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Chapter 2

Programming Aids

Brent Anderson and Sheldon Leemon

BASIC Aid

Twenty of the most useful programming aids, from searching and replacing strings to line renumbering, are included in this one package. Several DOS support commands also make it simple to see the directory (without affecting the program in memory), rename files, or load and run programs. Mistake-proof entry is easy when you use MLX to type in this program.

We'd all like to customize BASIC to fit our individual needs. It's not difficult to think of some valuable programming aids that were omitted from Commodore's BASIC. Renumbering, automatic line numbering, searching and replacing, merging, and deleting line ranges are just a few. Some of the short routines elsewhere in this book add just one or two of these functions. "BASIC Aid," however, gives you 20 new ways to help you write BASIC programs. Even more importantly, they're all in one package. You don't have to search and somehow splice together several different programs.

If you do any BASIC programming at all, this package will be one of your most valuable utilities. It takes up nearly 4K bytes of memory, but it's safe from BASIC. You can still program normally. And by using MLX, the Machine Language Editor found in Appendix D, you can be assured it's entered correctly.

Some History

The program was originally written for the PET/CBM computers by James Strasma, and later modified by F. Arthur Cochrane. It's become one of the most popular programs available for Commodore computers. Until now, unfortunately, there hasn't been a version written expressly for the 64. Brent Anderson, who translated this program to the 64, has been a user of Commodore computers since 1981, when he joined Strasma and others to form the Central Illinois PET Users Group. He currently heads ATUG, a Commodore users group dedicated to exchanging information dealing with machine language programs.

MLX and BASIC Aid

You'll use MLX to enter BASIC Aid. Before you begin to type in this program, make sure you read Appendix D. You'll also need to type in and save a copy of the MLX program to tape or disk. Once you've done that, load and run MLX. It will ask for the starting and ending

addresses for BASIC Aid. They are:

Starting address: 49152
Ending address: 52997

Once you've typed in those numbers, you're ready to begin entering BASIC Aid. You don't have to enter it in one session; you can stop and pick up where you left off any number of times. Refer to the instructions in Appendix D for details.

Once you've got BASIC Aid typed in (which may take you several sessions — it's a long program), make sure you save it to tape or disk. It's then ready to use.

Load BASIC Aid as you would any other completely machine language program by typing LOAD "filename",8,1. Then type NEW to reset the BASIC pointers. You start it by entering SYS 49152. BASIC Aid uses the wedge technique to add the following commands to BASIC. Since the wedge can slow execution of a program, all of these commands work only in direct mode (without using line numbers).

An additional feature lets you pause or stop any BASIC Aid command that displays to the screen. To pause the display, simply hold down the SHIFT key. To stop it, hit the SHIFT LOCK key or the space bar. To release, unlock the SHIFT, or hit the Commodore key. Pressing the STOP key aborts the feature entirely.

Programming Aids

Each of the aids supported by BASIC Aid is listed below. The syntax of the command is printed, and a short explanation of what each does is also included. Many of the features are obvious, and little information is necessary. Others, such as the CHANGE option, are more complex and are explained in greater detail. At the end of the program, you'll find a quick reference card you can cut out and place next to your computer.

AUTO

Syntax: AUTO *line increment* (to turn on)
AUTO (to turn off)

AUTO automatically numbers the lines of your BASIC program. You start the process by typing AUTO, followed by a line increment from 1 to 127. The first line number must be entered manually. The next line number in the sequence automatically appears from that point on. For example, if you enter *AUTO 10,* and then the line *10 REM THIS IS THE FIRST LINE,* the line number *20* appears under the *10,* ready for you to type in the next line. To turn this feature off, simply enter AUTO without a line number increment.

BREAK

Syntax: BREAK

The BREAK command is used to enter a machine language monitor like Micromon or Supermon, if such a program has been previously installed.

CHANGE

Syntax: CHANGE/*search string/replacement string/, line number range*
or
CHANGE*"search string"replacement string", line number range*

CHANGE replaces one string of characters (the search string) with another string of characters (the replacement string). Each line in which the string is replaced is displayed on the screen. If the optional range of line numbers is specified, the search string is replaced within that range. Otherwise, the search string is changed to the replacement string at every occurrence within the program. Line number ranges should be specified as they are in the LIST command. For instance, CHANGE*/FIRST STRING/SECOND STRING/, -100* changes the string in lines 0–100; CHANGE*/FIRST STRING/ SECOND STRING/, 100-200* changes it within lines 100–200; and CHANGE*/FIRST STRING/SECOND STRING/,200-* changes it from line 200 to the end of the program.

Two different delimiters can be used to set off the search and replacement strings. This is because BASIC stores keyword commands (such as PRINT) differently than it does the same combination of characters when they appear in quotes or as DATA. If it didn't, it would get terribly confused by statements such as PRINT "PRINT". It would try to execute the second PRINT, rather than printing it on the screen. The CHANGE command lets you decide which type of string you wish to change. If the backslash character is used to separate the two strings, BASIC reserved keywords are recognized as such. If quotation marks are used, all text is treated as strings of characters. For example, if the program in memory is:

```
10 PRINT"ALL THAT THIS PROGRAM DOES IS PRINT"
```

then the command CHANGE*/PRINT/REM/* alters the program to:

```
10 REM"ALL THAT THIS PROGRAM DOES IS PRINT"
```

while the command CHANGE*"PRINT"OUTPUT CHARACTERS"* changes the program to:

```
10 PRINT"ALL THAT THIS PROGRAM DOES IS OUTPUT CHAR
   ACTERS"
```

In the first case, only the tokenized PRINT command is recognized, while in the second, only the string literal "PRINT" is changed.

Keep in mind that every occurrence of the string is changed, even if that string appears as a substring in the middle of a word. For example, CHANGE/*TO/FROM*/ converts the line

```
100 PRINT"GET THE MESSAGE TO TONY"
```

to

```
100 PRINT"GET THE MESSAGE FROM FROMNY"
```

Such an error could be avoided by including the spaces around the word in the search and replacement strings (CHANGE/ *TO* / *FROM* /would have the desired effect). When in doubt, look for all occurrences of the search string with the FIND command before using CHANGE, so that no unwanted substrings crop up.

COLD

Syntax: COLD

The COLD command is used to cold start the computer. This means that the computer goes through all the steps it normally would when you turn the power off and on again, except that the contents of memory remain intact. Sometimes, when certain memory locations that BASIC uses have been changed, commands no longer function correctly. By entering COLD, then initializing BASIC Aid with a SYS 49152, and entering the OLD command, you can get a fresh start. COLD can also be used to disengage BASIC Aid and all other machine language programs like monitors that affect the operation of the computer.

CRT

Syntax: CRT

This command sends text and graphics characters to the printer exactly as they appear on the screen. This version accommodates only a Commodore printer connected as device number 4.

DELETE

Syntax: DELETE *line number range*

This command deletes a number of BASIC program lines at once. The line number range uses the same format as the LIST command. For example, DELETE -100 deletes all lines up to and including line

100, DELETE 100-200 deletes those two lines and all lines in between, and DELETE 200- deletes lines 200 and up.

DUMP

Syntax: DUMP

DUMP lists the variables used in a BASIC program in the order in which they were created, as well as shows their current value. Only scalar (nonarray) variables are displayed. DUMP can be handy for testing the effect of changing the value of a variable in a running program. Just hit the STOP key, type DUMP to check the current value of a variable, edit and enter a new value for the variable, and type CONT to continue the program using the new value.

FIND

Syntax: FIND/*search string/, line number range*
or
FIND *"search string", line number range*

The FIND command searches the BASIC program for a string of characters, and displays the program lines in which the string appears. This command displays every occurrence of the string, unless a limiting range of line numbers is specified. The format of this number range is the same used by the LIST command. If the backslash character is used to enclose the string, BASIC keyword tokens within the string are recognized as such, but if the string is enclosed in quotes, such words are treated as their literal string of characters. For examples of this distinction, see the CHANGE command.

FLIST

Syntax: FLIST *"BASIC program filename"*

This reads a BASIC program file on disk and lists the program to the screen without entering it into memory or otherwise affecting the program currently in memory. FLIST allows you to make certain you've got the right program before you try to LOAD or MERGE it.

HELP

Syntax: HELP

HELP displays the BASIC program line that was executing when the program was stopped, and highlights in reverse video the last character read by the program. It's helpful for finding which statement of a multistatement program line caused an error. On the 64 it's particularly useful when the screen has been changed from text to high-resolution graphics, and error messages cannot be read. Since changing the screen back to text with the RUN/STOP–RESTORE

combination also erases the error message, HELP can show where the error occurred.

HEX

Syntax: HEX $hexadecimal number
or
HEX decimal number

You can convert decimal numbers to hexadecimal notation and vice versa, with this feature. If the number entered is preceded by a dollar sign, it's considered a hexadecimal number in the range $0000 to $FFFF, and its decimal equivalent is displayed. If no dollar sign is entered, a decimal number in the range 0 to 65535 is converted to hex and then displayed.

KILL

Syntax: KILL

This disables BASIC Aid. To restart the program, type SYS 49152.

MERGE

Syntax: MERGE *"BASIC program filename"*

This command reads a BASIC program file from disk, lists each line on the screen, and enters the line just as if it had been typed in from the keyboard. To use MERGE, first load one program into the computer's memory. Do not run it. Then type MERGE *"filename"*, using the filename of the program you want to merge into the first. The program lines using numbers not already found in the first program (the one in memory) are added, while those that duplicate numbers already in use will replace those lines.

OLD

Syntax: OLD

As you might have guessed, the OLD command is used to undo the effects of an inadvertent NEW command. As long as no program lines are entered after NEW has been entered, OLD can recover the program. It can also be used to restore the program after a cold start (either from the COLD command, or using a reset switch connected to the user port for recovering from a crash).

OFF

Syntax: OFF

This command restores the normal IRQ vector, and turns off the interrupt-driven functions, namely, program scrolling, quote mode/

insert mode escape, and keyprint. (See the description of these functions below.)

READ

Syntax: READ *"sequential filename"*

The READ command reads a sequential file from disk and prints its contents to the screen. It can be used for viewing text or data files.

RENUMBER

Syntax: RENUMBER
or
RENUMBER *starting line number*
or
RENUMBER *starting line number, line increment*

RENUMBER completely renumbers the BASIC program in memory, including line number references in GOTO, GOSUB, and IF-THEN statements. If no numbers are entered after RENUMBER, the program will be renumbered starting at line 100, with line increments of 10. You can specify a different starting line number or a different increment value.

REPEAT

Syntax: REPEAT

This command is used to toggle the repeat key function. When BASIC Aid is started, all keys repeat if held down. Entering REPEAT disables this feature for all but the cursor and space keys; typing it again reenables it.

SCROLL

Syntax: SCROLL

SCROLL enables all of the interrupt-driven keystroke commands. These are:

1. Program scrolling. When you move the cursor to the bottom-left corner of the screen and press the cursor down key, the listing will roll up, and the next program line will be printed at the bottom of the screen. If you move the cursor to the top-left corner of the screen and press the cursor up key combination, the listing will roll down, and the previous program line will be displayed at the top.
2. Quote mode/Insert mode escape. By pressing the f1 key, quote mode and insert mode are canceled, allowing you to move the cursor normally.

3. Keyprint. This function allows you to send the characters currently on the text screen to a printer by pressing the f8 key (SHIFTed f7). In effect, this executes the CRT command (see above), but can be used while a program is running. With these you can make a hard copy of output normally only printed on the screen, such as program instructions. You must be careful, however, not to try to use this function while serial bus operations such as disk accesses are taking place, since this will lock up the system. This means that the keyprint feature cannot be used to print the directory displayed by the DOS wedge, or to print programs or text displayed by the READ or FLIST commands. Likewise, trying to use it without a printer connected may lock up the system or abort the program that is running.

When BASIC Aid is started, all of these interrupt-driven functions are enabled. During the course of programming, however, there are several ways in which the normal interrupt can be restored (such as by hitting the RUN/STOP–RESTORE combination, or by using the OFF command). To restart these functions, use the SCROLL command.

START

Syntax: Start *"program filename"*

The loading address for program files is located in the first two bytes of the file. This command reads those bytes from the specified program file on the disk and displays the starting address in decimal and hexadecimal. START is handy for finding where a nonrelocatable machine language program (one that is loaded with the LOAD "NAME",8,1 format) starts.

DOS Support Commands

Syntax: > *disk command* or *@disk command*
> $ or @$ (directory)
/ program name (LOAD)
↑ *program name* (LOAD and RUN)

BASIC Aid also supports many of the commands found in the DOS support program. The greater than (>) and commercial at (@) signs are used to communicate with the disk on the command channel. Using the symbol alone reads the error channel and prints it to the screen. Entering the symbol followed by a dollar sign prints the directory on the screen without altering the program in memory. Typing in the symbol followed by a command string sends that command to the disk, just as if you had typed in the BASIC line OPEN 1,8,15: PRINT#1,"command string": CLOSE 1. These commands include:

1. > *S0:filename.* Erases the named file from the disk. If wildcards such as * or ? appear in the filename, more than one file may be erased.
2. > *R0:new filename = old filename.* Changes the name of the disk file from *old filename* to *new filename.*
3. > *C0:new filename = old filename.* This command copies disk file *old filename* to the file *new filename.*
4. > *V0.* Performs a disk validation or collection, which reclaims disk blocks marked as in use, but which are in fact not used.
5. > *N0:disk name, ID.* Formats the disk for use, erasing all information that it previously contained, and giving it the title and disk ID number entered in the command.

Two additional DOS support functions are included. Entering the backslash (/) followed by the program filename loads that program from disk. Typing the up arrow (↑) followed by the program filename loads and runs the program.

BASIC Aid

Be sure to read "Using the Machine Language Editor: MLX," Appendix D, before typing in this program.

```
49152 :169,000,141,136,003,141,078
49158 :137,003,173,243,206,174,174
49164 :244,206,224,160,176,007,005
49170 :133,055,134,056,032,089,005
49176 :166,162,015,189,043,192,023
49182 :149,115,202,016,248,162,154
49188 :019,032,059,192,076,089,247
49194 :193,230,122,208,002,230,003
49200 :123,173,255,001,076,154,062
49206 :192,234,076,191,192,189,104
49212 :047,206,240,006,032,210,033
49218 :255,232,208,245,096,208,030
49224 :014,120,162,023,189,162,230
49230 :227,149,115,202,016,248,011
49236 :076,186,199,076,217,205,019
49242 :173,141,002,041,001,208,144
49248 :249,032,125,192,208,020,154
49254 :032,125,192,240,251,201,119
49260 :255,240,247,032,125,192,175
49266 :201,255,208,249,169,000,172
49272 :133,198,076,225,255,173,156
49278 :001,220,205,001,220,208,213
49284 :248,201,239,096,133,098,123
49290 :162,144,056,032,073,188,025
49296 :076,221,189,230,135,208,179
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49302 :002,230,136,096,133,131,110
49308 :134,151,186,189,001,001,050
49314 :201,140,240,035,166,123,043
49320 :224,002,240,011,134,138,149
49326 :166,122,134,137,076,183,224
49332 :192,164,133,166,151,165,127
49338 :131,201,058,176,200,201,129
49344 :032,240,003,076,179,227,181
49350 :076,115,000,189,002,001,069
49356 :201,164,208,231,032,183,199
49362 :192,144,077,165,131,016,167
49368 :002,230,122,162,000,134,098
49374 :127,132,133,164,122,185,061
49380 :000,002,056,253,086,206,063
49386 :240,019,201,128,240,019,057
49392 :230,127,232,189,085,206,029
49398 :016,250,189,086,206,208,177
49404 :228,240,182,232,200,208,006
49410 :224,132,122,104,104,165,085
49416 :127,010,170,189,192,206,134
49422 :072,189,191,206,072,032,008
49428 :181,192,076,115,000,032,104
49434 :207,195,141,136,003,076,016
49440 :002,194,104,104,165,131,220
49446 :032,107,169,240,041,173,032
49452 :136,003,240,036,024,165,136
49458 :020,109,136,003,133,099,038
49464 :165,021,105,000,032,136,003
49470 :192,162,000,189,001,001,095
49476 :240,006,157,119,002,232,056
49482 :208,245,169,032,157,119,236
49488 :002,232,134,198,076,159,113
49494 :164,208,020,120,173,245,248
49500 :206,141,020,003,173,246,113
49506 :206,141,021,003,032,031,020
49512 :206,088,076,116,164,076,062
49518 :217,205,044,141,002,240,191
49524 :045,032,133,198,162,000,174
49530 :134,199,134,198,134,197,094
49536 :228,212,240,004,134,212,134
49542 :208,004,228,216,240,016,022
49548 :134,216,230,198,164,211,013
49554 :136,169,032,145,209,169,238
49560 :157,141,119,002,165,197,165
49566 :201,003,240,206,201,004,245
49572 :240,210,173,248,206,072,033
49578 :173,247,206,072,008,072,180
49584 :072,072,076,049,234,032,199
49590 :061,195,165,095,166,096,192
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49596 :133,036,134,037,032,019,067
49602 :166,165,095,166,096,144,002
49608 :010,160,001,177,095,240,115
49614 :004,170,136,177,095,133,153
49620 :122,134,123,165,036,056,080
49626 :229,122,170,165,037,229,146
49632 :123,168,176,030,138,024,115
49638 :101,045,133,045,152,101,039
49644 :046,133,046,160,000,177,030
49650 :122,145,036,200,208,249,178
49656 :230,123,230,037,165,046,055
49662 :197,037,176,239,032,051,218
49668 :165,165,034,166,035,024,081
49674 :105,002,133,045,144,001,184
49680 :232,134,046,032,089,166,203
49686 :076,116,164,032,121,165,184
49692 :032,115,000,133,131,162,089
49698 :000,134,073,032,253,194,208
49704 :165,127,201,003,208,007,239
49710 :162,002,134,073,032,253,190
49716 :194,032,115,000,240,003,124
49722 :032,253,174,032,061,195,037
49728 :165,095,166,096,133,122,073
49734 :134,123,032,215,170,208,184
49740 :011,200,152,024,101,122,174
49746 :133,122,144,002,230,123,068
49752 :032,201,197,240,005,032,027
49758 :103,195,176,003,076,002,137
49764 :194,132,085,230,085,164,222
49770 :085,166,049,165,050,133,242
49776 :131,177,122,240,216,221,195
49782 :000,002,208,237,232,200,229
49788 :198,131,208,241,136,132,146
49794 :011,132,151,165,073,240,134
49800 :091,032,122,195,165,052,025
49806 :056,229,050,133,158,240,240
49812 :040,200,240,202,177,122,105
49818 :208,249,024,152,101,158,022
49824 :201,002,144,064,201,075,079
49830 :176,060,165,158,016,002,231
49836 :198,131,024,101,011,133,002
49842 :151,176,005,032,180,195,149
49848 :240,003,032,156,195,165,207
49854 :151,056,229,052,168,200,022
49860 :165,052,240,015,133,133,166
49866 :166,051,189,000,002,145,243
49872 :122,232,200,198,133,208,021
49878 :245,024,165,045,101,158,184
49884 :133,045,165,046,101,131,073
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49890 :133,046,165,122,166,123,213
49896 :133,095,134,096,166,067,155
49902 :165,068,032,018,196,032,237
49908 :090,192,240,158,164,151,215
49914 :076,101,194,164,122,200,083
49920 :148,049,169,000,149,050,053
49926 :185,000,002,240,047,197,165
49932 :131,240,005,246,050,200,116
49938 :208,242,132,122,096,208,002
49944 :033,141,003,002,142,004,093
49950 :002,140,005,002,008,104,035
49956 :141,002,002,169,164,072,074
49962 :169,116,072,056,108,022,073
49968 :003,201,171,240,004,201,100
49974 :045,208,001,096,076,217,185
49980 :205,144,005,240,003,032,177
49986 :049,195,032,107,169,032,138
49992 :019,166,032,121,000,240,138
49998 :011,032,049,195,032,115,000
50004 :000,032,107,169,208,224,056
50010 :165,020,005,021,208,006,003
50016 :169,255,133,020,133,021,059
50022 :096,032,201,197,133,067,060
50028 :032,201,197,133,068,165,136
50034 :020,197,067,165,021,229,045
50040 :068,096,165,122,133,034,226
50046 :165,123,133,035,165,045,024
50052 :133,036,165,046,133,037,170
50058 :096,165,034,197,036,208,106
50064 :004,165,035,197,037,096,166
50070 :230,034,208,002,230,035,121
50076 :164,011,200,177,034,164,138
50082 :151,200,145,034,032,139,095
50088 :195,208,235,096,165,036,079
50094 :208,002,198,037,198,036,085
50100 :164,011,177,036,164,151,115
50106 :145,036,032,139,195,208,173
50112 :235,096,201,034,208,008,206
50118 :072,165,015,073,128,133,016
50124 :015,104,096,032,107,169,215
50130 :165,021,208,004,165,020,025
50136 :016,002,169,127,096,076,190
50142 :217,205,208,251,032,232,087
50148 :195,076,116,164,032,215,002
50154 :170,133,073,166,043,165,216
50160 :044,134,095,133,096,160,134
50166 :000,177,095,170,200,177,041
50172 :095,208,003,076,115,000,237
50178 :197,138,144,235,228,137,057
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50184 :144,231,200,177,095,170,001
50190 :200,177,095,044,160,000,178
50196 :132,127,132,015,032,205,151
50202 :189,169,032,164,127,041,236
50208 :127,032,210,255,032,194,114
50214 :195,169,000,133,199,200,166
50220 :036,073,016,023,166,096,198
50226 :152,056,101,095,144,001,087
50232 :232,228,138,144,010,197,237
50238 :137,144,006,169,001,133,140
50244 :073,133,199,177,095,240,217
50250 :017,016,212,201,255,240,247
50256 :208,036,015,048,204,132,211
50262 :127,032,122,196,048,193,036
50268 :076,215,170,096,162,160,203
50274 :160,157,134,136,132,135,184
50280 :056,233,127,170,160,000,082
50286 :202,240,238,032,147,192,137
50292 :177,135,016,249,048,244,217
50298 :032,096,196,200,177,135,190
50304 :048,221,032,210,255,208,078
50310 :246,032,107,169,164,020,104
50316 :166,021,152,005,021,208,201
50322 :002,160,100,132,053,134,215
50328 :054,162,000,161,122,208,091
50334 :004,169,010,208,010,032,079
50340 :253,174,032,107,169,165,040
50346 :020,166,021,133,051,134,183
50352 :052,032,142,166,032,201,033
50358 :197,032,201,197,208,033,026
50364 :032,171,197,032,201,197,250
50370 :032,201,197,208,003,076,143
50376 :002,194,032,201,197,165,223
50382 :099,145,122,032,201,197,234
50388 :165,098,145,122,032,182,188
50394 :197,240,226,032,201,197,031
50400 :032,201,197,032,201,197,060
50406 :201,034,208,011,032,201,149
50412 :197,240,197,201,034,208,033
50418 :247,240,238,170,240,188,029
50424 :016,233,162,004,221,081,197
50430 :206,240,005,202,208,248,083
50436 :240,221,165,122,133,059,176
50442 :165,123,133,060,032,115,126
50448 :000,176,211,032,107,169,199
50454 :032,080,197,165,060,133,177
50460 :123,165,059,133,122,160,022
50466 :000,162,000,189,000,001,130
50472 :201,048,144,017,072,032,042
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50478 :115,000,144,003,032,129,213
50484 :197,104,160,000,145,122,012
50490 :232,208,232,032,115,000,109
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"Basic Aid" Clip-Out Quick Reference Card

Command and Syntax	Function
AUTO ***line increment***	Auto line numbering
BREAK	Enter monitor
CHANGE/*string/string/,line#*	Search and replace string
or	
CHANGE ***"string"string",line#***	
COLD	Cold start
CRT	Screen print
DELETE ***line# range***	Block delete
DUMP	List variables and values
FIND/*string/string/line#*	Find string
or	
FIND ***"string"string",line#***	
FLIST ***"filename"***	List to screen
HELP	Last line executed
HEX ***number***	Convert from decimal to hexadecimal; vice versa
KILL	Disable BASIC Aid
MERGE ***"filename"***	Merge two programs
OLD	Reclaim NEWed programs
OFF	Restore normal IRQ vector
READ ***"sequential filename"***	Read sequential file
RENUMBER	Renumber program lines
REPEAT	Toggle repeat key function
SCROLL	Enable interrupt-driven commands
START ***"filename"***	Starting address of program
$ or @$	List directory
/filename	LOAD program
↑filename	LOAD and RUN program

Jeff Young

Auto Line Numbering

This short routine is a handy, time-saving utility for programmers.

"Auto Line Numbering" is a utility which automatically generates a line number for the current BASIC program statement you're entering. As written, the routine numbers programs beginning with line 100 and increments by tens (100, 110, 120, and so on). This can be easily modified.

How to Use the Program

Auto Line Numbering consists of a BASIC loader which places a machine language subroutine into a free block of memory at location 49152 ($C000). This area of memory is not used by BASIC, so the program should be safe.

Type in the program and SAVE it. After LOADing, type RUN, press RETURN, type NEW, press RETURN, then type SYS 49152. If you wish to leave the program for any reason, just press RETURN immediately after you see a new line number. To return to the program, type SYS 49160. This will continue generating line numbers from where you left off.

Although the program will always begin numbering with 100 and increment by tens, you can modify either of these if you wish. If you want to begin with a number other than 100, determine the number with which you want to start, then subtract ten. POKE this number in low-byte/high-byte format into 251 and 252, then SYS 49160.

For example, if you wish to begin with line 1000, subtract ten. The number you are now working with is 990. To determine low-byte/high-byte, divide 990 by 256. The result, 3, is the number you POKE into location 252—POKE 252,3. The remainder of the division is 222. POKE 251,222. The *low byte* is location 251, and the *high byte*, 252.

If you wished to begin the line numbering with 1000 then, you'd enter:

```
POKE 251,222:POKE 252,3
SYS 49160
```

To change the increment from ten, POKE the desired number into location 49179. If you want to increment by fives, for example, you'd enter:

```
POKE 49179,5
```

This utility program can save you a lot of time when programming, and it provides a neat, structured sequence for program line numbers.

Auto Line Numbering

For mistake-proof program entry, be sure to read "The Automatic Proofreader," Appendix C.

```
1 X=49152                                          :rem 203
2 READY:IFY=-1THEN4                                :rem 199
3 POKEX,Y:X=X+1:Z=Z+Y:GOTO2                        :rem 22
4 IFZ<>12374THENPRINT"ERROR IN DATA STATEMENTS":EN
  D                                                :rem 236
100 DATA169,90,133,251,169,0,133,252,169,19,141,2,
    3,169,192,141,3,3,96,32,25                     :rem 203
110 DATA192,76,134,164,24,169,10,101,251,133,251,1
    44,2,230,252,165,251,133,99                    :rem 246
120 DATA165,252,133,98,162,144,56,32,73,188,32,221
    ,189,162,0,189,1,1,240,9,32                      :rem 4
130 DATA210,255,157,0,2,232,208,242,32,18,225,201,
    13,240,3,76,105,165,56,165                     :rem 182
140 DATA251,233,20,176,2,198,252,169,131,141,2,3,1
    69,164,141,3,3,76,118,165,-1                   :rem 36
```

Speed and Power

Machine language, the language that your Commodore 64 uses to calculate and process information, is fast and powerful. Much more so than BASIC, the programming language you're probably most familiar with. Until now, unless you knew how to program in ML, you could only look at machine language programs with envy. But it *is* possible to make BASIC and machine language work together.

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- A machine language assembler, a disassembler, and simple explanations of how ML is created and how it works.

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