TO: Multiuser Basic-2 Language Reference Manual

FROM: Technical Publications Department

SUBJECT: Update to Multiuser Basic-2 Language Reference Manual (700-4080E.02)

DATE: August 1989

This document updates Chapters 4, 5, 7, 11 and 12 of the Multiuser Basic-2 Language Reference Manual (700-4080E.02). It reflects new technical information for the CS386 CPU.

To update the Multiuser Basic-2 Language Reference Manual use the following collating instructions:

Remove

Chapter 4
Pages 4-14

Chapter 5
Pages 5-13, 5-27

Chapter 7
Pages 7-25, 7-26

Chapter 11
Pages 11-77 through 11-84
11-129 through 11-136

Chapter 12
Pages - None

Insert

Chapter 4
Pages 4-14, 4-15

Chapter 5
Pages 5-13, 5-27

Chapter 7
Pages 7-25, 7-26

Chapter 11
Pages 11-77 through 11-84
11-129 through 11-136

Chapter 12
Pages 12-36a, 12-36b, 12-36c
12-36d, 12-36e, 12-36f
12-36g, 12-36h

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CONTENTS

PREFACE

CHAPTER 1  INTRODUCTION

Overview ................................................................. 1-1
Multiuser Operation .................................................. 1-1
Interpretation Process ............................................... 1-1
Editing Features ...................................................... 1-2
Compatibility Features ............................................... 1-2
Types of BASIC-2 Instructions ................................. 1-2
System Commands .................................................... 1-2
Statements .............................................................. 1-3
BASIC-2 Statements and Program Execution .................. 1-3
Program Mode .......................................................... 1-3
Immediate Mode ....................................................... 1-4
Multiple-Statement Lines ........................................... 1-5
Phases of the Language Processor ............................... 1-5
Entry Phase ........................................................... 1-6
Resolution Phase ..................................................... 1-6
Execution Phase ...................................................... 1-6

CHAPTER 2  EDITING AND DEBUGGING FEATURES

Overview ................................................................. 2-1
Line Entry .............................................................. 2-1
Spaces ................................................................. 2-1
Maximum Line Length ............................................... 2-2
Upper/lowercase Entry .............................................. 2-2
Line Editing ........................................................... 2-2
Edit Keys and Their Operation ................................... 2-3
Program Development ................................................. 2-6
Replacing Lines ....................................................... 2-6
Deleting Lines ....................................................... 2-6
Renumbering Program Lines ....................................... 2-7
Combining Program Lines ........................................... 2-7
## CONTENTS (continued)

<table>
<thead>
<tr>
<th>Feature</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Debugging Features</td>
<td>2-8</td>
</tr>
<tr>
<td>Descriptive Error Messages</td>
<td>2-9</td>
</tr>
<tr>
<td>Stopping and Resuming Program Execution</td>
<td>2-9</td>
</tr>
<tr>
<td>Halting and Stepping Through a Program</td>
<td>2-10</td>
</tr>
<tr>
<td>Tracing Through a Program</td>
<td>2-10</td>
</tr>
<tr>
<td>Listing and Cross-Referencing a Program</td>
<td>2-10</td>
</tr>
</tbody>
</table>

### CHAPTER 3  SCREEN OPERATIONS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>3-1</td>
</tr>
<tr>
<td>Screen Control Codes</td>
<td>3-1</td>
</tr>
<tr>
<td>Cursor Control Codes</td>
<td>3-2</td>
</tr>
<tr>
<td>Character Display Attributes</td>
<td>3-3</td>
</tr>
<tr>
<td>HEX Codes Used to Invoke Display Attributes</td>
<td>3-3</td>
</tr>
<tr>
<td>Turning On Character Display Attributes</td>
<td>3-4</td>
</tr>
<tr>
<td>Turning Off Character Display Attributes</td>
<td>3-7</td>
</tr>
<tr>
<td>Using Isolated HEX(0E)</td>
<td>3-9</td>
</tr>
<tr>
<td>Special Uses of Alternate Display Attributes</td>
<td>3-11</td>
</tr>
<tr>
<td>Summary of Display Attribute Rules</td>
<td>3-12</td>
</tr>
<tr>
<td>Selection of Character Sets</td>
<td>3-13</td>
</tr>
<tr>
<td>Summary of Character Set Selection</td>
<td>3-14</td>
</tr>
<tr>
<td>Box Graphics</td>
<td>3-15</td>
</tr>
</tbody>
</table>

### CHAPTER 4  NUMERIC OPERATIONS

<table>
<thead>
<tr>
<th>Feature</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>4-1</td>
</tr>
<tr>
<td>Numeric Values</td>
<td>4-1</td>
</tr>
<tr>
<td>Fixed-Point Format</td>
<td>4-2</td>
</tr>
<tr>
<td>Exponential Format</td>
<td>4-2</td>
</tr>
<tr>
<td>Numeric Constants</td>
<td>4-2</td>
</tr>
<tr>
<td>Numeric Variables</td>
<td>4-3</td>
</tr>
<tr>
<td>Numeric Expressions</td>
<td>4-4</td>
</tr>
<tr>
<td>Arithmetic Operators</td>
<td>4-4</td>
</tr>
<tr>
<td>Order of Evaluation</td>
<td>4-5</td>
</tr>
<tr>
<td>Altering the Standard Order of Evaluation</td>
<td>4-5</td>
</tr>
<tr>
<td>Round/Truncate Option</td>
<td>4-6</td>
</tr>
<tr>
<td>Computational Errors</td>
<td>4-6</td>
</tr>
<tr>
<td>System-Defined Numeric Functions</td>
<td>4-6</td>
</tr>
<tr>
<td>INT and FIX Functions</td>
<td>4-8</td>
</tr>
<tr>
<td>MAX and MIN Functions</td>
<td>4-9</td>
</tr>
<tr>
<td>MOD Function</td>
<td>4-10</td>
</tr>
<tr>
<td>RND (Random Number) Function</td>
<td>4-10</td>
</tr>
<tr>
<td>ROUND Function</td>
<td>4-11</td>
</tr>
<tr>
<td>SGN (Sign) Function</td>
<td>4-12</td>
</tr>
<tr>
<td>Trigonometric Functions</td>
<td>4-13</td>
</tr>
</tbody>
</table>
CONTENTS (continued)

Special-Purpose Numeric Functions .......................................................... 4-13
SPACE Function ......................................................................................... 4-13
SPACEK Function ...................................................................................... 4-13
SPACE S and SK ......................................................................................... 4-14
#ID Function ............................................................................................ 4-14

CHAPTER 5 ALPHANUMERIC STRING MANIPULATION INSTRUCTIONS

Alphanumeric Character Strings ................................................................. 5-1
Alphanumeric String Variables ................................................................... 5-1
Alphanumeric-Variable Length ................................................................... 5-2
STR Function .............................................................................................. 5-3
Alphanumeric Literal Strings ...................................................................... 5-4
Hexadecimal Literal Strings ....................................................................... 5-5
Concatenation of Strings ........................................................................... 5-6
Using the Alpha-Array as a Scalar-Variable ............................................... 5-7
Alphanumeric Expressions ......................................................................... 5-8
General Forms of the Alphanumeric and Special-Purpose
  Functions and Operators ........................................................................... 5-9
ALL Function .............................................................................................. 5-10
AND, OR, XOR Operators .......................................................................... 5-11
BIN Function ............................................................................................. 5-13
BOOL Operator .......................................................................................... 5-14
DATE ............................................................................................................. 5-16
HEX Literal ................................................................................................ 5-17
LEN Function ............................................................................................. 5-18
NUM Function ............................................................................................ 5-20
POS Function ............................................................................................. 5-22
STR Function ............................................................................................. 5-24
TIME .............................................................................................................. 5-26
VAL Function ............................................................................................. 5-27
VER Function ............................................................................................. 5-28

CHAPTER 6 BINARY AND PACKED DECIMAL ARITHMETIC OPERATORS

Overview ....................................................................................................... 6-1
Decimal to Binary Conversion and Two's
  Complement Notation ............................................................................. 6-2
Decimal to Packed Decimal (BCD) Conversion and Ten's
  Complement Representation ..................................................................... 6-4
General Forms of the Binary and Packed
  Decimal Operators .................................................................................. 6-6
ADD Operator ............................................................................................ 6-7
DAC Operator ............................................................................................ 6-9
DSC Operator ............................................................................................ 6-10
SUB Operator ............................................................................................ 6-12
CONTENTS (continued)

CHAPTER 7 THE SELECT STATEMENT

Overview ........................................ 7-1
Math Mode Selection ............................ 7-1
Specifying Degrees, Radians, or Grads .... 7-2
Selecting Rounding or Truncation ......... 7-2
Computational Errors ......................... 7-2
Default Math Modes ......................... 7-3
Output Parameter Specification ............ 7-3
Selecting a Pause ............................ 7-3
Selecting the Number of Output Lines ... 7-4
Selecting the Line Width ................. 7-4
I/O Device Selection ....................... 7-6
The Classes of I/O Operations ............. 7-6
Device-Addresses ............................ 7-6
Selecting Device-Addresses for I/O Operations ... 7-7
System Default Device-Addresses ........ 7-8
The Device Table ............................ 7-9
Modifying Device Table Entries .......... 7-10
Explicit Device Table Modification ..... 7-10
The Console Input Select-Parameter .. 7-11
The INPUT Select-Parameter ............ 7-11
The Console Output Select-Parameter . 7-11
The PRINT Select-Parameter ............. 7-12
The LIST Select-Parameter ............ 7-13
The PLOT Select-Parameter ............ 7-13
The TAPE Select-Parameter ............ 7-13
The DISK Select-Parameter .............. 7-14
The File-Number Select-Parameter ...... 7-15
Multiple Select-Parameters in a Single
SELECT Statement ......................... 7-16
Implicit Device Table Modification .... 7-16
Master Initialization .................... 7-17
RESET ...................................... 7-17
CLEAR and LOAD RUN .................... 7-17
Device Types .................................. 7-18
Conditional Selection of Select-Parameters .. 7-19
General Forms of the SELECT Statements .. 7-20
LIST DT .................................. 7-21
ON/SELECT .................................. 7-23
SELECT Statement ......................... 7-25
SELECT Function .......................... 7-27

CHAPTER 8 PROGRAMMABLE INTERRUPTS

Overview ...................................... 8-1
Interrupt Programming .................... 8-1
<table>
<thead>
<tr>
<th>CONTENTS (continued)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interrupt Processing</td>
<td>8-2</td>
</tr>
<tr>
<td>Listing Interrupt Status</td>
<td>8-3</td>
</tr>
<tr>
<td>Definition and Enabling of Interrupts</td>
<td>8-3</td>
</tr>
<tr>
<td>General Forms of the Interrupt Control Instructions</td>
<td>8-4</td>
</tr>
<tr>
<td>$ALERT</td>
<td>8-5</td>
</tr>
<tr>
<td>LIST I</td>
<td>8-6</td>
</tr>
<tr>
<td>SELECT ON/OFF</td>
<td>8-8</td>
</tr>
<tr>
<td>SELECT ON CLEAR</td>
<td>8-11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 9 ERROR CONTROL FEATURES</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>9-1</td>
</tr>
<tr>
<td>Error Recoverability</td>
<td>9-2</td>
</tr>
<tr>
<td>ERR Function</td>
<td>9-3</td>
</tr>
<tr>
<td>ERR$ Function</td>
<td>9-5</td>
</tr>
<tr>
<td>ERROR</td>
<td>9-6</td>
</tr>
<tr>
<td>SELECT ERROR</td>
<td>9-8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 10 SYSTEM COMMANDS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>10-1</td>
</tr>
<tr>
<td>General Forms of the System Commands</td>
<td>10-3</td>
</tr>
<tr>
<td>CLEAR</td>
<td>10-4</td>
</tr>
<tr>
<td>CONTINUE</td>
<td>10-6</td>
</tr>
<tr>
<td>Function Keys</td>
<td>10-7</td>
</tr>
<tr>
<td>HALT</td>
<td>10-8</td>
</tr>
<tr>
<td>LIST</td>
<td>10-10</td>
</tr>
<tr>
<td>LIST COM/DIM</td>
<td>10-14</td>
</tr>
<tr>
<td>LIST T</td>
<td>10-15</td>
</tr>
<tr>
<td>LIST V</td>
<td>10-17</td>
</tr>
<tr>
<td>LIST #</td>
<td>10-20</td>
</tr>
<tr>
<td>LIST '</td>
<td>10-22</td>
</tr>
<tr>
<td>RENUMBER</td>
<td>10-23</td>
</tr>
<tr>
<td>RESET</td>
<td>10-25</td>
</tr>
<tr>
<td>RUN</td>
<td>10-26</td>
</tr>
<tr>
<td>STOP</td>
<td>10-27</td>
</tr>
<tr>
<td>TRACE</td>
<td>10-28</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHAPTER 11 GENERAL-PURPOSE BASIC-2 STATEMENTS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>11-1</td>
</tr>
<tr>
<td>General Forms of the General-Purpose Statements</td>
<td>11-5</td>
</tr>
<tr>
<td>COM</td>
<td>11-6</td>
</tr>
<tr>
<td>COM CLEAR</td>
<td>11-9</td>
</tr>
<tr>
<td>Command</td>
<td>Page</td>
</tr>
<tr>
<td>--------------------</td>
<td>------</td>
</tr>
<tr>
<td>CONVERT</td>
<td>11-11</td>
</tr>
<tr>
<td>DATA</td>
<td>11-15</td>
</tr>
<tr>
<td>DEFFN</td>
<td>11-17</td>
</tr>
<tr>
<td>DEFFN'</td>
<td>11-20</td>
</tr>
<tr>
<td>DIM</td>
<td>11-26</td>
</tr>
<tr>
<td>DO Group</td>
<td>11-29</td>
</tr>
<tr>
<td>END</td>
<td>11-30</td>
</tr>
<tr>
<td>FOR</td>
<td>11-31</td>
</tr>
<tr>
<td>$FORMAT</td>
<td>11-35</td>
</tr>
<tr>
<td>GOSUB</td>
<td>11-36</td>
</tr>
<tr>
<td>GOSUB'</td>
<td>11-38</td>
</tr>
<tr>
<td>GOTO</td>
<td>11-40</td>
</tr>
<tr>
<td>HEXPACK</td>
<td>11-41</td>
</tr>
<tr>
<td>HEXUNPACK</td>
<td>11-44</td>
</tr>
<tr>
<td>IF...THEN</td>
<td>11-45</td>
</tr>
<tr>
<td>Image (%)</td>
<td>11-48</td>
</tr>
<tr>
<td>INPUT</td>
<td>11-49</td>
</tr>
<tr>
<td>KEYIN</td>
<td>11-52</td>
</tr>
<tr>
<td>LET</td>
<td>11-54</td>
</tr>
<tr>
<td>LINPUT</td>
<td>11-55</td>
</tr>
<tr>
<td>MAT COPY</td>
<td>11-58</td>
</tr>
<tr>
<td>MAT MOVE</td>
<td>11-60</td>
</tr>
<tr>
<td>MAT SEARCH</td>
<td>11-64</td>
</tr>
<tr>
<td>NEXT</td>
<td>11-68</td>
</tr>
<tr>
<td>ON GOTO/GOSUB</td>
<td>11-70</td>
</tr>
<tr>
<td>PACK</td>
<td>11-72</td>
</tr>
<tr>
<td>$PACK</td>
<td>11-74</td>
</tr>
<tr>
<td>PRINT</td>
<td>11-84</td>
</tr>
<tr>
<td>PRINT AT</td>
<td>11-93</td>
</tr>
<tr>
<td>PRINT BOX</td>
<td>11-95</td>
</tr>
<tr>
<td>PRINT HEXOF</td>
<td>11-97</td>
</tr>
<tr>
<td>PRINT TAB</td>
<td>11-98</td>
</tr>
<tr>
<td>PRINT USING</td>
<td>11-99</td>
</tr>
<tr>
<td>PRINT USING TO</td>
<td>11-107</td>
</tr>
<tr>
<td>READ</td>
<td>11-109</td>
</tr>
<tr>
<td>REM</td>
<td>11-110</td>
</tr>
<tr>
<td>RESTORE</td>
<td>11-112</td>
</tr>
<tr>
<td>RETURN</td>
<td>11-114</td>
</tr>
<tr>
<td>RETURN CLEAR</td>
<td>11-116</td>
</tr>
<tr>
<td>ROTATE</td>
<td>11-117</td>
</tr>
<tr>
<td>STOP</td>
<td>11-119</td>
</tr>
<tr>
<td>$TRAN</td>
<td>11-120</td>
</tr>
<tr>
<td>UNPACK</td>
<td>11-124</td>
</tr>
<tr>
<td>$UNPACK</td>
<td>11-125</td>
</tr>
</tbody>
</table>
### CONTENTS (continued)

**CHAPTER 12 DISK I/O STATEMENTS**

- Overview ................................................................. 12-1
- File Catalog Mode ...................................................... 12-1
- Initializing the Catalog .............................................. 12-3
- Saving Cataloged Programs on Disk:
  - The SAVE Statement .............................................. 12-3
- Saving Modified Programs on Disk:
  - The RESAVE Statement ........................................... 12-4
- Changing the Names of Files:
  - The RENAME Statement ........................................... 12-4
- Retrieving Programs Stored on Disk:
  - The LOAD Command ............................................... 12-4
- Listing the Catalog Index: The LIST DC Statement .............. 12-5
- The LOAD RUN Command ............................................. 12-6
- Saving Data Files ................................................... 12-6
- The DATASAVE DC OPEN Statement ................................ 12-7
- The DATASAVE DC Statement ....................................... 12-8
- Opening a Second Data File on Disk ............................... 12-10
- The DATALOAD DC OPEN Statement ................................ 12-11
- The DATALOAD DC Statement ....................................... 12-12
- The DSKIP and DBACKSPACE Statements ............................ 12-13
- Scratching Unwanted Files ......................................... 12-15
- Making Backup Copies of Cataloged Files ......................... 12-15
- Closing a Data File .................................................. 12-15
- Sector Address Mode .................................................. 12-16
- RAMDISK ................................................................. 12-18
- What is RAMDISK ...................................................... 12-18
- Setting up RAMDISK .................................................. 12-19
- Accessing RAMDISK ................................................... 12-19
- General Forms of the Disk I/O Statements ......................... 12-19
  - COPY ................................................................. 12-21
  - DATALOAD BA ....................................................... 12-22
  - DATALOAD BM ....................................................... 12-23
  - DATALOAD DA ....................................................... 12-24
  - DATALOAD DC ....................................................... 12-26
  - DATALOAD DC OPEN ................................................ 12-27
  - DATASAVE BA ....................................................... 12-28
  - DATASAVE BM ....................................................... 12-29
  - DATASAVE DA ....................................................... 12-30
  - DATASAVE DC ....................................................... 12-32
  - DATASAVE DC CLOSE ............................................... 12-34
  - DATASAVE DC OPEN ................................................ 12-35
  - DATALOAD AC ....................................................... 12-36a
  - DATALOAD AC OPEN ................................................ 12-36b
  - DATASAVE AC ....................................................... 12-36c
  - DATASAVE AC OPEN ................................................ 12-36d
  - DATASAVE AC CLOSE ............................................... 12-36e
  - DATASAVE AC END .................................................. 12-36f
CONTENTS (continued)

<table>
<thead>
<tr>
<th>Command</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBBACKSPACE</td>
<td>12-37</td>
</tr>
<tr>
<td>DSKIP</td>
<td>12-38</td>
</tr>
<tr>
<td>$FORMAT DISK</td>
<td>12-39</td>
</tr>
<tr>
<td>LIMITS</td>
<td>12-40</td>
</tr>
<tr>
<td>LIST DC</td>
<td>12-42</td>
</tr>
<tr>
<td>LOAD (Immediate mode)</td>
<td>12-45</td>
</tr>
<tr>
<td>LOAD (Program mode)</td>
<td>12-46</td>
</tr>
<tr>
<td>LOAD DA (Immediate mode)</td>
<td>12-48</td>
</tr>
<tr>
<td>LOAD DA (Statement)</td>
<td>12-49</td>
</tr>
<tr>
<td>LOAD RUN</td>
<td>12-51</td>
</tr>
<tr>
<td>MOVE (file)</td>
<td>12-52</td>
</tr>
<tr>
<td>MOVE (disk)</td>
<td>12-53</td>
</tr>
<tr>
<td>MOVE END</td>
<td>12-54</td>
</tr>
<tr>
<td>RENAME</td>
<td>12-55</td>
</tr>
<tr>
<td>RESAVE</td>
<td>12-56</td>
</tr>
<tr>
<td>SAVE</td>
<td>12-57</td>
</tr>
<tr>
<td>SAVE DA</td>
<td>12-60</td>
</tr>
<tr>
<td>SCRATCH</td>
<td>12-61</td>
</tr>
<tr>
<td>SCRATCH DISK</td>
<td>12-62</td>
</tr>
<tr>
<td>VERIFY</td>
<td>12-64</td>
</tr>
</tbody>
</table>

CHAPTER 13 MATH MATRIX STATEMENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>13-1</td>
</tr>
<tr>
<td>Array Dimensioning</td>
<td>13-2</td>
</tr>
<tr>
<td>Array Redimensioning</td>
<td>13-2</td>
</tr>
<tr>
<td>Redimensioning Rules</td>
<td>13-3</td>
</tr>
<tr>
<td>General Forms of the Math Matrix Statements</td>
<td>13-3</td>
</tr>
<tr>
<td>MAT Addition: MAT +</td>
<td>13-4</td>
</tr>
<tr>
<td>MAT Constant: MAT CON</td>
<td>13-5</td>
</tr>
<tr>
<td>MAT Equality: MAT =</td>
<td>13-6</td>
</tr>
<tr>
<td>MAT Identity: MAT IDN</td>
<td>13-7</td>
</tr>
<tr>
<td>MAT INPUT</td>
<td>13-8</td>
</tr>
<tr>
<td>MAT Inverse: MAT INV</td>
<td>13-10</td>
</tr>
<tr>
<td>MAT Multiplication: MAT *</td>
<td>13-13</td>
</tr>
<tr>
<td>MAT PRINT</td>
<td>13-14</td>
</tr>
<tr>
<td>MAT READ</td>
<td>13-15</td>
</tr>
<tr>
<td>MAT Redimension: MAT REDIM</td>
<td>13-17</td>
</tr>
<tr>
<td>MAT Scalar Multiplication: MAT( )*</td>
<td>13-19</td>
</tr>
<tr>
<td>MAT Subtraction: MAT -</td>
<td>13-20</td>
</tr>
<tr>
<td>MAT Transpose: MAT TRN</td>
<td>13-21</td>
</tr>
<tr>
<td>MAT Zero: MAT ZER</td>
<td>13-22</td>
</tr>
</tbody>
</table>

CHAPTER 14 SORT STATEMENTS

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview</td>
<td>14-1</td>
</tr>
<tr>
<td>Sorting Numeric Data</td>
<td>14-2</td>
</tr>
</tbody>
</table>
### CONTENTS (continued)

Representation of Array Subscripts in the
- Locator-Array ........................................ 14-2
- General Forms of the Sort Statements .......... 14-3
- MAT MERGE ........................................... 14-4
- MAT MOVE ........................................... 14-13
- MAT SORT ............................................ 14-18

#### CHAPTER 15 GENERAL I/O STATEMENTS

Overview .................................................... 15-1
Considerations for the Use of $GIO .................. 15-1
I/O Bus ................................................... 15-2
- Address Bus Strobes ................................... 15-3
- Output Bus Strobes .................................... 15-3
- Wait For Ready ......................................... 15-4
- Input Bus Strobes .................................... 15-4
- General Forms of the General I/O Statements ...... 15-4
- $IF ON/OFF ............................................ 15-5
- $GIO .................................................... 15-8

#### CHAPTER 16 MULTIUSER OPERATION

Overview .................................................... 16-1
- Functional Description ................................ 16-2
- User Memory Allocation .............................. 16-5
- Peripheral Allocation ................................ 16-9
- Automatic Program Bootstrapping .................. 16-10
- Disabled Programming ............................... 16-11
- Broadcast Message .................................... 16-11
- Foreground and Background Processing .......... 16-12
- Background Terminal Printer Operation .......... 16-14
- Global Partitions .................................... 16-14
- Global Program Text .................................. 16-15
- Local Variables Referenced in a Global Partition .. 16-17
- Nesting Global Subroutines ......................... 16-18
- Some Programming Considerations for Global Program Text 16-19
- Global Variables .................................... 16-20
- Declaring Global Variables in a Nonglobal Partition .. 16-22
- Using Global Variables for Task Control .......... 16-22
- Further Details on Global Partitions .............. 16-24
- Terminal Connect/Disconnect Detection ............ 16-34
- Multiuser Language Features ....................... 16-34
- $BREAK ............................................... 16-36
- $CLOSE ................................................. 16-38
CONTENTS (continued)

DEFFN @PART .................................................. 16-39
$DISCONNECT ............................................... 16-41
$INIT ....................................................... 16-45
$MSG ........................................................ 16-49
$OPEN ....................................................... 16-50
$PSTAT ...................................................... 16-52
$RELEASE PART ........................................... 16-55
$RELEASE TERMINAL ................................. 16-57
SELECT @PART .............................................. 16-59
Programming Considerations ...................... 16-61
General Programming Considerations ........... 16-61
Considerations for Time-Dependent Programs ... 16-61
I/O Operations ........................................ 16-62
I/O Statement Restrictions ....................... 16-62
Default Disk Address ............................... 16-63
Special Features of the 2236MXE Controller .... 16-64

APPENDIX A KEY CODES AND CHARACTER SETS

APPENDIX B ERROR MESSAGES AND RECOVERY

APPENDIX C COMPATIBILITY WITH 2200 SERIES CPU's

APPENDIX D DEVICE ADDRESSES

APPENDIX E GLOSSARY

INDEX
# FIGURES

| Figure 3-1 | Examples of Control Codes | 3-3 |
| Figure 3-2 | The Display Attributes | 3-5 |
| Figure 3-3 | Highlighting Key Words | 3-6 |
| Figure 3-4 | Using HEX(0E) | 3-7 |
| Figure 3-5 | Selecting Another Attribute | 3-8 |
| Figure 3-6 | Testing Isolated HEX(0E) | 3-10 |
| Figure 3-7 | Using Isolated HEX(0E) | 3-11 |
| Figure 3-8 | Division of a Character Space | 3-14 |
| Figure 3-9 | Box Graphic Line Placement Relative to Character Position | 3-16 |
| Figure 3-10 | Box Graphic Line Placement Relative to Graphic Character Set | 3-16 |
| Figure 7-1 | Sample Device Table Screen | 7-9 |
| Figure 12-1 | The Catalog Index Listing | 12-5 |
| Figure 12-2 | Logical Record Consisting of One Sector | 12-9 |
| Figure 12-3 | Two One-Sector Logical Records | 12-10 |
| Figure 12-4 | Logical Records in TEST-1 | 12-13 |
| Figure 14-1 | Simplified Merge Sequence | 14-6 |
| Figure 14-2 | Control-Variable Prior to Beginning MAT MERGE | 14-7 |
| Figure 14-3 | Control-Variable Following Termination of MAT MERGE Due to Empty Row | 14-19 |
| Figure 14-4 | Simplified Sort Sequence | 14-19 |
| Figure 15-1 | Schematic of Input and Output Strobes for the Model 2250 I/O Interface Controller | 15-3 |
| Figure 16-1 | Memory Bank Organization | 16-6 |
| Figure 16-2 | The Universal Global Area | 16-7 |
| Figure 16-3 | A Multibank System Configuration | 16-8 |
| Figure 16-4 | Two Partitions Accessing Global Program Text | 16-16 |
| Figure 16-5 | Nesting Global Subroutines | 16-18 |
| Figure 16-6 | Variable Table Entries in Global and Nonglobal Partitions for Global and Local Variables | 16-21 |
| Figure 16-7 | Use of Text Pointer and Stack to Control Flow of Execution Following a Subroutine Call | 16-26 |
| Figure 16-8 | The Pointer Table | 16-27 |
| Figure 16-9 | Job Flow Between Originating Partitions and Global Partition | 16-28 |
| Figure 16-10 | Pointer Table for Partition #2 Following Master Initialization | 16-29 |
| Figure A-1 | The Default Font Character Set | A-4 |
| Figure A-2 | The Alternate Font Character Set | A-5 |

xiii
### TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2-1</td>
<td>Editing Functions</td>
<td>2-3</td>
</tr>
<tr>
<td>Table 3-1</td>
<td>Cursor Controls</td>
<td>3-2</td>
</tr>
<tr>
<td>Table 4-1</td>
<td>System-Defined Numeric Functions</td>
<td>4-7</td>
</tr>
<tr>
<td>Table 4-2</td>
<td>Special-Purpose Numeric Functions</td>
<td>4-14</td>
</tr>
<tr>
<td>Table 5-1</td>
<td>BOOLh Logical Functions</td>
<td>5-15</td>
</tr>
<tr>
<td>Table 5-2</td>
<td>Format-Character Definitions</td>
<td>5-29</td>
</tr>
<tr>
<td>Table 7-1</td>
<td>Default Addresses for Primary I/O Devices</td>
<td>7-8</td>
</tr>
<tr>
<td>Table 9-1</td>
<td>SELECT ERROR Return Values</td>
<td>9-9</td>
</tr>
<tr>
<td>Table 10-1</td>
<td>BASIC-2 System Commands</td>
<td>10-1</td>
</tr>
<tr>
<td>Table 11-1</td>
<td>General-Purpose BASIC-2 Statements</td>
<td>11-1</td>
</tr>
<tr>
<td>Table 11-2</td>
<td>Binary Values for HEXPACK Characters</td>
<td>11-42</td>
</tr>
<tr>
<td>Table 11-3</td>
<td>Valid Field Specifications</td>
<td>11-77</td>
</tr>
<tr>
<td>Table 11-4</td>
<td>Valid Delimiter Specifications</td>
<td>11-126</td>
</tr>
<tr>
<td>Table 11-5</td>
<td>Valid Field Specifications</td>
<td>11-129</td>
</tr>
<tr>
<td>Table 12-1</td>
<td>Sector Address Mode Statements and Commands</td>
<td>12-18</td>
</tr>
<tr>
<td>Table 13-1</td>
<td>Matrix Operations</td>
<td>13-1</td>
</tr>
<tr>
<td>Table 14-1</td>
<td>Values of Sign Bits and Their Meanings</td>
<td>14-15</td>
</tr>
<tr>
<td>Table 14-2</td>
<td>Decimal and Decimal Complement Forms</td>
<td>14-16</td>
</tr>
<tr>
<td>Table 15-1</td>
<td>Legend</td>
<td>15-21</td>
</tr>
<tr>
<td>Table 15-2</td>
<td>Summary Microcommand Categories</td>
<td>15-23</td>
</tr>
<tr>
<td>Table 15-3</td>
<td>Single Address Stroke</td>
<td>15-24</td>
</tr>
<tr>
<td>Table 15-4</td>
<td>Control Microcommands</td>
<td>15-25</td>
</tr>
<tr>
<td>Table 15-5</td>
<td>Single Character Output Microcommands</td>
<td>15-27</td>
</tr>
<tr>
<td>Table 15-6</td>
<td>Single Character Input Microcommands</td>
<td>15-29</td>
</tr>
<tr>
<td>Table 15-7</td>
<td>Multicharacter Output Microcommands</td>
<td>15-30</td>
</tr>
<tr>
<td>Table 15-8</td>
<td>Valid CHECK T Codes for Table 15-7</td>
<td>15-31</td>
</tr>
<tr>
<td>Table 15-9</td>
<td>Valid LEND Codes for Table 15-7</td>
<td>15-31</td>
</tr>
<tr>
<td>Table 15-10</td>
<td>Multicharacter Input Microcommands</td>
<td>15-32</td>
</tr>
<tr>
<td>Table 15-11</td>
<td>Valid CHECK T Codes for Table 15-10</td>
<td>15-33</td>
</tr>
<tr>
<td>Table 15-12</td>
<td>Valid LEND Codes for Table 15-10</td>
<td>15-34</td>
</tr>
<tr>
<td>Table 15-13</td>
<td>Register Usage</td>
<td>15-35</td>
</tr>
<tr>
<td>Table 16-1</td>
<td>Functions of Pointer Table Items</td>
<td>16-31</td>
</tr>
<tr>
<td>Table 16-2</td>
<td>Statements Which Modify the Pointer Table</td>
<td>16-33</td>
</tr>
<tr>
<td>Table 16-3</td>
<td>Multiuser Functions</td>
<td>16-35</td>
</tr>
<tr>
<td>Table 16-4</td>
<td>Devices to Which BASIC-2 Statements</td>
<td>16-63</td>
</tr>
<tr>
<td>Table A-1</td>
<td>BASIC-2 Standard Key Codes</td>
<td>A-1</td>
</tr>
<tr>
<td>Table A-2</td>
<td>BASIC-2 Special Key Codes</td>
<td>A-2</td>
</tr>
</tbody>
</table>
This manual is designed as a primary resource for using the BASIC-2 language on Wang computer systems. Users unfamiliar with the BASIC language are encouraged to refer to a standard textbook for an introduction to the language.

Throughout this manual, a general format accompanies each description of a command or statement. When more than one specific arrangement is permitted, there are separate numbered formats. Within a format, key words, connectives, and special characters appear in proper sequence. Unless otherwise stated, you can use only the sequence shown.

This manual uses the following conventions to define and illustrate the components of BASIC-2 program statements and commands:

• Uppercase letters (A through Z), digits (0 through 9), and special characters (such as *, /, +) must always be used for program entry exactly as presented in the general format.

• All lowercase words represent information that you must supply.

Example:

In the following statement, you must supply the line-number.

GOTO line-number

• When braces, { } enclose a vertically stacked list in a portion of a format, you must select one of the options within the braces.

Example:

    expression

ON

    alpha-variable
• Brackets, [ ] indicate that the enclosed information is optional. When brackets contain a vertical list of two or more items, you can use one or none of the items.

Example:

LOAD RUN [filename]

• The presence of an ellipsis (...) within any format indicates that the unit immediately preceding the notation can occur one or more times in succession.

Example:

COM com-element [,com-element] ...

• When one or more items appear in sequence, these items or their replacements must appear in the specified order.
Trigonometric Functions

The trigonometric functions SIN, COS, and TAN and their inverse functions, ARCSIN, ARCCOS, and ARCTAN, can be calculated in one of three modes: radians, degrees, or grads (360 degrees = 400 grads). Trigonometric functions are evaluated in radians, unless the system is explicitly instructed to use degrees or grads. If degrees or grads are required, they must be specified with the following SELECT statements prior to performing trigonometric calculations:

SELECT D -- Use degrees in all subsequent trigonometric calculations.

SELECT G -- Use grads in all subsequent trigonometric calculations.

SELECT R -- Use radians in all subsequent trigonometric calculations.

Radian measure is automatically selected upon Master Initializing the system or when a CLEAR command is issued.

SPECIAL-PURPOSE NUMERIC FUNCTIONS

A second group of numeric functions is available for certain special-purpose operations. These functions are summarized in Table 4-2. With the exceptions of the #ID, ERR, SPACE, and SPACEK functions, the remaining special-purpose numeric functions operate on alphanumeric arguments and are described in detail in Chapter 5. The ERR function is discussed with the error control features in Chapter 9.

SPACE Function

The SPACE function returns the amount of memory not currently occupied by program text or data, minus the amount of memory occupied by the value stack. The value returned represents the actual amount of free space in memory at any point during execution.

The Value Stack initially occupies zero bytes but expands during program execution. To determine how much free space is actually available, check the value of SPACE during program execution when the Value Stack attains its maximum size. Typically, the value stack reaches maximum size when the program executes the innermost loop in a series of nested loops.

SPACEK Function

Before memory has been partitioned, the SPACEK function returns the total amount of available user memory divided by 1,024. For example, a system with 56K of user memory returns SPACEK = 56. After a system has been partitioned, SPACEK returns the size of the partition that executes the SPACEK function.
SPACE S and SK

SPACE S determines the amount of memory that is not currently occupied by any partition. This is Ramdisk Memory. SPACE SK returns the total amount of memory including all allocated and Ramdisk memory. This is the total memory on the CPU board.

#ID Function

The #ID function returns the value of the CPU identification number (a number from 1 to 65535). With the #ID function, a program can distinguish one system from another. This capability is useful in licensing software to specific installations.

Table 4-2. Special-Purpose Numeric Functions

<table>
<thead>
<tr>
<th>Function</th>
<th>Meaning</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIN</td>
<td>Converts an integer value to a binary number.</td>
<td>A$ = BIN(65)</td>
</tr>
<tr>
<td>ERR</td>
<td>Returns the error code of the last error condition.</td>
<td>X = ERR</td>
</tr>
<tr>
<td>LEN</td>
<td>Determines the length of a character string.</td>
<td>X = LEN(A$)</td>
</tr>
<tr>
<td>NUM</td>
<td>Determines whether or not a character string is a legal representation of a BASIC number.</td>
<td>X = NUM(A$)</td>
</tr>
<tr>
<td>POS</td>
<td>Returns the position of the first (or last) character in a character string that meets a specified condition.</td>
<td>X = POS(A$=&quot;S&quot;)</td>
</tr>
<tr>
<td>VAL</td>
<td>Computes the decimal equivalent of a binary value.</td>
<td>X = VAL(A$)</td>
</tr>
<tr>
<td>VER</td>
<td>Verifies that a character string conforms to a specified format.</td>
<td>Y = VER(B$, &quot;###&quot;)</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Function</th>
<th>Meaning</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPACE</td>
<td>Determines the amount of free space available in memory.</td>
<td>Z = SPACE</td>
</tr>
<tr>
<td>SPACE K</td>
<td>Returns the total user memory size or partition size divided by 1,024.</td>
<td>Z1 = SPACE K</td>
</tr>
<tr>
<td>SPACE S*</td>
<td>Determines the amount of memory that is not currently occupied by any partition (Ramdisk Memory).</td>
<td>Z2 = SPACE S</td>
</tr>
<tr>
<td>SPACE SK*</td>
<td>Returns the total amount of memory including all allocated and Ramdisk memory.</td>
<td>Z3 = SPACE SK</td>
</tr>
<tr>
<td>#ID</td>
<td>Returns the CPU identification number</td>
<td>PRINT #ID</td>
</tr>
</tbody>
</table>

Note: * CS/386 ONLY
BIN Function

Format:

BIN( expression [,length] )

where:

length = numeric-variable or the digit 1, 2, 3, or 4

If length = 1, 0 <= value-of-expression < 256
If length = 2, 0 <= value-of-expression < 65,536
If length = 3, 0 <= value-of-expression < 16,777,216
If length = 4, 0 <= value-of-expression < 4,294,967,296

BIN is an alphanumeric function that uses a numeric argument, but returns an alphanumeric value; it is the inverse of the VAL function. The BIN (binary) function converts the integer value of the expression to a binary value. The number of bytes in the binary value is specified by the digit; if no digit is included, the length is assumed to be one byte. A numeric-variable can now be used to specify the length of the binary result of the BIN function. The BIN function can only be used in the alpha-expression portion of an alphanumeric assignment statement. BIN is especially useful for code conversion and conversion of numbers from internal decimal format to binary.

Example:

Sets A$ = A since the binary value of decimal 65 is the character code for the letter A.

A$ = BIN(65)

Examples of valid syntax:

B$ = BIN(X,L)
A$ = BIN(X)
STR(A$,I,2) = BIN(X,2)
C$ = BIN(X*Y/Z,4)
**BOOL Operator**

**Format:**

```
BOOL h
```

**where:**

```
h = hexadecimal digit (0-9 or A-F)
```

BOOL is a generalized logical operator that performs a specified operation on the value of the receiver-variable. The operation to be performed is specified by the hexadecimal digit following BOOL (refer to Table 5-3). BOOL can be used only in the alpha-expression portion of an alpha assignment statement. (Refer to the discussion of alpha expressions and the alpha assignment statement in the section entitled "Alphanumeric Expressions".) The value of the operand and the value of the receiver-variable are operated upon, and the result is assigned to the receiver-variable. For example, the following statement logically not-ANDs the value of B$ with the value of A$ and assigns the result to A$:

```
A$ = BOOL7 B$
```

The logical operations are performed on a character-by-character basis from left to right, starting with the leftmost character in each field.

- If the defined length of the operand is shorter than that of the receiver-variable, the remaining bytes of the receiver-variable are not changed.

- If the defined length of the operand is equal to that of the receiver-variable, the entire values of both, including any trailing spaces, are operated on. (Trailing spaces usually are not considered part of the value of an alpha-variable.)

- If the operand is longer than the receiver-variable, the operation terminates when the last byte of the receiver-variable has been operated on.

A specified portion of an alpha-variable can be operated on if the portion is defined with a string function. For example, the following statement operates only on the third and fourth bytes of A$:

```
STR(A$,3,2) = BOOL9 B$
```
**VAL Function**

Format:

\[
\text{VAL(} \begin{cases} \text{alpha-variable} \\ \text{literal-string} \end{cases} [, \text{length}] )
\]

where:

\( \text{length} = \text{numeric-variable} \) or the digit 1, 2, 3, or 4

VAL is a numeric function that uses an alphanumeric argument, but returns a numeric value; it is the inverse of the BIN function. The VAL (value) function converts the binary value in the alpha-variable or literal-string to a numeric value. The number of bytes in the binary value to be converted is specified by the digit; if no digit is included, the length is assumed to be one byte. A numeric-variable can now be used to specify the length of the binary value in the VAL function. The VAL function can be used wherever numeric functions are legal.

VAL is particularly useful in code conversion and table lookup operations since the converted number can be used as a subscript to retrieve the corresponding code from an array. Additionally, VAL can be used with the RESTORE statement to retrieve codes or data from DATA statements.

Examples:

:PRINT VAL(HEX(20))
32

:A$=HEX(1234)
:PRINT VAL(A$,2)
4660

Examples of valid syntax:

\[
X = \text{VAL(A$,L)}
X = \text{VAL(A$)}
\text{PRINT VAL("A")}
Y = \text{VAL(B$,2)}
\text{RESTORE VAL(STR(A$,I,1))+1}
B$ = A$(\text{VAL(C$)+1)}
\text{IF VAL(X$,2) > 1024 THEN 100}
\]
**VER Function**

**Format:**

\[
\text{VER(}\begin{cases}
\text{alpha-variable} \\
\text{literal-string}
\end{cases}, \text{format-specification})
\]

where:

\[
\text{format-specification} = \begin{cases}
\text{alpha-variable} \\
\text{literal-string}
\end{cases}
\]

The VER (verify) function verifies that the value of an alphanumerically variable or literal string conforms to a specified format. The first variable or literal string in the function is verified against the format specified by the second variable or literal string (the format-specification). The VER function returns the number of successive characters in the value being verified that conform to the format-specification. Each character in the defined length of the alpha-variable or literal string is verified by checking it against the character set associated with the specified format-character in the format-specification (refer to Table 5-4). If a character in the value being verified does not appear in the specified format-character set, it is regarded as an illegal character and causes a termination of the VER operation.

The verify operation terminates when an illegal character is found, when the end of the value (including any trailing spaces) is encountered, or when the end of the format-specification is reached.

VER is a special-purpose numeric function that uses an alphanumerically argument but returns a numeric result. The VER function can be used wherever numeric functions are legal. Refer to the discussion of numeric functions in Chapter 4.
SELECT Statement

Format:

SELECT select-parameter [,select-parameter ]...

where:

\[
\begin{align*}
D & \\
R & \\
G & \\
ERROR & \ (error-code)
\end{align*}
\]

\[
\begin{align*}
[NO] \text{ ROUND} & \\
P & \text{ [digit]} \\
LINE & \text{ numeric-expression} \\
CI & \text{ device-address} \\
INPUT & \text{ device-address} \\
CO & \text{ device-address } \[(width)\] \\
PRINT & \text{ device-address } \[(width)\]
\end{align*}
\]

select-parameter = \{

\[
\begin{align*}
\text{LIST} & \text{ device-address } \[(width)\] \\
\text{PLOT} & \text{ device-address} \\
\text{TAPE} & \text{ device-address} \\
\text{DISK} & \text{ device-address} \\
\text{file-number} & \text{ device-address} \\
\text{TC} & \text{ port-number} \\
\text{TERMINAL} & \text{ port-number} \\
\text{DRIVER} & \text{ device-address } \text{ [OFF]} \\
\text{NEW} & * \\
\text{OLD} & *
\end{align*}
\]

\}

device-address = \{

\[
\begin{align*}
/\text{taa,} & \\
\text{ } & \langle \text{ alpha-variable } \rangle
\end{align*}
\]

where:

\[
\begin{align*}
t & = \text{ one hex digit specifying the device-type} \\
\text{aa} & = \text{ two hex digits specifying the physical device address}
\end{align*}
\]

\[
\begin{align*}
\text{alpha-variable} & = \text{ three-byte variable whose value must be} \\
& \text{ three ASCII hex digits representing the} \\
& \text{ device type and address}
\end{align*}
\]

\[
\begin{align*}
\text{width} & = \text{ an expression } 0 < 256 \text{ specifying the} \\
& \text{ maximum number of characters on a single line}
\end{align*}
\]

\[
\begin{align*}
\text{file-number} & = \#n, \text{ where } n = \text{ an integer or} \\
& \text{ numeric-variable with a value } \geq 0 \text{ and } < 16
\end{align*}
\]

Note: * CS/386 ONLY
The SELECT statement is used for the following purposes:

- To select the desired math modes for arithmetic operations; including type of measure for trigonometric functions, rounding or truncation of numeric results, and desired system response to specific math errors. (Refer to the section entitled "Math Mode Selection".)

- To select output parameters for communicating with output devices. (Refer to the section entitled "Output Parameter Specification".)

- To select device-addresses for accessing specified devices with input/output statements and commands. (Refer to Section 7.4.)

- To select a 2236MXE port for telecommunications. Refer to the Asynchronous Communications User Guide for Model 2236MXE Terminal Processor and Option-W Terminal Processor (700-8098) for a discussion of SELECT TC, SELECT TERMINAL, and telecommunications using the 2236MXE.

- To control printer drivers. Refer to the BASIC-2 Utilities Manual for a discussion the use of SELECT DRIVER for controlling printer drivers.

- To Select the program saving format mode. The option OLD (Default) signifies format compatible with the current 2200 & VLSI CPUs. The NEW option is only compatible with the CS/386 CPU. It should be noted that the CS/386 takes less processing time to resolve the NEW file format. Because the new format takes more space to save a program line, old formats being resaved in the new format may fail with an A05 Error. To overcome this situation, the program line must be broken into additional line numbers.
The alpha-variable or literal string following the $F$ parameter contains the field specifications for the buffer. Each field specification consists of two bytes. The first byte specifies the type of field; the second byte specifies the field width (i.e., the number of characters in that field).

Example:

The following two examples illustrate that the field specifications for a buffer can either be contained within an alphanumeric-variable or expressed as a hexadecimal literal string:

\[
\$PACK (F = F\$) \ B\$( ) \ FROM \ X( ) \\
\$PACK (F = HEX(1008)) \ B\$( ) \ FROM \ X( )
\]

If the first byte of the field specification is HEX(00), the corresponding field in the buffer is skipped. Alphanumeric fields are indicated by specifying HEX(A0) as the first byte of the field specification. Several types of numeric fields are permitted; numeric data is indicated by specifying a hex digit from 1 to 6 as the first hex digit of the first byte in the field specification. Each of the digits 1 to 6 identifies a unique numeric format. Refer to Table 11-3. The second hex digit specifies the implied decimal position in binary; the decimal point is assumed to be the specified number of digits from the right-hand side of the field. For example, the value +123.45 is stored as +12345, and the implied decimal point position is 2. An error results if a numeric value is packed into an alphanumeric field or if an alphanumeric value is packed into a numeric field.

Table 11-3. Valid Field Specifications

<table>
<thead>
<tr>
<th>Numeric Fields</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>00xx</td>
<td>skip field</td>
</tr>
<tr>
<td>10xx</td>
<td>ASCII free format</td>
</tr>
<tr>
<td>2dxx</td>
<td>ASCII integer format</td>
</tr>
<tr>
<td>3dxx</td>
<td>IBM display format</td>
</tr>
<tr>
<td>4dxx</td>
<td>IBM USASCII -- 8 format</td>
</tr>
<tr>
<td>5dxx</td>
<td>IBM packed decimal format</td>
</tr>
<tr>
<td>6dxx</td>
<td>unsigned packed decimal format</td>
</tr>
<tr>
<td>7d0y</td>
<td>packed decimal with binary overflow format</td>
</tr>
<tr>
<td>8d0y</td>
<td>signed binary format</td>
</tr>
<tr>
<td>9d0y</td>
<td>unsigned binary format</td>
</tr>
<tr>
<td>A0xx</td>
<td>alphanumeric field</td>
</tr>
<tr>
<td>A1xx</td>
<td>compressed alphanumeric format</td>
</tr>
</tbody>
</table>

where:

\[
x = \text{field width in binary } (xx > 0) \\
y = \text{field width in binary } (0 < y < 4) \\
d = \text{implied decimal position in binary}
\]
You must supply a separate field specification for every variable or array in the variable list. All elements in an array use the field specification specified for that array.

Example:

The following statement requires three field specifications:

$PACK (F = F$) B$( ) FROM A$, B( ), C$

If F$ = HEX(A0081006A010), then

A008 is the field specification for A$
1006 is the field specification for each element in the array B( )
A010 is the field specification for C$

You can also mnemonically define a field specification in a $FORMAT statement. $FORMAT permits the use of simple mnemonic codes rather than hex codes to specify field formats. Refer to the discussion of the $FORMAT statement in this section.

Example:

The field specifications defined for F$ above could be defined as follows in a $FORMAT statement

$FORMAT F$ = A8, F6, A16

Buffer format:

| field 1 | field 2 | field 3 | ... | field n |

Data format:

- Alphanumeric Fields (A0xx)

| C | C | ... | C |

where:

C = one character of the value to be packed

11-78 General-Purpose BASIC-2 Statements
If the value is shorter than the length of the field, the value is left-justified in the field and the remainder of the field is filled with spaces. If the value is too long, it is truncated to fit within the field.

* Numeric Fields

**ASCII free format (10xx)**

```
   s  d  d  ...  d  .  d  ...  d
```
```
   s  d  .  d  d  d  d  d  d  d  d  d  d  E  ±  d  d
```

Where:

- s = sign (space if value > 0 or minus sign (-) if value < 0)
- d = ASCII digit

Format 1 is used if the value is greater than or equal to $10^{-1}$ and less than $10^{+13}$ or if the value is less than $10^{-1}$ but can be expressed in fewer than 13 digits. Format 2 is used in all other cases.

Numeric values are stored as ASCII characters in one of the formats illustrated above. Note that Formats 1 and 2 are the same formats used by the PRINT statement when printing numeric values. If the value to be stored is shorter than the length of the field, the value is left-justified in the field and the remainder of the field is filled with spaces. If the value is too large to fit in the field, it is truncated to the length of the field.

For the numeric formats illustrated, the following rule applies: If the value is shorter than the length of the field, leading zeros are inserted; if the value is too long, an error results.

* ASCII integer format (2dxx)

```
   s  d  d  ...  d
```

Where:

- s = sign (ASCII + or -), required
- d = ASCII digit
- IBM display format (3dxx)

| Fd | Fd | ... | Fd | sd |

where:

- \( s = \text{sign}(C = +, D = -) \)
- \( d = \text{digit}(0-9) \)

- IBM USASCII-8 format (4dxx)

| 5d | 5d | ... | 5d | sd |

where:

- \( s = \text{sign}(A = +, B = -) \)
- \( d = \text{digit}(0-9) \)

- IBM packed decimal format (5dxx)

| dd | dd | ... | dd | ds |

where:

- \( s = \text{sign}(C = +, D = -) \)
- \( d = \text{digit}(0-9) \)

- Unsigned packed decimal format (6dxx)

| dd | dd | ... | dd | dd |

where:

- \( d = \text{digit}(0-9) \)

The above formats are shown in hexadecimal notation.

Decimal arithmetic can be performed on unsigned packed decimal numbers. (Refer to the discussion of the DAC and DSC operators in Chapter 7.)
Example:

The following example assumes that the buffer B$ has three fields (one alpha and two numeric), each five characters long. $PACK packs the values of A$, X, and Y into B$.

:10 DIM B$15
:20 A$ = "ABC" :X = -12 :Y = +1.2345
:30 F$ = HEX(A00520051005)
:40 $PACK (F = F$) B$ FROM A$, X, Y
:50 PRINT "B$ = "; B$
:RUN

B$ = "ABC  -0012 1.23"

Example:

The following examples assume that X = 12.345.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>:10 F$ = HEX(100A)</td>
<td>B$ = &quot;12.345&quot;</td>
</tr>
<tr>
<td>:20 $PACK (F = F$) B$ FROM X</td>
<td></td>
</tr>
<tr>
<td>:10 F$ = HEX(240A)</td>
<td>B$ = &quot;+000123450&quot;</td>
</tr>
<tr>
<td>:20 $PACK (F = F$) B$ FROM X</td>
<td>Note that there is an implied decimal point four digits from the right end of the field.</td>
</tr>
<tr>
<td>:10 F$ = HEX(3305)</td>
<td>B$ = HEX(F1F2F3F4C5)</td>
</tr>
<tr>
<td>:20 $PACK (F = F$) B$ FROM X</td>
<td></td>
</tr>
<tr>
<td>:10 F$ = HEX(4206)</td>
<td>B$ = HEX(5050515253A4)</td>
</tr>
<tr>
<td>:20 $PACK (F = F$) B$ FROM X</td>
<td></td>
</tr>
<tr>
<td>:10 F$ = HEX(5506)</td>
<td>B$ = HEX(00001234500C)</td>
</tr>
<tr>
<td>:20 $PACK (F = F$) B$ FROM X</td>
<td>Results in an error because the receiving field is too small to hold the value.</td>
</tr>
</tbody>
</table>
Packed Decimal with Binary Overflow Format (7d0y)

The Packed Decimal with Binary Overflow Format is used to pack numeric values. The number is stored in packed decimal format (same as type 5dxxx) if it will fit in the specified field. The maximum field length allowed is 4. If the number is too large to be stored in packed decimal, it is converted to binary and stored in a binary format. If the binary number is still too large for the field, an error (ERROR X71) results. The last hexdigit of the packed value identifies the value as being either packed decimal or binary. If the last hexdigit is hex(C-F), the value is packed decimal. If the value is hex(0-B), the value is binary.

When a number is stored in binary format, it is first converted to a binary value the same length as the field. The number is too large to be packed if the upper hexdigit is greater than 5. The number is then shifted left by one hexdigit (4-bits). The low 3-bits of what was the upper hexdigit now become the upper 3-bits of the low hexdigit of the value. The lowest bit of the last hexdigit stores the sign of the value: zero for nonnegative and one for negative values.

Example:

10 X = 1234567
20 $PACK (F=HEX(7004)) D$ FROM X
30 $PACK (F=HEX(7003)) B$ FROM X

Results in D$ = HEX(12 34 56 7C) and
B$ = HEX(2D 68 72)
• Signed Binary Format (8d0y)

The Signed Binary Format is used to pack numeric values. The maximum field length allowed is 4. The value is converted to a binary value the same length as the field. If the binary number is too large for the field, an error (ERROR X71) results. Negative values are stored in 2's complement. Thus, the highest bit in the field can be used to determine the sign of the value: the bit is zero for nonnegative values and one for negative values.

Example:

\[
\begin{align*}
10 \ X &= \ 1234567 \\
20 \ \$PACK \ (F=HEX(8004)) \ \ P$ \ FROM \ X \\
30 \ \$PACK \ (F=HEX(8004)) \ \ N$ \ FROM \ -X
\end{align*}
\]

Results in \( P$ = \) \( 00 \ 2D \ 68 \ 72 \) and \( N$ = \) \( FF \ D2 \ 97 \ 8E \)

• Unsigned Binary Format (9d0y)

The Unsigned Binary Format is used to pack numeric values. The maximum field length allowed is 4. The sign of the number is ignored. The absolute value is converted to a binary value the same length as the field. If the binary number is too large for the field, an error (ERROR X71) results.

Example:

\[
\begin{align*}
10 \ X &= \ 1234567 \\
20 \ \$PACK \ (F=HEX(8004)) \ \ P$ \ FROM \ X \\
30 \ \$PACK \ (F=HEX(8004)) \ \ N$ \ FROM \ -X
\end{align*}
\]

Results in \( P$ = \) \( 00 \ 2D \ 68 \ 72 \) and \( N$ = \) \( 00 \ 2D \ 68 \ 72 \)

• Compressed Alphanumeric Format (Alxx)

The Compressed Alphanumeric Format provides a means to more compactly store characters with ASCII values \text{hex}(20) through \text{hex}(5F). These include the uppercase characters, digits, space, and certain symbols. Other characters in the string to be packed will cause an error (ERROR X71). The characters in the string to be packed are converted to 6-bit values. Specifically, characters \text{hex}(20) through \text{hex}(5F) are converted to the 6-bit values \text{hex}(00) through \text{hex}(3F). Then, the 6-bit characters are stored left-justified in the pack field. Thus, each four characters in the string to be packed is stored as three bytes in the pack field.
If the compressed value is shorter than the length of the field, the value is left-justified in the field and the remainder of the field is filled with 0 bits (effectively, the original value is padded with space characters on the right). If the compressed value is too long, it is truncated to fit within the field.

Example:

10 S$="ABCDERG"
20 $PACK (F=HEX(A103)) P$ FROM SS

Results in P$ = HEX(86 28 E4)

The Internal Form of the $PACK Statement

The internal form of $PACK stores data in the standard Wang 2200 disk record format. The values of the variables and arrays in the variable list are sequentially packed into the buffer. The packing terminates when all values have been packed.

Standard Wang 2200 Record Format (buffer format)

<table>
<thead>
<tr>
<th>SOV</th>
<th>value</th>
<th>SOV</th>
<th>value</th>
<th>SOV</th>
<th>value</th>
<th>EOB</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>01</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

control bytes

The SOV (Start-Of-Value) character precedes each data value in the record and indicates whether the value is numeric or alphanumerical and the length of the value.

The EOB (End-Of-Block, HEX(FD)) character indicates the end of valid data in the record.

Data format:

Alphanumeric Values

| C | C | ... | C |

where:

C = any character of the alphanumerical value to be packed

Trailing spaces are included after the actual value so that the length of the entire value stored is the same as the defined length of the alphanumerical-variable.
Numeric Values

Numeric values are stored in Wang Internal Numeric Format.

\[
\begin{array}{cccccccccccccccc}
& s & e & e & d & d & d & d & d & d & d & d & d & d & d & d & d \\
L & H & & & & & & & & & & & & & & (8 \text{ bytes})
\end{array}
\]

where:

\[
s = \text{sign:}
\]

\[
0 \text{ if mantissa } +, \text{ exponent } +
\]

\[
1 \text{ if mantissa } -, \text{ exponent } +
\]

\[
8 \text{ if mantissa } +, \text{ exponent } -
\]

\[
9 \text{ if mantissa } -, \text{ exponent } -
\]

\[
\begin{array}{cccc}
e & e & = & \text{exponent (2 digits)} \\
& L & H & \\
\end{array}
\]

\[
d = \text{mantissa digit (always 13)}
\]

Numeric values are normalized (i.e., leading zeros are eliminated). All digits must be BCD.

Example:

The following routine packs the values of A$ and X into a buffer BS in internal format:

:10 DIM BS$20, A$5
:20 A$ = "ABC" :X = 123.45
:30 $PACK BS$ FROM A$, X

The resulting buffer appears as follows:

\[
BS = \begin{array}{cccccccccccccccc}
& 80 & 01 & 85 & 41 & 42 & 43 & 20 & 20 & 08 & 02 & 01 & 23 & 45 & 00 & 00 & 00 & FD & 20 & 20 \\
\end{array}
\]

SOV \quad \text{value of A$} \quad \text{SOV} \quad \text{value of X} \quad EOB

Examples of valid syntax:

$PACK A$ FROM X
$PACK STR(BS$,3,8) FROM X, A$
$PACK (F = X$) BS$( ) FROM X( )
$PACK (D = D$) BS$( ) FROM BS$( ), X, Y, A$

General-Purpose BASIC-2 Statements 11-83
August 1989
The PRINT statement prints the values of the specified print-element(s) on a designated output device in a system-defined format. The PRINT statement can contain alphanumeric and numeric print-elements, as well as the PRINT functions AT, BOX, HEXOF, and TAB. These functions are described under separate headings later in this chapter.

In Program mode, PRINT outputs to the output device currently selected for PRINT operations. In Immediate mode, PRINT outputs to the currently selected Console Output device. The use of the Console Output device for Immediate mode PRINT output is a debugging feature that enables you to halt program execution and examine the results of Immediate mode PRINT statements on the screen while programmed PRINT output is selected to a printer. (Refer to Chapter 8 for a discussion of selecting PRINT and CO devices.)

**Alphanumeric Print-Elements**

An alphanumeric print-element can be a literal string, a HEX literal, or an alpha-variable. A literal string is printed exactly as it appears within the quotation marks, including trailing spaces. The quotation marks are not printed.

Example:

:10 PRINT "ABCD"
:RUN
ABCD
Example:

The following examples illustrate that the field specifications for a buffer can be either contained within an alphanumeric-variable or expressed as a hexadecimal literal string:

\$UNPACK (F = F$) B$( ) TO X, Y, Z

\$UNPACK (F = HEX(1008)) B$( ) TO X, Y, Z

If the first byte of the field specification is HEX(00), the corresponding field in the buffer is skipped. Alphanumeric fields are indicated by specifying HEX(A0) as the first byte of the field specification. Several types of numeric fields are permitted; numeric data is indicated by specifying a hex digit from 1 to 6 as the first hex digit of the first byte in the field specification. Each of the digits 1 to 6 identifies a unique numeric format. (Refer to Table 11-5.) The second digit specifies the implied decimal position in binary; the decimal point is assumed to be the specified number of digits from the right-hand side of the field. For example, if a field contains the value +12345 and an implied decimal position of 2 is specified, the value unpacked would be +123.45. An error results if a numeric field is unpacked into an alphanumeric-variable or if an alphanumeric field is unpacked into a numeric-variable.

Table 11-5. Valid Field Specifications

<table>
<thead>
<tr>
<th>Numeric Fields</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>00xx</td>
<td>skip field</td>
</tr>
<tr>
<td>10xx</td>
<td>ASCII free format</td>
</tr>
<tr>
<td>2dxx</td>
<td>ASCII integer format</td>
</tr>
<tr>
<td>3dxx</td>
<td>IBM display format</td>
</tr>
<tr>
<td>4dxx</td>
<td>IBM USASCII - 8 format</td>
</tr>
<tr>
<td>5dxx</td>
<td>IBM packed decimal format</td>
</tr>
<tr>
<td>6dxx</td>
<td>unsigned packed decimal format</td>
</tr>
<tr>
<td>7d0y</td>
<td>packed decimal with binary overflow format</td>
</tr>
<tr>
<td>8d0y</td>
<td>signed binary format</td>
</tr>
<tr>
<td>9d0y</td>
<td>unsigned binary format</td>
</tr>
<tr>
<td>A0xx</td>
<td>alphanumeric field</td>
</tr>
<tr>
<td>A1xx</td>
<td>compressed alphanumeric format</td>
</tr>
</tbody>
</table>

where:

xx = field width in binary (xx > 0)
y = field width in binary (0 < y <=4)
d = implied decimal position in binary
You must supply a separate field specification for every variable or array in the variable list. All elements in an array use the field specification for that array.

Example:

The following statement requires three field specifications:

\[ \$UNPACK \ (F = F$) \ B$( \ ) \ TO \ A$, B( ), C$ \]

If F$ = HEX(A0081006A010), then

A008 is the field specification for A$
1006 is the field specification for each element in the array B( )
A010 is the field specification for C$

You can also mnemonically define a field specification in a $FORMAT statement. $FORMAT permits the use of simple mnemonics rather than hex codes to specify field formats. Refer to the discussion of the $FORMAT statement in this section.

Example:

The field specification defined for F$ above could be defined as follows in a $FORMAT statement:

\[ $FORMAT F$ = A8, F6, A16 \]

Buffer format:

| field 1 | field 2 | field 3 | ... | field n |

Data format:

- Alphanumeric Fields (A0xx)

| C | C | ... | C |

where:

- C = any character in an alphanumeric field to be unpacked.
Numeric Fields

ASCII free format (10xx)

The data can be any valid BASIC representation of a number; spaces are ignored.

\[
\begin{array}{ccccccc}
  s & d & d & \ldots & d & . & d & d & \ldots & d & E & s & d & d \\
\text{sign} & \text{mantissa} & \text{exponent}
\end{array}
\]

where:

\begin{align*}
  s &= \text{sign (ASCII + or -), optional} \\
  d &= \text{ASCII digit} \\
  1 &< \text{number of mantissa digits} \leq 13 \\
  \text{decimal point} &\text{optional} \\
  \text{exponent} &\text{optional (one or two digits)}
\end{align*}

For the following formats, each number can have up to 13 digits of precision. If there are more than 13 significant digits in a numeric value, the exponent of the number is appropriately adjusted. Leading zeros are ignored.

- **ASCII integer format (2dxx)**

\[
\begin{array}{cccc}
  s & d & d & \ldots & d \\
\end{array}
\]

where:

\begin{align*}
  s &= \text{sign (ASCII + or -), required} \\
  d &= \text{ASCII digit}
\end{align*}

- **IBM display format (3dxx)**

\[
\begin{array}{cccccc}
  Fd & Fd & \ldots & Fd & sd \\
\end{array}
\]

where:

\begin{align*}
  s &= \text{sign (C = +, D = -)*} \\
  d &= \text{digit (0-9)}
\end{align*}
• IBM USASCII-8 format (4dxx)

\[
\begin{array}{llll}
5d & 5d & \ldots & 5d & sd \\
\end{array}
\]

where:

\[
s = \text{sign (A = +, B = -)*} \\
d = \text{digit (0-9)}
\]

• IBM packed decimal format (5dxx)

\[
\begin{array}{llll}
dd & dd & \ldots & ds \\
\end{array}
\]

where:

\[
s = \text{sign (C = +, D = -)*} \\
d = \text{digit (0-9)}
\]

*The $UNPACK$ statement considers B or D to be minus (-); any other hex digit is considered to be plus (+).

• Unsigned packed decimal format (6dxx)

\[
\begin{array}{llll}
dd & dd & \ldots & dd \\
\end{array}
\]

where:

\[
d = \text{digit (0-9)}
\]

The above formats are shown in hexadecimal notation.

Decimal addition and subtraction can be performed on unsigned packed decimal numbers. (Refer to the discussion of the DAC and DSC operators in Chapter 6.)

Examples:

The following examples assume that B$ = "+12345678901234567890"$.

<table>
<thead>
<tr>
<th>Statements</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>:100 F$ = \text{HEX(A005)}$</td>
<td></td>
</tr>
<tr>
<td>:110 $\text{UNPACK (F = F$)}$ B$ \text{ TO A$}$</td>
<td>A$ = &quot;+1234&quot;$</td>
</tr>
<tr>
<td>:100 F$ = \text{HEX(1010)}$</td>
<td>Results in an error because</td>
</tr>
<tr>
<td>:110 $\text{UNPACK (F = F$)}$ B$ \text{ TO X}$</td>
<td>B$ \text{ contains more than 13 digits.}$</td>
</tr>
<tr>
<td>:100 F$ = \text{HEX(2015)}$</td>
<td></td>
</tr>
<tr>
<td>:110 $\text{UNPACK (F = F$)}$ B$ \text{ TO X}$</td>
<td>X = 1.234567890123E19</td>
</tr>
<tr>
<td>Statements</td>
<td>Results</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>:100 F$ = HEX(2206)</td>
<td></td>
</tr>
<tr>
<td>:110 $UNPACK (F = F$) B$ TO X</td>
<td>X = 123.45</td>
</tr>
<tr>
<td>:10 B$ = HEX(F1F2F3D4)</td>
<td></td>
</tr>
<tr>
<td>:20 F$ = HEX(3304)</td>
<td></td>
</tr>
<tr>
<td>:30 $UNPACK (F = F$) B$ TO X</td>
<td>X = -1.234</td>
</tr>
<tr>
<td>:10 B$ = HEX(51525354A5)</td>
<td></td>
</tr>
<tr>
<td>:20 F$ = HEX(4005)</td>
<td></td>
</tr>
<tr>
<td>:30 $UNPACK (F = F$) B$ TO X</td>
<td>X = 12345</td>
</tr>
<tr>
<td>:10 B$ = HEX(000012345C)</td>
<td></td>
</tr>
<tr>
<td>:20 F$ = HEX(5105)</td>
<td></td>
</tr>
<tr>
<td>:30 $UNPACK (F = F$) B$ TO X</td>
<td>X = 1234.5</td>
</tr>
</tbody>
</table>

- Packed Decimal with Binary Overflow Format (7d0y)

The Packed Decimal with Binary Overflow Format is used to unpack numeric values that were stored with $PACK format 7d0y. The maximum field length allowed is 4. The last hexdigit of the packed value identifies the value as being either packed decimal or binary. If the last hexdigit is hex(C-F), the value is packed decimal (same as format 5dxx). If the value is hex(0-B), the value is binary.

For binary values, the upper 3-bits of the low hexdigit of the packed value are the high 3-bits of the binary value. The lowest bit of the last hexdigit is the sign of the value: zero for nonnegative and one for negative values.

Example:

10 D$=HEX(12 34 56 7C)
20 B$=HEX(2D 68 72)
30 $UNPACK (F=HEX(7004)) D$ TO X
40 $UNPACK (F=HEX(7003)) B$ TO Y

Results in X = 1234567 and
Y = 1234567
• Signed Binary Format (8d0y)

The Signed Binary Format is used to unpack numeric values that were packed with $PACK format 8d0y. The maximum field length allowed is 4. The value to be unpacked is a signed binary value. Negative values are stored in 2's complement.

Example:

10 P$=HEX(00 2D 68 72)
20 N$=HEX(FF D2 97 8E)
30 $UNPACK (F=HEX(8004)) P$ TO X
40 $UNPACK (F=HEX(8004)) N$ TO Y

Results in X = 1234567 and
Y = -1234567

• Unsigned Binary Format (9d0y)

The Unsigned Binary Format is used to unpack numeric values that were packed with $PACK format 9d0y. The maximum field length allowed is 4. The value to be unpacked is an unsigned binary value.

Example:

10 P$=HEX(00 2D 68 72)
20 $UNPACK (F=HEX(8004)) P$ TO X

Results in X = 1234567

• Compressed Alphanumeric Format (A1xx)

The $UNPACK Compressed Alphanumeric Format is used to decompress alphanumeric data compressed with $PACK format A1xx. Each 6-bits of the field is converted to an ASCII character. Thus, each three bytes of the field unpacks into four ASCII characters. Values hex(00) through hex(3F) are converted to the ASCII characters with values hex(20) through hex(5F). These include the uppercase characters, digits, space, and certain symbols.

If the compressed value is shorter than the receiver variable, the result is padded with trailing spaces. If the receiver is too short, the unpacked value is truncated.

Example:

10 P$=HEX(86 28 E4)
20 $UNPACK (F=HEX(A103)) P$ TO S$

Results in S$ = "ABCDEFGH"
The Internal Form of the $UNPACK Statement

Data stored in the standard Wang 2200 disk record format can be unpacked by the internal form of $UNPACK. Data records that have been saved on a disk platter by either the DATASAVE DC or the DATASAVE DA statement are stored in this format. Data values are sequentially read from the buffer and stored in the variables following the word TO. The unpacking terminates when the buffer is empty and the EOB (End-of-Block) character is encountered or when the entire variable list has been satisfied. An error results if a numeric value is unpacked into an alphanumeric-variable or if an alphanumeric value is unpacked into a numeric-variable.

Standard Wang 2200 Record Format (buffer format):

```
<table>
<thead>
<tr>
<th>80</th>
<th>01</th>
<th>SOV value</th>
<th>SOV value</th>
<th>SOV value</th>
<th>EOB</th>
</tr>
</thead>
</table>
```

- The SOV (Start-of-Value) character precedes each data value in the record and indicates whether the value is numeric or alphanumeric and the length of the value.

- The EOB (End-of-Block, HEX(FD)) character indicates the end of valid data in the record.
- $UNPACK ignores the first two control bytes.
- Data format:

```
Alphanumeric Values

C C ... C
```

where:

C = any character of the alphanumeric value to be unpacked.
Numeric Values

Numeric values must be in Wang Internal Numeric Format.

<table>
<thead>
<tr>
<th>s</th>
<th>e</th>
<th>d</th>
<th>d</th>
<th>d</th>
<th>d</th>
<th>d</th>
<th>d</th>
<th>d</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>H</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

where:

- \( s \) = sign: 0 if mantissa +, exponent +
  1 if mantissa -, exponent +
  8 if mantissa +, exponent -
  9 if mantissa -, exponent -

- \( e \) = exponent (2 digits)
  L H

- \( d \) = mantissa digit (always 13)

Leading zeros in numeric values are eliminated. All digits must be BCD.

Note: If the numeric values are invalid, the results of the conversion performed by $UNPACK are undefined.

Example:

Suppose B$ contains one alphanumeric value and one numeric value. The contents of B$ are to be unpacked into the variables A$ and X.

B$ = 80 01 83 41 42 43 08 02 01 45 00 00 00 FD AB CD

:100 $UNPACK B$ TO A$, X
:110 PRINT A$; X
:RUN
ABC 123.45

Examples of valid syntax:

$UNPACK A$ TO X
$UNPACK STR(A$,5) TO X, B$, Y
$UNPACK (F = FS$) A$( ) TO X ( )
$UNPACK (D = D$) A$( ) TO B$( )
$UNPACK (F = A$( ) B$ TO A$, B$, STR(C$,3,2)
$UNPACK (D = STR(Q$,3,2)) X$( ) TO X, Y, Z(1,2)
DATALOAD AC (CS/386 Only)

Format

DATALOAD AC [file #,] [record-number] alpha-variable

where:

alpha-variable = 512 bytes or larger

record-number = numeric-expression

The DATALOAD AC statement reads one record from a specified file of a specified disk and stores the entire 512 bytes in the designated alpha-variable. (Record = one sector = 512 bytes).

An error results if the alpha-variable is not large enough to hold at least 512 bytes. If the alpha-variable is larger than 512 bytes, the additional bytes of the array are not affected by the DATALOAD AC operation. An error will also occur if the record-number is beyond the total sectors of the file.

When a record-number is specified, the system runs Random Read mode. The statement reads one sector of the specified record which is relative to the start of the file opened. After execution, the current record-number is not affected.

If the record-number is not specified, the system is in Sequential Read mode. The statement gets the record-number from the Device Table and performs read operations. After execution, the record-number in the Device Table is automatically increased by one.

Examples of valid syntax

DATALOAD AC #2, (A) B$( )
DATALOAD AC #1, (20) X$ ( )
DATALOAD AC #1, A$( )

Disk I/O Statements 12-36a
August 1989
ALOAD AC OPEN (CS/386 Only)

Format

DATALOAD AC OPEN T [file #], filename

The DATALOAD AC OPEN statement opens data files that have been previously stored on a MS-DOS diskette. When the statement is executed, the system finds the named file on the specified disk and sets up the starting cluster, current record-number, and file length in sectors in the Device Table. (The current record-number is set to zero, one record = one sector = 512 bytes). Any request use of the same file number in other AC statements access this file. If no file number is included, the file is assumed to be associated with the default file number (0).

An error will result if the filename cannot be found in the directory area of the specified disk or the diskette is not in MS-DOS format.

Examples of valid syntax

DATALOAD AC OPEN T#2, A$
DATALOAD AC OPEN T#1, "Part.Dat"
DATASAVE AC (CS/386 Only)

Format

    DATASAVE AC [file#,] [(record-number)] (literal-string)
        (alpha-variable)

where:

    record-number = numeric-expression

The DATASAVE AC statement writes one record to the disk. The
alpha-variable or literal-string contains the data to be written.
(Record = one sector = 512 bytes). If the data is longer than 512
bytes, the first 512 bytes are written. If the data is shorter than 512
bytes, the remainder of the sector is filled with zeros.

If record-number is specified, the system runs Random Write mode. The
data is written into the record-number which is relative to the start of
the opened file. After execution, no information in the Device Table
will be altered.

When record-number is not specified, the system is in Sequential Write
mode. The statement gets the record-number from the Device Table and
performs write operations. The record-number in the Device Table
automatically increases by one after execution.

Examples of valid syntax

    DATASAVE AC #2,(1) A$(  )
    DATASAVE AC #1, A$(  )
DATASAVE AC OPEN (CS/386 Only)

Format

DATASAVE AC OPEN T [file #] (old-filename)
   ((size in sector) new-filename)

where:

Size = numeric-expression

The DATASAVE AC OPEN statement creates a new DOS file or rewrites an existing file.

If creating a new file, space is reserved in the disk and a file entry is made in the directory. (Space = sector number specified in size). The disk on which the file is stored, along with the file starting cluster, record-number (initially set to zero), and total sectors are entered in the Device Table. An error will occur if there is not enough space.

When rewriting an old file, the operations are the same as the DATALOAD AC OPEN statement.

Examples of valid syntax

DATASAVE AC OPEN T#2, (10) "Datal.Dat"
DATASAVE AC OPEN T#3, "Datal.Dat"
DATASAVE AC CLOSE (CS/386 Only)

Format

DATASAVE AC CLOSE file#

The DATASAVE AC CLOSE statement closes an individual data file if it is no longer used in the current or sequential program.

Example of valid syntax

DATASAVE AC CLOSE #1
After execution of the DATASAVE AC OPEN statement, the disk space is allocated for use. Completing the DATASAVE AC operations, you may find unused space. The DATASAVE AC END statement enables you to update the file length and return the unused disk space.

The DATASAVE AC END statement runs in sequential write mode. The statement takes the record-number from the Device Table as the total file sector number.

Restrictions

File# must be 0-15
You can shorten file length only; i.e., no expanded file length

Example of valid syntax

DATASAVE AC #1, END
The DBACKSPACE statement backspaces over logical records or sectors within a cataloged disk file. If a value is specified with a numeric expression and $S$ is not specified, the system backspaces over the number of logical records equal to the value of the numeric-expression, and the Current Sector Address of the file in the Device Table is updated to the starting sector of the new logical record. For example, if numeric-expression = 1, the Current Sector Address is set equal to the starting address of the previous logical record.

If the BEG parameter is used, the Current Sector Address is set equal to the Starting Sector Address of the file (i.e., the starting address of the first logical record in the file).

If the $S$ parameter is used, the value of the expression equals the total number of sectors to backspace. The Current Sector Address of the file in the Device Table is decreased by the number of sectors specified. If the amount specified is too large, the Current Sector Address is set to the starting Sector Address of the file. The $S$ parameter is particularly useful in files where all the logical records are of the same length (i.e., have the same number of sectors per logical record). Backspacing with the $S$ parameter is much faster than backspacing over logical records in a file since the system merely decreases the Current Sector Address in the Device Table by the specified number of sectors and no disk accesses are required. However, you must be certain that you know exactly how many sectors are in each logical record.

Examples of valid syntax:

```
DBACKSPACE BEG
DBACKSPACE 2*X
DBACKSPACE #2, 5S
DBACKSPACE #1, BEG
DBACKSPACE #A, 10
```
INDEX

A

ABS function, 4-7, 4-9, 4-12,
  6-4, 6-6, 9-9
access modes, 10-1, 10-7
ADD operator, 5-9 to 5-10, 6-1,
  6-6 to 6-8
addition, 4-4, 6-1, 6-7 to 6-9
$ALERT statement, 8-2, 8-4, 8-5
ALL function, 5-9 to 5-10, 5-12,
  5-15, 6-3 to 6-8, 6-13
alphanumeric
  argument, 6-6
  array, 5-2
  character String, 4-2, 5-1
  expression, 1-2, 5-8, 5-10
    7-20
  literal string, 5-4 to 5-5,
    5-17, 5-28, 6-1
  operator, 5-9
  string manipulation, 5-9
  variable, 1-3, 1-5, 5-1 to 5-2,
    5-4, 5-10 to 5-11, 5-18, 5-20,
    5-28, 6-9 to 6-12, 10-26
alternate character set, 3-1, 3-13
  3-14 to 3-15
AND operator, 5-6, 5-8, 5-9 to 5-12
  5-14 to 5-16
ARCCOS function, 4-8, 4-13
ARCSIN function, 4-8, 4-13
ARCTAN function, 4-8, 4-13
argument, 3-16, 4-9 to 4-13, 5-9,
  5-13, 5-18, 5-20, 5-23, 5-27,
  5-28, 6-6, 9-5, 9-9
arithmetic operators, 4-1, 4-4,
  4-5 to 4-6, 5-1, 6-4, 6-6
array
  alphanumeric, 5-7
dimensioning of, 4-4, 10-14, 13-2
  locator, 14-2
numeric, 4-3, 4-7, 4-9, 10-14,
  10-17
redimensioning of, 13-2, 13-3
variables, 5-2, 5-11
assignment statement, 1-5, 4-4,
  5-5 to 5-11, 5-13 to 5-14,
  5-25, 6-7, 6-9 to 6-10, 6-12,
  7-27, 9-5, 10-28
ATN function, 4-8

B

background processing, 16-12
BASIC statements, 1-3 to 1-5, 4-2,
  4-4, 11-5
BIN function, 4-14, 5-9, 5-13, 5-27
binary, 4-1, 4-14, 5-1, 5-9, 5-10,
  5-13, 5-15, 5-27
conversion, 6-2
addition, 6-1, 6-7, 6-9
subtraction, 6-1, 6-10, 6-12
operators, 6-1, 6-6
blanks
  initial value of branching,
    10-26
  trailing, 5-3
BOOL operator, 5-14 to 5-15
bootstrapping, 16-10
box graphics, 3-1, 3-15 to 3-16
branching, 1-4 to 1-6, 7-19, 8-9,
  9-4, 10-28, 10-30,
$BREAK statement, 16-36
broadcast message, 16-11

Index-1
character display attributes, 3-1, 3-3 to 3-4, 3-7, blinking, 3-3 to 3-4, bright, 3-3, reverse video, 3-3
character format, 5-29
character graphics, 3-1, 3-13 to 3-16
character mode, 3-15
character sets, 3-1, 3-13, 5-29 alternate, 3-13 to 3-15 normal, 3-13 to 3-14 selection of, 3-13 to 3-14
character string, 4-2, 4-14, 5-1, 5-2, 5-3, 5-4, 5-7 to 5-8, 5-10, 5-17, 5-21, 5-22, 5-24, 5-26, 6-1, 10-2, 10-7, 10-15, CLEAR command, 4-11, 4-13, 7-17, 8-3 to 8-5, 8-11, 9-3, 9-9, 10-1, 10-4, 10-10, 10-27, 10-28
CLEAR N, 10-5, 10-6, 10-8
CLEAR P, 2-6, 10-4, 10-5, 10-6, 10-8
CLEAR V, 10-4, 10-5, 10-6, 10-8
$CLOSE statement, 16-38
code conversion, 5-13, 5-27, 6-2 to 6-6.
COM CLEAR statement, 11-9
COM statement, 1-3, 4-3, 5-2, 10-14, 10-26, 11-6
communication asynchronous, 7-18, 7-26 concatenation operator (&), 5-6 5-9
condition code, 4-14
console operations, 7-4, 7-6, 7-8, 7-10 to 7-13, 7-16 to 7-18, 10-4, 10-10, 10-28
constants numeric, 4-1 to 4-2, 4-4
CONTINUE command, 2-10, 10-1, 10-2, 10-6, 10-7, 10-8, 10-25, 10-27
control codes, 3-1, 3-2, 3-3, 3-12, 5-5, 5-17, 5-20, 10-3, 10-4, 10-25
CONVERT statement, 5-21, 10-13, 11-11
COPY statement, 12-21
COS function, 4-8, 4-13
DAC operator, 5-9, 6-1, 6-6, 6-9
data pointer, 10-26
data types alphanumeric, 1-3, 4-1, 5-2, 6-1 numeric, 4-1, 5-1, 14-2
DATA statement, 1-3 to 1-4, 11-15, 5-27
DATALOAD BA, 12-22
DATALOAD BM, 12-23
DATALOAD DA, 12-24
DATALOAD DC, 12-11, 12-12, 12-26, 12-27
DATALOAD AC, 11-36a
DATASAVE BA, 12-28
DATASAVE BM, 12-29
DATASAVE DA, 12-30
DATASAVE DC, 12-7 to 12-8, 12-32, 12-34, 12-35
DATASAVE AC, 11-36c
DATE function, 5-16, 5-27
debugging, 1-1, 1-2, 1-4, 2-1, 2-8, 2-9, 4-10, 7-3, 8-3, 10-27, 10-28
DEFFN @PART statement, 16-39
DEFFN statement, 1-4, 11-17
DEFFN' statement, 1-4, 2-11, 9-4, 10-7, 10-22, 11-20
DELETE statement, 2-5
deleting characters, 2-2 lines, 2-6, 4-11
device address, 7-1, 7-6 to 7-27, 8-6, 8-8
Device Table, 2-11, 7-1, 7-5, 7-7 to 7-27, 10-2, 10-4
device type, 7-6 to 7-27
devices control of, 5-17, 7-1
INDEX (continued)

digit specifiers, 7-25
DIM statement, 4-3 to 4-4, 5-2, 5-5, 5-7, 5-18, 5-22 to 5-23, 6-2 to 6-13
$DISCONNECT statement, 16-41
division, 4-4 to 4-5, 4-10, 4-13, 4-14,
  by Zero, 9-5, 9-9
  of character space, 3-14
DO group, 9-6 to 9-7, 11-29
dollar sign ($), 5-1
DSC operator, 5-9, 6-1, 6-5, 6-6, 6-10

E
edit mode, 1-2, 1-4, 2-3
END statement, 1-6, 10-11 to 10-14, 10-21, 10-30, 11-30,
  4-14, 5-16 to 5-17, 5-26, 9-1 to 9-3
ERR function, 9-3
error conditions, 4-14, 5-16 to 5-17, 5-26, 9-1 to 9-3
error detection, 9-1, 10-26
error messages, 1-4 to 1-6, 2-8 to 2-9, 4-1, 4-6, 4-14, 7-2 to
  7-3, 7-12, 9-1 to 9-2, 9-5 to 9-6, 9-8, 10-23
error recoverability, 9-2
ERROR statement, 9-1 to 9-9
evaluation
  of numeric expressions, 4-1, 4-4 to 4-6
executable statements, 1-2, 1-3, 4-6
exponentiation, 4-1, 4-2, 4-5, 4-6
expressions
  alphanumeric, 1-2, 5-8, 5-10, 5-14, 5-16, 6-7, 6-9 to 6-11, 7-20
  numeric, 4-1 to 4-5, 4-9, 5-8, 7-1, 7-20, 7-23 to 7-24, 8-5
evaluation of, 5-13

F
file
  catalog mode, 12-1, 12-3
  number, 7-13 to 7-16, 7-21, 7-25 to 7-26
  status, 7-15
FIX function, 4-7 to 4-9, 4-12
floating point format, 4-1
FOR statement, 1-5, 4-11, 6-2 to 6-4, 10-25 to 10-29
foreground processing, 16-12
$FORMAT statement, 11-35, 12-39
function
  alphanumeric, 5-1, 5-13, 5-16, 7-27, 9-5
  defined, 1-2, 10-7
  keys, 10-7
  numeric, 4-4, 4-6 to 4-8, 4-13 to 4-14, 5-9, 5-18, 5-20,
  5-23, 5-26 to 5-28, 9-3

G
$GIO statement, 7-6, 7-13, 15-1, 15-8

global
  partition, 6-14, 16-24
  subroutines, 16-18
text, 16-15, 16-19
variable, 8-5, 16-17, 16-20, 16-22
GOSUB statement, 1-4, 5-22, 6-4, 6-6, 8-5, 8-6, 9-4, 10-9,
  10-21, 10-23,
GOSUB' statement, 1-4, 9-3, 9-6, 10-22, 11-38
GOTO statement, 1-4 to 1-5, 4-4, 5-21, 6-4, 6-6, 10-8, 10-21,
  10-23, 10-26, 10-28, 11-40

graphics
  box, 3-1, 3-15 to 3-16
  character, 3-1, 3-13, 3-15

Index-3
INDEX (continued)

H

HALT function, 1-6, 2-10, 7-6, 7-12, 10-1 to 10-2, 10-6, 10-8, 10-9 to 10-10, 10-25, 10-27
hex codes, 3-1, 3-2, 5-1, 5-5
attributes, 3-3
used to turn off attributes, 3-4, 3-7
hex control codes, 3-12, 3-13
HEX function, 3-1, 5-5, 5-17
hexadecimal
literal strings, 3-1, 5-5 to 5-6, 5-17
representation, 3-1, 5-10, 5-14 to 5-15, 5-22, 6-9 to 6-10, 7-6, 7-25
HEXPACK statement, 11-41
HEXUNPACK statement, 11-44

I

IF statement, 2-7, 5-11, 5-17, 5-19, 5-21, 5-23, 5-25, 5-27, 6-2 to 6-7, 9-3 to 9-4, 10-21, 11-45
$IF ON/OFF statement, 15-5
IF ... THEN statement, 11-45
Image (%), 2-2, 9-6, 11-48
Immediate mode, 1-2 to 1-6, 2-1 to 2-7, 2-9 to 2-10, 7-3, 7-6, 7-10, 7-11 to 7-13, 8-8, 10-1, 10-6, 10-8, 10-27,$INIT command, 16-45
INPUT statement, 1-4, 2-6, 2-8, 5-21, 7-4 to 7-6, 7-8, 7-11, 7-12, 7-17 to 7-18, 7-22, 7-25, 9-7, 10-4, 10-12, 10-13, 11-49
INT function, 4-7 to 4-10, 4-12
internal
decimal format, 5-13
interrupt
control statements, 8-1 to 8-4
Interrupt Table, 8-6, 8-11, 10-2
I/O

bus, 15-2
operations, 7-1, 7-6 to 7-8, 7-10, 7-16, 7-18, 8-2, 8-5, 16-62
statements, 15-4

K

keyboard, 3-1, 4-1, 5-1, 5-5, 5-17, 7-6 to 7-8, 8-2, 10-1, 10-3, 10-7, 10-25
Keys, 2-3 to 2-5, 2-7 to 2-8, 3-13
KEY function, 10-7
KEYIN statement, 7-6, 7-11 to 7-12, 7-18, 8-2, 10-4, 10-7, 10-21, 11-52,
Keyword, 1-6, 3-6

L

label, 10-11, 11-26
LEN function, 4-14, 5-3, 5-8 to 5-9, 5-18 to 5-19, 6-2 to 6-4
LET statement, 4-4, 10-28, 11-54
LGT function, 4-7
line
blank, 10-10
editing, 2-1 to 2-3
feed, 2-1, 3-2, 3-9
length, 2-2
multistatement, 1-5, 10-8
renumbering, 2-6 to 2-7
replacement, 2-6
width, 7-3 to 7-5, 7-10 to 7-13, 7-17, 7-21,
line numbers, 1-3 to 1-6, 2-7 to 2-11, 10-1 to 10-5, 10-8, 10-11 to 10-12, 10-20, 10-22 to 10-23, 10-26 to 10-30
LINPUT statement, 1-4, 3-11, 3-15, 5-22, 5-25, 7-6, 7-11 to 7-12, 7-18, 10-4, 11-55
LIST command, 2-8, 2-10, 7-1, 7-5, 7-7, 7-11, 7-21, 10-2, 10-4, 10-10, 10-12, 10-22,
LIST D, 2-10, 3-11, 10-11 to 10-13 10-13

Index-4
INDEX (continued)

LIST DC, 12-42
LIST DT, 2-11, 7-1, 7-9, 7-20 to 7-22, 10-2,
LIST I, 8-3 to 8-4, 8-6 to 8-7,
LIST T, 2-11, 10-2, 10-15 to 10-16
LIST V, 10-17
literal strings, 2-2, 3-1, 5-1, 5-4, 5-6, 5-10, 5-16, 5-22,
5-26 to 5-28, 8-6, 10-10, 10-14 to 10-16, 5-22, 5-26,
alphanumeric, 5-4 to 5-5, 5-17, 6-1
hexadecimal, 5-5 to 5-6, 5-17
LOAD command, 1-6, 7-11, 8-5, 9-3 to 9-4, 10-2, 10-11, 12-4,
12-45 to 12-46
LOAD DA, 12-48 to 12-49
LOAD RUN command, 7-4 to 7-5, 7-10, 7-17, 9-9, 10-2, 10-10,
12-6, 10-27, 12-51
LOG function, 1-6, 2-6, 4-7, 9-9
logical operators, 5-1, 5-11, 5-15
loops, 10-25 to 10-28
    nested, 4-13

M

Master Device Table, 7-7, 7-21
master initialization, 4-6, 4-11, 4-13, 7-2 to 7-5, 7-8, 7-10,
7-16 to 7-17, 9-9, 10-10
matrix Statements, 13-3
memory
    allocation, 16-5
message, 1-6, 2-8 to 2-9, 4-6, 7-11 to 7-12, 10-4, 10-25,
    modes
        box graphic, 3-16
        character, 3-15
        edit, 2-3
        immediate, 2-1 to 2-7, 2-9,
        2-10, 8-8, 9-6, 10-1
        operator's, 1-3
        programmer's, 1-4, 1-6
MAT *, 13-4
MAT CON, 13-5
MAT COPY, 11-58
MAT =, 13-6
MAT IDN, 13-7
MAT INPUT, 13-8
MAT INV, 13-10
MAT *, 13-13
MAT MERGE, 14-4
MAT MOVE, 11-60, 14-13
MAT PRINT, 13-14
MAT READ, 13-15
MAT REDIM, 13-17
MAT ( ), 13-19
MAT -, 13-20
MAT SEARCH, 11-64
MAT SORT, 14-18
MAT TRN, 13-21
MAT ZER, 13-22
MAX function, 4-7, 4-9
MIN function, 4-9
MOD function, 4-6 to 4-7, 4-10, 7-2,
MOVE statement, 12-52 to 12-54
$MSG statement, 16-49
multiplication, 4-4 to 4-5

N

names
    array, 4-3, 5-2, 5-7
    file, 7-15
    variable, 4-3, 5-1, 5-4, 10-28
    nested loops, 4-13
NEXT statement, 1-5 to 1-6, 4-11, 6-2 to 6-3, 10-25 to 10-29
NUM function, 4-14, 5-9, 5-20
numeric
    constants, 4-2
    expressions, 1-2 to 1-3, 4-4, 5-8, 7-20, 7-23 to 7-25, 8-5
    functions, 4-6, 4-13, 5-9, 5-18, 5-23, 5-27 to 5-28, 9-3
    values, 4-1, 5-23, 5-27, 6-2
    variables, 4-3, 5-1, 5-4, 7-19, 7-25, 7-27, 8-8, 10-26

Index-5
INDEX (continued)

O

ON/GOSUB statement, 1-4, 7-19, 11-70
ON/GOTO statement, 1-4, 7-19, 1026, 11-70
ON/SELECT statement, 7-19 to 7-20, 7-23 to 7-24
$OPEN statement, 16-50
operators, 1-2 to 1-3
    alphanumeric, 6-1
    arithmetic, 4-1 to 4-6, 5-1, 6-4, 6-6
    binary, 6-1
    concatenation, 5-6, 5-9
    logical, 5-1, 5-10 to 5-11, 5-14
    relational, 5-11, 5-14, 5-22, 8-4
OR operator, 5-9, 5-11 to 5-12, 5-15
output
    devices, 7-1, 7-3 to 7-5, 7-11 to 7-13, 7-21, 7-26
    formatting, 7-3

P

parameters
    selecting, 7-11 to 7-16
partitions, 4-11, 4-13 to 4-14, 7-9, 7-21, 8-2, 8-5, 8-8
PACK statement, 6-4 to 6-6, 6-10, 11-72
$PACK statement, 11-74
parenthesis
    specifying Arrays, 4-3, 5-7
    specifying Order of, 5-9
    evaluation, 4-5
#PART function
partition
    global, 16-22, 16-24
pause mode, 7-3 to 7-4, 10-4, 10-25
peripheral
    allocation, 16-9
POS function, 4-14, 5-9, 5-22 to 5-23
PRINT AT statement, 3-2, 3-12, 3-16, 10-15, 11-93
PRINT BOX statement, 3-1, 3-15 to 3-16, 11-95
PRINT HEX statement, 3-2, 3-5 to 3-11, 11-97
PRINT statement, 1-4 to 1-5, 3-6, 3-11, 4-2, 4-4 to 4-6, 4-11, 4-14, 5-4, 7-4, 7-9 to 7-10, 7-12, 10-4, 11-84
Printer Device Table, 7-21
printer driver, 7-26
printers, 7-3 to 7-4, 7-7, 7-12 to 7-13, 7-23, 8-1,
PRINTUSING statement, 3-2, 7-4, 7-6, 7-10, 7-12, 10-4, 10-23, 11-99, 11-107
program execution, 1-3, 2-9 to 2-10, 4-2 to 4-3, 4-6, 4-13, 7-2, 7-19, 9-1 to 9-2, 9-6 to 9-8, 10-1 to 10-3, 10-6 to 10-8, 10-25, 10-27 to 10-28
program lines, 1-4 to 1-6, 2-1 to 2-2, 2-5 to 2-7, 2-11
program mode, 1-3
program statements, 1-5, 5-6
program termination, 7-2, 9-6
prompting input, 9-1
$PSTAT statement, 16-52

Q

question mark, 10-22
quotes, 5-4, 5-17

R

RAMDISK, 12-18 to 12-19
READ statement, 1-6, 5-25, 9-7, 10-24, 10-26, 11-109
$RELEASE statement, 16-57
REM statement, 1-3, 3-11, 6-2 to 6-6, 8-5, 8-11, 10-11 to 10-15, 10-21, 10-24, 10-30, 11-110, 12-55
RENAME statement, 10-2, 12-4
RENUMBER command, 10-3, 10-6, 10-8, 10-23 to 10-24
RESAVE statement, 12-56, 12-4
**INDEX (continued)**

<table>
<thead>
<tr>
<th>Command/Keyword</th>
<th>Page References</th>
</tr>
</thead>
<tbody>
<tr>
<td>RESET, 1-6, 3-12, 3-14, 7-4 to 7-5, 7-16 to 7-17, 10-3, 10-6, 10-8, 10-25, 10-27 to 10-28</td>
<td>1-6, 9-1</td>
</tr>
<tr>
<td>RESTORE statement, 3-8, 5-27, 11-112</td>
<td>11-112</td>
</tr>
<tr>
<td>RETURN CLEAR statement, 11-116</td>
<td></td>
</tr>
<tr>
<td>RETURN statement, 1-4, 2-5, 6-2 to 6-6, 8-2 to 8-3, 10-11, 10-21, 10-24, 10-26, 10-28, 10-30, 11-114</td>
<td></td>
</tr>
<tr>
<td>RND function, 4-7, 4-10 to 4-11</td>
<td></td>
</tr>
<tr>
<td>ROTATE statement, 11-117</td>
<td></td>
</tr>
<tr>
<td>ROUND function, 4-6 to 4-7, 4-11 to 4-12</td>
<td></td>
</tr>
<tr>
<td>RUN command, 1-6, 5-3 to 5-6, 5-18, 5-20, 5-21, 5-23 to 5-25, 6-7 to 6-13, 7-4, 7-11, 8-5, 10-3, 10-7 to 10-8, 10-26 to 10-27</td>
<td></td>
</tr>
<tr>
<td>SAVE statement, 5-22, 10-3, 12-57, 12-60, 12-3</td>
<td></td>
</tr>
<tr>
<td>scalar variable</td>
<td></td>
</tr>
<tr>
<td>alphanumeric, 5-2, 5-7, 10-17</td>
<td></td>
</tr>
<tr>
<td>numeric, 4-3, 10-17, 10-19</td>
<td></td>
</tr>
<tr>
<td>SCRATCH statement, 12-61 to 12-62</td>
<td></td>
</tr>
<tr>
<td>SELECT ERROR statement, 1-6, 4-7, 7-2, 9-2 to 9-3, 9-6 to 9-9</td>
<td></td>
</tr>
<tr>
<td>SELECT NO ROUND, 4-6, 7-2</td>
<td></td>
</tr>
<tr>
<td>SELECT ON CLEAR statement, 8-11</td>
<td></td>
</tr>
<tr>
<td>SELECT ON/OFF statement, 8-1 to 8-11</td>
<td></td>
</tr>
<tr>
<td>SELECT P, 2-10</td>
<td></td>
</tr>
<tr>
<td>SELECT @PART, 16-59</td>
<td></td>
</tr>
<tr>
<td>SELECT ROUND, 4-6</td>
<td></td>
</tr>
<tr>
<td>SELECT statement, 7-1 to 7-3, 7-6 to 7-7, 7-10, 7-14 to 7-16, 7-19 to 7-20, 7-25 to 7-26, 8-1, 10-10, 10-16</td>
<td></td>
</tr>
<tr>
<td>semicolon, 5-4, 7-19 to 7-20, 7-23</td>
<td></td>
</tr>
<tr>
<td>SGN function, 4-7, 4-9, 4-12</td>
<td></td>
</tr>
<tr>
<td>SIN function, 4-8, 4-13</td>
<td></td>
</tr>
<tr>
<td>sort</td>
<td></td>
</tr>
<tr>
<td>numeric data, 14-2</td>
<td></td>
</tr>
<tr>
<td>statements, 14-3</td>
<td></td>
</tr>
<tr>
<td>SPACE function, 4-13 to 4-14</td>
<td></td>
</tr>
<tr>
<td>SPACEK function, 4-13, 4-14</td>
<td></td>
</tr>
<tr>
<td>SPACE S &amp; SK, 4-13, 4-14</td>
<td></td>
</tr>
<tr>
<td>SQR function, 4-4, 4-6 to 4-7, 7-2</td>
<td></td>
</tr>
<tr>
<td>STOP statement, 1-6, 10-1, 10-3, 10-6, 10-8 to 10-9, 10-24, 10-27, 11-119</td>
<td></td>
</tr>
<tr>
<td>STR function, 6-2 to 6-9, 6-12 to 6-13, 5-3, 5-24</td>
<td></td>
</tr>
<tr>
<td>strobe</td>
<td></td>
</tr>
<tr>
<td>address, 15-3</td>
<td></td>
</tr>
<tr>
<td>input, 15-4</td>
<td></td>
</tr>
<tr>
<td>output, 15-3</td>
<td></td>
</tr>
<tr>
<td>SUB operator, 5-9, 6-1, 6-12 to 6-13</td>
<td></td>
</tr>
<tr>
<td>subroutine, 7-16, 9-6, 10-1 to 10-2, 10-5, 10-7, 10-22, 10-25 to 10-26</td>
<td></td>
</tr>
<tr>
<td>interrupt, 8-1 to 8-9</td>
<td></td>
</tr>
<tr>
<td>subscript, 4-3 to 4-4, 5-27</td>
<td></td>
</tr>
<tr>
<td>substring, 5-3 to 5-4, 5-11, 5-24 to 5-25</td>
<td></td>
</tr>
<tr>
<td>subtraction, 4-5</td>
<td></td>
</tr>
<tr>
<td>binary, 6-1, 6-10, 6-12</td>
<td></td>
</tr>
<tr>
<td>decimal, 6-1, 6-10</td>
<td></td>
</tr>
<tr>
<td>syntax</td>
<td></td>
</tr>
<tr>
<td>errors, 9-1 to 9-2, 10-17, 10-19, 10-21, 10-24, 10-26, 10-27, 10-30</td>
<td></td>
</tr>
<tr>
<td>valid examples of, 4-5, 5-10 to 5-27, 6-8 to 6-13, 7-22, 7-24, 7-27, 8-5, 8-7, 8-10 to 8-11, 9-4 to 9-7, 9-9, 10-5 to 10-6, 10-13 to 10-16</td>
<td></td>
</tr>
<tr>
<td>system commands, 1-2, 1-4, 10-3</td>
<td></td>
</tr>
<tr>
<td>T</td>
<td></td>
</tr>
<tr>
<td>TAN function, 4-8, 4-13</td>
<td></td>
</tr>
<tr>
<td>text entry mode, 5-26, 5-16</td>
<td></td>
</tr>
<tr>
<td>TRACE command, 2-10, 7-3, 7-6, 7-12, 10-3, 10-8 to 10-9, 10-28, 10-30</td>
<td></td>
</tr>
<tr>
<td>$TRAN statement, 11-120</td>
<td></td>
</tr>
<tr>
<td>truncation, 4-6, 4-9, 4-11</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td></td>
</tr>
<tr>
<td>UNPACK statement, 6-6, 11-124</td>
<td></td>
</tr>
<tr>
<td>$UNPACK statement, 11-125</td>
<td></td>
</tr>
</tbody>
</table>
INDEX (continued)

V

VAL function, 4-14, 5-9, 5-13, 5-27, 6-4
variable, 2-9 to 2-11, 4-1 to 4-4, 4-9, 5-1
VER function, 4-14, 5-9, 5-28, 5-29
VERIFY statement, 5-22, 12-64

X

XOR operator, 5-10, 5-11 to 5-12, 5-15

Z

zoned format, 3-12
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</thead>
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