVL# | acs,acs,SNC | Skip if contents of ACS < 0. |
| ADDO# | acs,acs,SEZ | Skip if contents of ACS ≤ 0. |
| ADDO# | acs,acs,SBN | Skip if contents of ACS > 0. |
| MOVL# | acs,acs,SZC | Skip if contents of ACS ≥ 0. |