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The Transactor

The Tech/News Journal For Commodore Computers

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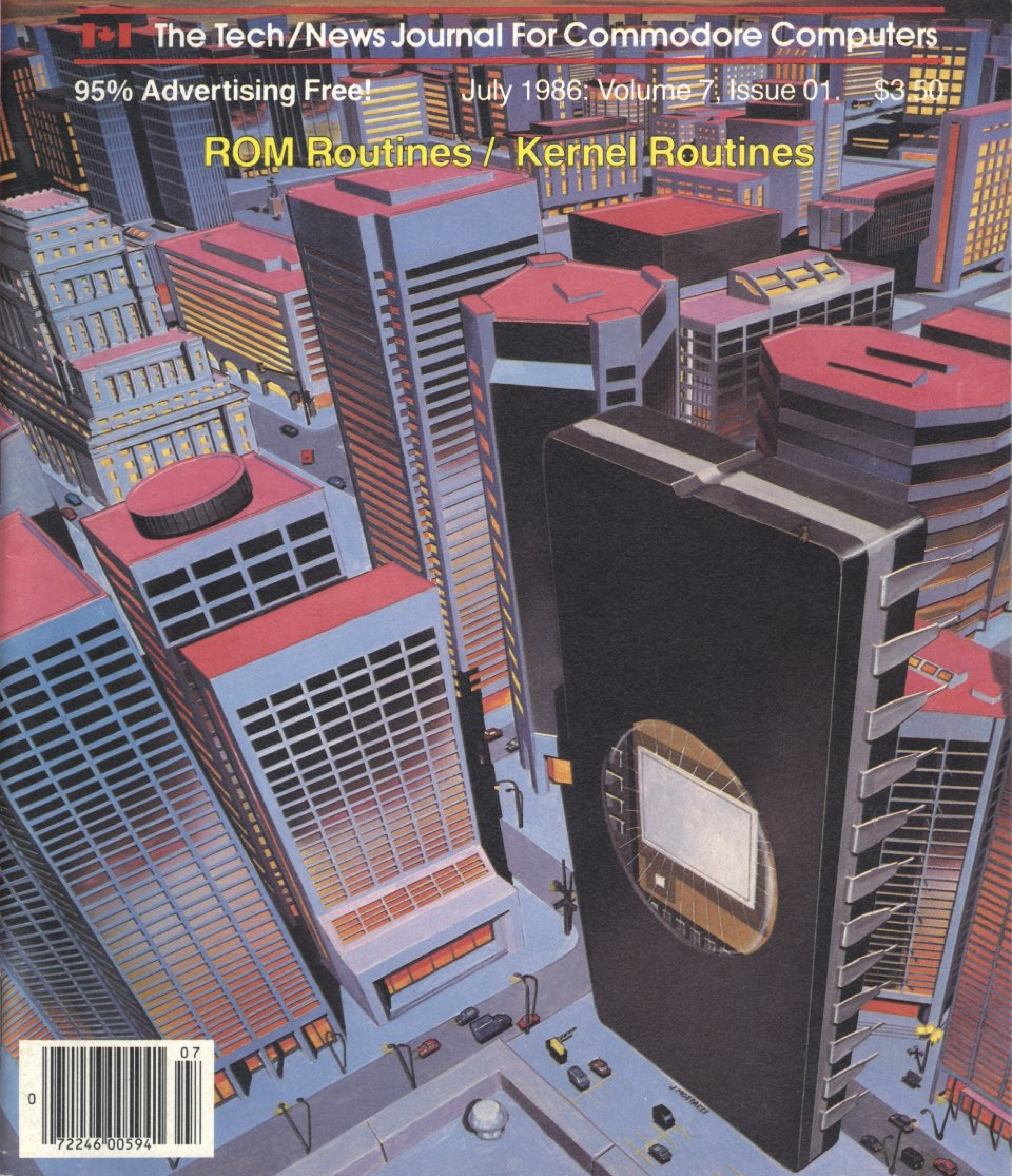
ROM Routines / Kernel Routines



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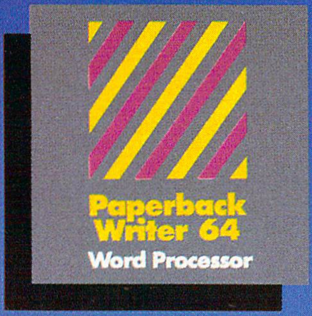

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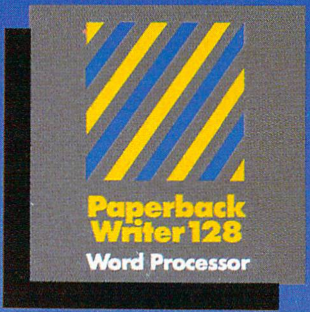

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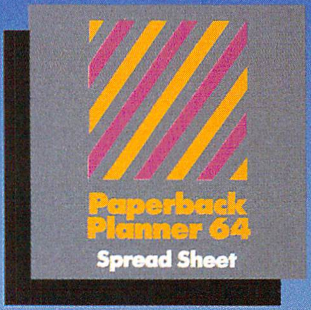

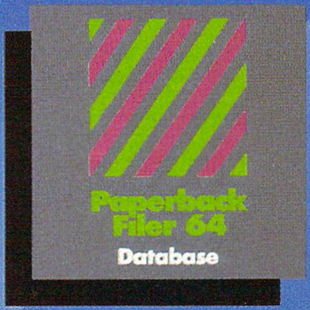

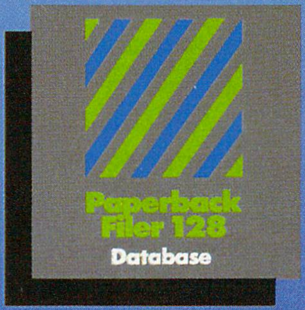

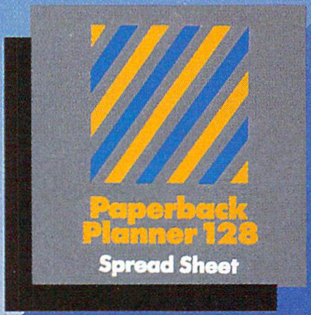

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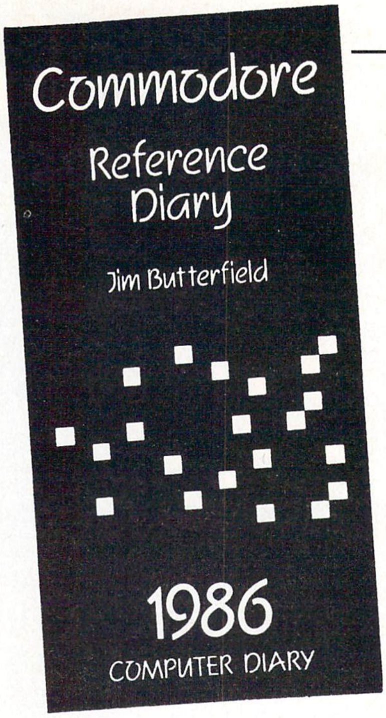

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Note: Before entering programs, see "Verifizer" on page 4 and 11

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Program Listings In The Transactor

All programs listed in The Transactor will appear as they would on your screen in Upper/Lower case mode. To clarify two potential character mix-ups, zeroes will appear as '0' and the letter "o" will of course be in lower case. Secondly, the lower case L ('l') has a flat top as opposed to the number 1 which has an angled top.

Many programs will contain reverse video characters that represent cursor movements, colours, or function keys. These will also be shown exactly as they would appear on your screen, but they're listed here for reference. Also remember: CTRL-q within quotes is identical to a Cursor Down, et al.

Occasionally programs will contain lines that show consecutive spaces. Often the number of spaces you insert will not be critical to correct operation of the program. When it is, the required number of spaces will be shown. For example:

```
print "          flush right "   – would be shown as –   print "[10 spaces]flush right "
```

Cursor Characters For PET / CBM / VIC / 64

Down –	q	Insert –	T
Up –	Q	Delete –	t
Right –	]	Clear Scrn –	S
Left –	[Lft]	Home –	s
RVS –	r	STOP –	c
RVS Off –	R		

Colour Characters For VIC / 64

Black –	P	Orange –	A
White –	e	Brown –	U
Red –	£	Lt. Red –	V
Cyan –	[Cyn]	Grey 1 –	W
Purple –	[Pur]	Grey 2 –	X
Green –	↑	Lt. Green –	Y
Blue –	←	Lt. Blue –	Z
Yellow –	[Yel]	Grey 3 –	[Gr3]

Function Keys For VIC / 64

F1 –	E	F5 –	G
F2 –	I	F6 –	K
F3 –	F	F7 –	H
F4 –	J	F8 –	L

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Special April Feature:

S.N.I.F.F. : A Bold New Vision In Recording Media

Software with an added dimension of realism

Transactor magazine has just scooped the story on an incredible breakthrough in floppy-disk technology which promises to add a new dimension to software realism. Sensory Laboratories of Fremont Wyoming, a company which develops more natural man-machine interfaces, has been secretly developing their new floppy-disk technology, called "Sensory Nasal Interface For Floppies", or SNIFF.

The technology is now ready to be released for license by major software companies. Sensory Labs has managed to embed scents within the magnetic particles on a magnetic disk's surface. The basic idea works much like the "Scratch-n-Sniff" scent samples provided on paper carriers. The disk-based smells, however, are released by the heat-producing friction caused by the pressure pad opposite the Read/Write head. As the disk spins and the pressure pad rubs on the disk surface, the disk surface is slightly worn and heated, releasing the smells to the surrounding air, which is then wafted into the room through the drive's ventilation slots.

Software vendors should be excited by the new sniff-disks (known as "floppy-sniffs"), since they can add a realism to their programs which was never before possible. Sensory Labs' President, Terrence Price, explains: "The first computers printed all their results on paper. Then, we had the CRT, which eventually opened up the wonderful visual world of computer graphics. Now we have high-quality sound and speech synthesis as well. The sense of smell is the next logical step in human interface technology."

The first batch of disks will be released in 4 TPS (Tracks Per Sniff) format. On a 35-track disk like the Commodore 1541 uses, this will give eight different smells which can be released. (The directory tracks are not scented because they need to be accessed periodically during a sniff-access.) A program releases a desired scent by moving the Read/Write head to the proper sniff-track and holding it there for at least three seconds. (This is called a "Sniff access" or just a "Sniff".) Sniff-access time is expected to improve in future advancements of the technology. Applications are expected to include games (smell the musty dungeon in an adventure); and a whole range of Sniffware for the blind, who have a keener sense of smell and will be able to follow scent prompts from the programs.

Price admits that the idea is not completely original; he was inspired by the cinema technique known as Smell-o-Rama, most recently used in the movie "Polyester". But he maintains that Sensory Labs is going beyond simple one-at-a-time sniffs, into the exciting science of compound scent. Scientists at Sensory Labs have broken down smells into nine primary elements, out of which almost all other smells can be created. Smells can thus be synthesized from the primary smells on disk, as the Read/Write head quickly seeks from one track to another, blending the smells to create new ones.

"Once we come out with the 3 TPS format", explains Price, "We'll be able to put all of the primary smells on a floppy, making true sniff-synthesis a reality. At that stage, we can sell our 'Sniff-Writer' software which will allow developers or even users to create any smell they need without having to place a special order."

One of the problems being worked on still is the sniff-life of a disk; currently a typical track is good for about five sniff-hours. This may be enough for most games, but serious Sniffware will demand greater Sniff-lives. Improvements are on the way though, and Sensory Labs is even hoping to come out with a Hard-disk version called the "Hard-Sniff". Another potential problem is that in the event of certain hardware failures, the air in the room can be contaminated quickly. Sniff-disks come with warnings to use only in well-ventilated areas. This is especially true for programs using some of the stronger smells: for example, in an Adventure game the player may enter a recently-used bathroom.

Looking towards the future, Sensory Labs hopes to have 3.5 inch Sniff-disks out by June, and the Hard-sniff by next year. When asked about the future of Sniff-disk technology, Price predicts: "I see a major demand for Sniffware in the next few years, because people are always looking for new methods of getting information from their computers. And as we say here at Sensory Labs, 'a picture may be worth a thousand words, but a sniff is worth a million' ".

And remember. . . you read it first in The Transactor April Edition – CZ

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Using "VERIFIZER"

The Transactor's Foolproof Program Entry Method

VERIFIZER should be run before typing in any long program from the pages of The Transactor. It will let you check your work line by line as you enter the program, and catch frustrating typing errors. The VERIFIZER concept works by displaying a two-letter code for each program line which you can check against the corresponding code in the program listing.

There are two versions of VERIFIZER on this page; one is for the PET, the other for the VIC or 64. Enter the applicable program and RUN it. If you get the message, "***** data error *****", re-check the program and keep trying until all goes well. You should SAVE the program, since you'll want to use it every time you enter one of our programs. Once you've RUN the loader, remember to enter NEW to purge BASIC text space. Then turn VERIFIZER on with:

```
   SYS 828  to enable the C64/VIC version (turn it off with SYS 831)
or SYS 634 to enable the PET version       (turn it off with SYS 637)
```

Once VERIFIZER is on, every time you press RETURN on a program line a two-letter report code will appear on the top left of the screen in reverse field. Note that these letters are in uppercase and will appear as graphics characters unless you are in upper/lowercase mode (press shift/Commodore on C64/VIC).

Note: If a report code is missing it means we've editted that line at the last minute which changes the report code. However, this will only happen occasionally and only on REM statements.

With VERIFIZER on, just enter the program from the magazine normally, checking each report code after you press RETURN on a line. If the code doesn't match up with the letters printed in the box beside the listing, you can re-check and correct the line, then try again. If you wish, you can LIST a range of lines, then type RETURN over each in succession while checking the report codes as they appear. Once the program has been properly entered, be sure to turn VERIFIZER off with the SYS indicated above before you do anything else.

VERIFIZER will catch transposition errors (eg. POKE 52381,0 instead of POKE 53281,0), but ignores spaces, so you may add or omit spaces from the listed program at will (providing you don't split up keywords!). Standard keyword abbreviations (like nE instead of next) will not affect the VERIFIZER report code.

Technical info: VERIFIZER resides in the cassette buffer, so if you're using a datasette be aware that tape operations can be dangerous to its health. As far as compatibility with other utilities goes, VERIFIZER shouldn't cause any problems since it works through the BASIC warm-start link and jumps to the original destination of the link after it's finished. When disabled, it restores the link to its original contents.

Listing 1a: VERIFIZER for C64 and VIC-20

```
KE  10 rem* data loader for "verifizer" *
JF  15 rem vic/64 version
LI  20 cs=0
BE  30 for i=828 to 958:read a:poke i,a
DH  40 cs=cs+a:next i
GK  50 :
FH  60 if cs<>14755 then print"***** data error *****": end
KP  70 rem sys 828
AF  80 end
IN  100 :
EC  1000 data  76,  74,   3, 165, 251, 141,   2,   3, 165
EP  1010 data 252, 141,   3,   3,  96, 173,   3,   3, 201
OC  1020 data   3, 240,  17, 133, 252, 173,   2,   3, 133
MN  1030 data 251, 169,  99, 141,   2,   3, 169,   3, 141
MG  1040 data   3,   3,  96, 173, 254,   1, 133,  89, 162
DM  1050 data   0, 160,   0, 189,   0,   2, 240,  22, 201
CA  1060 data  32, 240,  15, 133,  91, 200, 152,  41,   3
NG  1070 data 133,  90,  32, 183,   3, 198,  90,  16, 249
OK  1080 data 232, 208, 229,  56,  32, 240, 255, 169,  19
AN  1090 data  32, 210, 255, 169,  18,  32, 210, 255, 165
GH  1100 data  89,  41,  15,  24, 105,  97,  32, 210, 255
JC  1110 data 165,  89,  74,  74,  74,  74,  24, 105,  97
EP  1120 data  32, 210, 255, 169, 146,  32, 210, 255,  24
MH  1130 data  32, 240, 255, 108, 251,   0, 165,  91,  24
BH  1140 data 101,  89, 133,  89,  96
```

Listing 1b: PET/CBM VERIFIZER (BASIC 2.0 or 4.0)

```
CI  10 rem* data loader for "verifizer 4.0" *
CF  15 rem pet version
LI  20 cs=0
HC  30 for i=634 to 754:read a:poke i,a
DH  40 cs=cs+a:next i
GK  50 :
OG  60 if cs<>15580 then print"***** data error *****": end
JO  70 rem sys 634
AF  80 end
IN  100 :
ON  1000 data  76, 138,   2, 120, 173, 163,   2, 133, 144
IB  1010 data 173, 164,   2, 133, 145,  88,  96, 120, 165
CK  1020 data 145, 201,   2, 240,  16, 141, 164,   2, 165
EB  1030 data 144, 141, 163,   2, 169, 165, 133, 144, 169
HE  1040 data   2, 133, 145,  88,  96,  85, 228, 165, 217
OI  1050 data 201,  13, 208,  62, 165, 167, 208,  58, 173
JB  1060 data 254,   1, 133, 251, 162,   0, 134, 253, 189
PA  1070 data   0,   2, 168, 201,  32, 240,  15, 230, 253
HE  1080 data 165, 253,  41,   3, 133, 254,  32, 236,   2
EL  1090 data 198, 254,  16, 249, 232, 152, 208, 229, 165
LA  1100 data 251,  41,  15,  24, 105, 193, 141,   0, 128
KI  1110 data 165, 251,  74,  74,  74,  74,  24, 105, 193
EB  1120 data 141,   1, 128, 108, 163,   2, 152,  24, 101
DM  1130 data 251, 133, 251,  96
```

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Bits and Pieces

Got an interesting programming tip, short routine, or an unknown bit of Commodore trivia? Send it in – if we use it in the Bits & Pieces column, we'll credit you in the column and send you a free one-year's subscription to The Transactor

1541 Error Allocater Scott Gray, New Bloomfield, MO

Do you have a disk you can't use because of errors on it? Rejoice, for help is here! Type in and SAVE Error Allocater. Place the faulty disk in the drive and RUN the Allocater. In a few minutes every sector with an error on it will be allocated. Now, since DOS won't try to write to those sectors, you can SAVE programs to that disk without encountering the dreaded Read Error!

```
DA  10 rem 1541 error allocater
KI  20 c$=chr$(147): h$=chr$(19): l$=chr$(157):
MN  30 print c$: open 15,8,15,"u;": open 2,8,2,"#"
GD  40 gosub 110: if ef then stop
CO  50 for t=1 to 35: for s=0
       to 20+2*(t>17)+(t>24)+(t>30)
FA  60 print h$"track"t" sector"s;
ML  70 print tl$"[3 spaces]": print#15,"u1:"2;0;t;s
       : gosub 110: if ef=0 then 100
HA  80 print#15,"b-f:"0;t;s: print#15,"b-a:"0;t;s
OL  90 print: print"error"er"on"t","s"
PB  100 next: next: close 2: close 15: end
FK  110 input#15,er,er$,e1,e2
        : ef=1+(er=0 or er=65 or er=73): return
```

Coloured Remarks Without REM Luis Pistoia, Argentina

Here is a simple way to make important REMs, such as those identifying subroutines, to stand out in program listings.

Instead of the usual REM, like

```
1000 rem *** sound routine ***
```

Make your subroutine-identifying remark like this:

```
1000 rem "MQ[YEL]*** sound routine ***Z
```

To get the Reverse-M, enter the line with a space in its place at first, then move the cursor over the space and press RVS ON, shift-M, and RETURN.

When you list your program, the above line will appear in yellow as:

```
*** sound routine ***
```

You can use your favorite colour instead of yellow, or use RVS-ON to highlight the message.

Directory Filename Highlighter Dino Bavaro, Don Mills, ON

Here is a handy disk utility which allows you to highlight any filename in the directory. This is useful in making certain programs stand out, such as program boots; or to title various sections of the directory. The highlighting is achieved by renaming the file with four special characters preceding it. The four characters are: shifted space, two delete characters and a reverse-on. This leaves enough space for only twelve characters for the rest of the filename. The routine below will first ask you whether you want to highlight or un-highlight and then ask for the filename. To load a highlighted file from the directory you can use:

```
load"[shifted space]???filename",8,1
```

```
NM  10 rem filename highlighter
BN  20 open 15,8,15: gosub1000
GI  30 hd$=chr$(160)+chr$(20)+chr$(20)+chr$(18)
FN  40 input"1:highlight, 2:un-highlight";n
FG  50 on n gosub 100,200
MD  60 end
KL  70 :
BB  100 input"filename to highlight";hp$
GM  110 print#15,"r0:"+hd$+hp$+"="+hp$
NA  120 gosub 1000 :rem check disk error
OJ  130 return
AA  140 :
MF  200 input"filename to un-highlight";dp$
KA  210 print#15,"r0:"+dp$+"="+hd$+dp$
BH  220 gosub 1000 :rem check disk error
CA  230 return
EG  240 :
AC  1000 input#15,e,e$,t,s
GE  1010 if e then print e,e$: end
IB  1020 return
```

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Easy Speedup For The C-128 With 1541 Drive

Richard Young
Greenwood, NS

Remember the VIC-20 and the 1541 disk drive? Remember the instruction in the disk drive manual for adjusting the 1541 for use with the VIC-20? Actually, the command OPEN 15,8,15, " UI- " was not required to make the 1541 VIC-20 compatible, but rather it allowed the 1541 to function *faster* with the VIC. Now note the FAST command in the Commodore 128 (in 128 mode); it turns off the 40-column screen - no big deal because every 128 user should run it in 80 columns for anything but graphics - and allows the 128 to function much faster. Naturally, it can easily keep up with the 1541 set for the VIC-20 speed. An estimated 17 to 18 percent increase in speed for all disk I/O is the result. With a 1541 and Commodore 128 in 80 columns, enter:

```
fast: open 15,8,15, " ui- "
```

Now you're in for faster business without special speed-up software! Note that " UI+ " puts the 1541 back to the slower speed required for the 64 mode and 128 in 40 columns. Of course, a 1571 is much faster still. . .

C-128 Key Repeat

Mort Adler, Winnipeg, MB

The C-128 has auto-repeating keys as a default after power-up. To disable the auto-repeat, simply type:

```
poke 2594,64.
```

To re-enable auto-repeat, type:

```
poke 2594,128
```

C-64 Load It My Place Not Yours!

Frank Colaricci
Winter Park, FL

The Volume 6 Issue 05 Bits & Pieces section contained a program named " relocate ". I would like to suggest a relocatable load as an alternative to editing the load address of a disk file.

Here's a routine that can be appended to your program that will load in PRG files where you want them. The ML program that " LOAD.IT.HERE " creates is relocatable and may be loaded wherever you have 73 bytes of free memory. Please note that locations 251 through 253 are used during the execution of this ML program.

The syntax of using LOAD.IT.HERE is:

```
SYS start, " filename " ,device number,load address
```

Here's the BASIC Loader:

```
EH  10 rem " load.it.here " by frank colaricci
ME  15 rem loads a prg at a given address
IE  20 rem 100% relocatable - edit line 35
HO  25 rem syntax:
IC  30 rem sys a, " filename " ,device number,
          load address
NI  35 a=49152
LC  40 for i=a to a+72: read b: poke i,b: next
NC  45 end
BG  50 data 032, 253, 174, 032, 158, 173, 032, 143
DF  55 data 173, 169, 100, 160, 101, 032, 219, 182
KD  60 data 160, 002, 177, 100, 153, 251, 000, 136
LI  65 data 016, 248, 165, 251, 166, 252, 164, 253
II  70 data 032, 189, 255, 032, 253, 174, 032, 158
AJ  75 data 173, 032, 247, 183, 152, 170, 169, 008
NH  80 data 160, 000, 032, 186, 255, 032, 253, 174
KJ  85 data 032, 158, 173, 032, 247, 183, 072, 152
PG  90 data 170, 104, 168, 169, 000, 032, 213, 255
PA  95 data 096
```

C-64 *Italics*

Glen Mackinnon, Hanover, ON

Do you wish the Commodore 64 had more than one built-in character font? Thanks to the VIC II chip you can design your own custom fonts, unlike PET owners who are stuck with the Commodore set.

Custom character sets are usually reproduced in magazines via hundreds of DATA statements, but this short program creates the new characters by modifying the old character patterns in memory. This program uses the built-in character set to create a new set of pseudo-italic characters.

The program shifts the upper four rows of each character to the right (the N/2 in line 70), giving them an italics-type slant. The new character set is located at 12288 (hex $3000) and is enabled by a POKE 53272,29. Since this program uses straightforward POKEs and only a divide-by-2 (shift right in machine language), it is a challenging but not impossible task for beginners learning machine language to try to translate. In fact, this program should be translated to machine language for increased speed; it is presented here in BASIC to clearly show the method of italicizing the characters.

After the program runs, the upper and lower-case characters are unchanged, but replacing the reverse characters are the italic-like letters (this has the side effect of destroying the cursor). To use the italics, just print or type your desired text in reverse-field. To switch back to the regular character set, use POKE 53272,21.

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```
EI   10 rem italics for the c64
BF   20 poke 53272,29: rem change char. set
PO   30 ad=55296: t1 =12288: t2=13312
MK   40 poke 56333,127: poke 1,51: rem disable
        irq, get char. rom
JO   50 for i=0 to 1023: n=peek(ad+i)
CC   60 poke t1 +i,n
AM   70 if (i and 4)=0 then n=n/2
DF   80 poke t2+i,n: next i
LM   90 poke 1,55: poke 56333,129: re-enable irq,
        normal rom
HB   100 print" normal characters"
HM   110 print" r italics characters! "
```

The SCNKEY Kernal Routine (Author Unknown)

Here it is, the naked truth: the SCNKEY Kernal routine has been sadly neglected. Well, no more! For speedy keyboard input, it is unparalleled, a hare to GETIN's tortoise.

To tell you the truth, I'm not even sure how it was that I stumbled across this handy routine (located at 65439 – $ff9f). I noticed that in all the memory maps, it was marked as not returning any values, but decided to try it out anyway. Voilà! When the routine is called, the Ascii value of the current key down is returned in the .X register!. This was something I'd been looking for for a long time, and has since proved to be superior to GETIN to check for keypresses.

It works this way: the GETIN routine takes a character from the keyboard buffer and returns it in the accumulator. All keys can be made to repeat by putting a 128 in location 650, but a delay loop in the keyboard scan means that only about 7 characters a second are returned.

But SCNKEY has no such limitations. It is called as part of the standard interrupt process and updates the keyboard buffer and all key locations. However, reading from the buffer is slow and the locations (such as location 203) return values other than Ascii codes. It's the .X register that's the key. The value left here takes into account the shift, CTRL and Commodore–logo keys and reflects the state of the keyboard when SCNKEY is called. Best of all, SCNKEY can be called and the keyboard read even when interrupts are disabled. Try this; the speed is amazing.

The SCNKEY routine can be used to great advantage in both ML and BASIC. To use it from BASIC, SYS 65439 and then PEEK(781) to get the Ascii value of the key currently held down. I only hope that future memory maps will give this great little piece of code its due.

C–64 and VIC Un–NEWs Shea T. Small, Thornhill, ON

It's probably happened to everyone. While working on some BASIC program you accidentally type "NEW". Usually that's the end of that. All those hours of work gone down the drain. But there is a way out of that. Enter this line:

```
For the 64 –    poke2050,1:sys42291:poke45,peek(34)
                :poke46,peek(35):clr
For the VIC –   poke4098,1:sys50483:poke45,peek(34)
                :poke46,peek(35):clr
```

Fast Memory Clear Using Garbage Donald Fulton Stoneman, MA

Garbage can be useful. The BASIC line below will clear most of free memory, from 40K to 8K in only 2 seconds. Doing the same job with POKE would take almost 2 minutes.

```
z$=" ": for x=1 to 255: z$=z$+chr$(0): next
```

In generating one active string of 255 characters, an amazing 32K of dead strings are left behind in dynamic string space. The math is the sum of 1+2+3+. . .+254+255.

This technique is effective in clearing a hi–res screen (or filling it with any given byte) if the screen is located within the normal free RAM area (below $A000). Do the clear before moving the top of BASIC down.

(PRINT AT Update) Update Mike Schmidt North Tonawanda, NY

In the Volume 6, Issue 5 Bits and Pieces column an article titled "PRINT AT Update" stated that the Kernal PLOT routine was unreliable when entered through the jump table at 65520 ($FFF0).

This is not the case if the carry is set or cleared before calling the routine by POKEing the desired status into memory location 783 ($030F). Before executing the routine, BASIC will put the contents of 783 into the processor status register.

So, to set the cursor position:

```
poke 781,row: poke 782,col: poke 783,0
: sys 65520: print "message"
```

To read the cursor position:

```
poke 783,1: sys 65520: row=peek(781)
: col=peek(782)
```

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User Friendly Commands **Frank E. DiGioia, Athens, GA**

Commodore Trivia Department: Did you know that there are two commands on the C64 which cannot give a syntax error no matter what kind of arguments you use with them (if any)? Can you guess which ones they are? (Hint: they aren't STOP and END.)

The Answer: GOTO and GOSUB

Place the following program in memory (so we'll have something to GOTO) and then try to crash the GOTO or GOSUB statements.

```
0 print " this is line 0 "
1 print " this is line 1 "
```

Now give them your worst:

```
goto (fred)
goto $$$
gosub " string var "
gosub for/next
```

You simply *cannot* crash these commands.

REM RAM: Tag–Along Program Variables **Herbert R. Coburn, Spokane, WA**

Here's a trick I have not seen in any magazine or book about Commodore.

The two bytes at $43 and $44 point to the start of BASIC text. Start your program with a REM statement and a chr$(34) to gain a block of reserved memory imbedded in the program. Add six to the pointer at $43 and it points to the first byte of the reserved block. The block of memory can be as much as 74 bytes, depending on whether or not you allow the line to be listed. The chr$(34) following the REM token lets most values POKEd into the line to be displayed.

The value of this trick is that the block of memory rides along with the program when it is SAVEd. For those of us not enamoured by copy protection, it lets the user copy an installed program without having to worry about tag–along files. I use it to store initial values that depend upon a user's configuration. Simple instructions to the user can guide him, or her, through placing the correct values in the line by using the Screen Editor and SAVEing the program under another name. Or, one can be more ambitious and have the program determine if it has been 'installed'. It can then ask the appropriate questions, POKE the right values, SAVE and RUN itself. This way, all previously set up parameters are there as soon as the program is LOADed – no need to store them in separate files anywhere.

Editor's Note: A good example of this technique is the program which Mr. Cohen enclosed with this article, but was not printed here for lack of space. When first run, the program allows you to set up the background, border and character colours to your liking, then stores these values in the REM statement as described above, and finally, SAVEs itself. The next time you LOAD and RUN the program, it restores these colours by looking at the three bytes it stored in the REM statement. Using the REM storage technique, a program can know whether it was run before, and it can find out some information from the previous run as well. –T.Ed

Stringings **Jonathan Hill, Bloomfield, CT**

In Commodore BASIC, there are some conditions that occur when using such character string functions as LEFT$, RIGHT$, and MID$ that programmers should be aware of. The condition can first be described when using the function:

```
b$ = left$(a$,3)
```

This command appears fine: B$ should contain the first three characters that are in A$. But look again! If A$ is shorter than three characters, B$ will also be less than three characters long. This is definitely something to be wary of, as sometimes in a program, strings must be of a known fixed length.

One solution is to use a decision statement before the string function to see if the character string is long enough to fill the bounds set by the string function, but there is a better solution. In the above example if three spaces are added to A$, then B$ is guaranteed to be three characters long, even if A$ hasn't been assigned anything yet and contains a null (a zero–length string). For example:

```
b$ = left$(a$ + " [3 spaces] " )
```

A similar method will work for RIGHT$ and MID$, simply adding spaces to the right or left of the character string, where needed. Keep in mind, too, that you can pad the string with characters other than spaces.

Finally, this solution also provides a handy formatting tool for the PRINT statement. C–64 BASIC has no PRINT USING command, such as is used on other computers to set up fixed length output fields, but you can achieve the same effect by printing strings of a fixed length using the above technique. Numerical data can be formatted by first converting to a string with the STR$ function. The following are examples:

```
print right$(" [4 spaces] " + c$,4)
print " amount payable " ;right$(" ****** " + str$(amt),6)
print mid$(e$ + " [2 spaces] " ,2,1)
```

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Rhetorical Loops

The following program is just a nine–digit counter which starts at zero and counts up. Big deal. But it uses nested FOR/NEXT loops to do it, and the variable names used are unconventional enough to turn the code into readable nonsense. Here's the program:

```
1 rem "Programmable Prose by Chris Zamara
   and Nick Sullivan
2 mo=9:ol=9:in=9:om=9:od=9:ps=9:ro=9:r=9
3 :
100 ford = automobile
110 fork = food tool
120 for a nice time = call antoinette
130 forty thieves = far too many
140 forsaken = stood up
150 forest = treetops
160 fort knox = hard to rob
170 formula = highly top secret
180 foreigner = visitor
190 :
300 print d;k;an;ty;sa;es;tk;mu;ei
310 next ei,mu,tk,es,sa,ty,an,k,d
```

The above program is fairly useless, but shows that if you really want to, BASIC will let you write strange–looking and difficult to understand code. It's the programmer's responsibility to use meaningful variable names and put spaces in the right place. On the other hand, perhaps "programmable prose" could be a new form of expression.

SYSing With The C–128

The C–128, like the 64, allows you to pass values to a machine language routine through the A, X and Y registers, and also read the contents of these registers after the routine has finished. You can POKE the desired values into special RAM locations to initialize the registers, SYS to the routine, then PEEK the locations to find the values set by the ML routine. The locations are as follows:

Location		
C64	C128	Register
780	6	Accumulator
781	7	.X register
782	8	.Y register
783	5	.P (Processor Status) register

But wait! With the C–128 it's even easier than that. You can pass values of A, X, Y and P to a machine language program *directly from the SYS statement*. To do this, just put the parameters after the SYS like this:

```
SYS address,A,X,Y,P
```

Any or all of the parameters can be left out, and they will default to what's in the memory locations indicated above. For example, you could code "SYS addr,20" to set the accumulator to 20, or "SYS addr,,,,1" to set the carry flag (processor status = 1) before entering the routine.

Using your favorite Kernal routine from BASIC has never been simpler than on the 128! You can make your BASIC programs more efficient by making calls directly to ROM routines. This makes for awful, unportable code, but if you need more speed, a few strategic SYSes may do the trick.

Running ABasiC From The CLI On The Amiga

Robert Case
Springfield, OR

To run ABasiC from the CLI (instead of by clicking the ABasiC icon from WorkBench), you have to first increase the stack size to prevent a crash. From the CLI, enter:

```
STACK 8000
RUN ABASIC
```

ABasiC will then come up on a screen of its own. To return to the CLI or WorkBench, first reduce the ABasiC window size and move the window to reveal the ABasiC template on the top line of the screen. You can then slide down the ABasiC screen or click it behind with the re–ordering gadgets to reveal the WorkBench screen and other open windows.

C–64 Auto–Start

Steen Pederson
Frederiks, Denmark

Here is a compact BASIC program which will turn any program into one which will automatically RUN when loaded. Just enter and run "Autostart 1.1" listed below, and it will ask for the name of the program to convert. It then asks for the name of the new, auto–start version of the program to put on disk. After a while (depending on the length of the program), Autostart will finish, but leave the machine in a confused state. You'll have to reset the machine (turn OFF then ON) at this point.

The new file created on disk must be loaded in the following way:

```
load"filename",8,1
```

Your program will then LOAD and automatically RUN. The STOP and RESTORE keys will be disabled, so your auto–start programs will be protected from being modified and re–saved to disk.

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```
BE  100 print " Enter name of program to be auto-started "
CK  110 input " present name " ;f$
AO  120 print " Enter filename for new auto-boot program "
KM  130 input " new name " ;n$
MH  140 poke 649,0: open 1,8,1, " 0: " + n$
CO  150 print#1,chr$(199);chr$(2);
EC  160 for i = 1 to 61
FL  170 read v: print#1,chr$(v);: next
CD  180 for i = 772 to 2048
OG  190 print#1,chr$(peek(i));: next
NO  200 open 2,8,3,f$: get#2,g$,g$
CI  210 for i = 0 to 1
AC  220 get#2,g$: if g$ = " " then g$ = chr$(0)
OH  230 i = st: print#1,g$;: next
PK  240 close 1: close 2
OG  250 :
PE  260 data 169,  47, 133,   0, 169,  55, 133,   1
GD  270 data 169,   0, 133, 157,  32,  68, 229, 169
MJ  280 data  82, 141, 119,   2, 169, 213, 141, 120
JK  290 data   2, 169,  13, 141, 121,   2, 169,   3
IG  300 data 133, 198, 169, 131, 141,   2,   3, 169
EG  310 data 164, 141,   3,   3, 169,  52, 141,  20
GF  320 data   3, 169, 173, 141,  24,   3,  76, 116
CM  330 data 164, 139, 227, 199,   2
```

The C-64 Great Escape

David Claussen
Menomonee Falls, WI

Below is a short machine language program for the C-64 that creates the effect of an escape key. An escape key, which is normally found on IBM compatibles, is normally not available for Commodore owners. What an escape key does, simply put, is let the user " escape " from whatever he or she may be doing at the time.

While programming in BASIC, what this function does is clear the screen line that the cursor is on and position the cursor at the first column. It also turns off quote mode, which allows normal use of the cursor and other control keys. And finally, it turns off reverse mode.

The back-arrow key (located at the top left corner of the keyboard) becomes the escape key. If you wish to use the back-arrow key in a program, hold down the Commodore-logo key while pressing back-arrow.

```
FB  10 rem ** escape key - press backarrow **
FM  20 for j = 49152 to 49227: read x: poke j,x
       : ck = ck + x: next
HF  30 if ck<>8698 then print " data error " : stop
FB  40 sys 49152
GK  50 :
GJ  100 data 120, 169,  13, 141,  20,   3, 169, 192
AM  110 data 141,  21,   3,  88,  96, 165, 197, 201
OJ  120 data  57, 208,  54, 173, 141,   2, 201,   2
KL  130 data 240,  47, 166, 214,  32, 255, 233, 160
OM  140 data   0,  24,  32,  10, 229, 169,  29, 141
BJ  150 data 119,   2, 169, 157, 141, 120,   2, 169
JL  160 data   2, 133, 198, 169,   0, 133, 212, 169
CH  170 data   0, 133, 199, 169,  32, 141, 119,   2
FN  180 data 169, 157, 141, 120,   2, 169,   2, 133
LG  190 data 198,  76,  49, 234
```

Return of The Swords Of Doom

Arthur Wolf
Wichita, KS

We told you they'd be back! This time, thanks to Mr. Wolf's program, the Evil Swords appear as comets! Ooh, scary stuff, kids!

```
EP  10 rem for frustrated comet gazers
JE  15 rem here's this rendition of chris's
KN  20 rem " Evil Swords of Doom " (6/4 p.9)
NI  25 :
BP  30 l$ = chr$(157)
KG  35 poke 53280,0: poke 53281,0
AB  40 a$ = " [BLUE]M q M q [CYAN]M q M q [WHT]
        QQQQQ " + l$ + l$ + l$ + l$ + l$ + " q "
FP  45 b$ = "   q   q   q   q   "
MC  50 print chr$(142)
OC  55 print " s " tab(rnd(1)*41)
LM  60 for i = 1 to 19: print a$;
FP  65 for d = 1 to 15: next
BE  70 next i: printb$;: goto55
```

Date Conventions

R.C. Eldridge
Pemberton, BC

There has always been confusion because of the U.S. convention of expressing the date in the order " month-day-year " and the rest of the world using day-month-year. Several years ago an international standards body recommended that everyone use year-month-day and it is slowly catching on.

If you use year-month-day as a date reference in one field of a data file, the computer will automatically sort references into the right chronological order. For logging purposes where precise time is important the number can be extended to year-month-day-hour-minute.

The basic idea is useful in a two-day amateur radio contest log. If you use the form day-hour-minute for the time entry, the log can be re-sorted easily into chronological order after having sorted into callsigns or countries or whatever for analysis.

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The Hidden Message

Jim Butterfield, Toronto

There's an encrypted message in the Commodore 128. You'll never find it by inspecting memory, since it is definitely in code . . . and not an easy one to crack.

I'll tell you where it is located. It's in bank 15 – that's ROM – at addresses 44644 to 44799. It's not easy to crack; since every one of the 156 characters has a different " key " value, it's not a simple Caesar cipher. In fact, if the 156 keys were independent and random, the code would indeed be uncrackable, since no key is repeated. But each key is mathematically related to the previous one, and a cracker with time and ingenuity might – perhaps – be able to break it. I'm about to give it away, so you might like to stop reading right now if you're a serious cipher solver.

Secret code can often be found in software. Sometimes it's a personal signature by the author. Sometimes it's a secret proof of copyright. Sometimes it's an amusement. Here's a simple Basic program to make the code readable.

By the way, if you just want to read the message, I'll give you a quick method at the end of this article.

Enter the following crude decoding program on your Commodore 128. Use 40 column mode, because I'm POKE–ing to the screen.

```
100 bank 15
110 print chr$(147);chr$(14)
120 print:print:print
130 for j = 1 to 156
140 x = xor(xor(peek(44643 + j),j),59)
150 m = 192:if(x and m) = 0 or (x and m) = m then m = 0
160 if (xor(x,m) and 32)>0 then m = xor(128,m)
170 poke 1023 + j,255 and xor(j,m)
180 next j
```

You'll see the message in crude screen format – formatting characters such as RETURN will appear as control characters, but it's readable.

If you just want to read the message, and don't care where it's stored or in the decoding process, there's an easier (and neater) way to see it on your 128 screen. Just type:

sys 32800,123,45,6

Verfizer For The Plus 4 and C128

By next issue we'll have a Verifizer for the B Machines and for the C128 in 80 Column mode. They'll all appear up at the front with the other Verifizer programs.

Plus 4 Verfizer

```
NI  1000 rem * data loader for " verifizer +4 "
PM  1010 rem * commodore plus/4 version
EE  1020 graphic 1: scnclr: graphic 0: rem make
            room for code
NH  1030 cs = 0
JI  1040 for j = 4096 to 4216: read x: poke j,x
            : ch = ch + x: next
AP  1050 if ch<>13146 then print " checksum error "
            : stop
NP  1060 print " sys 4096: rem to enable "
JC  1070 print " sys 4099: rem to disable "
ID  1080 end
PL  1090 data  76,  14,  16, 165, 211, 141,   2,   3
CA  1100 data 165, 212, 141,   3,   3,  96, 173,   3
OD  1110 data   3, 201,  16, 240,  17, 133, 212, 173
LP  1120 data   2,   3, 133, 211, 169,  39, 141,   2
EK  1130 data   3, 169,  16, 141,   3,   3,  96, 165
DI  1140 data  20, 133, 208, 162,   0, 160,   0, 189
LK  1150 data   0,   2, 201,  48, 144,   7, 201,  58
GJ  1160 data 176,   3, 232, 208, 242, 189,   0,   2
DN  1170 data 240,  22, 201,  32, 240,  15, 133, 210
GJ  1180 data 200, 152,  41,   3, 133, 209,  32, 113
CB  1190 data  16, 198, 209,  16, 249, 232, 208, 229
CB  1200 data 165, 208,  41,  15,  24, 105, 193, 141
PE  1210 data   0,  12, 165, 208,  74,  74,  74,  74
DO  1220 data  24, 105, 193, 141,   1,  12, 108, 211
BA  1230 data   0, 165, 210,  24, 101, 208, 133, 208
BG  1240 data  96
```

C128 Verifizer (40 column mode)

```
PK  1000 rem * data loader for " verifizer c128 "
AK  1010 rem * commodore c128 version
JK  1020 rem * use in 40 column mode only!
NH  1030 cs = 0
OG  1040 for j = 3072 to 3214: read x: poke j,x
            : ch = ch + x: next
JP  1050 if ch<>17860 then print " checksum error "
            : stop
MP  1060 print " sys 3072,1: rem to enable "
AG  1070 print " sys 3072,0: rem to disable "
ID  1080 end
GF  1090 data 208,  11, 165, 253, 141,   2,   3, 165
MG  1100 data 254, 141,   3,   3,  96, 173,   3,   3
HE  1110 data 201,  12, 240,  17, 133, 254, 173,   2
LM  1120 data   3, 133, 253, 169,  38, 141,   2,   3
JA  1130 data 169,  12, 141,   3,   3,  96, 165,  22
EI  1140 data 133, 250, 162,   0, 160,   0, 189,   0
KJ  1150 data   2, 201,  48, 144,   7, 201,  58, 176
DH  1160 data   3, 232, 208, 242, 189,   0,   2, 240
JM  1170 data  22, 201,  32, 240,  15, 133, 252, 200
KG  1180 data 152,  41,   3, 133, 251,  32, 135,  12
EF  1190 data 198, 251,  16, 249, 232, 208, 229,  56
CG  1200 data  32, 240, 255, 169,  19,  32, 210, 255
EC  1210 data 169,  18,  32, 210, 255, 165, 250,  41
AC  1220 data  15,  24, 105, 193,  32, 210, 255, 165
JA  1230 data 250,  74,  74,  74,  74,  24, 105, 193
CC  1240 data  32, 210, 255, 169, 146,  32, 210, 255
BO  1250 data  24,  32, 240, 255, 108, 253,   0, 165
PD  1260 data 252,  24, 101, 250, 133, 250,  96
```

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C-128's Help Key Redefined

Walter Kiceleff
Buenos Aires, Argentina

I really like your magazine and I would like to contribute by sending you this 'Curiosity' I discovered in my computer.

In the Commodore 128, you can redefine the 'HELP' key to use it like a Function key. The HELP key has a memory assignment of only 5 bytes (4168–4172). If you Poke these locations with the Ascii value of the characters you want to use; Presto! It works. For example:

```
10 for i=4168 to 4172
20 read a$: poke i,asc(a$)
30 next i
40 data p,r,i,n,t
```

If you want to add a carriage return, poke 4172,13. Then your message with have 4 letters (not 5) plus a carriage return.

Amiga Lattice C Notes

Robert Case
Springfield, Oregon

While using the Amiga Lattice C Compile, version 3.02, I encountered two problems. A description of each problem follows:

First Problem: *scanf*. . . When *scanf* was used in the following form, the program didn't halt and wait for keyboard input:

```
scanf ("%f%c\n", &first, &second);
```

When the form was changed to:

```
scanf (" %f %c\n", &first, &second)
```

The program would halt and wait for keyboard input. The addition of a space before each '%' corrected the problem.

Second Problem: letters "E" and/or "e". . . when these letters were used as a key to "exit" the program using 'scanf', their use was not recognized. When the letter "Q" was substituted for the letter "E", the program worked as expected. Is it possible that the letter "E" is a reserved word in this version of C?

Another point: it is often helpful while working from the CLI to have a larger STACK to prevent a system crash. I reset the stack to 8000 or even higher before programming and testing. *(See next Bit)*

Reading 8250–Formatted Disks with an 8050

Since the 8250 uses both sides of a diskette, you can't use an 8050 to read any data on the opposite side. Fortunately, the 8250 only uses the other side when the first side gets full. To find out if any data has been placed on the opposite side, check the number of blocks free. If there's less than 2052 blocks free, you can read all the files on the disk with an 8050.

1571's Can Be *too* Smart

We all know that the 1571 is the greatest thing since the return of the mini-skirt. But it tries so hard that it can confuse instead of help. For example, consider this sequence of events:

1) LOAD in a short (1 block) program from the C128
2) Remove the disk, put it into a 1541 and use a C–64 to replace the program with a different one
3) Put the disk back into the 1571 and LOAD "*",8

You would expect it to load in the new version of the program, right? Well, the 1571 still has the program in its RAM buffer, and thinks it can be smart and save time by giving you the copy from RAM instead of going out to disk. So, you get the original, un-modified program that doesn't even exist on the disk anymore. Proof that "A little knowledge is a dangerous thing". Or, as Nietzsche put it, "Better know nothing than half-know many things".

Holy Input–Buffer, Batman!

"Robin. . . I think there is a diabolical plot brewing at Commodore headquarters."

"Say it isn't so, Batman!"

"I'm afraid it is. Are you familiar with the Input buffer in the Commodore 64?"

"Well, Batman, from the Bat–Computer I've learned that BASIC program lines are stored in the input buffer after they're entered."

"Right Robin! I believe that after the lines are stored, they are also tokenized in the buffer, are they not?"

"Gosh, Batman, you're so right!"

"Very perceptive of you, Boy Wonder. Now I have but one more question for your keen mind: is the line number stored in the Input Buffer?"

"This one I know! Just like the Bat–Buffer here in the Cave, the C–64 Input Buffer only stores the line itself, without the line number."

"Excellent Robin! Now look at this Bat–Dump of the Commodore 128 Input buffer right after a line has been entered."

"Holy RAM–Chip! There's the line number at the start of the buffer, just as it was enterd by the user, leading zeros, trailing spaces and all! In ASCII! What kind of a fiend would concoct such a scheme?"

"The world is full of forces we don't understand, Robin. Commodore is just one of them. They've done the same with the Plus 4 and C–16 as well! Just thank the good Lord that we have Bat–Dumps, Bat–Anthologies, and the minds to comprehend them."

"Well said, Bat–Friend!"

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Letters

Help: Line Scanner Required: Some time ago, in 'some' computer magazine, I saw an advertisement for what I believe might have been called a 'line copier' or 'line scanner' for PCs. It was supposed to be able to copy printed or typed text directly from paper and put it in the computer's memory and, presumably, onto disk as sequential files. Is such a device available for the Commodore 64 ?

William R. Carr
R.R.#3, Box 233
Harrisburg, IL, USA
62946

About a year ago, The Transactor appeared at a computer show called the Computer Fair in the heart of Toronto. The booth next to ours was displaying a product that really caught our eye. It was a line scanner called the Omni–Reader. It worked in a novel manner: the "eye" of the reader was mounted on a vertical/horizontal slider assembly. A document would be placed underneath it and you would scan each line by hand with the slider. At a pretty good pace, it would recognize about 6 or 8 different type fonts, and send out their character codes to an RS232 port. We were impressed. So, in the true spirit of advancing with the times, Karl struck up a conversation with the sales rep, who promptly agreed to lend us one for a few days to try out.

Well, the people representing the Omni–Reader must have fallen off of the edge of the world because we never heard of them again. Too bad; an item like that deserves some terrific free press. My advice today is to hope that this letter/reply will generate some response from our reading audience. If anyone reading knows of a line scanner for the Commodore 64, or for that matter any computer, please drop us or William a line. We would really appreciate it.

Attention Hot 1541 Owners: Here's a bit of helpful information to help hot disk drive users to cool down.

An easy and inexpensive way to prevent overheating of your 1541 disk drive is to buy four new pencils and cut them down to two and a quarter inches, measured from the end of the eraser. Bevel the cut ends slightly with a pencil sharpener. Place the bevelled ends into the recessed screw holes on the underside of the disk drive. This allows fresh air to get to the breathers located on the underside of the drive.

I would also like to ask a question. If I get a C–128 will my C–64 modem be compatible with the C–128 in all modes? What about an interface for a printer?

Duane Barry, Cambridge, Ontario

A 1541 on four legs. It might catch on. I am pretty sure that 'hot' 1541 users all over will appreciate your advice. Thanks.

About the C64 modem. The modem will work in the C128 mode but not the CP/M mode, at least not yet. The modem itself is not at fault on this one. It's just that Commodore did not include a driver for the RS–232 port just yet in their release version of CP/M Plus. Word's out, though, that a version is available through Compuserve that supports RS–232 communications, and that within a few months Commodore will be releasing the same for general public consumption. About Compuserve and CP/M: apparently, Commodore has included some extra software that re–configures your C128 in C128 mode to act like a CP/M machine so you can download the new CP/M and store it on a CP/M formatted diskette. Just make sure that you are in C128 mode with an appropriate terminal package when you phone in, and have a CP/M formatted disk handy.

A regular Commodore serial printer will work in all modes of the C–128. If you have an interface that hangs off the serial port to some strange type of printer, chances are that it will work just fine. But if your interface, whatever the type, connects to the cartridge port, as with an IEEE interface, you can be pretty well assured that the C128 won't like it.

Take for example an IEEE interface that we all use at the magazine. It has been dubbed the GLINK (Garvin's Link). It is a terrific true-to-life IEEE interface for the Commodore 64. Its true beauty lies in the fact that it doesn't do anything: no extra commands and no special tricks. It just supplies a really fast IEEE interface for your 64 without consuming memory. It does this by swapping itself into ½ of the E ROM. The RAM underneath is left alone, assuming that one lead is hooked up correctly inside of the 64 to a resistor. But the C128 is a totally seperate system and the GLINK is not compatible with C128 ROM.

However, the GLINK will work on the C128 in 64 mode, as will most of the cartridge port cards for the 64. Be careful though - some have leads that are connected internally and the C128 PC board is much different than the C64. The GLINK, for instance, has a lead to the left lead of R44 on the 64; on the C128 it goes to Pin 29 of the OS8502 chip. This little trick was supplied to us by a gentleman we met recently while out in San Francisco.

One last point: the GLINK works fine with both Viewtron and Quantum Link downloads. The Viewtron software loads and runs fine from the IEEE drives, but the Quantum software must be loaded from a 1541 or compatible. But Quantum downloads to the IEEE work - just flip the GLINK switch back to serial when it's done.

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"... but if you fool me twice then I'm indeed a fool.": Thank you very much for publishing John Holttum's 'The Commodore 128: Impressions and Observations' in Vol. 6, Issue 5. Like many C–64 owners I suspect, I felt wined and dined by Commodore's advance advertising for the new C–128. But I was mildly suspicious because of their poor record with the Plus/4 and C–16, notably their failure to provide good documentation and programmer's support for those models, i.e. something akin to the 'Commodore 64 Programmers Reference Guide'. Also, the C–1541 disk drive's SAVE@ and SCRATCH (yes Ma, there's a SCRATCH bug too) bugs are a perpetual pain in the you–know–what for (a) programmers during the process of writing code, and (b) for the prospects of reliable database systems which involve scratching or replacing files on disk.

Thanks to Mr. Holttum and The Transactor, I no longer have any problem deciding whether to purchase the C–128/1571 system. Actually, I decided that my next disk drive would have to be a dual drive and presumably the 1572 is essentially just two 1571's in the same case. But in any case, I will not be buying the C–128/1571/1572 until there are plenty of independent public reports that Commodore has remedied the above mentioned problems. You can fool me once (the C–1541), but if you fool me twice them I'm indeed a fool.

John R. Menke, Chessoft Ltd., Mt. Vernon, IL

Nice to hear from you again John. There is a rumour that new 1571 ROMs are under construction that fix Save@ as well as other bugs. When it will be released and under what kind of offer we probably won't know 'till it's ready.

Documentation seems to be coming. Commodore is releasing a technical reference through SAM's again, Abacus has the "Internals" book and another on the way, and Jim Butterfield's book will be updated too.

Relative File Access In ML: Loved your excellent article on disk access from machine code in Volume 6 Issue 5, and yes I would like to see more code on the use of relative files.

So here's some stuff. The syntax in Basic for relative files is:

```
OPEN the command channel OPEN 15,8,15
OPEN the relative file         OPEN 2,8,2, "0:filename"
Set the POINTER to the record with:
PRINT#15, "P" +CHR$(channel#+96)+CHR$(lo–rec#)
      +CHR$(hi–rec#)+CHR$(character)
WRITE or READ the file with PRINT#2, INPUT#2, or GET#2
CLOSE the channels after use.
```

One word of caution; if you write to the file, IMMEDIATELY after writing the file, reset the pointer to the beginning of the file accessed with a recall to the set POINTER routine. This will stop any mess–up of files.

Sorry I don't have PAL but I'm saving my pennies up to get it. In machine code the routines are similar to your article.

```
OPEN Command Channel
        lda   #$0f
        tay
        ldx   #$08
        jsr   $ffba      ;setlfs
        lda   #$00
        jsr   $ffbd      ;setnam
        jsr   $ffc0      ;open
        jsr   $kerr      ;your kernal error routine

OPEN Relative File:
        lda   #$02
        tay
        ldx   #$08
        jsr   $ffba      ;setlfs
        lda   #<nam      ;lo address file name
        lda   #>nam      ;hi address file name
        jsr   $ffbd      ;setnam
        jsr   $ffc0      ;open
        jsr   $kerr      ;kernal error
        jsr   $derr      ;disk error check routine

Pointer Routine
        ldx   #$0f
        jsr   $ffc9      ;chkout channel 15
        ldy   #$00       ;length of word to send
;
load    =     *
        lda   word,y     ;load word
        jsr   $ffd2      ;output word to command channel
        iny
        cpy   #$05       ;end of word yet?
        bne   load
        jsr   $ffcc      ;clrchn
;
word   .byte $50, $5c, $01, $00, $01
```

The characters in WORD are:

$50 =	Ascii for the letter 'p'
$5c =	Ascii for channel # + 96 (2+96)
$01 =	Ascii for lo byte record # (#1)
$00 =	Ascii for hi byte record # (#0)
$01 =	Ascii for character # (first char)

To access any record all you have to do is update the 3rd, 4th, and 5th characters of WORD (lo/hi byte record#) before you call the POINTER routine. To write or read the data use the appropriate input or output routines as in your article.

It's easy and simple to use relative files. They are fun, fast and NOT computer memory robbers. Hope this info is of use.

John Houghton, Collingwood, Ontario

It's nice to hear a kind word mixed with some good advice. Thanks for all. I agree that a pretty large hole was left in my article by excluding relative file access, but I felt it hard to write pure theory without including a ML relative file access demo that worked in a

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friendly way, ie. verbose. As you have shown, ML relative file access is not code consuming. At the time I knew that the only code consuming part would be through trying to make it easily useable. Perhaps in a future issue I'll write up a good and friendly data base or something that people can use and learn from. Might be worth a shot.

In case it hasn't been noticed yet, I did encourage a little bit of bad practice in my article with the file read/write technique employed. With the PET, CBM, VIC and 64, code such as:

```
ldx   #lfinp
jsr   chkin      ;set input device
jsr   chrin      ;get a character
pha
ldx   #lfout
jsr   chkout     ;set output device
pla
jsr   chrout     ;write the character
```

Would have been acceptable, as stated in the article. Unfortunately, with a machine such as the C128 a mess would have developed. You have to make sure that CLRCHN was performed before setting either the input or output channels. For the example above, the statement 'JSR CLRCHN' should be inserted before the 'LDX #LF' for both input and output. This is actually good practice irregardless of the machine you are working on. A temporary lapse into bad form caused this unfortunate slip. Sorry about that.

Real Programmers. . .: In light of my first letter, I thought I'd better send you this. I found it after many hours of research (i.e. I got lucky looking through some old files). At any rate, I would really like to thank you for giving the ICLIG some free press.

Anyway, I have enclosed my subscription for The Transactor. Nasty trick on your part. Raising the price so we get a better discount. Gee, I wish I would have thought of that sooner.

Kent Tegels
Manager: International Commodore Language Interest Group
18112 North I
Fremont, NE, 68025

Real Programmers Don't Write Specs **by Peter S. Hill**
NCA Corporation

As taken from 'The Special Character Set' – September 1, 1983

Real programmers don't write specs - users should consider themselves lucky to get any programs at all and like what they get.

Real programmers don't comment their code. If it was hard to write, it should be hard to understand.

Real programmers don't write application programs; they program right down on the bare metal. Application programming is for feebs who can't do systems programming.

Real programmers don't eat quiche. In fact real programmers don't know how to SPELL quiche. They live on Twinkies, Doritos, Coke and Swechwan food.

Real programmers don't write in COBOL. COBOL is for wimpy applications programmers.

Real programmers' programs never work right the first time. But if you throw them on the machine they can be patched into working in 'only a few' 30–hour debugging sessions.

Real programmers don't write in FORTRAN. FORTRAN is for pipe stress freaks and crystallography weenies.

Real programmers never work 9 to 5. If any real programmers are around at 9 AM it is because they were up all night.

Real programmers don't write in BASIC. Actually, no programmers write in BASIC after the age of 12.

Real programmers don't write in PL/1. PL/1 is for programmers who can't decide whether to write in COBOL or FORTRAN.

Real programmers don't play tennis, or any other sport that requires you to change clothes. Mountain climbing in OK, and real programmers wear their climbing boots to work in case a mountain should suddenly spring up in the middle of the machine room.

Real programmers don't document. Documentation is for simps who can't read the listings or the object code.

Real programmers don't write in PASCAL or BLISS or ADA or any of those PINKO computer science languages. Strong typing is for people with weak memories.

We do receive the odd piece of mail from time to time. Thanks for relaying that strange bit of tongue–in–cheek programming advice. My addition today to Mr. Hill's list is 'Real programmers do it in their drives!'. A bit wierd but it seems to follow the pattern.

Help Required: I am looking for people interested in helping me type in the New Testament using a word processor. The processor I am presently using is SpeedScript, but another processor would be acceptable as long as the files are compatible, or could be converted for our use. I am using a Commodore 64, with a 1541 disk drive.

After collecting, compiling and editing all the incoming data, I would distribute the finished work to all the participants. If you are interested please call or write for assignments.

Randall J. Bernard
Box 630
Morenci, Arizona
85540 (602) 865–3550

Wow! What a doozy of a task. With a good database and indexing system though, it would be a terrific item. The ability to search the

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New Testament via disk would be ideal for report references. Let us know when it's done.

The Drive Disaster: Re: Trans. Disk #10. A Frantic Wave–Off! I tried 'Improved 1541 Head–Cleaning Program'. DISASTER! Drive was 100% OK before using prg. Drive is now in shop for re-alignment!

D.C. Kerrigan, Greenville, SC

The program as listed in the magazine, Volume 6 Issue 05 page 6, is perfect, as is the copy on disk #10. Although we can assure you of this and feel confident that the code was OK, your drive is still in intensive care. For this we offer two possible explanations.

1) The Commodore drives have an awful habit of getting stuck at times, causing them to no longer function properly for apparently no reason. The real crunch is that even after powering down, the drive doesn't return to normal. Often times this prompts people to bring their drive in for service. Unfortunately, this is often a waste of time and money. A simple initialization of a diskette in the offending drive will cure the problem. This strange occurence can be traced back to the drive's head being pushed out to an extreme position in either direction. Once in that position there exists a chance that the head will get stuck. Once stuck nothing but a drive initialization or a little internal push on the mechanism will help. Your drive may have been one of the unluckies that gets stuck in extreme positions.

2) The 'Improved Head–Cleaning Program' article stated that the program was not to be run twice in a row, as the quote to follow explains:

"The NEW at the end of the program is not an attempt at program protection, it's there as drive protection. This direct method of stepping the head does not update location $24. If the program was immediately rerun, the drive head could end up being stepped to track 35 or to bump up against the stop at track 0."

As a test, I deleted line 460 of the program then ran it for the first time. Following that I immediately re–ran the program to see what would happen. Around track 22 the drive mechanism started making an awful noise and continued to do so through track 35. Following this, I loaded in the directory. The drive chattered a bit initially but did finally load the directory. There was no permanent damage to the drive. My drive is almost new and in perfect mechanical shape. A drive that has had a few miles on it might not have faired as well. If this was the case, I still feel that an initialization would force the drive's head back into reality once again. Although running the program twice in a row would have been almost impossible as it was supplied on disk and listed in the magazine, it could have been accomplished as I stated above. Your problem can probably be written off to explanation #1. Just remember, when in a bind, initialize.

Verifizer Update: After recently retiring from 21 years of designing 'Little Black Boxes' for Cesna Aircraft Co., I purchased a C–64. I am primarily interested in graphics and animation. What little I have learned so far seems to indicate that machine language is the way to go. In pursuit of this I have been attempting to learn what I can about ML but have been disappointed with what I have found. It seems to me that your publication has much to offer towards this goal. . .

. . . One small problem: When using 'Verifizer', the left character of the check signal hides in the upper left corner of the monitor. How do I move it about two spaces to the right?

W.D. Ackerson, Wichita, Kansas

As you have discovered, The Transactor lives for machine language. However, there are a few good books on the market to teach you the basics through extremes of talking to your computer in its mother tongue. One book, which I can't say enough good things about, is Jim Butterfield's Machine Language Book. Published by Bradey/Prentice–Hall, it's an educational dream front to back. If you ever see it in a book store, do it the service of a quick look–over. You will probably be impressed.

About your Verifizer blues: there is a cure. Steve Walley, a reader in Sunnymead CA, ran into the same problem that you did, and as such sent us his modified version of Verifizer that prints two sets of Verifizer checksums on the screen. See 'Double Verifizer' in Volume 6 Issue 06 on page 5.

Sky Travel Support: I enjoyed the review of Sky Travel and would like to mention that I agree with your assessment of the program. What's more. I might just mention a couple of quick utilities:

A seasoned veteran amateur astronomer friend of mine was so delighted with Sky Travel, he dumped his color computer system and purchased a Commodore 64. During December and January we used the program to locate Halley's Comet (as well as several other objects) with surprising accuracy. As a rank amateur astronomer, (I barely know the correct end of a telescope to look in) I was able to locate the comet using hard copy from the program, a compass and binoculars. However, for those with sophisticated systems, the data generated for right ascention and declination seem to be right on the button (provided of course your location and times are correct).

Several friends of mine who are also ham radio operators, are experimenting with using the program for moon bounce. The tracking feature and program's apparent accuracy make this a natural.

I have also used the program with my children (and myself) to become a bit more familiar with the southern New Jersey skies (when the garbage in the air is not too bad).

It's a first rate package and one which ought to cost at least three or four times more than it does. . . an extraordinary buy for $29.95 - especially given what you can do with it and the information it contains. . . and especially given how much is charged for many poor packages.

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Commodore did us a favour putting that one out. . . hope people do take advantage of it.

Peter R. Bent, West Deptford, NJ

Frank Covitz reads The Transactor. Frank Covitz wrote Sky Travel. I am pretty sure that Frank is smiling right about now. But only about the compliment. It seems that Sky Travel is often times pretty difficult to locate. Frank wrote the package but Commodore kind of distributed it. At one point, right about the time that my review was published, Sky Travel was close to being listed as missing in action. But a mixture of public pressure and common logic brought the Sky Travel back from the dead into retail distribution once again. If for any reason anyone would like to get a copy of Sky Travel but can't find it anywhere, then either phone or write Commodore direct, or if that doesn't work, drop us a line. We'll make sure that your request does not go unheard. Frank did too good of a job to allow Sky Travel to fade away so easily.

LADS to PAL Conversion: My recent subscription to The Transactor has gone far in rescuing this amateur from some sort of computer oblivion. Other mags are just fine and often very helpful but games and ads get in the way quite a lot. In The Transactor one finds a balanced, practically fat-free diet of pertinent, challenging and useful information. In short, I'm a very happy customer.

Quite apart from this statement of unbridled joy, I found a statement by Nick Sullivan on page 15 of my first issue (Vol.6, Issue 03) indicating that his Transbasic practically requires the use of a PAL assembler.

I use a RAM-based version of Richard Mansfield's LADS/64 assembler and find it very dependable and easy to use.

Without experience with any other assembler, I find it difficult to decide whether it would be possible to translate Transbasic for assembly with the unit I use. Your advice would be helpful at this point.

R.G. Tischer, Starkville, MS

To best help out everyone trying to convert PAL format to their own special brand of assembler, it might be best if I run down a few of the main PAL directives to be found in The Transactor. They are as follows:

.OPT

This pseudo–op is a directive of output (OutPuT). There are a number of ways to use it. For example:

```
.OPT N    ;Outputs nothing. Just checks assembly to see if errors
           exist.
.OPT OO   ;Outputs object to origin (memory).
.OPT O8   ;Outputs object to device #8 (ie. OPEN 8,8,1,"0:fi-
           lename" before)
.OPT P    ;Outputs source listing to the default output device
           during assembly
.OPT P4   ;Outputs source listing to device #4 (ie. OPEN 4,4
           executed before)
```

Further to this, .OPT can be forced to perform multiple directives of output. For example:

```
.OPT O8, P4 ; would output the Object to unit 8 and Print the
              source listing to unit #4.
```

To continue, you will notice a SYS700 at the start of all PAL source listings for the 64. This calls PAL so that whatever follows will be treated as assembler source code. For other assemblers, this is either omitted or substituted with whatever command starts up the assembly process.

To set the origin that you would like your code to be assembled, you would use a statement such as this:

```
*=$C000
```

The '*' represents the current program counter, so in effect you are telling the assembler that the program counter should equal $C000. Some assemblers use .ORG but the "splat" is more common.

.WORD and .BYTE

These pseudo-ops allow either bytes to be assigned to RAM, or space to be set aside for the same. Most assemblers use the same conventions but I have seen .DW (define word, I guess) and .DS (define storage?). .WORD 0,0 is Ok as is .BYTE 0,1,2,3,4,5,6,7,8 etc. They both allow RAM vectors to be set, or byte tables, or word tables.

.ASC allows strings to be placed in memory such as:

```
.ASC "A STRING IN MEMORY"
```

Other than these few quicky psuedo ops, you will find we rarely use any of others, such as .FILE to chain in other source files, .BAS to write Basic code within your assembly listing, and great scads more. For a more detailed synopsis of PAL commands, look in Karl's 'Complete Inner Space Anthology'. You will find that most RAM-based assemblers can take advantage of our source listings.

TransBASIC, however, requires that modules be "merged" together. This is why they seem, at first glance, to have odd line number sequences. You'll notice that certain "areas" of each module are written in very specific line ranges. This is so they merge together with the same "areas" of other modules. If your assembler 1) uses the BASIC editor to create source code files, or 2) has a merge feature, you should have no problem after making the previously mentioned adjustments. Otherwise you may have to simulate the merging process.

Don't forget, The TransBASIC Disk is now available and comes complete with the SYMASS assembler. For $9.95, TransBASIC becomes a totally self-contained utility. See our order card.

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TransBASIC Installment #9

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The TransBASIC Disk

The TransBASIC Disk contains all of the modules published so far and it comes with its own assembler, SYMASS 3.1. Any combination of modules can be linked into BASIC with only a few simple steps. From start to finish is usually no more than a couple of minutes. . . even less once you get the hang of it. It comes with a handy reference for just $9.95. See the order card at center page.

TransBASIC Parts 1 to 8 Summary:

Part 1: *The concept of TransBASIC – a custom command utility that allows one to choose from a library only those commands that are necessary for a particular task.*

Part 2: *The structure of a TransBASIC module – each TransBASIC module follows a format designed to make them simple to create and "mergeable" with other modules.*

Part 3: *ROM routines used by TransBASIC – many modules make use of ROM routines buried inside the Commodore 64. Part 3 explains how to use these routines when creating new modules.*

Part 4: *Using Numeric Expressions – details on how to make use of the evaluate expression ROM routine.*

Part 5: *Assembler Compatibility – TransBASIC modules are written in PAL Assembler format. Techniques for porting them to another assembler were discussed here.*

Part 6: *The USE Command – The command 'ADD' merges TransBASIC modules into text space. However, as more modules are ADDed, merging gets slow. The USE command was written to speed things up. USE also counts the number of statements and functions USEd and updates the totals (source line 95) automatically.*

Part 7 – *Usually TransBASIC modules don't need to worry about interfering with one another. When two or more modules want to alter the same system vector, however, a potential crash situation exists. Part 7 deals with avoiding this problem.*

Part 8 – *Describes the five modules for Part 8.*

TransBASIC Part 9

This issue I want to do nothing more than present a few short modules that will bring this column into step with the new TransBASIC Disk.

First off (Program 1) is String Synthesis, which contains a handful of specialized functions for generating special strings. The most instructive of these from a module–creator's point of view is the BUILD$(function, which is a sort of glorified CHR$(that can take multiple PETSCII arguments, including ranges, to build special strings.

The ability of BUILD$(to handle multiple arguments means that we have to be careful in managing the memory used for intermediate results, since each argument can itself be a complex expression with its own function calls, theoretically even including calls to BUILD$(itself. For this reason, BUILD$(uses the two routines PSHTEM and PULTEM, which together take care of saving and restoring the temporary memory registers T2 through T6 whenever a new argument is evaluated.

This might be a good time to mention a couple of things that distinguish statements from functions with respect to zero page storage. One is that the locations $14 and $15 are used by statements only, never by functions, so you can expect data store in those locations to survive expression evaluations intact, no matter how complex the expression may be. The POKE statement, for example, stores the POKE address at $14/15 before evaluating the POKE value. Just remember never to use $14/15 for storage when writing functions of your own, or you'll end up clobbering some innocent statement that calls your function.

Another point is that both statements and functions have access to the TransBASIC storage area T2 through T6. If you use this area and then evaluate an expression, do not expect the registers to be unchanged. Either push the values onto the stack with the PSHTEM routine, or one like it, or create a storage area within your own program code.

The Delay module (Program 2) contains a single statement, DELAY, which hangs the computer for a specified number of hundredths of seconds. One thing you might want to adopt for your own programs is the check for the STOP key (JSR $A82C), which will break automatically to direct mode if the key is down.

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The Slide module (Program 3) contains the statement SLIDE, which lets you move a sprite by specifying a displacement (relative) rather than a destination (absolute). SLIDE will wait until the raster scan is off the current location of the sprite before allowing it to move: in most cases this eliminates the shearing effect that arises when the raster catches a sprite in motion. Another interesting thing about SLIDE is that you can specify the direction of movement either as an integer or as a string. The routine that interprets the input might be useful in other commands as well.

The Make module (Program 4) contains the statement MAKE, which prints a specified number of repetitions of a string. You can use this to produce patterns and borders, and strings requiring repetitive cursor movement.

The Centre module (Program 5) contains the statement CENTRE, which prints a specified string of up to 40 characters centred on the monitor screen. The handy thing about this command is that it ignores control characters in the string (RVS and colour control characters, for example) when deciding how far to indent the string.

Finally, the Vocab Manager module (Program 6) contains two statements and two functions that will help in vocabulary searching applications like adventure games. The FILE statement, which is similar in structure to DATA, reads in alphanumeric strings and stores them under the BASIC ROM. With the SCAN(function, you can find the position of a particular string within the vocabulary.

When Vocab Manager is combined with other modules like Inline (in TransBASIC #8), First & BF$ (#7), and Strip & Clean (#4), many applications that depend on input parsing become much simpler to program. Not only that, but the strings stored in the vocabulary are unknown to BASIC itself, and will not create garbage collection problems.

New Commands

DELAY (Type: Statement   Cat #: 026)
Line Range: 3180–3214
Module: DELAY
Example: IF A = B THEN DELAY 100: PRINT "WHAT?"
Execution is suspended for the specified number of hundredths of seconds (0 to 65535). The timing is not accurate for very small values.

SLIDE (Type: Statement   Cat #: 043)
Line Range: 3830–3928
Module: SLIDE
Example: FOR I = 1 TO 30: SLIDE 0, "E": NEXT
Example: SLIDE 3,2,84
Example: DI$ = "U": SLIDE 7,DI$,2
This command takes two arguments plus an optional third. The first is the sprite number (0–7), the second the direction in which it is to be displaced, and the third is the amount of displacement. If the third argument is not present it is taken to be one. The second argument may be given as a number from 0 to 3; as a string beginning with one of "n", "e", "s", "w"; or as a string beginning with one of "u", "r", "d", "l". The strings may be in either upper or lower case.

MAKE (Type: Statement   Cat #: 048)
Line Range: 4106–4142
Module: MAKE
Example: MAKE 22, "TRANSBASIC" + CHR$(13)
The string argument is printed the specified number of times (up to 255) from the current cursor position.

CENTRE (Type: Statement   Cat #: 049)
Line Range: 4144–4192
Module: CENTRE
Example: CENTRE "A PAINTED SHIP UPON A PAINTED OCEAN"
The string is centred on the current screen line. Control characters are ignored in calculating the offset from the margin. Strings longer than 40 characters (not counting control characters) generate a STRING TOO LONG error.

FILE (Type: Statement   Cat #: 050)
Line Range: 4194–4272
Module: VOCAB MANAGER
Example: FILE "SWORD,MACE,SPEAR,POISON–TIPPED BANANA
The strings separated by commas are stored under the BASIC ROM starting at $A001 (40961). A pointer (FLPTR) points to the next free byte. Only alphanumerics are stored. Upper case alphabetics are converted to lower case. A vocabulary built by FILE statements can be searched with the SCAN(function (053). The only quote allowed in a FILE statement is the one that precedes the string data; also, no other statement may follow the FILE statement on the same line.

INITFP (Type: Statement   Cat #: 051)
Line Range: 4274–4306
Module: VOCAB MANAGER
Example: INITFP
Example: INITFP 43257
The FILE statement pointer is initialized. If no parameter is present the pointer is initialized to address 40961. If a parameter between 40961 ($A001) and 49151 ($BFFF) is present the pointer is initialized to that address. The second form of the INITFP statement would normally be used only when a prepared vocabulary is loaded from disk, instead of being generated from FILE statements within a program. In this case the FILE statement pointer would have to be initialized to the value determined with the FPLOC function (052) after the vocabulary was first generated.

FPLOC (Type: Function   Cat #: 052)
Line Range: 4308–4314
Module: VOCAB MANAGER
Example: PRINT FPLOC–40961
A quasi-variable returning the current value of the FILE statement pointer (40961 to 49151).

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SCAN (Type: Function Cat #: 053)
Line Range: 4316–4468
Module: VOCAB MANAGER
Example: IF SCAN(AN$)<83 GOTO 770
The vocabulary compiled by the FILE statement is searched for an entry matching the argument string. Only alphanumerics are used in the comparison, and upper case alphabetic characters are converted to lower case. The number of the first matching vocabulary entry is returned, counting from one. Zero is returned if the search is unsuccessful.

ALPH$ (Type: Function Cat #: 021)
Line Range: 2894–2900
Module: STRING SYNTHESIS
Example: PRINT LEFT$(ALPH$,13)
A quasi-variable that returns a string consisting of the lower case alphabet.

UCALPH$ (Type: Function Cat #: 022)
Line Range: 2902–2908
Module: STRING SYNTHESIS
Example: PRINT ALPH$ + UCALPH$
A quasi-variable that returns a string consisting of the upper case alphabet.

NUM$ (Type: Function Cat #: 023)
Line Range: 2910–2926
Module: STRING SYNTHESIS
Example: A = AWAIT(NUM$)
A quasi-variable that returns a string consisting of the digits from 0 to 9.

RVS$ (Type: Function Cat #: 024)
Line Range: 2928–2984
Module: STRING SYNTHESIS
Example: PRINT RVS$("RUMPELSTILTSKIN")
Returns the argument string in reverse order (in this case, "NIKSTLITSLEPMUR").

BUILD$ (Type: Function Cat #: 025)
Line Range: 2986–3098
Module: STRING SYNTHESIS
Example: A$ = BUILD$(36,48;57,32,65;70)
Returns a string specified by its ASCII components. Individual values may be specified, as well as ranges. In the latter case the low and high ends of the range are separated by a semicolon. The string "$0123456789 ABCDEF" is returned by the example.

Program 1: STRING SYNTHESIS

```
OE  0 rem string synthesis (aug 29/84)   :
FH  1 :
MH  2 rem 0 statements, 5 functions
HH  3 :
CF  4 rem keyword characters: 28
JH  5 :
NJ  6 rem keyword        routine    line    ser #
MI  7 rem f/alph$        alph       2894    021
CB  8 rem f/ucalph$      ucalph     2902    022
OE  9 rem f/num$         num        2910    023
BK  10 rem f/rvs$(       rvs        2928    024
MO  11 rem f/build$(     build      2986    025
AI  12 :
EN  13 rem u/pshtem (3100/060)
KP  14 rem u/pultem (3134/061)
HP  15 rem u/kpftop (3156/062)
EI  16 :
PD  17 rem ================================
GI  18 :
LC  603 .asc "alph":.byte$a4:.asc "ucalph"
        :.byte$a4:.asc "num":.byte$a4
CF  604 .asc "rvs$":.byte$a8:.asc "build$":.byte$a8
KK  1603 .word alph-1,ucalph-1,num-1
MB  1604 .word rvs-1,build-1
OB  2894 ucalph  lda  #"A"       ;range of upper
EE  2896         ldx  #"Z"       ; case alphabet
HH  2898         bne  num1
KM  2900 ;
DG  2902 alph    lda  #"a"       ;range of lower
MM  2904         ldx  #"z"       ; case alphabet
PH  2906         bne  num1
CN  2908 ;
IB  2910 num     lda  #"0"       ;range of digits
OL  2912         ldx  #"9"
CM  2914 num1    sta  t3
PE  2916         lda  #0
EM  2918         sta  t2
DK  2920         lda  #$80
MM  2922         sta  t4
AH  2924         bne  bu2
EO  2926 ;
AJ  2928 rvs     jsr  $aef4      ;eval expr, chk ')'
PK  2930         jsr  $b6a3      ;create descriptor
CD  2932 rv1     sta  $61        ;save length
KK  2934         stx  t5         ;save pointer
AH  2936         sty  t6         ; to string
EG  2938         jsr  $b47d      ;allocate memory
KE  2940         tay             ;test string null
EH  2942         beq  rv3        ; yes
CM  2944         dey             ;index to last char
IM  2946         lda  #0         ;index to 1st chart
MB  2948         sta  t2         ;lower index save
PL  2950 rv2     sty  t3         ;upper index save
FB  2952         lda  (t5),y     ;get upper char
GK  2954         pha             ;set it aside
HB  2956         ldy  t2         ;get lower index
FC  2958         lda  (t5),y     ;get lower char
LP  2960         tax             ;set it aside
GK  2962         pla             ;re-get upper char
PA  2964         sta  ($62),y    ;store as lower
NN  2966         txa             ;re-get lower char
DF  2968         ldy  t3         ; and upper index
NC  2970         sta  ($62),y    ;store as upper
OH  2972         beq  rv3        ;when len(str) = 1
HN  2974         inc  t2         ;bump lower index
AO  2976         dey             ;back upper index
HO  2978         cpy  t2         ;test indices cross
GD  2980         bcs  rv2        ; not yet
PG  2982 rv3     jmp  $b4ca      ;return str descr
OB  2984 ;
HK  2986 build   ldy  #0         ;clear temp storage
KG  2988         sty  t2
AH  2990         sty  t4
DL  2992 bu1     jsr  pshtem     ;push t2 - t6
CG  2994         jsr  kpf1       ;eval byte to .x
```

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```
OK  2996          stx  $67      ; and save
GA  2998          jsr  pultem   ;pull t2 – t6
KK  3000          ldx  $67      ;retrieve byte
HH  3002          stx  t3       ; and save
EL  3004          jsr  $79      ;test range char
LA  3006          cmp #";"
MJ  3008          bne  bu2      ; no
EA  3010          jsr  pshtem   ;push t2–t6
LJ  3012          jsr  kpftop   ;eval byte to .x
AM  3014          stx  $67      ; and save
IB  3016          jsr  pultem   ;pull t2–t6
ML  3018          ldx  $67      ;retrieve byte
HN  3020 bu2      txa           ;test upper bound
BK  3022          sec           ; >= lower bound
CA  3024          sbc  t3
EJ  3026          bcc  bu7      ; no
MO  3028          adc  #0       ;test rangesize 256
LM  3030          bcs  bu8      ; yes
DD  3032          pha           ;push rangesize
LI  3034          adc  t2       ;test result > 255
BN  3036          bcs  bu8      ; yes
NE  3038          sta  t2       ;save result so far
PC  3040          pla           ;pull rangesize
HE  3042          stx  t3       ;save upper bound + 1
OP  3044          jsr  $b47d    ;reserve str space
LH  3046          stx  $22      ;create pointer to
FH  3048          sty  $23      ; string data
FE  3050          ldx  t3       ;get upper bound + 1
PD  3052          sta  t3       ;save string size
LO  3054          ldy  #$ff     ;init index to str
DJ  3056 bu3      txa           ;char to store
FJ  3058          iny           ;bump index
KC  3060          cpy  t3       ;test = string size
NN  3062          beq  bu4      ; yes
MJ  3064          sta  ($62),y  ;store character
JL  3066          dex           ;next char down
NJ  3068 bcc      bu3           ;branch always
DF  3070 bu4      bit  t4       ;test alph$ etc
FO  3072          bmi  bu6      ; yes
OG  3074          jsr  $79      ;test more to build
EC  3076          cmp #","
LO  3078          bne  bu5      ; no
FD  3080          jsr  $73      ;skip comma
OM  3082          bne  bu1      ;branch always
EO  3084 bu5      jsr  $aef7    ;check close paren
JG  3086 bu6      lda  t2       ;create descriptor
KP  3088          ldx  $62
DA  3090          ldy  $63
KF  3092          jmp  rv1      ;reverse the string
HP  3094 bu7      jmp  $b248    ;'illegal quantity'
OK  3096 bu8      jmp  $a571    ;'string too long'
AJ  3098 ;
EA  3100 pshtem   lda  #3       ;check 6 stack
IC  3102          jsr  $a3fb    ; bytes free
LH  3104          pla           ;save return addr
NO  3106          sta  $71
MK  3108          pla
EP  3110          sta  $72
NM  3112          ldx  #4       ;push t6 to t2
HC  3114 pht1     lda  t2,x
IK  3116          pha
FO  3118          dex
EH  3120          bpl  pht1
KG  3122 pht2     lda  $72      ;retrieve rts addr
AL  3124          pha
DM  3126          lda  $71
EL  3128          pha
GC  3130          rts
CL  3132 ;
PB  3134 pultem   pla           ;save return addr
LA  3136          sta  $71
KM  3138          pla
CB  3140          sta  $72
DD  3142          ldx  #$fb     ;pull t2 to t6
FN  3144 plt1     pla
GG  3146          sta  $7,x
IC  3148          inx
FI  3150          bmi  plt1
PK  3152          bpl  pht2     ;retrieve rts addr
IM  3154 ;
AO  3156 kpftop   jsr  $73      ;skip separator
HN  3158 kpf1     lda  $33      ;push fretop ptr
EN  3160          pha
IO  3162          lda  $34
IN  3164          pha
OA  3166          jsr  $b79e    ;eval byte to .x
IM  3168          pla           ;pull fretop ptr
OC  3170          sta  $34
MO  3172          pla
PC  3174          sta  $33
EF  3176          rts
AO  3178 ;
```

Program 2: DELAY

```
HK  0 rem delay (aug 25/84)          :
FH  1 :
AI  2 rem  1 statement, 0 functions
HH  3 :
FO  4 rem keyword characters: 5
JH  5 :
NJ  6 rem keyword     routine    line    ser #
JO  7 rem delay       dela       3180    026
MH  8 :
HD  9 rem ================================
OH  10 :
DH  106 .asc "delaY"
IG  1106 .word dela–1
KB  3180 dela     jsr  $ad8a    ;eval num expr
CC  3182          jsr  $b7f7    ;conv to int at $14
OK  3184 de1      ldy  #$0e     ;count 1/100 sec
MC  3186 de2      ldx  #$85
NG  3188 de3      dex
PF  3190          bne  de3
DD  3192          dey
AG  3194          bne  de2
FN  3196          jsr  $a82c    ;check stop key
IC  3198          ldx  $14      ;decrement counter
MG  3200          bne  de4
PG  3202          ldy  $15
FN  3204          beq  de5      ;countdown complete
OA  3206          dec  $15
PG  3208 de4      dec  $14
IG  3210          jmp  de1      ;not done yet
KK  3212 de5      rts
EA  3214 ;
```

Program 3: SLIDE

```
HL  0 rem slide (aug 25/84)          :
FH  1 :
```

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```
AI  2 rem  1 statement, 0 functions
HH  3 :
FO  4 rem keyword characters: 5
JH  5 :
NJ  6 rem keyword     routine    line    ser #
JL  7 rem s/slide     slid       3830    043
MH  8 :
DP  9 rem  u/chkspr (3664/037)
CM  10 rem u/raschk (3676/038)
GL  11 rem u/direct (3930/044)
KN  12 rem d/powers (3694/039)
BI  13 :
MC  14 rem  this module also contains one
NO  15 rem  line from set sprites -- 3624
EI  16 :
PD  17 rem ================================
GI  18 :
DI  110 .asc " slidE "
GJ  1110 .word slid-1
PB  3624 xs3     jmp  $b248      ;'illegal quantity'
JO  3664 chkspr  jsr  $73        ;skip byte
OC  3666 chs1    jsr  $b79e      ;eval expr to .x
HL  3668         cpx  #8         ;test valid sprite
OF  3670         bcs  xs3        ; no
EE  3672         rts
AN  3674 ;
JD  3676 raschk  pha
FO  3678 ras1    lda  $d012      ;get raster pos'n
FG  3680         sbc  $d001,x    ;test above sprite
IF  3682         bcc  ras2       ; yes
JB  3684         cmp #$2b        ;test below sprite
EB  3686         bcc  ras1       ; no
FN  3688 ras2    pla
GF  3690         rts
CO  3692 ;
FJ  3694 powers  .byte 1,2,4,8,16,32,64,128
GO  3696 ;
HF  3830 slid    jsr  chs1       ;eval sprite #
MJ  3832         stx  $14        ;save
MO  3834         jsr  $aefd      ;check for comma
LL  3836         jsr  direct     ;get direction
PA  3838         pha             ;push direction
NN  3840         lda  $14        ;push sprite #
OH  3842         pha
NI  3844         lda  #1         ;save default
NN  3846         sta  t3         ; displacement
EC  3848         jsr  $79        ;test for comma
KC  3850         cmp # " , "
EO  3852         bne  sl1        ; no
KH  3854         jsr  $b79b      ;eval displacement
ON  3856         stx  t3         ; and store
JF  3858 sl1     pla             ;pull sprite #
BI  3860         tay             ;mask index .y
NP  3862         asl             ;position index .x
DO  3864         tax
PB  3866         pla             ;pull direction
GE  3868         jsr  raschk     ;wait for raster
JD  3870         bne  sl2        ;direction not up
AB  3872         lda  $d001,x    ;subtract disp
CC  3874         sbc  t3         ; from y-pos'n
HF  3876         sta  $d001,x
CB  3878         rts
HO  3880 sl2     cmp #2          ;test dir down
IA  3882         bne  sl3        ; no
KE  3884         clc             ;add disp
NA  3886         lda  $d001,x    ; to y-pos'n
EE  3888         adc  t3
FG  3890         sta  $d001,x
AC  3892         rts
EG  3894 sl3     cmp #1          ;test dir right
MB  3896         bne  sl5        ; no
OJ  3898         lda  $d000,x    ;add disp
NN  3900         clc             ; to y-pos'n
CF  3902         adc  t3
CH  3904         sta  $d000,x
IH  3906         bcc  sl6        ;don't cross seam
LH  3908 sl4     lda  $d010      ;toggle msb
GF  3910         eor  powers,y   ; of x-pos'n
OB  3912         sta  $d010
GD  3914         rts
NG  3916 sl5     lda  $d000,x    ;subtract disp
NG  3918         sec             ; from x-pos'n
CI  3920         sbc  t3
EI  3922         sta  $d000,x
JF  3924         bcc  sl4        ;cross seam
LK  3926 sl6     rts
OM  3928 ;
LO  3930 direct  jsr  $ad9e      ;eval direction
JA  3932         bit  $0d        ;test expr type
DD  3934         bmi  di1        ; string
OB  3936         jsr  $b7a1      ;eval numeric to .x
LK  3938         cpx  #4         ;test < 4
KE  3940         bcs  di5        ; no
IC  3942         txa             ;return dir in .a
EF  3944         rts
MP  3946 di1     jsr  $b6a6      ;create descriptor
KJ  3948         tay             ;test length zero
MD  3950         beq  di3        ; yes
CB  3952         ldy  #0         ;get first char
ED  3954         lda  ($22),y
CO  3956         ldy  #$0f       ;test valid dir
NG  3958 di2     cmp dirs,y
JE  3960         beq  di4        ; yes
FD  3962         dey
MI  3964         bpl  di2
EH  3966 di3     jmp  $af08      ;'syntax'
KC  3968 di4     tya             ;reduce to numeric
LF  3970         lsr
NF  3972         lsr
CH  3974         rts
BE  3976 di5     jmp  $b248      ;'illegal quantity'
AA  3978 ;
CD  3980 dirs    .asc " UuNnRrEeDdSsLlWw "
EA  3982 ;
```

Program 4: MAKE

```
AM  0 rem make (aug 25/84)              :
FH  1 :
AI  2 rem  1 statement, 0 functions
HH  3 :
EO  4 rem keyword characters: 4
JH  5 :
NJ  6 rem keyword     routine    line    ser #
IO  7 rem make        mak        4106    048
MH  8 :
HD  9 rem ================================
OH  10 :
```

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```
LI | 111 .asc "makE"
CF | 1111 .word mak-1
FD | 4106 mak  jsr  $b79e    ;eval # repetitions
OC | 4108      txa           ;push
KI | 4110      pha
CA | 4112      jsr  $aefd    ;check for comma
MM | 4114      jsr  $ad9e    ;eval string
BA | 4116      jsr  $b6a3    ;make descriptor
HJ | 4118      tay           ;string length
FC | 4120      pla           ;pull # repetitions
AH | 4122      sta  t3       ;countdown register
DN | 4124      tya
PI | 4126 mak1 ldx  t3       ;get remaining reps
FD | 4128      beq  mak2     ;all done
OE | 4130      dec  t3       ;count down
AE | 4132      pha           ;print string
DG | 4134      jsr  $ab24
AL | 4136      pla
JF | 4138      jmp  mak1
DN | 4140 mak2 rts
EK | 4142 ;
```

Program 5: CENTRE

```
FD | 0 rem centre (sept 4/84)              :
FH | 1 :
AI | 2 rem  1 statement, 0 functions
HH | 3 :
GO | 4 rem keyword characters: 6
JH | 5 :
NJ | 6 rem keyword      routine    line    ser #
KG | 7 rem centre       cntr       4144    049
MH | 8 :
HD | 9 rem ===============================
OH | 10 :
PO | 112 .asc "centrE"
IL | 1112 .word cntr-1
MP | 4144 cntr jsr  $ad9e    ;eval string
PB | 4146      jsr  $b6a3    ;make descriptor
NF | 4148      tay           ;index from str end
HJ | 4150      pha           ;push string length
MG | 4152      ldx  #0       ;# printable chars
PK | 4154 ce1  dey           ;back up index
MA | 4156      cpy  #$ff     ;test done
AA | 4158      beq  ce2      ; yes
CI | 4160      lda  ($22),y  ;get a character
JJ | 4162      and  #$7f     ;clear high bit
OM | 4164      cmp  #$20     ;test ctrl char
HM | 4166      bcc  ce1      ; yes
KD | 4168      inx           ;bump counter
PO | 4170      bne  ce1      ;branch always
FK | 4172 ce2  txa           ;test counter <= 40
PM | 4174      sec
NK | 4176      sbc  #$29
MC | 4178      bcs  ce4      ; no
DJ | 4180      eor  #$ff     ;negate and halve
CB | 4182      lsr           ; result
KM | 4183      ldx  $d3      ;test logical line
KJ | 4184      cpx  #$28     ; 40 or 80
IJ | 4185      bcc  ce3      ; 40
OP | 4186      adc  #$27     ;add 40 (carry set)
DP | 4187 ce3  sta  $d3      ;set cursor horiz
BL | 4188      pla           ;pull string length
PF | 4189      jmp  $ab24    ;print string
```

```
LP | 4190 ce4      jmp  $a571
GN | 4192 ;
```

Program 6: VOCAB MANAGER

```
CL | 0 rem vocab manager (aug 29/84)       :
FH | 1 :
JH | 2 rem 2 statements, 2 functions
HH | 3 :
CE | 4 rem keyword characters: 20
JH | 5 :
NJ | 6 rem keyword      routine    line    ser #
KM | 7 rem s/file       fil        4194    050
IE | 8 rem s/initfp     infptr     4274    051
JL | 9 rem f/fploc      fplo       4308    052
JD | 10 rem f/scan(     scan       4316    053
PH | 11 :
OH | 12 rem u/cifchr (2560/003)
PE | 13 rem u/usfp   (2620/006)
CN | 14 rem u/cifnum (4092/047)
NN | 15 rem d/flptr  (4470/054)
EI | 16 :
PD | 17 rem ================================
GI | 18 :
DN | 113 .asc "filEinitfP"
OB | 610 .asc "fploCscan":.byte$a8
PF | 1113 .word fil-1,infptr-1
EC | 1610 .word fplo-1,scan-1
HC | 2560 cifchr  cmp #$5b       ;test alphabetic
OK | 2562         bcc  cic1      ; and if so return
LK | 2564         clc            ; carry set
FM | 2566         bcc  cic2
OB | 2568 cic1    cmp #$41
FJ | 2570 cic2    rts
CI | 2572 ;
GK | 2620 usfp    ldx  #0        ;convert .a/.y
AH | 2622         stx  $0d       ; to floating point
DN | 2624         sta  $62       ; from unsigned
OO | 2626         sty  $63       ; 16-bit integer
ON | 2628         ldx  #$90
HM | 2630         sec
NH | 2632         jmp  $bc49
AM | 2634 ;
AE | 4092 cifnum  cmp #":"       ;test numeric
LM | 4094         bcc  cin1      ; and if so return
HK | 4096         clc            ; carry set
CO | 4098         bcc  cin2
KP | 4100 cin1    cmp #"0"
NL | 4102 cin2    rts
OH | 4104 ;
NC | 4194 fil     cmp #$22       ;test leading quote
CD | 4196         bne  fi4       ; no
FM | 4198         ldy  flptr     ;make pointer to
IJ | 4200         lda  flptr+1   ; first free byte
OI | 4202         sty  $22
DD | 4204         sta  $23
OM | 4206 fi1     ldy  #0        ;set up index
AP | 4208         jsr  $73       ;get a character
GP | 4210         bcc  fi2       ;numerics ok
HE | 4212         cmp #0         ;test end of line
GE | 4214         beq  fi3       ; yes
MF | 4216         cmp #$22       ;test embedded qte
NE | 4218         beq  fi4       ; yes
GH | 4220         cmp #","       ;test end of word
```

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```
OE  4222         beq  fi3       ; yes
MN  4224         jsr  cifchr    ;test alphabetic
OB  4226         bcc  fi1       ; no
FD  4228 fi2     tax            ;save byte
MB  4230         sta  ($22),y   ;store to buffer
AK  4232         inc  $22       ;bump pointer
HH  4234         bne  fi1
JF  4236         inc  $23       ;test end of buffer
GB  4237         lda  $23
GP  4238         cmp #$c0       ; ($c000)
FF  4240         bne  fi1       ; no
ON  4242         jmp  $a435     ;'out of memory'
PC  4244 fi3     pha            ;push new byte
HL  4246         dey            ;point to previous
EP  4248         dec  $23       ; byte in buffer
AF  4250         txa            ;get old byte
MP  4252         ora  #$80      ;set high bit
ED  4254         sta  ($22),y   ;store to buffer
FC  4256         inc  $23       ;fix pointer
MM  4258         pla            ;pull new byte
MI  4260         cmp #","       ;test comma
AH  4262         beq  fi1       ; yes
LA  4264         ldy  $22       ;store new pointer
NF  4266         lda  $23       ; value to flptr
IL  4268         bne  ifp4      ;branch always
LE  4270 fi4     jmp  $af08     ;'syntax error'
GC  4272 ;
LO  4274 infptr  beq  ifp2      ;no param
OI  4276         jsr  $ad8a     ;eval param
CL  4278         jsr  $b7f7     ;convert to integer
OJ  4280         cmp #$a0       ;test >= $a000
JK  4282         bcc  ifp1      ; no
GN  4284         beq  ifp3      ; = is special case
PK  4286         cmp #$c0       ;test < $c000
IK  4288         bcc  ifp4      ; yes
OA  4290 ifp1    jmp  $b248     ;'illegal quantity'
DF  4292 ifp2    ldy  #1        ;default init
CD  4294         lda  #$a0      ; to $a001
MF  4296 ifp3    cpy  #0        ;test = $a000
HO  4298         beq  ifp1      ; yes
HM  4300 ifp4    sty  flptr     ;init flptr
LM  4302         sta  flptr+1
ML  4304         rts
IE  4306 ;
GO  4308 fplo    ldy  flptr     ;get flptr value
FJ  4310         lda  flptr+1
OF  4312         jmp  usfp      ;return as fl. pt.
AF  4314 ;
NH  4316 scan    jsr  $aef4     ;eval str, test )
GL  4318         jsr  $b6a3     ;get descriptor
HC  4320         sta  t3        ;store length
EE  4322         sta  t4
FD  4324         txa            ;push data address
CG  4326         pha
PJ  4328         tya
GG  4330         pha
MJ  4332         lda  t3        ;reserve memory
HC  4334         jsr  $b47d
EE  4336         stx  $24       ;make ptr to
IN  4338         sty  $25       ; reserved space
NA  4340         pla            ;make ptr to
LE  4342         sta  $23       ; argument data
AI  4344         pla
OL  4346         sta  $22
```

```
AA  4348         dec  1         ;switch out basic
LB  4350         ldy  #$ff
ND  4352         ldx  #0        ;init spare index
MC  4354 sca1    dec  t4        ;decr arg byte cntr
JI  4356 sca2    iny
GG  4358         cpy  t3        ;test end of word
DB  4360         beq  sca4      ; yes
BP  4362         lda  ($22),y   ;get arg byte
IL  4364         jsr  cifnum    ;test numeric
HB  4366         bcs  sca3      ; yes
AI  4368         and  #$7f      ;conv cap to lower
OG  4370         jsr  cifchr    ;test alphabetic
FN  4372         bcc  sca1      ; yes
KO  4374 sca3    sta  ($62,x)   ;add to new string
MP  4376         jsr  bmp62     ;bump new str ptr
NN  4378         bne  sca2      ;branch always
BD  4380 sca4    stx  t5        ;reset word counter
AO  4382         stx  t6
FN  4384         bit  t4        ;test srch str null
KC  4386         bmi  sca11     ; yes
NC  4388         lda  #1        ;init vocab pointer
PN  4390         sta  $62       ; to $a001
OH  4392         lda  #$a0
JP  4394         sta  $63
OJ  4396 sca5    inc  t5        ;bump word counter
EC  4398         bne  sca6
IH  4400         inc  t6
BH  4402 sca6    lda  $63       ;set carry if vocab
FB  4404         cmp flptr+1    ; pointer at end
MP  4406         bne  sca7      ; of buffer
GM  4408         lda  $62
HF  4410         cmp flptr
HL  4412 sca7    txa            ;.x = .y = 0
NA  4414         tay
EE  4416         bcs  sca12     ;end of buffer
PL  4418         dey            ;set up pre-incr
LF  4420 sca8    iny            ;bump pointer
DB  4422         lda  ($62),y   ;get vocab byte
FM  4424         cpy  t4        ;test last arg byte
JG  4426         beq  sca9      ; yes
DP  4428         cmp ($24),y    ;test arg=vocab
JG  4430         beq  sca8      ; yes
OP  4432         bne  sca10     ; no
FA  4434 sca9    sbc  ($24),y   ;test last vocab
DD  4436         cmp #$80       ; byte
GG  4438         beq  sca11     ; yes
JP  4440 sca10   lda  ($62,x)   ;advance vocab
DI  4442         php            ; pointer to
JF  4444         jsr  bmp62     ; end of word + 1
CC  4446         plp
EJ  4448         bpl  sca10
OO  4450         bmi  sca5      ;try next word
FE  4452 sca11   ldy  t5        ;get word counter
OI  4454         lda  t6
AL  4456 sca12   inc  1         ;switch in basic
MJ  4458         jmp  $b391     ;return as fl. pt.
GA  4460 bmp62   inc  $62       ;bump ptr at $62/63
IB  4462         bne  b62       ;return z clear
BC  4464         inc  $63
DF  4466 b62     rts
KO  4468 ;
PA  4470 flptr   .word $a001    ;ptr to file bufr
OO  4472 ;
```

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Longer Life For Your 64 and 1541

Robert V. Davis
Salina, KS

With the price of Commodore 64 computers at one-fourth what it was when the machines first hit the market, the temptation to replace an older 64 with one of the later models is strong. But for those of us willing to break out the screwdriver and soldering iron, there are some minor improvements possible to prolong the life of our computers and disk drives. Note that all the following instructions will invalidate your warranty, if any, and anyone who is not comfortable with the idea of digging into electronic equipment should go to the next article.

The first modification to the Commodore 64 is to improve its video quality . . . this only applies to those of us who have the earlier model C-64s with a five pin video output jack. The addition of some of the luminance signal to the composite colour video will usually sharpen the picture noticeably on a colour monitor. Note Figure 1, the illustration of the top centre of the C-64 main printed circuit board.

Between the five pin video connector and the aluminum box containing the TV modulator will be a resistor (usually 470 ohms). As shown in Figure 1, this resistor will connect the solder pad labelled number two to the ground at the edge of the board, passing over 'point 1'. Using a small soldering iron (25 Watts), undo the ground end of the resistor. Then solder a 150-ohm quarter-watt resistor to point one. Attach the other end of that 150-ohm resistor to the still-connected end of the original resistor at point two. Then, probably using additional wire, re-attach the other end of the 470-ohm resistor to the ground, all the while avoiding solder bridges, bare wires touching each other, and so on.

By the way, if you are using a monochrome video monitor on your C-64, a better display results from taking the luminance output instead of the normal video output containing colour information to your video display. You will have to move a wire in the five-pin DIN connector from pin four to pin one. Again, both of these hints are appropriate to those older C-64s which have a five-pin video connector.

Some C-64s came from the factory without a heat sink attached to the five volt regulator chip which is mounted next to the joystick ports. That regulator supplies power to the video circuitry and runs rather hot. The addition of a heat sink, along with heat transfer compound will really help the regulator do its job. Look next to the joystick ports on the right side of the board for a small device on three legs soldered close to the corner of the video and system shield box. If a flat black slotted hunk of metal about one inch square is bolted or riveted to the regulator, you are OK. If not, the regulator will be sticking up with a hole through its top just begging you to help it cool down. The parts list suggests a possible heat sink which will probably require some bending before it will properly fit.

A couple of ways to keep your 1541 (or 2031LP) disk drive cooler are in order now. The hard work involves taking the drive completely apart and adding heat sink grease to help transfer heat from the big black heat sink at the back of the drive to the frame of the unit. I have found this helpful in both old and new 1541 drives, to help get the heat from the drive and twelve volt regulators spread around inside the unit, instead of concentrated near the 6502 and 6522 chips.

Note again, you will have to remove the plastic top of the drive, the RF shield on top of the main PC board, and then remove the PC board itself to get to the part of the heatsink where you can apply the heat transfer compound. This is not for the faint of heart. Keep paper towels handy to clean up any heatsink grease other than that on the proper surfaces.

Finally, a foot or so of 5/16 inch wooden dowel rod cut into two to three inch lengths with four matching rubber feet can be (with some sanding) forced into the holes on the bottom of the 1541 where the screws holding the top of the case reside. (*Ends of pencils work great for this! -Ed.*) These legs will raise the drive and allow improved air circulation through it, prolonging the life of the electronic internals.

There you have some ways of keeping your system in good health at a minimum of expense. Good luck!

Parts list:
(Radio Shack Part numbers listed)

150 ohm 1/4 watt resistor	#271-1312
Heatsink	#276-1363
Heatsink grease	#276-1372
5/16 wooden dowel rod (4 two-inch lengths)	
5/16 inch rubber feet for ends of dowel	

(Four brand new pencils, cut to the proper length, may be used to replace the dowels and rubber feet)

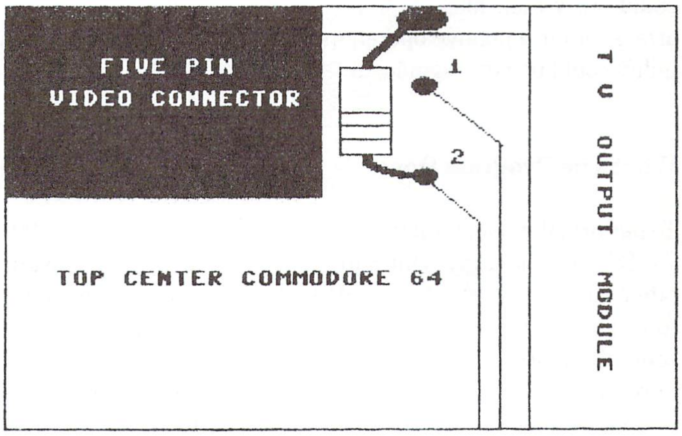

Figure 1

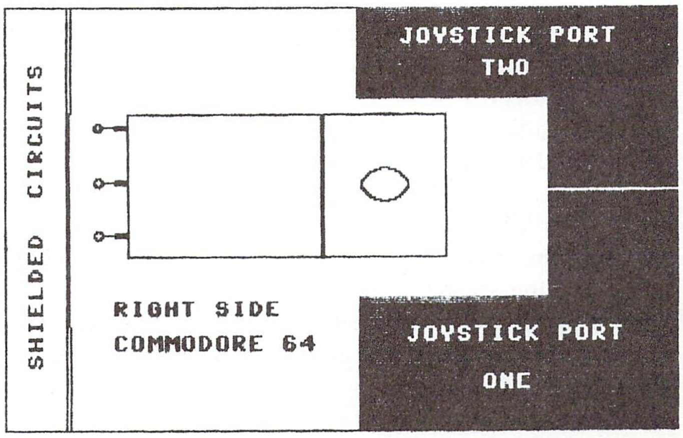

Figure 2

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Matrix Manipulator

Richard Richmond
Springfield, Ohio

Machine language program to set one array equal to another.

Because operations in BASIC must be handled through the interpreter, some tasks can be very slow. For example, the following BASIC line can take a very long time:

```
for i = 1 to n:a(n) = b(n):next n
```

Many operating systems for larger computers have machine language (ML) routines that allow matrices or arrays (arrays are just one-dimension matrices) to be manipulated like non-dimensioned variables. In such a system, the above example could be written like A = B. For large, multi-dimensional arrays, or for repetitive operations, the time saved with such a utility could be very significant.

What The Program Does

To perform the operation in the above example, use SYS 51800 "A,B" with the array names in quotes (to avoid conflicts with other ML utilities that start at 49152, this program is moved up to just below where the BASIC wedge would be loaded). Any properly dimensioned arrays may be used. The only restrictions are that both arrays must be of the same type and dimensioned the same size. The utility will not check for this, only that both names are in the array table. Unlike BASIC, the subroutine will not automatically dimension an array. Instead, an error message is printed and the program halts if both arrays have not been dimensioned.

As stated earlier, any type of array can be used and the subroutine does recognize the difference between types. For example, A,A% and A$ would be treated as different arrays just like in BASIC. When the subroutine returns to BASIC, each element of the first array will be the same as the corresponding element in the second array. The second array will not be affected. Note, the order in which the arrays are dimensioned is not important, only that the arrays are dimensioned before calling the routine. Also just to avoid possible confusion, I have been using A and B as my examples but there are no restrictions on the names that you can use, except for the normal BASIC restrictions.

How The Program Works

For those interested in ASSEMBLY programming, the commented listing in Program 1 should be useful. The listing is compatible with the IEA Assembler, but can be easily adapted to other Assemblers. In general, the following tasks are performed; ROM routines are used to find the location and length of the string in the calling SYS command. The two array names are then separated and the appropriate type designator is added. In BASIC, all arrays are stored in a block of memory. The starting address of this block is stored in locations $30,$2f. This address is loaded and the array memory area is scanned to find the starting address of the first array passed from BASIC. Some juggling of the array names then takes place so that the same portion of code can be used to find the address for the second name.

The length of the second array (actually the offset to the beginning of the next array in the storage area) is then found. The second array is then stored byte by byte in the first array. This simple byte for byte operation is why the routine is able to handle any type of variable. It is also the reason that the programmer must use similar arrays. If the first array was shorter the the second, the program would write past the end of the first array with possibly fatal results!

Typing It In

Program 2 is a ML loader program for the routine. As usual, first type it in and save it. With a disk in your drive, run the program. When the program is finished, you will have a file on your disk; "MATRIXML". To use the routine type LOAD "MATRIXML",8,1 and (RETURN). Then type NEW,(RETURN) and load your BASIC program.

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To illustrate the speed of this routine type in and run the following program:

```
OK  100 dim b(1000),d(1000)
DF  110 print" beginning basic loop "
BG  120 t1 = ti
GI  130 for i = 0 to 1000:b(i) = d(i):next
IH  140 t2 = ti
CF  150 print" end of basic loop
AA  160 print" beginning ml loop
JJ  170 t3 = ti
BP  180 sys51800  " b,d "
AL  190 t4 = ti
DE  200 print" end of ml loop
PJ  210 print" basic  =  ";t2–t1; " jiffies
KL  220 print" ml  =  ";t4–t3; " jiffies
GA  230 stop
```

This program just sets D equal to C. The actual values in the array are of no interest in this case because we are only interested in the relative speeds of the two methods. On my machine, BASIC takes 425 jiffies and ML only 22. That means that the ML routine is 20 times faster than BASIC. If the arrays are changed to integer (C%,D%) the times are 429 and 9, making ML almost 50 times faster! Different size arrays would yield different time savings. For all but the very shortest arrays, the ML routine should provide a significantly faster operation.

Future Additions

At present, I am working to expand this routine into an entire matrix operations package. Some of the other operations that I am working on include:

1. Initialize the array – set the entire array equal to a user defined value.

2. Four function math operations – add, subtract, multiply or divide an array by a variable or by another array.

3. Find maximum or minimum values of an array.

Such a package would be useful in graphics or other programs where large arrays of data must be worked with. These additional operations will included in a single program and be reached through different entry points.

Matrix Manipulator BASIC Loader

```
GA  30 hi = int(51800/256):lo = 51800–hi*256
BE  40 open 1,8,1, " 0:matrixml "
HH  50 print#1,chr$(lo)chr$(hi);
KO  60 for i = 51800 to 52203
HF  70 read da:print#1,chr$(da);
EF  80 next
NC  90 close 1
FB  100 data  76, 117, 202, 128,  44, 144, 214,  65
PO  110 data  82,  82,  65,  89,  32,  78,  79,  84
EA  120 data  32,  68,  73,  77,  69,  78,  83,  73
AE  130 data  79,  78,  69,  68,   0,  32, 158, 173
AL  140 data  32, 163, 182, 134, 251, 132, 252, 170
DJ  150 data 160,   0, 140, 173,   2, 140, 171,   2
AL  160 data 177, 251, 141, 172,   2, 200, 202, 177
LJ  170 data 251, 201,  47, 144,   6, 141, 173,   2
LB  180 data  76, 141, 202, 201,  44, 240,  20, 201
BH  190 data  37, 208,   8, 173, 172,   2,   9, 128
LO  200 data 141, 172,   2, 173, 173,   2,   9, 128
GK  210 data 141, 173,   2, 200, 202, 177, 251, 201
NI  220 data  47, 144, 248, 141, 170,   2, 200, 202
FC  230 data 240,  32, 177, 251, 201,  47, 144,   6
JO  240 data 141, 171,   2,  76, 190, 202, 201,  37
DA  250 data 208,   8, 173, 170,   2,   9, 128, 141
PA  260 data 170,   2, 173, 171,   2,   9, 128, 141
OB  270 data 171,   2, 160,   3, 185, 139,   0, 153
OF  280 data  91, 202, 136,  16, 247, 169,   0, 160
IC  290 data   3, 153, 139,   0, 136, 208, 250, 141
LD  300 data 167,   2, 165,  48, 133, 252, 165,  47
KD  310 data 133, 251, 160,   2, 177, 251, 133, 253
MG  320 data 200, 177, 251, 133, 254, 160,   0, 177
DG  330 data 251, 205, 172,   2, 208,   8, 200, 177
BL  340 data 251, 205, 173,   2, 240,  62, 165, 252
IL  350 data  24, 101, 254, 133, 252, 165, 251,  24
LF  360 data 101, 253, 133, 251, 144,   2, 230, 252
IO  370 data 165,  50, 197, 252, 208,   6, 165,  49
FI  380 data 197, 251, 240,   3,  76,   2, 203, 162
DK  390 data  95, 160, 202, 134, 251, 132, 252, 160
JF  400 data   0, 177, 251, 240,   7,  32, 210, 255
OP  410 data 200,  76,  73, 203,  32, 226, 203, 162
AC  420 data  26,  76,  55, 164, 165, 251, 141, 168
FL  430 data   2, 165, 252, 141, 169,   2, 169,   1
NG  440 data 205, 167,   2, 240,  28, 173, 170,   2
FN  450 data 141, 172,   2, 173, 171,   2, 141, 173
EP  460 data   2, 173, 169,   2, 133, 140, 173, 168
MM  470 data   2, 133, 139, 238, 167,   2,  76, 250
OO  480 data 202, 173, 169,   2, 133, 142, 173, 168
GN  490 data   2, 133, 141, 160,   3, 177, 141, 133
PC  500 data 252, 136, 177, 141, 133, 251, 165, 142
DF  510 data  24, 101, 252, 133, 254, 165, 141,  24
IP  520 data 101, 251, 133, 253, 208,   2, 230, 254
IO  530 data 169,   4, 101, 141, 133, 141, 208,   2
JC  540 data 230, 142, 169,   4, 101, 139, 133, 139
AA  550 data 208,   2, 230, 140, 160,   0, 177, 141
PB  560 data 145, 139, 230, 141, 208,   2, 230, 142
CB  570 data 230, 139, 208,   2, 230, 140, 166, 141
DH  580 data 228, 253, 208, 234, 166, 142, 228, 254
GL  590 data 208, 228, 160,   3, 185,  91, 202, 136
IN  600 data  16, 250,  96,   0
```

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Matrix Manipulator Source Code

```
100 ;ml routine to set a=b
110 ;where a,b are arrays
120 ;written by
130 ;richard richmond
140 ;308 rosewood ave
150 ;springfield, ohio 45506
160 ;(513)322-7650
170 *        =    $ca58        ;sys 51800 "a,b"
180          jmp  start
190 zpage    =    *
200 *        =    *+4
210 two      =    $02aa
220 one      =    $02ac
230 chrout   =    $ffd2
240 word     =    *
250          .asc "array not dimensioned"
260          .byte 0
270 start    =    *            ;use rom routine
280          jsr  $ad9e        ;to get string
290          jsr  $b6a3
300          stx  $fb          ;address
310          sty  $fc
320          tax               ;length
330          ldy  #$00
340          sty  one+$01
350          sty  two+$01
360 first    =    *            ;first character
370          lda  ($fb),y
380          sta  one          ;1st array
390 ab       =    *
400          iny
410          dex
420          lda  ($fb),y
430          sta  one+$01      ;2nd char
440          bcc  skip
450          sta  one+$01
460          jmp  ab
470 skip     =    *
480          beq  second       ;comma
490 ;check for '$,%' in last character
500 ;name. bit 7 set in both bytes if
510 ;array is integer
520 ;bit 7 in 2nd byte set if
530 ;array is string
540          beq  second
550          cmp  #$25
560          bne  skip1
570          lda  one
580          ora  #$80
590          sta  one
600 skip1    =    *
610          lda  one+$01
620          ora  #$80
630          sta  one+$01
640 second   =    *
650 ;repeat for second argument
660          iny
670          dex
680          lda  ($fb),y
690          cmp  #$2f
700          bcc  second
710          sta  two
720 sec2     =    *
730          iny
740          dex               ;check for
750          beq  done         ;string end
760          lda  ($fb),y
770          cmp  #$2f         ;check for
780          bcc  ac           ;alphanum
790          sta  two+$01
800          jmp  sec2
810 ac       =    *
820          cmp  #$25
830          bne  ad
840          lda  two
850          ora  #$80
860          sta  two
870 ad       =    *
880          lda  two+$01
890          ora  #$80
900          sta  two+$01
910 done     =    *
920 ;done with names. now save part
930 ;of zero page 8b-8e
940          ldy  #$03
950 szpage   =    *
960          lda  $008b,y
970          sta  zpage,y
980          dey
990          bpl  szpage
1000         lda  #$00
1010         ldy  #$03
1020 clear   =    *
1030         sta  $008b,y
```

```
1040         dey
1050         bne  clear
1060         sta  $02a7        ;initial cntr
1070 done1   =    *
1080 ;store address of beginning
1090 ;of array storage in fc,fb
1100         lda  $30
1110         sta  $fc
1120         lda  $2f
1130         sta  $fb
1140 d0      =    *
1150         ldy  #$02
1160         lda  ($fc),y
1170         sta  $fd          ;offset lo
1180         iny
1190         lda  ($fb),y
1200         sta  $fe          ;offset hi
1210         ldy  #$00
1220 ;load 1st character of array
1230 ; and compare with 1st of
1240 ; argument
1250         lda  ($fb),y
1260         cmp  one
1270         bne  d2
1280         iny
1290         lda  ($fb),y
1300         cmp  one+$01
1310         beq  b3           ;jmp when
1320 ;array found
1330 d2      =    *
1340         lda  $fc
1350         clc
1360 ;add hi byte offset to address
1370         adc  $fe
1380         sta  $fc
1390         lda  $fb
1400         clc
1410 ;add lo byte offset to address
1420         adc  $fd
1430         sta  $fb
1440         bcc  d4
1450         inc  $fc
1460 d4      =    *
1470 ;check if end of array
1480 ;storage has been reached
1490         lda  $32
1500         cmp  $fc
1510         bne  d3
1520         lda  $31
1530         cmp  $fb
1540         beq  out
1550 ;branch to error routine
1560 ; if end of array storage
1570 d3      =    *
1580         jmp  d0
1590 ;jmp back and check next array
1600 out     =    *            ;beginning of error routine
1610 ;print error message
1620         ldx #>word : ldy #<word
1630         stx  $fb
1640         sty  $fc
1650         ldy  #$00
1660 error   =    *
1670         lda  ($fb),y
1680         beq  return
1690         jsr  chrout       ;rom routine
1700         iny
1710         jmp  error
1720 return  =    *
1730         jsr  reset        ;restore zpage
1740         ldx  #$1a
1750         jmp  $a437        ;exit through
1760 ; rom routine to print error
1770 b3      =    *
1780 ;   store address of first array
1790 ; in argument
1800         lda  $fb
1810         sta  $02a8
1820         lda  $fc
1830         sta  $02a9
1840 b4      =    *
1850         lda  #$01         ;check
1860         cmp  $02a7        ;pointer
1870 ; jmp to b5 2nd time
1880 ; through loop
1890         beq  b5
1900 ; transfer second argument
1910 ; address to 1st storage
1920         lda  two
1930         sta  one
1940         lda  two+$01
1950         sta  one+$01
1960 ; transfer address of first
1970 ; argument to zero page
1980 ; at $8c,$8b
1990         lda  $02a9
```

```
2000         sta  $8c
2010         lda  $02a8
2020         sta  $8b
2030         inc  $02a7
2040 ;increment pointer and
2050 ; branch back to find address
2060 ; of second argument
2070         jmp  done1
2080 b5      =    *
2090 ;address of second argument
2100 ; stored at $8e,$8d
2110 ; length of arrays stored
2120 ; at $fc,$fb
2130 ; only second array length
2140 ; used. both arrays must have
2150 ; dimensioned the same size
2160         lda  $02a9
2170         sta  $8e
2180         lda  $02a8
2190         sta  $8d
2200         ldy  #$03
2210         lda  ($8d),y
2220         sta  $fc
2230         dey
2240         lda  ($8d),y
2250         sta  $fb
2260         lda  $8e
2270         clc
2280 ;ending address of second
2290 ; array stored at
2300 ; $fe,$fd
2310         sta  $fe
2320         lda  $8d
2330         clc
2340         adc  $fb
2350         sta  $fd
2360         bne  b7
2370         inc  $fe
2380 b7      =    *
2390 ; skip 4 bytes
2400 ; this skips past the name and
2410 ; offset bytes in array storage
2420         lda  #$04
2430         adc  $8d
2440         sta  $8d
2450         bne  b8
2460         inc  $8e
2470 b8      =    *
2480         lda  #$04
2490         adc  $8b
2500         sta  $8b
2510         bne  b9
2520         inc  $8c
2530 b9      =    *
2540 ; now ready to begin transfering
2550 ; data from 2nd array to 1st
2560         ldy  #$00
2570 b13     =    *
2580 ;load data byte by byte
2590         lda  ($8d),y
2600 ;store in 1st array
2610         sta  ($8b),y
2620 ; increment pointer - 2nd
2630         inc  $8d
2640         bne  b10
2650         inc  $8e
2660 b10     =    *
2670 ; increment pointer - 1st
2680         inc  $8b
2690         bne  b11
2700         inc  $8c
2710 b11     =    *
2720 ; compare pointer with end
2730 ; end of 2nd array
2740         ldx  $8d
2750         cpx  $fd
2760         bne  b13
2770         ldx  $8e
2780         cpx  $fe
2790         bne  b13
2800 reset   =    *
2810 ; when finished, restore
2820 ; zero page memory and return
2830 ; to basic
2840         ldy  #$03
2850 restorez =   *
2860         lda  zpage,y
2870         dey
2880         bpl  restorez
2890         rts
2900 .end
```

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Jim Butterfield's Complete C128 Memory Map

A few issues back we published an abridged C128 RAM/ROM map as prepared by Jim Butterfield. At the time we were quite pleased to have the privilege of publication. Although the maps were not in any way complete, they were good enough to start many hungry programmers on their way with the C128.

After many months of careful and very well calculated pestering on our part, Jim has finally consented to allow us to publish his yet unreleased C128 Map. This opportunity comes as a form of prelude to Jim's yet unreleased new version of, "Machine Language For The Commodore 64 And Other Commodore Computers". Jim has carefully re-written it to include the C128, and as is usual with Jim's books, articles, videos, TV shows, etc., etc., etc., his Machine Language book takes the reader by the hand and gently force feeds knowledge without any painful infliction.

Jim's new book is expected to be released in April of 1986, published by Bradey, a division of Simon and Shuster. As with his last Machine Language book, this version will be available most everywhere through many of the major book stores. If after this incredible bit of JB propaganda you remain unmoved, let me assure you that I am not being paid for this, except for a bottle of Steam beer he bought me in San Francisco (for which I paid him back promptly). If ever you get the chance, have a read. . . you will not be disappointed. – RTE

COMMODORE 128 Memory Maps **Jim Butterfield**

These maps apply to the machine when used in the 128K mode. When used in the 64 mode, the machine's map is identical to that of the Commodore 64.

Architecture: "Bank numbers" as used in Basic BANK and the MLM addressing scheme are misleading; in fact, they are more correctly "configuration numbers". Bank 0 shows RAM level 0, which contains work areas and the user's Basic program. Bank 1 also shows RAM, this time (for addresses above hexadecimal 0400) level 1 which contains variables, arrays, and strings. Other "banks" are really configurations, with various types of ROM or I/O overlaying RAM. Thus, bank 15 (the most popular) is ROM and I/O covering RAM bank 0. Bank 14, however, is ROM and the character generator overlaying RAM bank 0. Architecture is set so that addresses below $0400 reference bank 0 only. Other bank switching (more complex than the simplified 16–bank concept) is accomplished via storing a mask to address $FF00, or calling up pre-stored masks by writing to $FF01–FF04.

The Commodore C128 Memory Map as of February 1986

All Banks:

Hex	Decimal	Description
0000	0	I/O directional register
0001	1	I/O port, similar to C64
0002 -0004	2-4	SYS address, MLM registers (SR, PC)
0005 -0009	5-9	SYS, MLM register save (A, X, Y, SR/SP)
000A	10	Scan-quotes flag
000B	11	TAB column save
000C	12	0=LOAD, 1=VERIFY
000D	13	Input buffer pointer/number of subscripts
000E	14	Default DIM flag
000F	15	Type: FF=string; 00=numeric
0010	16	Type: 80=integer; 00=floating point
0011	17	DATA scan/LIST quote/memory flag
0012	18	Subscript/FNx flag
0013	19	0=INPUT;$40=GET;$98=READ
0014	20	ATN sign/Comparison evaluation flag
0015	21	Current I/O prompt flag
0016 -0017	22-23	Integer value
0018	24	Pointer: temporary string stack
0019 -0023	25-35	Stack for temporary strings
0024 -0027	36-39	Utility pointer area
0028 -002C	40-44	Product area for multiplication
002D -002E	45-46	Pointer: start-of-BASIC (for bank 0)
002F -0030	47-48	Pointer: start-of-variables (bank 1)
0031 -0032	49-50	Pointer: start-of-arrays
0033 -0034	51-52	Pointer: end-of-arrays
0035 -0036	53-54	Pointer: string-storage (moving down)
0037 -0038	55-56	Utility string pointer
0039 -003A	57-58	Pointer: limit-of-memory (bank 1)
003B -003C	59-60	Current BASIC line number
003D -003E	61-62	Textpointer: BASIC work point
003F -0040	63-64	Utility Pointer
0041 -0042	65-66	Current DATA line number
0043 -0044	67-68	Current DATA address
0045 -0046	69-70	Input vector
0047 -0048	71-72	Current variable name
0049 -004A	73-74	Current variable address
004B -004C	75-76	Variable pointer for FOR/NEXT
004D -004E	77-78	Y-save; op-save; BASIC pointer save
004F	79	Comparison symbol accumulator
0050 -0055	80-85	Miscellaneous work area, pointers, and so on
0056 -0058	86-88	Jump vector for functions
0059 -0062	89-98	Miscellaneous numeric work area
0063	99	Accum#1: exponent
0064 -0067	100-103	Accum#1: mantissa
0068	104	Accum#1: sign
0069	105	Series evaluation constant pointer
006A -006F	106-111	Accum#2: exponent, and so on
0070	112	Sign comparison, Acc#1 versus #2
0071	113	Accum#1 lo-order (rounding)
0072 -0073	114-115	Cassette buffer len/Series pointer
0074 -0075	116-117	Auto line number increment
0076	118	Graphics flag
0077	119	Color source number
0078 -0079	120-121	Temporary counters
007A -007C	122-124	DS$ descriptor
007D -007E	125-126	BASIC pseudo-stack pointer
007F	127	Flag: 0=direct mode
0080 -0081	128-129	DOS, USING work flags
0082	130	Stack pointer save for errors
0083	131	Graphic color source
0084	132	Multicolor 1 (1)
0085	133	Multicolor 2 (2)
0086	134	Graphic foreground color (13)
0087 -008A	135-138	Graphic scale factors, X & Y
008B -008F	139-143	Graphic work values
0090	144	Status word ST
0091	145	Keyswitch IA: STOP and RVS flags
0092	146	Timing constant for tape
0093	147	Work value, monitor, LOAD/SAVE
0094	148	Serial output: deferred character flag
0095	149	Serial deferred character
0096	150	Cassette work value
0097	151	Register save
0098	152	How many open files
0099	153	Input device, normally 0
009A	154	Output CMD device, normally 3
009B -009C	155-156	Tape parity, output-received flag
009D	157	I/O messages: 192=all, 64=errors, 0=nil
009E -009F	158-159	Tape error pointers
00A0 -00A2	160-162	Jiffy Clock HML
00A3 -00AB	163-171	I/O work bytes
00AC -00AD	172-173	Pointer: tape buffer, scrolling
00AE -00AF	174-175	Tape end adds/End of program
00B0 -00B1	176-177	Tape timing constants
00B2 -00B3	178-179	Pointer: start of tape buffer
00B4 -00B6	180-182	RS-232, Misc work values
00B7	183	Number of characters in file name
00B8	184	Current logical file
00B9	185	Current secondary address
00BA	186	Current device
00BB -00BC	187-188	Pointer to file name
00BD -00C5	189-197	I/O work pointers
00C6 -00C7	198-199	Banks: I/O data, filename
00C8 -00CB	200-203	RS-232 input/output buffer addresses
00CC -00CD	204-205	Keyboard decode pointer (bank 15)
00CE -00CF	206-207	Print string work pointer
00D0	208	Number of characters in keyboard buffer
00D1	209	Number of programmed chars waiting
00D2	210	Programmed key character index
00D3	211	Key shift flag: 0=no shift
00D4	212	Key code: 88 if no key
00D5	213	Key code: 88 if no key
00D6	214	Input from screen/from keyboard
00D7	215	40/80 columns: 0=40 columns
00D8	216	Graphics mode code
00D9	217	Character base: 0=ROM, 4=RAM
00DA-00DF	218-223	Misc work area
00E0 -00E1	224-225	Pointer to screen line/cursor
00E2 -00E3	226-227	Color line pointer
00E4	228	Current screen bottom margin
00E5	229	Current screen top margin
00E6	230	Current screen left margin
00E7	231	Current screen right margin
00E8 -00E9	232-233	Input cursor log (row, column)
00EA	234	End-of-line for input pointer
00EB	235	Position of cursor on screen line
00EC	236	Row where cursor lives
00ED-00EE	237-238	Maximum screen lines, columns
00EF	239	Current I/O character
00F0	240	Previous character printed
00F1	241	Character color
00F2	242	Temporary color save
00F3	243	Screen reverse flag
00F4	244	0=direct cursor; else programmed
00F5	245	Number of INSERTs outstanding
00F6	246	255=Auto Insert enabled
00F7	247	Text mode lockout
00F8	248	0=Scrolling enablled
00F9	249	Bell disable
00FA -00FF	250-255	Not used
0100 -01FF	256-511	Processor stack area
0100 -013E	256-318	Tape error log
0100 -0124	256-292	DOS work area
0125 -0138	293-312	PRINT/USING work area
0200 -02A0	512-672	BASIC input buffer
02A2 -02AE	674-686	Bank peek subroutine
02AF -02BD	687-701	Bank poke subroutine
02BE -02CC	702-716	Bank compare subroutine
02CD -02E2	717-738	JSR to another bank
02E3 -02FB	739-763	JMP to another bank
02FC -02FD	764-765	Function execute hook [4C78]
0300 -0301	768-769	Error message link
0302 -0303	770-771	BASIC warm start link
0304 -0305	772-773	Crunch BASIC tokens link
0306 -0307	774-775	Print tokens link
0308 -0309	776-777	Start new BASIC code link
030A -030B	778-779	Get arithmetic element link
030C -030D	780-781	Crunch FE hook
030E -030F	782-783	List FE hook
0310 -0311	784-785	Execute FE hook
0312 -0313	786-787	Unused
0314 -0315	788-789	IRQ vector [FA65]
0316 -0317	790-791	Break interrupt vector [B003]
0318 -0319	792-793	NMI interrupt vector [FA40]
031A -031B	794-795	OPEN vector [EFBD]

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031C	-031D	796-797	CLOSE vector [F188]
031E	-031F	798-799	Set-input vector [F106]
0320	-0321	800-801	Set-output vector [F14C]
0322	-0323	802-803	Restore I/O vector [F226]
0324	-0325	804-805	Input vector [EF06]
0326	-0327	806-807	Output vector [EF79]
0328	-0329	808-809	Test-STOP vector [F66E]
032A	-032B	810-811	GET vector [EEEB]
032C	-032D	812-813	Abort I/O vector [F222]
032E	-032F	814-815	Machine Lang Monitor link
0330	-0331	816-817	LOAD link
0332	-0333	818-819	SAVE link
0334	-0335	820-821	Control code (low) link
0336	-0337	822-832	High ASCII code link
0338	-0339	824-825	ESC sequence link
034A	-0353	842-851	Keyboard buffer
0354	-035D	852-861	Tab stop bits
035E	-0361	862-865	Line wrap bits
0362	-036B	866-875	Logical file table
036C	-0375	876-885	Device number table
0376	-037F	886-895	Secondary address table
0380	-039E	896-926	CHRGET subroutine
0386		902	CHRGOT entry
039F	-03AA	927-938	Fetch from RAM bank 0
03AB	-03B6	939-950	Fetch from RAM bank 1
03B7	-03BF	951-959	Fetch from RAM bank 1
03C0	-03C8	960-968	Fetch from RAM bank 0
03C9	-03D1	969-977	Fetch from RAM bank 0
03D2	-03D4	978-980	Unused
03D5		981	Current BANK for SYS, PEEK
03D6	-03D9	982-985	INSTR work values
03DA		986	Bank location for string
03DB	-03DD	987-989	Sprite work bytes
03DF		991	Accum#1: Overflow
03E0	-03E1	992-993	Sprite work bytes
03E2		994	Graphic/Text backgrounds
03E3		995	Graphic/Multi color log
03F0	-03F6	1008-1014	DMA link code
FF00		65280	MMU configuration register
FF01			Bank 0
FF02			Bank 1
FF03			Bank 14
FF04			Bank 14 over RAM 1
FF01	-FF04	65281-65284	MMU load config registers
Bank 0:			
0400	-07E7	1024-2023	40-column screen memory
07F8	-07FF	2040-2047	Sprite identity area (text)
0800	-09FF	2048-2560	BASIC pseudo-stack
0A0C		2572	CIA 1 interrupt log
0A0D		2573	CIA 1 timer enabled
0A0F	-0A17	2575-2583	RS-232 work values
0A18		2584	RS-232 receive pointer
0A19		2585	RS-232 input pointer
0A1A		2586	RS-232 transmit pointer
0A1B		2587	RS-232 send pointer
0A1D	-0A1F	2588-2590	Sleep countdown; FFFF = disable
0A20		2592	Keyboard buffer size
0A21		2593	Screen freeze flag
0A22		2594	Key repeat: 128 = all, 64 = none
0A23		2595	Key repeat timing
0A24		2594	Key repeat pause
0A25		2595	Graphics/text toggle latch
0A26		2596	40-col cursor mode
0A27	-0A2A	2597-2600	40-col blink values
0A2B		2601	80-col cursor mode
0A2C		2602	40-col video $D018 image
0A2E	-0A2F	2606-2607	80 col pages - screen, color
0A40	-0A5A	2624-2650	40/80 pointer swap $E0-FA
0A60	-0A6D	2656-2669	40/80 data swap $354-361
0AC0		2752	PAT counter
0AC1	-0AC4	2753-2756	ROM Physical Address Table
0B00	-0BBF	2816-3007	Cassette buffer
0BC0	-0BFF	3008-3071	
0C00	-0DFF	3072-3583	RS-232 input, output buffers
0E00	-0FFF	3584-4095	System sprites (56-63)
1000	-1009	4096-4105	Programmed key lengths
100A	-10FF	4106-4351	Programmed key definitions
1100	-1130	4352-4400	DOS Command staging area
1131	-116E	4401-4462	Graphics work area
116F		4463	Trace mode: FF = on
1170	-1173	4464-4467	Renumbering pointers
1174	-1177	4468-4471	Directory work pointers
1178	-1197	4472-4473	Graphics index
117A	-117B	4474-4475	Float-fixed vector [849F]
117C	-117D	4476-4477	Fixed-float vector [793C]
117E	-11D5	4478-4565	Sprite motion tables (8 x 11 bytes)
11D6	-11E5	4566-4581	Sprite X/Y positions
11E6		4582	Sprite X-high positions
11E7	-11E8	4583-4584	Sprite bump masks (sprite, backgnd)
11E9	-11EA	4585-4586	Light pen values, X and Y
11EB		4587	CHRGEN ROM page, text [D8]
11EC		4588	CHRGEN ROM page, graphics [D0]
11ED		4589	Secondary address for RECORD
11EE	-11FF	4590-4607	Unused
1204	-1207	4612-4615	PU characters (,.$)
120B	-120C	4619-4620	TRAP address: FFFF if none
1210	-1211	4624-4625	End of Basic (Bank 0)
1212	-1213	4626-4627	Basic program limit [FF00]
1214	-1217	4628-4631	DO work pointers
1218	-121A	4632-4634	USR program jump [7D28]
121B	-121F	4635-4639	RND seed value
1222		4642	Sound tempo
122F		4655	Music sequencer
1234	-1237	4660-4663	Note image
1239	-123E	4665-4670	Current env pattern
123F	-1270	4671-4720	Envelope tables ..
123F	-1248	4671-4680	AD(SR) pattern
1249	-1252	4681-4690	(AD)SR pattern
1253	-125C	4691-4700	Waveform pattern
125D	-1266	4701-4710	Pulse width pattern
1267	-1270	4711-4720	Pulse width hi pattern
1271	-1274	4721-4274	Note: xx,xx,volume
1275		4725	Previous volume image
1276	-1278	4726-4728	Collision IRQ task table
1279	-127E	4729-4734	Collision IRQ address tables
127F		4735	Collision mask
1280		4736	Collision work value
12B1		4785	PEN work value
1300	-17FF	4864-6143	Unused
1800	-1BFF	6144-7167	Reserved for key functions
1C00	-FBFF	7168-64511	BASIC RAM memory (text)
1C00	-1FF7	7168-8186	Video (color) matrix (hi-res)
1FF8	-1FFF	8187-8191	Sprite identities (hi-res)
2000	-3FFF	8192-16383	Screen memory (hi-res)
4000	-FBFF	16384-64511	BASIC RAM memory (hi-res)
Bank 1:			
0400	-FBFF	1024-64511	Basic variables, arrays, strings
Bank 14: Same as Bank 15, below, except:			
D000	-DFFF	53248-57343	Character generator ROM
Bank 15:			
4000	-CFFF	16384-53247	ROM: BASIC
D000	-D02E	53248-53294	40-col video chip 8564
D400	-D41C	54272-54300	SID sound chip 6581
			Memory Management Unit 8722
D500		54528	MMU primary config register
D501	-D504	54529-54532	MMU preconfig registers
D505	-D506	54533-54534	MMU mode, ram registers
D507	-D50A	54535-54538	MMU page 0, page 1 regs
D600	-D601	54784-54785	80-column CRT contr 8563
10	-11	16-17	X, Y positions
12	-13	18-19	On-chip RAM address
1A		26	Background color
1F		31	On-chip RAM data
D800	-D8E7	55296-56295	Color nybbles
DC00	-DC0F	56320-56336	CIA 1 (IRQ) 6526
DD00	-DD0F	56576-56591	CIA 2 (NMI) 6526
DF00	-DF0A	57088-57098	DMA slot
E000	-FEFF	57344-65279	ROM: Kernal
FF05	-FFFF	65285-65535	ROM: Transfer, Jump Table

ROM Map

4000	Basic Entry Jumps
4009	Basic Restart
4023	Basic Cold Start
4045	Set-Up Basic Constants
4112	Chime
417A	Set Preconfig Registers
4189	Registers For $D501
418D	Init Sprite Movement Tabs
419B	Print Startup Message
4251	Set Basic Links
4267	Basic Links
4279	Chrget For $0380
42CE	Get From ($50) Bank 1
42D3	Get From ($3F) Bank 1
42D8	Get From ($52) Bank 1
42DD	Get From ($5C) Bank 0
42E2	Get From ($5C) Bank 1
42E7	Get From ($66) Bank 1
42EC	Get From ($61) Bank 0
42F1	Get From ($70) Bank 0
42F6	Get From ($70) Bank 1
42FB	Get From ($50) Bank 1
4300	Get From ($61) Bank 1
4305	Get From ($24) Bank 0
430A	Crunch Tokens
43E2	Check Keyword Match
4417	Keywords
46FC	Action Vectors
47D8	Function Vectors
4828	Defunct Vectors
4846	Unimplemented Commands
484B	Messages
4A82	Find Message
4B34	Update Continue Pointer
4B3F	Execute/Trace Statement
4BCB	Perform [stop]
4BCD	Perform [end]
4BF7	Setup FN Reference
4C86	Evaluate <or>
4C89	Evaluate <and>
4CB6	Evaluate <compare>
4D2A	Print 'ready'
4D37	Error or Ready
4D3A	Print 'out of memory'
4D3C	Error
4DAF	Break Entry
4DC3	Ready For Basic
4DE2	Handle New Line
4F4F	Rechain Lines
4F82	Reset End-of-Basic
4F93	Receive Input Line
4FAA	Search B-Stack For Match
4FFE	Move B-Stack Down
5017	Check Memory Space
5047	Copy B-Stack Pointer
5050	Set B-Stack Pointer
5059	Move B-Stack Up
5064	Find Basic Line
50A0	Get Fixed Pt Number
50E2	Perform [list]
5123	List Subroutine
51D6	Perform [new]
51F3	Set Up Run
51F8	Perform [clr]
5238	Clear Stack & Work Area
5250	Pudef Characters
5254	Back Up Text Pointer
5262	Perform [return]
528F	Perform [data/bend]
529D	Perform [rem]
52A2	Scan To Next Stmnt
52A5	Scan To Next Line
52C5	Perform [if]
5320	Search/Skip Begin/Bend
537C	Skip String Constant
5391	Perform [else]
53A3	Perform [on]
53C6	Perform [let]
54F6	Check String Location
553A	Perform [print#]
5540	Perform [cmd]
555A	Perform [print]
5600	Print Format Char
5612	Perform [get]
5635	Getkey
5648	Perform [input#]
5662	Perform [input]
569C	Prompt & Input
56A9	Perform [read]
57F4	Perform [next]
587B	Perform [dim]
5885	Perform [sys]
58B4	Perform [tron]
58B7	Perform [troff]
58BD	Perform [rreg]
5901	Assign <mid$>
5975	Perform [auto]
5986	Perform [help]
59AC	Insert Help Marker
59CF	Perform [gosub]
59DB	Perform [goto]
5A15	Undef'd Statement
5A1D	Put Sub To B-Stack
5A3D	Perform [go]
5A60	Perform [cont]
5A9B	Perform [run]
5ACA	Perform [restore]
5AF0	Keywords To Renumber
5AF8	Perform [renumber]
5BAE	Renumber - Continued
5BFB	Renumber Scan
5D19	Convert Line Number
5D68	Get Renumber Start
5D75	Count Off Lines
5D89	Add Renumber Inc
5D99	Scan Ahead
5DA7	Set Up Block Move
5DC6	Block Move Down
5DDF	Block Move Up
5DEE	Check Block Limit
5DF9	Perform [for]
5E87	Perform [delete]
5EFB	Get Line Number Range
5F34	Perform [pudef]
5F4D	Perform [trap]
5F62	Perform [resume]
5FB7	Reinstate Trap Point
5FD8	Syntax Exit
5FDB	Print 'can't resume'
5FE0	Perform [do]
6039	Perform [exit]
608A	Perform [loop]
60B4	Print 'loop not found'
60B7	Print 'loop without do'
60DB	Eval While/Until Argument
60E1	Define Programmed Key
610A	Perform [key]
61A8	Perform [paint]
627C	Check Painting Split
62B7	Perform [box]
642B	Perform [sshape]
658D	Perform [gshape]
668E	Perform [circle]
6750	Draw Circle
6797	Perform [draw]
67D7	Perform [char]
6955	Perform [locate]
6960	Perform [scale]
69E2	Perform [color]
6A4C	Color Codes
6A5C	Log Current Colors
6A79	Perform [scnclr]
6B06	Fill Memory Page
6B17	Set Screen Color
6B30	Clear Hi-Res Screen
6B5A	Perform [graphic]
6BC9	Perform [bank]
6BD7	Perform [sleep]
6C09	Multiply Sleep Time
6C2D	Perform [wait]
6C4F	Perform [sprite]
6CB3	Bit Masks
6CC6	Perform [movspr]
6DE1	Perform [play]
6E02	Analyze Play Character
6EB2	Set SID Sound
6EFD	Play Error
6F03	Dotted Note
6F07	Note Length Char
6F1E	Note A-G

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6F52	.. votxum ..	864D	Pull String Parameters	928D	Call 'plot'	B3C7	Print 'error'	C854	Chr$(29) Cursor Right
6F69	Sharp	8668	Evaluate <len>	9293	Call 'get'	B3DB	Perform [f]	C85A	Chr$(17) Cursor Down
6F6C	Flat	866E	Exit String Mode	9299	Make Room For String	B406	Perform [a.]	C875	Chr$(157) Cursor left
6F78	Rest	8677	Evaluate <asc>	92EA	Garbage Collection	B536	Print 'space <esc-q>'	C880	Chr$(14) Text
6FD7	Perform [tempo]	8688	Calc String Vector	9409	Evaluate <cos>	B57C	Check 2 A-Matches	C8A6	Chr$(11) Lock
6FE4	Voice Times Two	869A	Set Up String	9410	Evaluate <sin>	B57F	Check A-Match	C8AC	Chr$(12) Unlock
6FE7	Length Characters	874E	Build String to Memory	9459	Evaluate <tan>	B58B	Try Next Op Code	C8B3	Chr$(19) Home
6FEC	Command Characters	877B	Evaluate String	9485	Trig Series	B599	Perform [d]	C8BF	Chr$(146) Clear Rvs Mode
702F	Chime Seq	87E0	Clean Descriptor Stack	94B3	Evaluate <atn>	B5B1	Print '<cr> <esc-q>'	C8C2	Chr$(18) Reverse
7039	SID Voice Steps	87F1	Input Byte Parameter	94E3	Series	B5D4	Display Instruction	C8C7	Chr$(2) Underline-On
7046	Perform [filter]	8803	Params For Poke/Wait	9520	Print Using	B5F5	Print '<3 spaces>'	C8CE	Chr$(130) Underline-Off
70C1	Perform [envelope]	8815	Float/Fixed	99C1	Evaluate <instr>	B659	Classify Op Code	C8D5	Chr$(15) Flash-On
7164	Perform [collision]	882E	Subtract From Memory	9B0C	Evaluate <rdot>	B6A1	Get Mnemonic Char	C8DC	Chr$(143) Flash-Off
7190	Perform [sprcolor]	8831	Evaluate <subtract>	9B30	Draw Line	B6C3	Mode Tables	C8E3	Open Screen Space
71B6	Perform [width]	8845	Add Memory	9BFB	Plot Pixel	B715	Mode Characters	C91B	Chr$(20) Delete
71C5	Perform [vol]	8848	Evaluate <add>	9C49	Examine Pixel	B721	Compacted Mnemonics	C932	Restore Cursor
71EC	Perform [sound]	8917	Trim FAC#1 Left	9C70	Set Hi-Res Color Cell	B7A5	Input Parameter	C94F	Chr$(9) Tab
72CC	Perform [window]	894E	Round Up FAC#1	9CCA	Video Matrix Lines Hi	B7CE	Read Value	C961	Chr$(24) Tab Toggle
7335	Perform [boot]	895D	Print 'overflow'	9CE3	Position Pixel	B88A	Number Bases	C96C	Find Tab Column
7372	Perform [sprdef]	899C	Log Series	9D1C	Bit Masks	B88E	Base Bits	C980	Esc-z Clear All Tabs
7691	Sprite Vectors	89CA	Evaluate <log>	9D24	Calc Hi-Res Row/Column	B892	Display 5-Digit Address	C983	Esc-y Set Default Tabs
76EC	Perform [sprsav]	8A0E	Add 0.5	9DF2	Restore Pixel Cursor	B8A5	Display 2-Digit Byte	C98E	Chr$(7) Bell
77B3	Perform [fast]	8A24	Multiply By Memory	9E2F	Parse Graphics Command	B8A8	Print Space	C9B1	Chr$(10) Linefeed
77C4	Perform [slow]	8A27	Evaluate <multiply>	9E32	Get Color Source Param	B8AD	Print Cursor-Up	C9BE	Analyze Esc Sequence
77D7	Type Match Check	8A89	Unpack ROM to FAC#2	9F29	Conv Words Hi	B8B4	New Line	C9DE	Vectors
77DA	Confirm Numeric	8AB4	Unpack RAM1 to FAC#2	9F3D	Conv Words Lo	B8B9	Blank New Line	CA14	Esc-t Top
77DD	Confirm String	8AE3	Adjust FAC#1/#2	A022	Move Basic to $1C01	B8C2	Output 2-Digit Byte	CA16	Esc-b Bottom
77E7	Print 'type mismatch'	8B17	Multiply By 10	A07E	Perform [catalog/directory]	B8D2	Byte to 2 Ascii	CA1B	Set Window Part
77EA	Print 'formula too complex'	8B2E	+10	A11D	Perform [dopen]	B8E7	Get Input Char	CA24	Exit Window
77EF	Evaluate Expression	8B33	Print 'division by zero'	A134	Perform [append]	B8E9	Get Character	CA3D	Esc-i Insert Line
78D7	Evaluate Item	8B38	Divide By 10	A157	Find Spare SA	B901	Copy Add0 to Add2	CA52	Esc-d Delete Line
793C	Fixed-Float	8B49	Divide Into Memory	A16F	Perform [dclose]	B90E	Calculate Add2-Add0	CA76	Esc-q Erase End
7950	Eval Within Parens	8B4C	Evaluate <divide>	A18C	Perform [dsave]	B922	Subtract	CA8B	Esc-p Erase Begin
795C	Check Comma	8BD4	Unpack ROM to FAC#1	A1A4	Perform [dverify]	B93C	Subtract 1	CA9F	Esc-@ Clr Remainder of Scrn
796C	Syntax Error	8BF9	Pack FAC#1 to $5E	A1A7	Perform [dload]	B950	Increment Pointer	CABC	Esc-v Scroll Up
7978	Search For Variable	8BFC	Pack FAC#1 to $59	A1C8	Perform [bsave]	B960	Decrement Pointer	CACA	Esc-w Scroll Down
7A85	Unpack RAM1 to FAC#1	8C00	Pack FAC#1 to RAM1	A218	Perform [bload]	B974	Copy to Register Area	CAE2	Esc-l Scroll On
7AAF	Locate Variable	8C28	FAC#2 to FAC#1	A267	Perform [header]	B983	Calculate Step/Range	CAE5	Esc-m Scroll Off
7B3C	Check Alphabetic	8C38	FAC#1 to FAC#2	A2A1	Perform [scratch]	B9B1	Perform [$+&%]	CAEA	Esc-c Cancel Auto Insert
7B46	Create Variable	8C47	Round FAC#1	A2D7	Perform [record]	BA07	Convert to Decimal	CAED	Esc-a Auto Insert
7CAB	Set Up Array	8C57	Get Sign	A322	Perform [dclear]	BA47	Transfer Address	CAF2	Esc-s Block Cursor
7D25	Print 'bad subscript'	8C65	Evaluate <sgn>	A32F	Perform [collect]	BA5D	Output Address	CAFE	Esc-u Underline Cursor
7D28	Print 'illegal quantity'	8C68	Byte Fixed-Float	A346	Perform [copy]	BA90	Perform [@]	CB0B	Esc-e Cursor Non Flash
7E3E	Compute Array Size	8C75	Fixed-Float	A362	Perform [concat]	C000	-cint-	CB21	Esc-f Cursor Flash
7E71	Array Pointer Subrtn	8C84	Evaluate <abs>	A36E	Perform [rename]	C006	Get From Keyboard	CB37	Esc-g Bell Enable
8000	Evaluate <fre>	8C87	Compare FAC#1 to Memory	A37C	Perform [backup]	C009	Screen Input Link	CB3A	Esc-h Bell Disable
8020	Decrypt Message	8CC7	Float-Fixed	A3BF	Parse DOS Commands	C00C	Screen Print Link	CB3F	Esc-r Screen Reverse
804A	Evaluate <val>	8CFB	Evaluate <int>	A5E7	Print 'missing file name'	C00F	-screen-	CB48	Esc-n Screen Normal
8052	String to Float	8D22	String to FAC#1	A5EA	Print 'illegal device number'	C012	-scnkey-	CB52	Esc-k End-of-Line
8076	Evaluate <dec>	8DB0	Get Ascii Digit	A5ED	Print 'string too long'	C018	-plot-	CB58	Get Screen Char/Color
80C5	Evaluate <peek>	8E17	Conversion Values	A627	DOS Command Masks	C021	Define FN Key	CB74	Check Screen Line of Lo
80E5	Perform [poke]	8E26	Print 'in'. . .	A7E1	Print 'are you sure?'	C024	IRQ Link	CB81	Extend/Trim Screen Line
80F6	Evaluate <err$>	8E32	Print Integer	A80D	Release String	C027	Upload 80 Col	CB9F	Set Up Line Masks
8139	Swap .x With .y	8E42	Float to Ascii	A845	Set Bank 15	C02A	Swap 40/80	CBB1	Esc-j Start-of-Line
8142	Evaluate <hex$>	8F76	+0.5	A84D	IRQ Work	C02D	Set Window	CBC3	Find End-of-Line
816B	Byte to Hex	8F7B	Decimal Constants	AA1F	Perform [stash]	C033	Screen Address Low	CBED	Move Cursor Right
8182	Evaluate <rgr>	8F9F	TI Constants	AA24	Perform [fetch]	C04C	Screen Address High	CC00	Move Cursor Left
818C	Get Graphics Mode	8FB7	Evaluate <sqr>	AA29	Perform [swap]	C065	I/O Link Vectors	CC1E	Save Cursor
819B	Evaluate <rclr>	8FBE	Raise to Memory Power	AE64	Encrypted Message	C06F	Keyboard Shift Vectors	CC27	Print Space
8203	Evaluate <joy>	8FC1	Evaluate <power>	AF00	Basic Vectors	C07B	Initialize Screen	CC2F	Print Character
824D	Evaluate <pot>	8FFA	Evaluate <negate>	B000	Perform [monitor]	C142	Reset Window	CC32	Print Fill Color
82AE	Evaluate <pen>	9005	Exp Series	B009	Break Entry	C150	Home Cursor	CC34	Put Char to Screen
82FA	Evaluate <pointer>	9033	Evaluate <exp>	B00C	Print 'break'	C156	Goto Left Border	CC5B	Get Rows/Columns
831E	Evaluate <rsprite>	90D0	I/O Error Message	B021	Print 'call' entry	C15C	Set Up New Line	CC6A	Read/Set Cursor
8361	Evaluate <rspcolor>	90D8	Basic 'open'	B03D	Print 'monitor'	C17C	Do Screen Color	CCA2	Define Function Key
837C	Evaluate <bump>	90DF	Basic 'chrout'	B050	Perform [r]	C194	(IRQ) Split Screen	CD2C	Esc-x Switch 40/80
8397	Evaluate <rspos>	90E5	Basic 'input'	B053	Print 'pc sr. . .'	C234	Get a Key	CD57	Position 80-col Cursor
83E1	Evaluate <xor>	90EB	Redirect Output	B08B	Get Command	C29B	Input From Screen	CD6F	Set Screen Color
8407	Evaluate <rwindow>	90FD	Redirect Input	B0BC	Error	C2BC	Read Screen Char	CD9F	Turn Cursor On
8434	Evaluate <rnd>	9112	Perform [save]	B0BF	Print '?'	C2FF	Check For Quotes	CDCA	Set CRTC Register 31
8490	Rnd Multiplier	9129	Perform [verify]	B0E3	Perform [x]	C30C	Wrap Up Screen Print	CDCC	Set CRTC Register
849A	Value 32768	912C	Perform [load]	B0E6	Commands	C320	Ascii to Screen Code	CDD8	Read CRTC Register 31
849F	Float-Fixed Unsigned	918D	Perform [open]	B0FC	Vectors	C33E	Check Cursor Range	CDDA	Read CRTC Register
84A7	Evaluate Fixed Number	919A	Perform [close]	B11A	Read Banked Memory	C363	Do New Line	CDE6	Set CRTC to Screen Address
84AD	Float-Fixed Signed	91AE	Get Load/Save Parameters	B12A	Write Banked Memory	C37C	Insert a Line	CDF9	Set CRTC to Color Address
84C9	Float (.y,.a)	91DD	Get Next Byte Value	B13D	Compare Banked Memory	C3A6	Scroll Screen	CE0C	Set Up 80 Column Char Set
84D0	Evaluate <pos>	91E3	Get Character or Abort	B152	Perform [m]	C3DC	Delete a Line	CE4C	Ascii Color Codes
84D9	Check Direct	91EB	Move to Next Parameter	B194	Perform [;]	C40D	Move Screen Line	CE5C	System Color Codes
84DD	Print 'illegal direct'	91F6	Get Open/Close Params	B1AB	Perform [>]	C4A5	Clear a Line	CE6C	Bit Masks
84E0	Print 'undef'd function'	9243	Release I/O String	B1CC	Print 'esc-o, up'	C53C	Set 80-column Counter to 1	CE74	40-Col Init Values ($E0)
84E5	Set Up 16 Bit Fix-Float	9251	Call 'status'	B1D6	Perform [g]	C53E	Set 80-column Counter	CE8E	80-Col Init Values ($0A40)
84F5	Print 'direct mode only'	9257	Call 'setlfs'	B1DF	Perform [j]	C55D	Keyboard Scan Subrtn	CEA8	Prog Key Lengths
84FA	Perform [def]	925D	Call 'setnam'	B1E8	Display Memory	C651	Key Pickup & Repeat	CEB2	Prog Key Definitions
8528	Check FN Syntax	9263	Call 'getin'	B20E	Print ':<rvs-on>'	C6DD	Programmed Keys	E000	Reset Code
853B	Perform [fn]	9269	Call 'chrout'	B231	Perform [c]	C6E7	Flash 40 Column Cursor	E04B	MMU Set Up Bytes
85AE	Evaluate <str$>	926F	Call 'clrchn'	B234	Perform [t]	C72D	Print to Screen	E056	-restor-
85BF	Evaluate <chr$>	9275	Call 'close'	B2C3	Add 1 to Op 3	C77D	Esc-o (escape)	E05B	-vector-
85D6	Evaluate <left$>	927B	Call 'clall'	B2C6	Do Next Address	C79A	Vectors	E073	Vectors to $0314
860A	Evaluate <right$>	9281	Print Following Text	B2CE	Perform [h]	C7B6	Print Control Char	E093	-ramtas-
861C	Evaluate <mid$>	9287	Set Load/Save Bank	B337	Perform [lsv]	C802	Print Hi-Bit Char	E0CD	Code For High RAM Banks

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E105	RAM Bank Masks	E68E	Set RS-232 Bit Count	EEA8	IRQ Vectors	F53E	-save-	F7AE	Get Char From Memory
E109	-ioinit-	E69D	(NMI) RS-232 Receive	EEB0	Kill Tape Motor	F5B5	Terminate Serial Input	F7BC	Store Loaded Byte
E1DC	Set Up CRTC Registers	E75F	Send to RS-232	EEB7	Check End Address	F5BC	Print 'saving'	F7C9	Read Byte to be Saved
E1F0	Check Special Reset	E795	Connect RS-232 Input	EEC1	Bump Address	F5C8	Save to Tape	F7D0	Get Char From Memory Bank
E242	Reset to 64/128	E7CE	Get From RS-232	EEC8	(IRQ) Clear Break	F5F8	-udtim-	F7DA	Store Char to Memory Bank
E24B	Switch to 64 Mode	E7EC	Interlock RS-232/Serial	EED0	Control Tape Motor	F63D	Watch For RUN or Shift	F7E3	Compare Char With Memory Bank
E263	Code to $02	E805	(NMI) RS-232 Control I/O	EEEB	-getin-	F65E	-rdtim-	F7EC	Load Mem Control Mask
E26B	Scan All ROMs	E850	RS-232 Timings	EF06	-chrin-	F665	-settim-	F7F0	Bank Masks
E2BC	ROM Addresses Hi	E878	(NMI) RS-232 Receive Timing	EF48	Get Char From Tape	F66E	-stop-	F800	Subrtns to $02A2-$02FB
E2C0	ROM Banks	E8A9	(NMI) RS-232 Transmit Timing	EF79	-chrout-	F67C	Print 'too many files'	F85A	DMA Code to $03F0
E2C4	Print 'cbm' Mask	E8D0	Find Any Tape Header	EFBD	-open-	F67F	Print 'file open'	F867	Check Auto Start ROM
E2C7	VIC 8564 Set Up	E919	Write Tape Header	F0B0	Set CIA to RS-232	F682	Print 'file not open'	F890	Check For Boot Disk
E2F8	CRTC 8563 Set Up Pairs	E980	Get Buffer Address	F0CB	Check Serial Open	F685	Print 'file not found'	F90B	Print 'booting'
E33B	-talk-	E987	Get Tape Buffer Start & End Addrs	F106	-chkin-	F688	Print 'device not present'	F92F	Print '. . .'
E33E	-listen-	E99A	Find Specific Header	F14C	-chkout-	F68B	Print 'not input file'	F98B	Wind Up Disk Boot
E43E	-acptr-	E9BE	Bump Tape Pointer	F188	-close-	F68E	Print 'not output file'	F9B3	Read Next Boot Block
E4D2	-second-	E9C8	Print 'press play . . .'	F1E4	Delete File	F691	Print 'missing file name'	F9FB	To 2-Digit Decimal
E4E0	-tksa-	E9DF	Check Tape status	F202	Search For File	F694	Print 'illegal device no'	FA08	Block Read
E503	-ciout- Print Serial	E9E9	Print 'press record..'	F212	Set File Parameters	F697	Error #0	FA15	Print '#i'
E515	-untlk-	E9F2	Initiate Tape Read	F222	-clall-	F6B0	Messages	FA17	Print a Message
E526	-unlsn-	EA15	Initiate Tape Write	F226	-clrchn-	F71E	Print If Direct	FA40	NMI Sequence
E535	Reset ATN	EA26	Common Tape Code	F23D	Clear I/O Path	F722	Print I/O Message	FA65	(IRQ) Normal Entry
E545	Set Clock High	EA7D	Wait For Tape	F265	-load-	F731	-setnam-	FA80	Keyboard Matrix Un-Shifted
E54E	Set Clock Low	EA8F	Check Tape Stop	F27B	Serial Load	F738	-setlfs-	FAD9	Keyboard Matrix Shifted
E557	Set Data High	EAA1	Set Read Timing	F32A	Tape Load	F73F	Set Load/Save Bank	FB32	Keyboard Matrix C-Key
E560	Set Data Low	EAEB	(IRQ) Read Tape Bits	F3A1	Disk Load	F744	-rdst-	FB8B	Keyboard Matrix Control
E569	Read Serial Lines	EC1F	Store Tape Chars	F3EA	Burst Load	F757	Set Status Bit	FBE4	Keyboard Matrix Caps Lock
E573	Stabilize Timing	ED51	Reset Pointer	F48C	Close Off Serial	F75C	-setmsg-	FF00	MMU Controls
E59F	Restore Timing	ED5A	New Char Set Up	F4BA	Get Serial Byte	F75F	Set Serial Timeout	FF05	NMI Transfer Entry
E5BC	Prepare For Response	ED69	Send Transitn to Tape	F4C5	Receive Serial Byte	F763	-memtop-	FF17	IRQ Transfer Entry
E5C3	Fast Disk Off	ED8B	Write Data to Tape	F503	Toggle Clock Line	F772	-membot-	FF33	Return From Interrupt
E5D6	Fast Disk On	ED90	(IRQ) Tape Write	F50C	Print 'u0' Disk Reset	F781	-iobase-	FF3D	Reset Transfer Entry
E5FB	Fast Disk On/Off	EE2E	(IRQ) Tape Leader	F50F	Print 'searching'	F786	Search For SA	FF47	Jumbo Jump Table
E5FF	(NMI) Transmit RS-232	EE57	Wind Up Tape I/O	F521	Send File Name	F79D	Search & Set Up File	FFFA	Transfer Vectors
E64A	RS-232 Handshake	EE9B	Switch IRQ Vector	F533	Print 'loading'	F7A5	Trigger DMA		

8502 Processor I/O Registers

0000	X	0=in	1=out	0=in	1=out	1=out	1=out	1=out	00000
0001	X	Caps Key	Tape Motor	Tape Sense	Tape Output	HiRes	LoRes	Color Access	00001

8722 Memory Management Unit

D500	RAM select 0-3		HIGH RAM /ROM		MID RAM /ROM		LO RAM	C GEN	54528
D501-D504	Preconfiguration registers; Similar to D500, above								54529-54532
D505	40/80 Key	C64 Mode	Cartr-Sense Color-Bank		Fast Disk	X	X	Z80	54533
D506	Video-Bank		X	X	Shared RAM hi	low	Shared RAM 0=1K		54534
D507	Zero Page Pointer ($0000) L								54535
D508	Zero Page Pointer ($0000) H								54536
D509	Stack Page Pointer ($0000) L								54537
D50A	Stack Page Pointer ($0000) H								54538

DMA Controller

DF00	Busy	Fault	X	X	X	X	X	X	57088
DF01	Exec	Sum	X	X	IRQ	Inc	Mode		57089
DF02	Host Address L								57090
DF03	Host Address H								57091
DF04	Expansion Address L								57092
DF05	Expansion Address H								57093
DF06	X	X	X	X	X	Expansion Bank			57094
DF07	Transfer Length L								57095
DF08	Transfer Length H								57096
DF09	Checksum								57097
DF0A	Version, Maximum-Memory								57098

6526 CIA 1 (IRQ)

(Same as CIA 1 for C64, until DC0C)

DC00	Paddle Select A	B		Joystick 0 Fire	Right	Left	Down	Up	PRA	56320
	Keyboard Row Select (inverted)									
DC01				Joystick 1 Fire	Right	Left	Down	Up	PRB	56321
	Keyboard Column Read									
DC02	$FF - All Output								DDRA	56322
DC03	$00 - All Input								DDRB	56323
DC04	Timer A L								TAL	56324
DC05	Timer A H								TAH	56325
DC06	Timer B L								TBL	56326
DC07	Timer B H								TBH	56327
DC0C	Serial (shift) Register									56332
DC0D	IRQ	X	X	Flag	S.Reg	X	Tim.B	Tim.A		56333
DC0E		S Reg I/O		Load	O/S	Timer A Toggle		Start		56334
DC0F				Load	O/S	Timer B		Start		56335

6526 CIA 2 (NMI)

(Same as CIA 2 for C64)

DD00	Serial IN	Clock IN	Serial OUT	Clock OUT	ATN OUT	RS232 OUT	Video	Block	PRA	56576
DD01	DSR IN	CTS IN		DCD* IN	RI* IN	DTR OUT	RTS OUT	RS232 IN	PRB**	56577
DD02	IN	IN	OUT	OUT	OUT	OUT	OUT	OUT	DDRA	56578
DD03	$06 for RS232								DDRB	56579
DD04	Timer A L								TAL	56580
DD05	Timer A H								TAH	56581
DD06	Timer B L								TBL	56582
DD07	Timer B H								TBH	56583
DD0D				RS232 IN			Timer B	Timer A	ICR	56589
DD0E								Timer A Start	CRA	56590
DD0F								Timer B Start	CRB	56591

* Connected but not used by O.S.
** PRB is the Parallel User Port
DDRA = $3F at reset

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8564 Video Chip
Control & Miscellaneous Registers

D011		Extended Clr. Mode	Bit Map	Display Enable	Row Select	Y-Scroll			53265
D012	Raster Register								53266
D013	Light Pen Input							X	53267
D014								Y	53268

D016	x	x	Reset	Multi Colour	Column Select	X-Scroll			53270

	Screen				Character Base				
D018	VM13	VM12	VM11	VM10	CB13	CB12	CB11	x	53272
D019	IRQ	**Interrupt Sense:**			Light Pen	Spr-Spr Collision	Spr-Back Collision	Raster	53273
D01A		**Interrupt Enable:**			Light Pen	Spr-Spr Collisions	Spr-Back Collisions	Raster	53274

Colour Registers

D020	X	Exterior Colour (Border)	53280
D021	X	Background Colour #0	53281
D022	X	Background Colour #1	53282
D023	X	Background Colour #2	53283
D024	X	Background Colour #3	53284
D025	X	Sprite MultiColour #0	53285
D026	X	Sprite MultiColour #1	53286

D02F	x	x	x	x	x	[Keyboard Rows]			53295
D030	X	X	X	X	X	X	Test	Fast Clock	53296

8564 Video Chip
Sprite Registers

Sprite 0	Sprite 7		Sprite 0	Sprite 7
D000	D00E	X Position	53248	53262
D001	D00F	Y Position	53249	53263
D027	D02E	Sprite Colour	53287	53294

Bit For Sprite#:

	7	6	5	4	3	2	1	0	
D010	X-Position High								53264
D015	Sprite Enable Flags								53269
D017	Y-Expand								53271
D01B	Background Priority								53275
D01C	Sprite MultiColour Mode								53276
D01D	X-Expand								53277
D01E	Interrupt: Sprite Collision								53278
D01F	Interrupt: Background Collision								53279

8563 80-Column CRT Controller

D600 read (status):

D600	Status	Light Pen	Vert Blank	X	X	X	X	X	54784

D600 54784	D601 54785									Typical Value
0 $00	Horizontal Total									126
1 $01	Horizontal Characters Displayed (80)									80
2 $02	Horizontal Sync position									102
3 $03	Vertical Sync Width				Horizontal Sync Width					1 and 3
4 $04	X	Vertical Total								32 or 39
5 $05	X	X	X	Vertical Total Adjust						0
6 $06	X	Vertical Displayed (25)								25
7 $07	X	Vertical Sync Position								29 or 32
8 $08	X	X	X	X	X	X	Interlace			0
9 $09	X	X	X	Scan Lines per Character						7
10 $0A	X	Cursor Mode		Cursor Start						32
11 $0B	X	X	X	Cursor End						7
12 $0C	X	X	Display Address						H	0
13 $0D									L	0
14 $0E	Cursor Address								H	0
15 $0F									L	0
16 $10	Light Pen Input								H	varies
17 $11									L	varies
18 $12	Video RAM Address (See register 31)								H	varies
19 $13									L	varies
20 $14	Colour Address								H	8
21 $15									L	0
22 $16	Character Total				Character Display Horizontal					120
23 $17	X	X	X	Character Display Vertical						8
24 $18	Block Copy	Scrn RVS	Blink Rate	V Scroll						32
25 $19	Bit Map	Colour Enable	Semi Graph	Wide Pixel	H Scroll					64 or 71
26 $1A	Foreground Colour				Background Colour					240
27 $1B	Scroll Control Horizontal									0
28 $1C	Char Set Address			RAM	X	X	X	X		32
29 $1D	X	X	X	Underline Scan Line Count						7
30 $1E	Character Count									varies
31 $1F	Video RAM data (see registers 18,19)									varies
32 $20	Block Copy Start Address								H	varies
33 $21									L	varies
34 $22	Display Enable								begin	125
35 $23									end	100
36 $24	X	X	X	X	DRAM Refresh Rate					5

6581 SID Sound Chip
(Identical to 6581 on C64)

Voice 1	Voice 2	Voice 3										Voice 1	Voice 2	Voice 3
D400	D407	D40E	Frequency								L	54272	54279	54286
D401	D408	D40F									L	54273	54280	54287
D402	D409	D410	Pulse Width								L	54274	54281	54288
D403	D40A	D411	0	0	0	0					H	54275	54282	54289
D404	D40B	D412	NSE	Voice Type: PUL	SAW	TRI				Key		54276	54283	54290
D405	D40C	D413	Attack Time: 2ms-8sec				Decay Time: 6ms-24sec					54277	54284	54291
D406	D40D	D414	Sustain Level:				Release Time: 6ms-24sec					54278	54285	54292

Voices are "write-only"

D415	0	0	0	0	0				L	54293
D416	Filter Frequency								H	54292
D417	Resonance				Ext	Filter Voices V3	V2	V1		54295
D418	V3 off	Passband HI	BP	LO	Master Volume					54296

Filter and Volume (write only)

D419	Paddle X (A/D #1)	54297
D41A	Paddle Y (A/D #2)	54298
D41B	Noise 3 (random)	54299
D41C	Envelope 3	54300

Sense (read only)

Note: Special Voice Features
(TEST, RING, MOD, SYNC)
are omitted from the above diagram

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The C128 – You Can Bank On It

Jim Butterfield
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You may have noticed that the Commodore 128 has sixteen "memory banks". In Basic, you may call whatever bank you want (for PEEK, POKE, SYS or WAIT) by using the BANK command with a value from 0 to 15. Similarly, machine language types will reference banks in the monitor by prefixing an address with a digit from 0 to F – the same bank values of 0 to 16.

However, the average programmer – with no cartridge, internal ROM, or RAM expansion – can only make use of four of these numbers. The only ones that make sense are banks 0, 1, 14 and 15 (hex 0, 1, E, and F)

What about the other numbers? Banks 2 and 3 are reserved for memory expansion. Banks 4 to 7 and bank 12 are only useful if the empty socket inside your machine has been fitted with an "internal" ROM chip. Banks 5 to 11 and 13 are only useful if a cartridge ROM is plugged into your machine. And even if you have these extra things fitted, chances are that a commercial software house has taken care of all the banking you're likely to need, leaving you with little to look at for fun.

I don't like the term 'bank' as it is used on this machine. These numbers represent configurations; each so-called bank is an assembly of varying parts of memory.

Only 'Bank 0' is not a mixture: it uses one kind of memory only, the RAM where your Basic programs are held (usually called RAM 0). All the others are mixtures of different types of memory appearing at various addresses. Even bank 0 is slightly "impure" – addresses hex FF00 to FF04 are not RAM, they hold a special memory control chip called the MMU (memory management unit).

Bank 1, for example, is almost entirely the RAM where Basic's variables, arrays and strings are stored (RAM 1). But there's a little bit of bank 0 still in there, at addresses 2 to 1023; and the MMU is still present at FF00 to FF04. In fact, these items will be there in all "normal" configurations.

Banks 0 and 1, then, are pure RAM, random access memory. You can store things there, and you can read the contents of these addresses. But you'd have trouble running most machine language programs in one of these banks (don't let terminology throw you: I mean, "in one of these configurations"). You have no input/output paths available from these configurations, and you don't have the built-in operating system (the 'Kernal ROM') to help the program do its job. In most cases, you'd find bank 15 (hex F) to be much more useful for running a program.

Excuse the hexadecimal numbers, but serious architecture students will want to see them that way. Bank 15 (F) has RAM 0 from address 2 to $3FFF; above that is the ROM that holds the Basic logic, from 4000 to BFFF; above that is the Kernal operating system, in two chunks from C000 to CFFF and E000 to FFFF; and finally, the block from D000 to DFFF is used for the Input/Output (I/O) chips. If you need to use the character generator, Bank 14 (E) has the same architecture except that the block from D000 to DFFF contains the character set instead of I/O.

When you give a BANK command, nothing happens; the number you supply is stored (at address $03D5). It won't be used until you give a command which needs this number: POKE, PEEK, SYS, WAIT and some of the DOS commands such as BLOAD and BSAVE. Even then, the computer will only set up the configuration for a fleeting moment while it transfers material to or from the selected bank.

Roll Your Own

So you have only banks 0, 1, 14 and 15 for your work. No problem for a Basic programmer who might occasionally PEEK and POKE. But for the serious machine language programmer, it's somewhat limiting. To keep the Kernal and I/O, the programmer is forced to select BANK 15; and that limits the program to RAM in the area below $4000 (decimal 16384). This could be somewhat restricting, especially when a high-resolution screen might reside in the same area.

There's hope. In fact, there are sixteen architectures that the ML programmer can use. Only four of them have BANK numbers, but the others can be reached by storing a value at $FF00.

Table 1 shows all the practical combinations. Here's a quick rundown on some of the most important:

00 – Storing this value in FF00 causes the C128 to take up its "normal" BANK 15 configuration. Use this before returning to Basic.

3F and 7F – Storing $3F into FF00 creates the BANK 0 architecture; storing $7F creates BANK 1. Careful: you have no I/O or Kernal ROM. There's a shortcut to these architectures: storing anything to FF01 creates Bank 0; storing anything to FF02 creates Bank 1.

0E and 4E – Storing $0E into FF00 creates the RAM 0 for addresses up to BFFF; storing $4E creates RAM 1 for this area. The Kernal and I/O take up their normal positions. This are the "ideal" configurations for serious machine language stuff: 0E for a program in RAM 0, and 4E for a program in RAM 1. Basic is removed, and you have lots of memory to play with.

0F and 4F – These are similar to 0E and 4E above, except that the character generator chip is at addresses $D000 to DFFF instead of I/O.

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Use one of these configurations (briefly) when you need to examine the pixels of the character generator; but don't call any input or output when you are set up this way.

02, 03, 42 and 43 – These are curious configurations that keep the upper half of Basic (from 8000 to BFFF). They would not be used much except by enthusiasts who wanted to get at the floating point math routines in that area.

Summary

You can arrange any of a number of custom architectures if you need to. The standard BANKS are of limited help; use them to get from Basic and then organize your own architecture with a POKE to FF00.

Table 1. The sixteen 'useful' architectures.

FF00 Poke Value	(Addresses whose first hex digits are:) 0123	4567	89AB	CEF	D	Bank Number	Store to
00	RAM0	ROM	ROM	ROM	I/O	"BANK 15"	
01	RAM0	ROM	ROM	ROM	CGEN	"BANK 14"	FF03
02	RAM0	RAM0	ROM	ROM	I/O		
03	RAM0	RAM0	ROM	ROM	CGEN		
0E	RAM0	RAM0	RAM0	ROM	I/O		
0F	RAM0	RAM0	RAM0	ROM	CGEN		
3E	RAM0	RAM0	RAM0	RAM0	I/O		
3F	RAM0	RAM0	RAM0	RAM0	RAM0	"BANK 0"	FF01
40	RAM1	ROM	ROM	ROM	I/O		
41	RAM1	ROM	ROM	ROM	CGEN		FF04
42	RAM1	RAM1	ROM	ROM	I/O		
43	RAM1	RAM1	ROM	ROM	CGEN		
4E	RAM1	RAM1	RAM1	ROM	I/O		
4F	RAM1	RAM1	RAM1	ROM	CGEN		
7E	RAM1	RAM1	RAM1	RAM1	I/O		
7F	RAM1	RAM1	RAM1	RAM1	RAM1	"BANK 1"	FF02

Note that in all configurations, the first 1K of memory (addresses 0002 to 03FF) is always RAM0. Addresses 0 and 1 are internal to the processor chip.

An Architecture–Testing Program

You might like to try your hand at checking the type of architecture that results when specific values are poked into location $FF00. Run this program, supply a value, and see what you get.

The "business end" is a machine language program which tries the architecture and peeks various locations, reporting what it finds. Such a program must be tucked into the first 1K of memory: that's the only place that is safe from architecture switches.

The specific locations examined by the program are (hex): 3000, 6000, B000, F000, and D020. A value of 0 is poked to these locations in RAM 0, a value of 1 in RAM 1. The ROM values are fixed, hopefully: 6000 contains 60, b000 contains 4C, and F000 contains 29. At D020, the character generator contains 78, and we make sure that the video chip border colour is set to its normal value of FD.

The machine language program sets the requested value into FF00, and then tests the contents of the specific locations. A zero is taken to be RAM 0; a 1 to be RAM 1; other values are tested for a match to the known ROM values. If none of these are recognized, the numeric value is printed. Each location is tested five times; if the value is not constant for every read, it's likely "not there" and is shown as VARYING.

C128 Architester

```
10 data 120, 141,   0, 255
20 data 174,   0,  48, 142, 128,   2
30 data 174,   0,  96, 142, 129,   2
40 data 174,   0, 176, 142, 130,   2
50 data 174,   0, 240, 142, 131,   2
60 data 174,  32, 208, 142, 132,   2
70 data 169,   0, 141,   0, 255,  88,  96
80 for j=dec("250") to dec("278")
90 read x:t=t+x:poke j,x
100 next j
110 if t<>4305 then stop
120 for j=3 to 0 step -1
130 bank j
140 poke dec("3000"),j:a(0,0)=-1
150 poke dec("6000"),j:a(1,0)=dec("60")
160 poke dec("b000"),j:a(2,0)=dec("4c")
170 poke dec("f000"),j:a(3,0)=dec("29")
180 poke dec("d020"),j:a(4,0)=dec("78")
190 next j
200 bank 15
210 poke dec("d020"),253
220 a$(0)="0400-3fff"
230 a$(1)="4000-7fff"
240 a$(2)="8000-bfff"
250 a$(3)="c000-cfff/e000-ffff"
260 a$(4)="d000-dfff"
270 input "value of $ff00 poke(hex)";x$
280 x=dec(x$):if x>255 goto 270
290 for t=1 to 5
300  sys dec("0250"),x
310  for j=0 to 4:a(j,t)=peek(j+dec("0280")):next j
320  next t
330 for j=0 to 4:q=fre(1)
340  a=a(j,1):r$=""
350  for t=2 to 5:if a<>a(j,t)then a=444
360  next t
370  if a=0 then r$="ram0"
380  if a=1 then r$="ram1"
390  if a=2 then r$="ram2"
400  if a=3 then r$="ram3"
410  if a=a(j,0) then r$="rom":if j=4 then r$="cgen"
420  if j=4 and a=253 then r$="i/o"
430  if a=120 then r$="cgen"
440  if a=444 then r$="varies"
450  if r$="" then r$=str$(a)
460  print a$(j);" - ";
470  print r$
480 next j
```

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Getting The C128's CP/M+ In Gear

Clifton Karnes
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After stating we felt there was not enough demand for more CP/M info than is already available, we were deluged with letters. Several of the responses explained it was just the contrary - that what little CP/M info is around, is hard to find. So here is the first of what we hope will be more articles on C128 CP/M+. - EIC.

One of the nicest things about the new C128 and 1571 disk drive is that they have a CP/M mode that can read real CP/M disks. The system as supplied has some excellent features but unfortunately it is incomplete. There is, however, a solution.

In this article I will discuss how to get the C128's CP/M+ system up to par, how to begin tapping the huge source of public domain software, and describe some language implementations (both commercial and public domain) that I've tried on the C128 in CP/M mode.

Where's the Assembler?

The first thing you'll notice about the CP/M+ disks is that they contain no Assembler (MAC), debugger (SID), or any of the other utilities and source files that are supposed to come with CP/M+. This problem is easily solved. Just send in the card for the "DRI Special Offer" (and $19.95). Commodore will send you the missing utilities and a huge manual.

Where's the I/O?

The next thing you'll notice about the CP/M+ is that, besides the console and disk, all the serial I/O routines are null. This means that the User's Port is dead. If your printer uses this port or you have a modem you would like to use, you are out of luck. But don't despair.

Where's the Standard ASCII?

The next question that may arise regards ASCII. CP/M uses standard ASCII and the 128 implies it does (see the SETKEY utility). This is true in part. The characters sent to the screen are standard representations (characters unusual to Petscii are formed with the CTRL key plus the key that most nearly resembles the character eg. CTRL [and CTRL] for left and right curly brackets, CTRL / for backslash). But the codes sent to the printer are Petscii and there's no way to change that. In other words, if you've got a flexible printer like the Star SG–10 and an interface, you can't get out of emulation mode to use any of the printer's extra features or for that matter its standard characters that aren't part of Petscii. There's hope.

Commodore, CompuServe and Irv Hoff to the Rescue!

CBM Engineering (in the guise of Von Ertwine) has been working on these problems and there is a new approved CP/M+ operating system available free to all on CompuServe. This new operating system enables the serial I/O so your User's Port is undead. In addition to the new operating system, there's a new utility called CONF that allows you to configure your system using an ASCII printer, dual disk drives, define baud rate, screen and cursor colors, key feel, and much more. If this weren't enough there is even a modem program for the 128 available on CompuServe: IMP by Irv Hoff. IMP is the latest CP/M modem program in the honorable line that began with MODEM7. This modem program is excellent and opens up the world to CP/Mers.

How can you get this stuff? First you must be a member of CompuServe. If you're not then this is a good time to join. You'll need VIDTEX 4.0C to start downloading. All of this material is in DL3 of CPM–IG. CPM–IG (the CP/M Special Interest Group on CompuServe) has started DL3 as a Data Library specifically for C128 CP/Mers. Nice.

The thing to do first is download C128.IRV. This file explains which other files are needed and how to get them. You'll need NEWSYS-.COM (this creates a new CP/M+ operating system), IMP–C8.BIN and IMP.DOC (this is the modem program and its documentation), I2C8–1.ASM (this is an overlay to let you customize the modem program), CONF.COM and CONF.HLP (these allow you to set system parameters and tell you how), C1571.COM (this nearly doubles the write speed of the 1571 in CP/M mode). In addition there are two files to help you with the downloading process: BIBOOT.IMG (for single drive users) and 64CONV (for users with two drives). Even at 300 baud none of these files are long enough to be very expensive to download. I recommend that if you're not a member of CompuServe you join, but if for one reason or another the way of getting this software I've described isn't appealing, then you can send me a formatted CP/M+ disk, and SASE and $3.00 and I'll copy the files for you.

Free Software

Now that you've got your system tuned up you'll want to get some free software. The best place to get started is to look into two books on the subject: Free Software by Robert A. Froelich (New York: Crown Publishers, 1984) and How to Get Free Software by Alfred Glossbrenner (New York: St. Martin's Press, 1984). Both of these works give excellent introductions to obtaining free software.

There are two basic ways to get public domain software: download it or buy the disks. You can download from a commercial database, like CompuServe or from a bulletin board. You don't actually buy public domain software (or shouldn't) but most user's groups charge a donation for equipment wear-and-tear, etc. and there are copy services that copy public domain programs for profit (you're paying

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for their service – not the software). Which procedure is more economical? That depends on your situation. If you've got a 1200 bps modem and a local bulletin board or if the files you're interested in are fairly short then downloading is the way to go. If, however, you're not in this situation, it can become very expensive to download programs with all the relevant files. The costs vary with buying the disks themselves from something like a dollar a disk for local user's groups (you'll usually have to join the group too, which will be around $10 - $25) to $15 and up for copy services.

There are two principal national sources of CP/M public domain software on disks: CP/M User's Group (CPMUG) and the Special Interest Group for Microcomputers (SIG/M). These groups both have extensive libraries. These books discuss both these sources at length. As for the formats that will work on your 128: Kaypro 2, 4, IBM CP/M 86 and Osborne Double–Density all work fine. That covers a lot of territory. Most of the public domain software out there is for CP/M 2.2, but I haven't found any incompatibilities yet with the CP/M 3.0 on the 128.

Programming Languages

The main reason many of you are interested in CP/M is the programming languages available. Many languages are even in the public domain. The most famous of these is perhaps Small–C. What follows is an annotated listing of commercial programming languages and editors I've tried that are low in price and that work on the 128, followed by some public domain packages available from the national user's groups mentioned above.

The Beginning

Although this is the end of our smorgasbord of information on C128 CP/M+, I hope it will be the beginning for you. Find a source and start checking the stuff out. Maybe the Transactor will even start giving a page each issue to C128 CP/M+ developments.

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Addresses of Software Sources Mentioned

Mix Software
2116 E. Arapaho
Suite 363
Richardson, TX 75081
(214) 783–6001

SIG/M Main Office (write to them to find your nearest SIG/M representative)
Box 97
Iselin, NJ 08830

Ellis Computing
3917 Noriega St.
San Francisco, CA 94122
(415) 753–0186

CPMUG
1651 Third Ave.
New York, NY 10128

Software Toolworks
14478 Glorietta Dr.
Sherman Oaks, CA 91423
(818) 986–4885

C User's Group (CUG)
Box 97
McPherson, KS 67460
(216) 241–1065

Language	Description	Price	Supplier
MIX C	Full K&R C compiler with UNIX functions, 400–page manual	$39.95	MIX Software
Nevada FORTRAN	Fortran IV with '77 extensions	$49.95	Ellis Computing
Nevada COBOL	ANSI COBOL '74 with level II features	$49.95	Ellis Computing
LISP/80	InterLISP dialect	$39.95	Software Toolworks
MIX Edit	Full screen / Split screen, programmable	$29.95	Mix Software
Nevada Edit	Full screen	$49.95	Ellis Computing
(I received excellent service from all of commercial sources listed above). In addition to the these commercial packages there are several languages available in the public domain. These include:			
EBASIC	Gordon Eubank's Master's thesis and a forerunner of the widely used CBASIC	Free	CPMUG Volume 30
Small–C	'C' programming language by Ron Cain, with only int and char data types but widely used. Comes with source code.	Free	C User's Group
XLISP	Experimental Lisp by David Betz. Comes with source code in C. Soon to be upgraded to a subset of Common Lisp.	Free	SIG/M Volume 118
FORTH–83	Forth–83 implementation version 2.0	Free	SIG/M Volume 204
E–Prolog	A small Prolog implementation. Comes with ASM source and a VALGOL compiler written in Prolog.	Free	SIG/M Volume 242
JRT Pascal	Full Pascal implementation	Free	CPMUG Volume 82
This is just a list of the more popular languages available – there are others. And lots of other software including: assemblers, text editors, disk utilities (there are tons of these – one of the best is SWEEP in its latest version), and games. As the two books mentioned above show there is no such thing as completely free software, the price you pay for public domain programs (either in downloading time or to user's group or copy service) is usually a very small fraction of the value of work. Also, most of the above–mentioned public domain works can be downloaded from any number of sources if you choose that route.			

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C128 RAM Disk

Noel Nyman, Seattle, WA

Add A 16K RAM Disk To Your C–128 With No Additional Hardware!

A RAM disk is a chunk of random access (read/write) memory that acts like a disk drive. LOAD and SAVE work with it. It cannot be reached by store, PEEK or POKE. RAM disk is external hardware, a circuit board with chips of various sorts. If it has enough memory to be practical it is physically large and expensive.

The advantage of RAM disk is speed. Files can be located and LOADed rapidly. Some database users find RAM disks worthwhile. But a 170K RAM disk costs about what you would pay for a 1541, and the memory goes away when the power is turned off.

If you own a C–128 you can try RAM disk with no additional outlay for hardware. Every C–128 has 16K of RAM that is not part of the regular memory map – the eighty column video RAM. Although a 16K RAM disk is small by commercial standards, it will hold 62 blocks of Basic programs or one–fourth of the Basic variable memory. A new Basic program, or a whole new set of variable values, can be brought into memory in about two seconds.

To understand how our RAM disk will work, you must know a little about the eighty column display system. We only have access to the 8563 eighty column video chip and its RAM through two addresses or " ports ". One of these ports, located at Bank 15, address 54784 ($D600 in hexadecimal), is used to select a register in the 8563. The other port, located at 54785 ($D601 hex), is used to read from or write to the selected register. The video chip uses the register data to make changes on the screen. The buzz–word used to describe this situation is " pipelined architecture " .

There are 37 registers in the video chip. Some of them are high/low address vectors (pointers) to the video RAM. Others change eighty column screen functions by passing numbers or setting and clearing flags. We'll only be concerned with three of the registers.

Registers 18 and 19 hold the vector to an address in video RAM. The vector is stored in HIGH/LOW order. Machine language programmers are used to two byte addresses being stored in the opposite sequence, so it's important to note the difference.

Register 31 is the CPU Data register. The value at the address pointed to by registers 18/19 is available in register 31. If we access register 31 and store a number at the data port ($D601), it will be placed at the video RAM address pointed to by registers 18/19. The vector at 18/19 is then incremented automatically.

When we store a new register value at address $D600, the video chip is probably busy updating the eighty column screen. We have to wait until the chip is ready to look at our data, or we get erratic results. Bit #7 of address $D600 is held low when the video chip is busy, and goes high when it is ready to accept new data. The ROM routine below is used by the 8502 processor to check bit #7.

```
FCDCA  A2  1F      LDX #$1F
 CDCC  8E  00  D6  STX  $D600
 CDCF  2C  00  D6  BIT  $D600
 CDD2  10  FB      BPL  $CDCF
 CDD4  8D  01  D6  STA  $D601
 CDD7  60          RTS
```

The video register to be accessed is stored in the X register of the 8502 and the routine is entered at address $CDCC. The value in X is stored at $D600. Then the BIT command checks for bit #7 to go high. Until it does, the BPL command will branch back to the BIT instruction. Once bit #7 goes high, the video chip is ready and the new data is stored at the data port, $D601.

If we want to store data in register 31, the routine is entered at address $CDCA which stores 31 ($1F) in X for us. There is a complementary routine starting at $CDD8 that reads a video chip register.

The following programs will store data to the 16K video RAM and retrieve it for later use. You must use the 40 column screen with them, since any printing done to the 80 column area will garble the data you've placed there. Before RUNning the programs, switch to 40 column mode. If you have an 80 column monitor available, clear the 80 column screen and type the following:

```
POKE 54784,25: POKE 54785,128
```

Storing 128 in register 25 puts the video chip in Hi-Res or bit mapped mode. The two sets of vertical bars at the top of the screen are the text (CHR$(32) on a cleared screen) and attribute (color ram) screens. The horizontal bars below are remnants of the RAM test done on power-up. The five columns at the bottom are the character sets data. The blank spaces are there for additional character information for a double wide character mode.

By switching to bit mapped mode, you'll be able to see the data and programs being SAVEd to RAM disk.

Listing #1 is a Basic loader for a routine designed to copy portions of memory from any Bank to RAM disk. Enter the loader, RUN it, then SAVE the resulting machine language program by typing:

```
BSAVE " MEMORY DRAM " , B0, P3072 TO P3184
```

To use the routine, set–up the beginning and ending addresses of memory using these commands:

```
SYS 3072,lb,hb
SYS 3077,le,he
```

Where:

lb	=	low byte of address of beginning of memory
hb	=	high byte of address of beginning of memory
le	=	low byte of address (+1) of end of memory
he	=	high byte of address (+1) of end of memory

For example, if you want to save all the variables (except dynamic string data) created by a Basic program, type:

```
SYS 3072, PEEK(47), PEEK(48)
SYS 3077, PEEK(51), PEEK(52)
```

Be sure that no more than 16K of memory is involved. Then type:

```
SYS 3082,0,0,1
```

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The first two numbers after the SYS address are the low/high vector to the location in video RAM where the memory will be stored. The third number is the Bank number of the memory to be copied. For variables, this would be Bank 1.

After storing to RAM disk, type:

```
PRINT PEEK(251), PEEK(252)
```

This will give you the low/high vector of the next available location in video RAM. You can store several blocks of memory and retrieve them independently by keeping track of their video RAM starting addresses.

To get the data back, set up the starting and ending addresses as above. Then SYS to the routine using the same video ram address vectors. Add " 128 " to the Bank number to signal the routine to retrieve from the video RAM rather than copy to it. If retrieving variables for use with Basic, you should also POKE the appropriate values in locations 47/48 and 51/52.

If you want to use the eighty column text screen, you can still have access to 4K of disk RAM. The area between video RAM addresses 4049 and 8191 is unused in text mode. If you store more than 4K in this area, you'll overwrite the character set data.

Listing #2 is a Basic loader for a routine to SAVE and LOAD Basic programs. As before, enter the program, RUN it, and type the following to SAVE the machine code:

```
BSAVE " BASIC DRAM " , B0, P2956 TO P3573
```

To activate the routine enter

```
SYS 2956.
```

BASIC DRAM Adds 3 Commands to the C-128.

MSAVE	SAVEs the Basic program in memory to RAM disk, assigns it a number, and shows the amount of memory remaining in RAM disk.
MLOAD	LOADs a program from RAM disk to the current Basic memory space in Bank 0. The command must be followed immediately, no spaces, with the number (0-9) of a program already MSAVEd.
MSCRATCH	Asks for a starting program number and " scratches " that program and all programs with higher numbers from the RAM disk.

MLOAD can be followed by a colon and other commands in direct mode. For example:

```
MLOAD2 : RUN
```

will place program #2 from RAM disk into memory and RUN it.

The C-128 has two 256 byte pages permanently designated for RS-232 use that sit below the Basic program area. These are destined to become popular " safe " locations for machine code. The MEMORY DRAM code is located in the RS-232 input buffer. The BASIC DRAM program is longer and uses both buffers and the top of the tape buffer as well. If you RUN a Basic program that uses any of these buffers, the computer will probably " crash ".

You can also use the video RAM from C-64 mode. The eighty column screen will be accessible, provided that you've used the command "GO64" after first booting in C-128 mode. Listings #3 and #4 are the C-64 mode versions of the MEMORY and BASIC DRAM programs. They are relocated to start at 51200 ($C800) in the C-64 memory map. This is half way between the popular 49152 ($C000) location used by many machine language routines and 52224 ($CC00) used by the DOS 5.1 wedge.

To use the C-64 MEMORY DRAM, enter:

```
SYS 51200,lb,hb

SYS 51212,le,he

SYS 51224,0,0,0
```

The three zeroes after the last SYS represent any low/high byte address in video RAM and the flag to store or retrieve memory. Since there are no Banks in C-64 mode, use a zero to store and 128 to recover.

For C-64 BASIC DRAM, SYS 51200 to initialize the program. The same three commands are added and follow the same rules as C-128 mode, except that additional commands cannot be used on the same line as MLOAD.

To disable BASIC DRAM in either mode, use the reset switch near the on-off switch or manually change the ERROR vector at $0300/$0301 to its default value. The BASIC DRAM (for both modes) is a compromise between features and length. It will give you a " DISK FULL " error if you try to SAVE more than ten programs. But it doesn't check for actual memory left in video RAM. If you SAVE something too large, the address registers will merrily " roll over " to zero and store on top of data you've already placed there.

Assigning numbers to the programs is another compromise. It would have been best to intercept the LOAD and SAVE routines, assign an unused device number to the RAM disk, use file names, etc. This would have required a lot more code, too much to type in from a magazine listing.

Possibly the most significant compromise was made to allow the RUN-STOP/RESTORE key combination to halt Basic programs. The C-128 RESTORE routine clears both screens when executed. Since clearing a RAM disk isn't what we had in mind, the NMI vector is relocated to point to an abbreviated routine that leaves the RAM disk alone. The normal RESTORE resets several pointers, NMI among them. Since we can't have that either, the pointer routine was also eliminated. RESTORE uses several JSR calls to ROM routines. To leave out only small portions of these routines, we would have to put the balance of them in our program, and you would have to type them in. Instead, we've left out several of the JSR calls, and kept the minimum to get Basic to work properly. If you have a favorite program that uses any machine code, test it thoroughly when using it with BASIC DRAM.

These problems don't plague the C-64 version. There is no eighty column screen to clear on a C-64, so RESTORE doesn't have that function. We can leave the normal NMI routines intact.

We did have to add some code to the C-64 version, however. The SYS command in the C-128 looks for values separated by commas following the SYS address. The first three will be transferred to the A, X, and Y registers of the 8502. This makes passing values to ML short and sweet. (A fourth value will be placed in the Status Register, but beware of that! The value placed there will affect all the flags, including decimal mode. The processor will also set bit #5, the unused flag, even if your passed value left in clear.)

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The C-64 doesn't have this feature, and to keep the commands the same, the code must be added. We also needed to add the routines to access the register and data ports for the video chip.

Both BASIC DRAM's use the error wedge technique described by Brian Munshaw in Transactor 5-6 ("A New Wedge for the Commodore 64"). The three added commands cause a "syntax error". Our program intercepts all error messages and passes on any except syntax errors. These are examined for the use of an illegal character in front of a LOAD, SAVE, or SCRATCH token. Since any illegal character will work, XSAVE will have the same effect as MSAVE.

The C-64 doesn't tokenize the word "scratch", so some additional code is required. To eliminate excess typing, we've decoded only the "sc" portion. MSCREAM will work as well for MSCRATCH.

We hope that you enjoy experimenting with RAM disk and find it useful. For example, you could MSAVE several programs such as Disk Doctor, Directory Reorganizer, Two Column Directory Printer, etc. prior to a heavy disk reorganization session. Then a simple MLOAD# will quickly bring in each program as you need it. This would be a real advantage to anyone using a 1541/C-128 combination.

The Merlin source code for the DRAM programs will be found on The Transactor Disk for this issue. If you'd prefer hard copy of the source code, mail $2 (either Canadian or US) and a large addressed envelope to:

Noel Nyman
Geoduck Developmental System
PO Box 58587
Seattle, WA 98188

Listing One

```
LL  1000 rem save"0:mem dram.ldr",8
GG  1010 :
CH  1020 for j=3072 to 3183: read x: poke j,x:
         ch=ch+x: next
LJ  1030 if ch<>19056 then print "checksum error"
EI  1040 :
EE  1050 data 133, 251, 134, 252,  96, 133, 253, 134
PC  1060 data 254,  96, 133, 200, 134, 201, 132, 250
KM  1070 data  72, 138, 162,  18,  32, 204, 205, 232
HK  1080 data 104,  32, 204, 205, 160,   0, 165, 250
ML  1090 data  48,  42, 166, 250, 169, 251,  32, 116
CP  1100 data 255,  32, 202, 205, 230, 251, 208,   2
MJ  1110 data 230, 252, 165, 251, 197, 253, 208, 234
KI  1120 data 165, 252, 197, 254, 208, 228, 162,  18
HL  1130 data  32, 218, 205, 133, 252, 232,  32, 218
BP  1140 data 205, 133, 251,  96,  41,  15, 133, 250
LA  1150 data 169, 251, 141, 185,   2,  32, 216, 205
OL  1160 data 166, 250,  32, 119, 255, 230, 251, 208
KH  1170 data   2, 230, 252, 165, 251, 197, 253, 208
NM  1180 data 236, 165, 252, 197, 254, 208, 230,  96
```

Listing Two

```
JJ  2000 rem save"0:bas dram.ldr",8
OE  2010 :
LH  2020 for j=2956 to 3571: read x: poke j,x:
         ch=ch+x: next
JJ  2030 if ch<>69893 then print "checksum error"
MG  2040 :
ID  2050 data 120, 173,   0,   3, 201,  63, 208,  29
GB  2060 data 141, 179,  11, 173,   1,   3, 141, 180
AI  2070 data  11, 169, 181, 141,   0,   3, 169,  11
EM  2080 data 141,   1,   3, 169, 195, 141,  24,   3
LI  2090 data 169,  13, 141,  25,   3,  88,  96,   0
FF  2100 data   0, 224,  11, 240,   3, 108, 179,  11
MC  2110 data 201, 147, 208,   3,  76, 208,  12, 201
GL  2120 data 148, 240,   7, 201, 242, 208, 238,  76
AG  2130 data  60,  13, 169,   0, 141,   0, 255, 173
NE  2140 data 223,  13, 201,  10, 144,  28,  32, 125
MC  2150 data 255,  13,  18,  82,  65,  77,  32,  68
AN  2160 data  73,  83,  75,  32,  70,  85,  76,  76
IK  2170 data  27,  81, 141,   0,  32, 142, 201,  76
JH  2180 data 182,  12,  10, 168, 133, 200, 185, 224
EA  2190 data  13, 162,  18,  32, 204, 205, 185, 225
JI  2200 data  13, 232,  32, 204, 205,  56, 173,  16
DF  2210 data  18, 133, 253, 229,  45,  32, 202, 205
MN  2220 data 173,  17,  18, 133, 254, 229,  46,  32
HA  2230 data 202, 205, 165,  45, 133, 251, 165,  46
JN  2240 data 133, 252, 160,   0, 162,   0, 169, 251
FM  2250 data  32, 116, 255,  32, 202, 205, 230, 251
IL  2260 data 208,   2, 230, 252, 165, 251, 197, 253
MB  2270 data 208, 234, 165, 252, 197, 254, 208, 228
LP  2280 data 164, 200, 200, 200, 162,  18,  32, 218
NA  2290 data 205, 133, 252, 153, 224,  13, 232,  32
AB  2300 data 218, 205, 133, 251, 153, 225,  13,  32
FE  2310 data 125, 255, 141,  83,  65,  86,  69,  68
CG  2320 data  32,  80,  82,  79,  71,  82,  65,  77
EK  2330 data  32,   0, 169,   0, 174, 223,  13,  32
PE  2340 data 187,  12,  32, 125, 255,  27,  81, 141
BI  2350 data  32,  32,   0,  56, 169, 128, 229, 251
PP  2360 data 170, 169,  62, 229, 252,  32, 187,  12
OM  2370 data  32, 125, 255,  32,  66,  89,  84,  69
EM  2380 data  83,  32,  82,  69,  77,  65,  73,  78
CM  2390 data  73,  78,  71,  32,  73,  78,  32,  82
HM  2400 data  65,  77,  32,  68,  73,  83,  75,  32
HI  2410 data  27,  81, 141,   0, 238, 223,  13,  32
AF  2420 data 142, 201, 162, 128, 108, 179,  11, 160
IL  2430 data   0, 132,  98, 133,  97, 134,  96,  32
DL  2440 data   7, 186, 169,   0, 162,   8, 160,   3
MB  2450 data  32,  93, 186,  96,  32, 128,   3,  41
AM  2460 data  15, 205, 223,  13, 144,   3,  76, 158
FL  2470 data  13,  10, 168, 169,   0, 141,   0, 255
KE  2480 data 165, 200, 185, 224,  13, 162,  18,  32
JJ  2490 data 204, 205, 133, 252, 232, 185, 225,  13
DM  2500 data  32, 204, 205,  32, 216, 205, 133, 253
MH  2510 data  32, 216, 205, 133, 254,  24, 165,  45
CM  2520 data 133, 251, 101, 253, 133, 253, 141,  16
DP  2530 data  18, 165,  46, 133, 252, 101, 254, 133
GB  2540 data 254, 169, 251, 141, 185,   2, 160,   0
BD  2550 data  32, 216, 205, 162,   0,  32, 119, 255
EO  2560 data 230, 251, 208,   2, 230, 252, 165, 251
BH  2570 data 197, 253, 208, 236, 165, 252, 197, 254
MD  2580 data 208, 230,  32,  79,  79,  76, 162,  82
HB  2590 data 169,   0, 141,   0, 255,  32, 125, 255
AA  2600 data 141,  83,  67,  82,  65,  84,  67,  72
EJ  2610 data  32,  83,  84,  65,  82,  84,  73,  78
HJ  2620 data  71,  32,  87,  73,  84,  72,  32,  80
NM  2630 data  71,  77,  32,  78,  85,  77,  66,  69
EM  2640 data  82,  32,  63,  32,   0,  32, 228, 255
LI  2650 data 201,   0, 240, 249,  32, 210, 255, 201
PG  2660 data  48, 144,  39, 201,  58, 176,  35,  41
NO  2670 data  15, 205, 223,  13, 176,  28, 141, 223
DN  2680 data  13, 133, 200, 230, 200,   6, 200, 164
```

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```
KM  2690 data 200, 169,   0, 153, 224,  13, 153, 225
FP  2700 data  13, 200, 200, 192,  20, 208, 244,  76
LK  2710 data 182,  12,  32, 125, 255, 141,  18,  73
DD  2720 data  78,  86,  65,  76,  73,  68,  32,  80
AD  2730 data  82,  79,  71,  82,  65,  77,  32,  78
BI  2740 data  85,  77,  66,  69,  82,  27,  81, 141
KJ  2750 data   0,  32, 142, 201,  76, 182,  12, 216
EO  2760 data 169, 127, 141,  13, 221, 172,  13, 221
KL  2770 data  32,  61, 246,  32, 225, 255, 208,   8
JB  2780 data 169, 147,  32, 210, 255, 108,   0,  10
NO  2790 data  76,  51, 255,   0,   0,   0,   0,   0
OL  2800 data   0,   0,   0,   0,   0,   0,   0,   0
IM  2810 data   0,   0,   0,   0,   0,   0,   0,   0
```

Listing Three

```
ND  1000 rem save "0:64mem dram.ldr",8
GG  1010 :
HG  1020 for j=51200 to 51374: read x: poke j,x:
         ch=ch+x: next
CJ  1030 if ch<>26408 then print "checksum error"
EI  1040 :
HD  1050 data  32, 152, 200, 165, 170, 133, 251, 165
KE  1060 data 171, 133, 252,  96,  32, 152, 200, 165
NF  1070 data 170, 133, 253, 165, 171, 133, 254,  96
II  1080 data  32, 141, 200, 165, 169, 133, 167, 165
IG  1090 data 170, 133, 168, 162,  18,  32, 115, 200
CO  1100 data 232, 165, 167,  32, 115, 200, 160,   0
IP  1110 data 165, 171,  48,  37, 177, 251,  32, 113
DE  1120 data 200, 230, 251, 208,   2, 230, 252, 165
BN  1130 data 251, 197, 253, 208, 239, 165, 252, 197
FJ  1140 data 254, 208, 233, 162,  18,  32, 129, 200
NH  1150 data 133, 252, 232,  32, 129, 200, 133, 251
DH  1160 data  96,  32, 127, 200, 145, 251, 230, 251
GH  1170 data 208,   2, 230, 252, 165, 251, 197, 253
ON  1180 data 208, 239, 165, 252, 197, 254, 208, 233
BE  1190 data  96, 162,  31, 142,   0, 214,  44,   0
OO  1200 data 214,  16, 251, 141,   1, 214,  96, 162
NB  1210 data  31, 142,   0, 214,  44,   0, 214,  16
BP  1220 data 251, 173,   1, 214,  96,  32, 253, 174
BB  1230 data  32, 158, 173,  32, 170, 177, 132, 169
GG  1240 data  32, 253, 174,  32, 158, 173,  32, 170
AE  1250 data 177, 132, 170,  32, 253, 174,  32, 158
FH  1260 data 173,  32, 170, 177, 132, 171,  96
```

Listing Four

```
BA  2000 rem save "0:64bas dram.ldr",8
OE  2010 :
MF  2020 for j=51200 to 51777: read x: poke j,x:
         ch=ch+x: next
JI  2030 if ch<>67582 then print "checksum error"
MG  2040 :
MN  2050 data 120, 173,   0,   3, 201, 139, 208,  19
FE  2060 data 141,  29, 200, 173,   1,   3, 141,  30
BB  2070 data 200, 169,  31, 141,   0,   3, 169, 200
CF  2080 data 141,   1,   3,  88,  96,   0,   0, 224
BP  2090 data  11, 240,   3, 108,  29, 200,  32, 121
IA  2100 data   0, 201, 147, 208,   3,  76, 234, 200
PL  2110 data 201, 148, 240,  21, 169,   1, 133, 122
FC  2120 data  32, 121,   0, 201,  83, 208, 228,  32
MB  2130 data 115,   0, 201,  67, 208, 221,  76,  72
LL  2140 data 201, 173,  45, 202, 201,  10, 144,  10
LO  2150 data 169, 170, 162, 201,  32,  30, 171,  76
FO  2160 data 229, 200,  10, 168, 133, 167, 185,  46
MO  2170 data 202, 162,  18,  32, 144, 201, 185,  47
HA  2180 data 202, 232,  32, 144, 201,  56, 165,  45
CJ  2190 data 133, 253, 229,  43,  32, 142, 201, 165
DE  2200 data  46, 133, 254, 229,  44,  32, 142, 201
EO  2210 data 165,  43, 133, 251, 165,  44, 133, 252
MO  2220 data 160,   0, 177, 251,  32, 142, 201, 230
IK  2230 data 251, 208,   2, 230, 252, 165, 251, 197
KA  2240 data 253, 208, 239, 165, 252, 197, 254, 208
KP  2250 data 233, 164, 167, 200, 200, 162,  18,  32
NM  2260 data 158, 201, 133, 252, 153,  46, 202, 232
GC  2270 data  32, 158, 201, 133, 251, 153,  47, 202
LB  2280 data 169, 187, 160, 201,  32,  30, 171, 169
GA  2290 data   0, 174,  45, 202,  32, 205, 189, 169
LF  2300 data 203, 160, 201,  32,  30, 171,  56, 169
HD  2310 data 128, 229, 251, 170, 169,  62, 229, 252
BJ  2320 data  32, 205, 189, 169, 207, 160, 201,  32
ND  2330 data  30, 171, 238,  45, 202, 162, 128, 108
HB  2340 data  29, 200,  32, 115,   0, 176, 246,  41
GC  2350 data  15, 205,  45, 202, 144,   3,  76, 132
MM  2360 data 201,  10, 168, 185,  46, 202, 162,  18
KN  2370 data  32, 144, 201, 232, 185,  47, 202,  32
AI  2380 data 144, 201,  32, 156, 201, 133, 253,  32
HI  2390 data 156, 201, 133, 254,  24, 165,  43, 133
HG  2400 data 251, 101, 253, 133, 253, 133,  45, 165
MI  2410 data  44, 133, 252, 101, 254, 133, 254, 133
DK  2420 data  46, 160,   0,  32, 156, 201, 145, 251
CG  2430 data 230, 251, 208,   2, 230, 252, 165, 251
CP  2440 data 197, 253, 208, 239, 165, 252, 197, 254
AA  2450 data 208, 233,  32,  51, 165,  76, 229, 200
OA  2460 data 169, 238, 160, 201,  32,  30, 171,  32
DP  2470 data 228, 255, 201,   0, 240, 249,  32, 210
EF  2480 data 255, 201,  48, 144,  39, 201,  58, 176
JL  2490 data  35,  41,  15, 205,  45, 202, 176,  28
KJ  2500 data 141,  45, 202, 133, 167, 230, 167,   6
PF  2510 data 167, 164, 167, 169,   0, 153,  46, 202
LP  2520 data 153,  47, 202, 200, 200, 192,  20, 208
DE  2530 data 244,  76, 229, 200, 169,  19, 160, 202
JN  2540 data  32,  30, 171,  76, 229, 200, 162,  31
LO  2550 data 142,   0, 214,  44,   0, 214,  16, 251
CP  2560 data 141,   1, 214,  96, 162,  31, 142,   0
JC  2570 data 214,  44,   0, 214,  16, 251, 173,   1
FI  2580 data 214,  96, 141,  18,  82,  65,  77,  32
HI  2590 data  68,  73,  83,  75,  32,  70,  85,  76
OP  2600 data  76, 141,   0, 141,  83,  65,  86,  69
LK  2610 data  68,  32,  80,  82,  79,  71,  82,  65
BD  2620 data  77,  32,   0, 141,  32,  32,   0,  32
HM  2630 data  66,  89,  84,  69,  83,  32,  82,  69
JM  2640 data  77,  65,  73,  78,  73,  78,  71,  32
IN  2650 data  73,  78,  32,  82,  65,  77,  32,  68
BO  2660 data  73,  83,  75,  32, 141,   0, 141,  83
AP  2670 data  67,  82,  65,  84,  67,  72,  32,  83
HO  2680 data  84,  65,  82,  84,  73,  78,  71,  32
GO  2690 data  87,  73,  84,  72,  32,  80,  71,  77
BA  2700 data  32,  78,  85,  77,  66,  69,  82,  32
NO  2710 data  63,  32,   0, 141,  18,  73,  78,  86
DA  2720 data  65,  76,  73,  68,  32,  80,  82,  79
GB  2730 data  71,  82,  65,  77,  32,  78,  85,  77
BE  2740 data  66,  69,  82, 141,   0,   0,   0,   0
MI  2750 data   0,   0,   0,   0,   0,   0,   0,   0
GJ  2760 data   0,   0,   0,   0,   0,   0,   0,   0
IE  2770 data   0,   0
```

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AmigaBasic Function Plot

Chris Zamara, Technical Editor

An Auto-Scaling Plotting Demo

This program will open a new window with all the standard gadgets and display the graph of a function within it, including the X and Y axes. The graph always fills the entire window, and will re-plot to a new size if you resize the window with its sizing gadget. The function to be plotted is defined in the program with a DEF FN statement, over a range of X values defined by the variables DOMAIN1 and DOMAIN2.

Before plotting the function, the program finds the highest and lowest values of the function so that it can scale to the size of the output window. The message "Scaling. . ." will be printed while this process takes place. After scaling, the function is plotted, taking up the entire height of the window, with the lines X=0 and Y=0 plotted in colour 2 (default colour black). You can move the output window around with the drag bars in the usual manner, and if you re-size the window, the program re-plots the function to fill the window at its new size. Since the function is only re-evaluated for each pixel in the width of the window, you'll find that the function plots faster when the window width is smaller.

When the output window is first opened by the program, it is sized so that a function is aspect-ratio corrected. That is, the X and Y co-ordinates are the same size on the screen, if not the same number of pixels. Thus, the function Y=X will describe a true 45-degree angle. This, of course, can be changed by re-sizing the window, stretching the function in the X or Y direction.

The output window is opened and selected by the following line in the program:

```
WINDOW 2,title$,(5,10)-(502,115),31 'new window
```

The above command will open a NEW window, leaving the standard BASIC window in place. The window is also auto-refreshed: moving it around won't mess up what's inside. That takes up a lot of memory, so if you only have 256K, you'll have to change it to WINDOW 1, replacing the BASIC window. Or, you can just remove the line altogether, using the BASIC window with its original size and title.

To set up the function to be plotted, just change the DEF FN function definition as shown in the listing, and change the DOMAIN1 and DOMAIN2 variable assignments to define the start and end X values for which the function is evaluated. as listed, the program will plot the function Y=SIN(X) from 0 to 2π, which is good for demonstration purposes but a bit boring. Several other functions appear as comments, along with recommended domain parameters. Take out the comment character "'" (apostrophe) and comment out the "DEF FN Y(X)=SIN(X)", then set up the DOMAIN1 and DOMAIN2 variable assignments to try one of the listed functions.

The program uses many of AmigaBasic's advanced capabilities. It uses no line numbers or labels, using control structures to control program flow. The scaling and plotting are done by local procedures, which only affect the required variables and produce no side effects like a standard BASIC subroutine does.

The only bug I know about is that sometimes the function will re-plot twice after a window re-sizing operation. It probably occurs when the window is re-sized between checks for window width and height.

The method of providing the function to the program is obviously primitive. A more polished program could easily grow from the humble bit of code presented here today. Pull-down menus could be used to select functions and the domain of the functions. A good idea might be a kind of "function construction kit", pulling out individual terms of an equation and combining them to create the desired function. Another good idea might be to allow different functions to be plotted on different windows, or maybe on the same window. A fairly easy feature to add would be a magnify function: pick a start and end point on the graph, and re-plot the chosen section. You could also get it to plot pre-calculated data from DATA statements or a disk file.

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```
' function plot from Transactor Magazine
' this program may be freely disributed
' Mar 86 - CZ
' Plots any function and scales
' to the size of the output window.
'
' Set the function using DEF FN below
' and set the range of X values
' with the 'domain1' and 'domain2' variables.
'
pi = 3.141592


'put your function below. . .
title$ = " y=sin(x) "  'output window title
DEF FN y(x) = SIN(x) 'use 0 to 2*pi for domain

'. . .or try one of these
' DEF FN y(x) = SIN(x) + COS(2*x)   'domain=(0, 2*pi)
' DEF FN y(x) = SIN(x) + 2*SIN(15*x) 'domain=(-pi, +pi)
' DEF FN y(x) = -5*x-2*x*x-3*x*x*x  'try (-10, +10)
' DEF FN y(x) = SQR(9-x*x)         '(-3, +3)

'..set the domain of X values here
domain1 = 0   'x start
domain2 = 2*pi 'x end

'=======================
'make new window to display graph
WINDOW 2,title$,(5,10)-(502,115),31 'new window
'find highest and lowest y values for scaling
CALL scale(range1, range2)

prev.width=0: prev.height=0
WHILE 1 'continuous loop
  new.width  = WINDOW(2)
  new.height = WINDOW(3)
  'plot graph if window is re-sized
  IF new.width<>prev.width OR new.height<> prev.height THEN
    CALL PlotGraph(range1, range2)
  END IF
  prev.width  = new.width
  prev.height = new.height
WEND

SUB scale(range1, range2) STATIC
  ' find max. and min. y values of function
  ' from domain1 to domain2

  SHARED domain1, domain2
  SHARED FN y()

  PRINT "Scaling. . ."
  s=(domain2-domain1)/WINDOW(2)
  range1 = FN y(domain1)
  range2 = range1

  FOR x = domain1 TO domain2 STEP s
    y = FN y(x)
    IF y < range1 THEN range1 = y
    IF y > range2 THEN range2 = y
  NEXT x
END SUB


SUB PlotGraph(range1, range2) STATIC
  ' Plot Graph of function Y to scale
  ' of current output window

  SHARED domain1, domain2
  SHARED FN y()

  window.width  = WINDOW(2)-1
  window.height = WINDOW(3)-1
  X.scale = (domain2-domain1)/window.width
  Y.scale = window.height/(range2-range1)
  Y.zero  = range2*Y.scale
  X.zero  = -domain1/X.scale

  'draw axis: lines y=0 and x=0
  CLS
  LINE (0, Y.zero)-(window.width, Y.zero),2
  LINE (X.zero, 0)-(X.zero, window.height),2
  'plot first point
  PSET (0, Y.zero-FN y(domain1)*Y.scale)
  'now plot whole function
  FOR x.pixel = 0 TO window.width
    x = x.pixel*X.scale+domain1
    y = FN y(x)
    y.pixel = Y.zero - y*Y.scale
    LINE -(x.pixel, y.pixel)
  NEXT x.pixel
END SUB
```

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Kernel Routines In The B128

Liz Deal
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This is a list of 46 KERNEL routines in the B128. It is somewhat different from the list in the Protecto/CBM Guide. Most of the routines in the B128 are similar to the C64, but some call addresses have been changed, setup registers sometimes differ, and there is more impact on the registers than was the case with the C64. This list is also valid for the B256 models which have the same Kernel ROM as the B128. Some B256 machines (in Europe) may have a different Kernel ROM. They can be distinguished from the most recent version by the presence of code in the "patch area", $ECB0–ECE8.

Making this list would not have been possible without help from Jim Butterfield in the form of memory maps and a superb disassembler.

Unless otherwise noted, long addresses are normally sent/returned in this order: A = bank#, Y = high byte, X = low byte of address.

Usually in zero page, it is kept in the lo–hi–bank order. Often a register points to the first of the three bytes.

A, X, Y are data registers. If unchecked, it means, positively, that the routine has no effect on the register. The "C" column refers to the carry flag. It is a rare subroutine that does not affect the C status. So to avoid ambiguous clutter, the only time C is checked off is when it means something. Much of the time in the I/O routines C indicates an error, but ST does the job better – it may show an error while C is clear. ST = 64 at the end of file; this is not indicated in the table below.

Jumbo Jump Table in Chronological Order – CBM names

ff6c	jmp $fe9d		;txjump	transfer of execution jump
ff6f	jmp $fbca		;vreset	power on/off vector reset
ff72	jmp $fe33		;ipcgo	loop for ipc system
ff75	jmp $e022		;funkey	function key vector
ff78	jmp $fcab		;iprqst	send ipc request
ff7b	jmp $f9fb		;ioinit	i/o initialization
ff7e	jmp $e004		;cint	screen initialization
ff81	jmp $f400		;alocat	allocation of memory
ff84	jmp $fba9		;vector	read/set i/o vectors
ff87	jmp $fba2		;restor	restore i/o vectors
ff8a	jmp $f660		;lkupsa	match sa
ff8d	jmp $f678		;lkupla	match la
ff90	jmp $fb5a		;setmsg	enable/disable os messages
ff93	jmp ($324)	$f274	;second	send sa after listen
ff96	jmp ($326)	$f280	;talksa	send sa after talk
ff99	jmp $fb78		;memtop	set/read top of memory
ff9c	jmp $fb8d		;membot	set/read bottom of memory
ff9f	jmp $e013		;scnkey	scan keyboard
ffa2	jmp $fb74		;settmo	set ieee timeout
ffa5	jmp ($328)	$f30a	;acptr	handshake ieee byte in
ffa8	jmp ($32a)	$f297	;ciout	handshake ieee byte out
ffab	jmp ($32c)	$f2ab	;untlk	send untalk to ieee
ffae	jmp ($32e)	$f2af	;unlsn	send unlisten to ieee
ffb1	jmp ($330)	$f234	;listen	send listen to ieee
ffb4	jmp ($332)	$f230	;talk	send talk to ieee
ffb7	jmp $fb4a		;readst	read/set st
ffba	jmp $fb43		;setlfs	set files la,fa,sa
ffbd	jmp $fb34		;setnam	set file name length and adrs.
ffc0	jmp ($306)	$f6bf	;open	open logical file
ffc3	jmp ($308)	$f5ed	;close	close/abort logical file
ffc6	jmp ($30a)	$f549	;chkin	connect input channel
ffc9	jmp ($30c)	$f5a3	;chkout	connect output channel
ffcc	jmp ($30e)	$f6a6	;clrchn/restio	reset default i/o devices
ffcf	jmp ($310)	$f49c	;chrin/basin/input	input a byte from open ch.
ffd2	jmp ($312)	$f4ee	;chrout/basout	output a byte to open ch.
ffd5	jmp ($31a)	$f746	;load	load from file
ffd8	jmp ($31c)	$f84c	;save	save to file
ffd8	jmp $f90e		;settim	set TOD clock
ffde	jmp $f8e6		;rdtim	read TOD clock
ffe1	jmp ($314)	$f96b	;stop	check STOP key
ffe4	jmp ($316)	$f43d	;getin	get byte from KB or channel
ffe7	jmp ($318)	$f67f	;clall	close or abort files
ffea	jmp $f979		;udtim	last row KB scan
ffed	jmp $e010		;scrorg/screen	return screen size
fff0	jmp $e019		;plot	read/set cursor position
fff3	jmp $e01c		;iobase	return i/o base address
fff6	sta $0:rts		;goodbye	goes to another bank
fff9	.byte 1			
fffa	Hardware vectors: nmi $fb31, reset $f997, irq $fbd6.			

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B128 Kernel Routines

CBM Label	Jump addr	Ind addr	Real code	Operation Details		IN A X Y C	MOD A X Y C	MOD ST
ACPTR	FFA5	328	f30a	Get byte from IEEE	out: C = 1 and ST = 2 if timeout	- - - -	a - - c	*
ALOCAT	FF81	---	f400	Allocate YX bytes relative to top of user memory	in: X = low Y = high out: C = 1 if failed (use MEMTOP)	- x y -	a x y c	
CHKIN	FFC6	30a	f549	Open channel for input	in: X = logical file# out: C = 0 if keyboard or RS232 if IEEE, C = 1 if no file,no device	- x - -	a x - c	
CHKOUT	FFC9	30c	f5a3	Open channel for output	(see CHKIN)	- x - -	a x - -	
CHRIN	FFCF	310	f49c	Input character	out: C = 0 if keyboard or IEEE (use ST) RS232 if STOPped turns C = 1	- - - -	a - - c	*
CHROUT	FFD2	312	f4ee	Output character	out: C = 0 if screen or IEEE (use ST) RS232 if STOPped turns C = 1	a - - -	- - - c	*
CINT	FF7E	---	e044	Initialize screen editor, top of user memory, function keys		- - - -	a x y -	
CIOUT	FFA8	32a	f297	Output byte to IEEE	out: C = 1 and ST = 1 if timeout	a - - -	- - - c	*
CLALL	FFE7	318	f67f	Close or abort all files	in: A = dev#, C = 0 aborts, does CLRCHN C = 1 closes until error, aborts files after first error	a - - c	a x y c	
CLOSE	FFC3	308	f5ed	Close one file	in: A = log. file#, C = 0 aborts file, C = 1 real close file	a - - c	a x y -	*
CLRCHN	FFCC	30e	f6a6	Restore default devices		- - - -	a x - -	
FUNKEY	FF75	---	e6f8	Print/Edit function key definitions	Print all dfns- in: Y = 0 Edit key- in: Y = key# A = zero pg ptr to length of dfn and long addr.	- - y - a - y -	a x y - a x y -	
GETIN	FFE4	316	f43d	Get a byte	out:XY unchanged in RS232/IEEE C = 0 in keyboard,RS232,IEEE (use ST)	- - - -	a x y -	*
IOBASE	FFF3	---	e03a	Returns address of I/O devices	out:bank15,X = low,Y = high addr	- - - -	- x y -	
IOINIT	FF7B	---	f9fb	Initialize I/O and TOD clock		- - - -	a x y -	
IPCGO	FF72	---	fe33	Loop for other processor		- - - -	a x y -	
IPRQST	FF78	---	fcab	Send ipc request		- - - -	a x y -	
LISTEN	FFB1	330	f234	Make IEEE device listen	in: A = device#	a - - -	a - - -	*
LKUPLA	FF8D	---	f678	Lookup parameters for file#	in: A = log. file# out: A = log. file#, X = dev# Y = sec addr, C = 1 if no file LA	a - - -	a x y c	
LKUPSA	FF8A	---	f660	Lookup parameters on known sec.addrs	in: Y = secondary address out: A = log. file#, X = dev# Y = sec addr, C = 1 if no file matches SA	- - y -	a x y c	
LOAD	FFD5	31a	f746	Load after call to SETLFS,SETNAM	in: A bit 7 = 0 to load, bit 7 = 1 to verify, bits 0-3 dest. bank# Y,X = destination addr hi,lo (X = Y = $FF to load at header addr) out: A,Y,X = long addr. last byte in.	a x y -	a x y -	*
MEMBOT	FF9C	---	fb8d	Read/Set bottom of memory	set: C = 0; A,Y,X = long address read: C = 1; A,Y,X = long address	a x y c - - - c	- - - - a x y -	
MEMTOP	FF99	---	fb78	Read/Set top of memory	in: C = 0; A,Y,X = long address out: C = 1; A,Y,X = long address	a x y c - - - c	- - - - a x y -	
OPEN	FFC0	306	f6bf	Open a logical file	in: C = 0 for normal open C = 1 temp IEEE channel, no table.	- - - c	a x y -	
PLOT	FFF0	---	e025	Read/Set cursor position	read- in: C = 1 out: X = row Y = column set- in: C = 0; X = row Y = column	- - - c - x y c	- x y - a - - -	
RDTIM	FFDE	---	f8e6	Read TOD clock in BCD (see book for bit assignments)		- - - -	a x y -	
READST	FFB7	---	fb4a	Read/Set ST	read- in: C = 1 set- in: C = 0 A = value to go to ST	- - - c a - - c	a - - - - - - -	
RESTOR	FF87	---	fba2	Restore system default vectors		- - - -	a x y -	
SAVE	FFD8	31c	f84c	Save any memory	in: X = zero pg ptr to long start addr Y = zero pg ptr to long end addrs out: AXY are NOT final address	- x y -	a x y -	*
SCNKEY	FF9F	---	e013	Scan keyboard		- - - -	a x y -	
SCREEN	FFED	---	e010	Return screen size X = columns Y = rows		- - - -	- x y -	
SECOND	FF93	324	f274	Send secondary adrs after listen		a - - -	- - - -	*
SETLFS	FFBA	---	fb43	Set file parameters	in :A = log. file#, X = dev#, Y = sec addr	a x y -	- - - -	
SETMSG	FF90	---	fb5a	Enable/Disable OS messages	in: A bit 7 = 1 KERNEL msgs on, bit 6 = 1 Control msgs on	a - - -	- - - -	
SETNAM	FFBD	---	fb34	Set file name	in: A = length of file name, X = zero pg ptr to long name addr	a x - -	a - - -	
SETTIM	FFDB	---	f90e	Set TOD clock using BCD values	in: bits assignments-see book	a x y -	a - - -	
SETTMO	FFA2	---	fb74	Enable/Disable IEEE timeout	in: A bit 7 = 0 enable, bit 7 = 1 disable	a - - -	- - - -	
STOP	FFE1	314	f96b	Check Stop key	out: Z = 0 if STOP not used; X unchanged Z = 1 if STOP used, X changed by call to CLRCHN	- - - -	a x - -	
TALK	FFB4	332	f230	Make IEEE device talk	in: A = device#	a - - -	a - - -	*
TLKSA	FF96	326	f280	Send secondary address after talk	in: A = secondary address	a - - -	a - - -	*
TXJUMP	FF6C	---	fe9d	Jump to code at long address AYX		a x y -	a x y c	
UDTIM	FFEA	---	f979	Part of KB scan (no clockwork!!)	logs keys: enter, +, -, /, stop	- - - -	a - - -	
UNLSN	FFAE	32e	f2af	Unlisten all IEEE devices		- - - -	a - - -	*
UNTLK	FFAB	32c	f2ab	Untalk all IEEE devices		- - - -	a - - -	*
VECTOR	FF84	---	fba9	RAM vectors storing	in: C = 0 moves user list at AYX to vector area C = 1 moves vectors to addr AYX	a x y c	a x y -	
VRESET	FF6F	---	fbca	Set button-reset code to bank 15 at X,Y	in: X = low Y = high	- x y -	a - - -	

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Unmasking The Kernal

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– A collection of notes about using the I/O routines

Every programmer who takes up machine language soon runs into those puzzling phenomena known as the "Kernal Routines". Those who have already attained enlightenment use them with abandon and urge others to do the same, but they can be pretty darn confusing if you have barely passed the "LDA #$00" stage. At least, they were to me, armed as I was with only a C64 Programmer's Reference Guide and a copy of Supermon.

I was by no means an overnight success at learning machine language. At first I shunned the machine language section of the Guide as if I was afraid the pages would bite me. But older, wiser heads assured me that if I progressed to the point where I needed speed beyond that of Basic, I would have to become involved with machine language. I was tough to convince, but eventually I was gripped with curiosity.

And so one day I decided to give M–L a try. I studied carefully the explanations and examples from the Reference Guide. I fiddled with Supermon. I printed the alphabet. I changed the colour of the screen, and finally figured out what numbers such as $D020 stood for. I memorized the mnemonics and their functions. I printed the alphabet again. But it was here that I was stopped cold, because I couldn't really cause anything to happen (aside from changing the screen colours and the ever-popular alphabet printing). I needed two things : y-indexed loops and Kernal Routines. The former were described well enough in the Guide, I just had to think a bit about where to use them; the Kernal Routines, however, were downright confusing. This might not seem like a major crisis – who needs them, anyway? What exactly do they do? Well, the easiest way to explain it is to say that without them, the only way to make the computer communicate with the outside world (i.e. you or another user) is by poking information either to screen memory or to the mysterious "CIA chips" (one bit at a time!). This did not seem to me to be a real possibility, so I set about to figure out exactly what the Kernal was all about.

Don't laugh, but I thought that Supermon would understand the names of each routine, so I had commands like "JSR CHROUT" without benefit of an assembler (Supermon, Micromon et al, with their narrow format for entering instructions, are monitors). I couldn't figure out the order of many sequences. There are a host of routines that can be used to access the disk or printer, and just to be safe, I would always use as many as I could. Needless to say, it was a nice while before I could do anything with the drive or printer.

My biggest beef was that many important routines, like "CLRCHN" are not identified as important, and routines like "LISTEN" (which I have never once needed to call directly) are not identified as unnecessary. How could that be a problem, you ask? I "listened" and "unlistened" my drive to death but never did a "CLRCHN", so I always ended up with a locked up computer, an error light, and a star file in my directory.

The universal input/output routines are not identified as such, so I could never decide which one was the right one (CHROUT and GETIN are always best, with one exception – simulating a Basic INPUT statement). Also, there was no step-by-step guide to opening a file and performing I/O functions. I ran out of stack space in my head trying to follow all those preparatory routines back to the beginning. And putting ",s,w" or ",p,w" in the filenames in order to write anything to the disk escaped me for quite some time.

An extreme case? Learning disabilities? I was beginning to suspect that such had to be true. In contrast to my quick grasp of commands and techniques in Basic, I was a snail at learning machine language.

Looking back, I can see that it wasn't really that bad. Once I learned the op-codes and the different types of indexing I could do anything I wanted to, limited only by my knowledge of the 64's input/output chips. Now when I'm asked questions about machine language by learners, I find I'm able to give detailed answers without referring to memory maps or the Guide – because I was forced to figure such things out for myself and test them by trial and error.

I suspect that everyone has similar problems, at least starting off. And accessing the Kernal Routines properly is likely to be the highest hurdle you'll have to clear on your way to becoming a proficient M–L programmer.

So: here's my guide to using Kernal Routines.

– Learn the hex addresses of the important routines. Using the symbolic labels in an assembler such as PAL is all very well and good, but you'll have difficulty understanding disassemblies or other people's code otherwise. I find "jsr $FFD2" just as easy to type and recognize as "jsr CHROUT".

– However, those who have access to an assembler can save themselves time and bother by assigning labels to important routines early in a program (eg OPEN = $FFC0). For those who do programming which makes extensive use of the Kernal, save a PAL symbol table or a Library file (for the Commodore Macro Assembler) which consists of nothing but the labels and addresses of frequently used Kernal routines. Use a ".lst" in PAL or ".lib" in the Macro Assembler to have the labels assigned automatically.

– To print a character to any device (including screen) use CHROUT ($FFD2). No need to ever use CIOUT, LISTEN, or SECOND, because the routine at $FFD2 checks to see if the character is going to disk or printer and calls these routines when they are necessary.

– To receive a character from any device (including keyboard) use GETIN ($FFE4). This does away with the need for ACPTR, CHRIN, TALK, UNTLK, and TKSA, for the same reasons as above.

– Of course, this means that any time you want to send to or get from disk, printer, modem, etc. you must first indicate this to the computer (Aha! you say). After a file has been opened, use CHKIN or CHKOUT to select that file for the proper operations. To avoid serial bus confusion, use CLRCHN first. It's easier to remember if you put in a routine called "toprinter" or "fromdisk" which will call CLRCHN, then CHKIN or CHKOUT whenever necessary (or if you're not sure where your data is going to or coming from).

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– The friendliest routine to use both before and after doing disk or printer work is CLRCHN ($FFCC). Anytime you perform input or output to peripherals, use this afterwards to make sure input and output go back to keyboard/screen. Use it often; you can never be too careful.

– Use CHRIN only as the equivalent of a Basic input statement, and in exactly the way it's shown in examples. This is a bizarre routine which can have unpredictable results if not handled carefully. Try calling it a single time if you're not convinced.

– When using LOAD and SAVE, don't use OPEN first. They perform OPEN automatically.

– CLALL doesn't always do what you'd expect. Use the CLOSE routine on each individual file. If you're lazy (like me), have several files open, or have a program crash with the drive light on and file number unknown, OPEN the disk command channel, then CLOSE it. This closes all open files to the disk, so never CLOSE the command channel if you're not finished with your other files.

– If you are sending disk commands, using block read or write, checking the error channel, or anything that requires you to have the command channel to the disk open, keep it open for the duration. It can't hurt, and you will suffer no ill effects if it isn't closed at the end. There will, however, be nasty surprises if you close it before finishing up with your other files.

– Sending a command to the disk is most easily done by setting the filename to be the command (e.g. "s0:test") before performing the OPEN. Then simply open the command channel. If no command is to be set, use a filename of length zero. Disk commands after the first must be printed to the channel, as in the Basic command print#15,"i0".

– The READST routine ($FFB7) is used mainly to detect the end of a file (this is the cryptic "EOI line" mentioned in the C64 Guide; it stands for "End Or Identity"). A loop using it would look something like this :

```
getin  =   $ffe4
chrout =   $ffd2
readst =   $ffb7
loop   =   *
       jsr   getin      ;get a char
       jsr   chrout     ;print it
       jsr   readst     ;check status
       and   #$40       ;is bit 6 (EOI) still clear
       beq   loop       ; yes, go back
```

– When reading the error channel, a loop must be used to get characters until a return (chr$(13)) is received in order to turn off the error light.

– If you get "searching for. . ." and similar messages when loading and saving with machine language you can turn them off with "asl $9d". This clears a certain bit and avoids the hassle of the SETMSG routine.

– Use drive and file-type declarations in filenames to avoid errors – don't call it "test", call it "0:test,p,w". The exceptions to this rule are LOAD and SAVE, which don't require file type to be specified. It is, however, possible to get a look at a sequential file by doing a LOAD of "name,s,r". The resulting program is somewhat garbled, but it can be a useful time-saver.

A few examples (in PAL format) should serve to make things more clear. Users of M-L monitors should use actual numbers and addresses in place of labels.

To open program file "test" on disk for reading. . .

```
; **** below is equivalent of: 'open 8,8,8,"name" ' ******
       lda   #$08       ;the file number the computer refers to
       ldx   #$08       ;device number 8 – the drive
       ldy   #$08       ;secondary address 8 – anything other than
                        15, 0, or 1 is safest
       jsr   $ffba      ;setlfs – use the above numbers
       lda   #$0a       ;10 chars in filename
       ldx   #<name     ;the $34 in an address like $1234
       ldy   #>name     ;the $12 in an address like $1234
       jsr   $ffbd      ;set the file's name
       jsr   $ffc0      ;do the actual opening
       ldx   #$08       ;file #8 (NOT device 8)
       jsr   $ffc6      ;chkin – ignore keyboard, receive charac-
                        ters from file #8

(routine using $FFE4 to read from file)

; **** close file # 8 ****
       jsr   $ffcc      ;finished with disk for now
       lda   #$08       ;file #8 again
       jsr   $ffc3      ;close file #8
       rts              ;and we're done
;
name   =     *          ;filename goes below
       .asc  "0:test,p,r"
;
;NB: users of monitors must poke their
;    filenames into memory and figure
;    out the hex addresses themselves
```

To save memory from $1234 to $5678 as "prog" on disk. . .

```
start  =   $1234        ;start of ram to save
end    =   $5679        ;end of ram + 1
;
       lda   #$08
       tax
       tay
       jsr   $ffba      ;3 8's, as in above example
       lda   #$06       ;6 chars in filename
       ldx   #<name     ;lower 2 hex digits of address
       ldy   #>name     ;higher 2 hex digits
       jsr   $ffbd      ;set the filename
       lda   #>start
       sta   $fa        ;start of save
       lda   #<start    ;goes into $fa,$fb
       sta   $fb        ;as lo-byte, hi-byte
       lda   #$fa       ;because $fa was used above
       ldy   #<end      ;one more than
       ldx   #>end      ;end of save
       jsr   $ffd8      ;now save it
       rts
;
name   =     *          ;could be anywhere
       .asc  "0:prog"   ;no file type needed for load & save
```

Notice that when save was used, there was no need to open a channel or set an output device. Doing so can lead to a file with file type "del" in the directory.

Of course, it's impossible to cover all aspects of the Kernal routines in a single article – you could write a sizable manual on their intricate workings. The best bet is for programmers to refer to a work like the Programmer's Reference Guide (hence the name) for detailed how-to-use information and the quirks each routine has. And, of course, keep reading The Transactor!

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Kernal Who?

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I started computing when FORTRAN IV was popular and the machine filled the basement of one of the halls on campus. Interactive was a word used in teaching, not in programming. All jobs were run in batch mode; you punched your card deck, dropped it off at midnight, and came back at 3 AM to get the printout. A few of the well-equipped physics labs had a PDP-4 model or two, a mini-computer. In those days "mini" meant really small (like skirts). The PDP series was lucky to have 8k of memory installed, and many had 4k. I dropped out of computing for a number of years, not being able to afford 2-3 million for a computer or a van to port it around in. Then came PET. I eagerly laid out $1200 dollars for one of the first ones to hit B.C. back around 1978 and took it home to see what it could do. I soon discovered the *great* feeling of being able to change a program the moment a mistake was discovered. This was interactive programming. To add to this, the PET has one of the best screen editors ever implemented (long before IBM PC or TI Professional). One thing led to another, and soon I was searching for a way to boost performance. There is only one really practical way to do this, and that is machine language.

What's a KERNAL?

Machine language is SUPER SPEEDY compared to BASIC, but you have to do every little thing yourself and it is difficult to make your routines as flexible as BASIC. Fortunately, there is help, and it resides within the ROMs included with your computer. This help is in the form of a useful set of general-purpose machine language routines that perform a variety of functions. These functions are primarily input, output and internal housekeeping. The routines are set up so that they will access the correct device, passing information back and forth from your program in a simple and predefined way. This block of machine language routines is the heart of the computer's operating system, and in the C-64 has a ROM chip all of its own to live in. Around these routines are built many of the functions utilized by BASIC or most any other program written in machine language. Because the routines are such a central element of the computer, the name KERNAL is applied. Many programming languages exist that have a core of predefined routines that may be used to assemble more complex functions. In these languages the central core routines are often called the KERNAL. The method of using these routines in Commodore computers is the same, regardless of which model you own. To Commodore's credit, the requirements for entering each routine and the results have been kept as constant as possible on different machines.

The Jump Table

The jump table is the way by which all KERNAL routines should be called. This table is a sequence of ML jump instructions found near the top of memory. They are in the same place in all Commodore computers except for routines that are unique to a specific machine. To call a KERNAL routine one must first call any prerequisite routines and then load certain registers with byte values needed to transfer required information to the KERNAL routine. Some routines need no setup at all, while others need one or two previous routine calls to get things ready. For the purposes of this discussion we will use the C-64 jump table as an example. Those of you using other models of Commodore computers, particularly the PET series, will find the jump table similar, generally containing a subset of the C-64 jump table. If you have a machine language monitor handy for your computer, (such as supermon, micromon, etc.) you should have a look at the section of memory starting at $FF81. When this area is disassembled, you will find a sequence of "JMP $xxxx" instructions where "$xxxx" is an address of either a routine in the ROM or of an indirect jump vector.

In the case of an indirect vector the address of the actual routine will be contained in two consecutive memory locations starting with the one referenced by the "JMP" instruction. The target address is stored in the vector location with the low order byte in the low order memory address and the high byte in the high order memory location. For example, the CHROUT ($FFD2) routine (see table I) vectors through location $0326 by means of a "JMP ($0326)" instruction in the jump table. When this instruction is executed, the microprocessor will fetch the two bytes contained in locations $0326 and $0327 and install them in the program counter. Program execution will then continue starting at this new address.

A very important feature of the routines using an indirect jump vector is the fact that the vectors are stored in R/W memory (usually known as RAM even though ROM's are also Random Access Memory). This means that the programmer may change these vectors to point to his own routines, or simply to a RTS instruction so as to disable a routine. "Patching" these vectors is a simple and effective way of adding or modifying the operation of the computer operating system. As an example, new commands may be added to BASIC by changing the error message vector ($0300) to point to your routine. This routine would then use the CHRGET routine to re-get the offending statement and compare it to your list of valid commands. If no match were found then the accumulator value would be restored and control passed on to BASIC by JMPing to the normal error routine ($E38B). Another technique for changing KERNAL vectors, particularly those using direct JMP commands, is to copy the KERNAL to the underlying RAM and switching off the KERNAL ROM. It is now possible to change anything you wish in the KERNAL including any and all jump table vectors.

Using The KERNAL

Most of the KERNAL routines require some form of setup before being called. Some, however, do not. Generally, the routines that reset or clear something do not require any preparation. For example, the RESTOR routine does not require any prior KERNAL calls or register setup. When called, it will rewrite the jump table vectors starting at $0300 to the default values. An idiosyncrasy of the manner in which

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this routine is written causes it to also write the jump table vectors to RAM locations $FD30-$FD4F. This happens because the routine VECTOR uses part of the same code and is written to allow moving of the vectors. As a result, if you have anything important stored in $FD30-$FD4F it will be over-written when RESTOR is called. RESTOR is one of the routines called when the keys RUN/STOP-RESTORE are pressed. (You will notice these bytes being over-written if you view a high-res screen at $E000, then RUN/STOP-RESTORE and view it again.)

More commonly, the KERNAL routines require some register setup before use. Probably the most-used such routine and perhaps the most complex is CHROUT ($FFD2). This routine is used to output a single character. The byte value of the character is placed in the accumulator with a LDA XX command and CHROUT is called using JSR $FFD2. If printing on the screen is desired, no other setup will be required. The CHROUT routine will examine several flags to find out what channel is to be used. If no channels are open or enabled, CHROUT will then examine the byte value and determine if it is a control character.

If not, the correct screen location will be calculated, the character translated to the correct screen code, reverse printing checked, the value placed in screen memory, the color memory updated, screen scrolling checked/done, line link table updated and more. When done, CHROUT and all other KERNAL routines return with an RTS command.

The nice part is that the programmer does not have to worry about any of this. The KERNAL does it for you. Another well used routine is GETIN. This functions in almost the same manner as the BASIC GET statement. When GETIN is called, with no channels open, a single character from the keyboard buffer will be returned in the accumulator. If the keyboard buffer is empty, the value zero will be returned.

PROGRAM 1

Program 1 is a simple input routine in machine language which uses the GETIN routine to fetch characters from the keyboard buffer. The program exits when a return is pressed. Only alpha–numeric input is allowed with no control or cursor characters recognized or printed. Unlike the BASIC input routine this program will accept up to 255 characters as input. It is not possible to move off the line as only the delete key may be used to edit. When the return key is pressed, the program alters the pointer of the first BASIC variable declared by the BASIC program to point at the input buffer. For this reason, the first variable declared in the BASIC program should be a string variable. Upon return from this program this first variable will contain the input data. The length of input may be controlled by the second variable declared in the BASIC program. This must be an integer variable with a value range of 0–255. Program 1 as written will use $C000 to $C0FF as the input buffer. See table II for entry address and examples of use.

Program 1 gets all input from the keyboard and puts all output to the screen. This is because no input or output channels other than the default ones have been specified. To get information from some channel or device other than the keyboard, it is necessary to call some preparatory routines first. Similarly, to output to a device other than the screen, some setup is required.

PROGRAMS 2 and 3

Program 2 is a low resolution screen dump routine. This program opens a file to disk and writes the contents of the screen including sprite pointers on the disk. It functions by first obtaining the location in memory of the first variable declared in a BASIC program and using the contents of this string as the file name/command string to send to the disk drive. The KERNAL routine SETNAM is then called to set up system pointers to this string.

The logical file number, the device number and the secondary address are then loaded in the correct registers and the SETLFS routine is called. At this point all that remains is a call of the OPEN routine and we have a open file. This sequence produces exactly the same result as the BASIC statement OPEN 1,8,2,"0:test,s,w" assuming the string variable passed from BASIC to program 2 contained "0:test,s,w". The file name/command string may be located anywhere in memory. All that is necessary is to place the low/high values of the start address of the command sequence in the .x and .y registers along with the length in the .A register (Accumulator) and call the SETNAM routine.

Next in program 2 the CHROUT routine is directed to the device used by file #1 by loading the .x register with the file number and calling the CHKOUT routine. This means that any calls of CHROUT will send the byte in the accumulator to the disk. All values (0-255) are written with no filtering of exceptions. After reading all bytes from the screen and sending them, the accumulator is loaded with the file number and the CLOSE routine is called. This closes the file and notifies the disk drive that it is the end of the file. The CLALL routine is called next; this resets all I/O to the default channels and clears the file table.

Program 3 is the screen read routine and is very similar to program 2. The main difference is that the file opened is a read file (0:test,s,r) and the channels opened are input channels. It should be noted that a channel may be enabled for input using CHKIN without affecting the output channel when calling CHROUT. The same is true for output. It is therefore possible to input from disk using GETIN and print to the screen using CHROUT. Conversely, input from the keyboard using GETIN and output to disk or printer using CHROUT is possible. An important difference in program 3 is the use of a temporary storage location for the index variable used in the .y register. This is necessary because all registers are clobbered by the GETIN ($FFE4) routine (see TABLE I).

The file opened in programs 2 and 3 is exactly the same as a file opened by a BASIC program. Because of this, if a machine language program is to be used as a subroutine of a BASIC program, it is perfectly okay to open and close the file within the BASIC portion of the program. It is recommended that when fetching data from the disk the GETIN routine be used instead of the CHRIN routine. The reasons are the same as for using GET in BASIC instead of INPUT in that GETIN will accept any and all characters. The nice thing about machine language is that GETIN will work just as fast as the CHRIN routine when all the overhead of BASIC is absent. Program 3 does not test for a valid character after calling GETIN since the file length is always constant.

PROGRAM 4

Program 4 is the most complex. This program provides instant checking of the disk error channel when the Commodore and control keys are pressed together. The disk status is printed on the top line of the screen and the cursor position is maintained. If it is desired to call this program from within another program, the last instruction can be changed to a RTS, the error check BCS EXIT changed to NOP's, and the program called at BEGIN.

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Program 4 uses the serial bus communication routines in the KERNAL without opening a file. The serial device is commanded "speak" with the TALK ($FFB4) routine and the secondary address sent using the TKSA ($FF96) routine. The *Commodore Programmers Reference Guide* incorrectly states that to send the secondary address one loads the accumulator with the secondary address value and calls the routine. The GUIDE does not mention that the secondary address value must first be OR'ed with the hex value $60. To access the disk command channel, secondary address $6F must be sent ($0F OR $60 = $6F). This applies only to the direct serial secondary address routines TKSA and SECOND. The SETLFS routine requires only the unmodified correct secondary address value.

When program 4 is run, the interrupt vector at $0314–$0315 is set to point at the main body of program 4. Sixty times per second the system interrupt causes the code at START to execute. If a match between location $028D and $FE is found, the rest of the program will execute. If no match is found the normal interrupt routine is JMP'ed to. When the program executes a new value is placed in the count-down timer $FE and the TALK ($FFB4) routine is called with a device number of eight. Following, the TKSA ($FF96) routine is called with secondary address $6F. This opens the command channel in the disk drive for talking (to the computer).

Next the PLOT ($FFF0) routine is called with the carry bit set. This returns the row and column position of the cursor in the .x and .y registers. These are stored. The cursor is now set to the home position by a call to CHROUT with a value of $13 in the accumulator. Next the status byte (same as ST in BASIC) is set to zero.

The ACPTR ($FFA5) routine is then called and the returned value printed on the screen by CHROUT. A call to READST ($FFB7) follows to determine if an EOI was sent. If not, the program loops to NEXT and repeats until READST returns a non–zero value. This indicates the disk has said all it is going to and isn't speaking to us anymore.

We then try to reset the cursor back where it came from and run into a problem in the PLOT routine. Unfortunately, the values returned when PLOT is called to obtain cursor position are not always the same as the values we must use to restore cursor position. The problem comes up when the cursor is positioned on a wrap line, ie. one that is longer than 40 characters. The restore position part of the PLOT routine incorrectly handles the row calculations. We must test the column position returned by PLOT and if it is greater than $27 (decimal 39) we must subtract $28 before calling PLOT.

Finally we call the UNTLK ($FFAB) routine to untalk the serial bus devices and then JMP to the normal interrupt handler.

PROGRAM 5

Program 5 is a BASIC program that generates a machine language program file on disk. This file will contain all four example programs with the call addresses as listed in TABLE II. Just type it in and place a ready to use disk in the drive. Then RUN the program. The ML program can be loaded with LOAD "KERNAL WHO C100 ",8,1.

Problems and tips

A few problems have been noted when using the KERNAL routines to talk to the disk drive. If a UNTLK is followed immediately by a TALK command the computer may "crash". This appears to be caused by the drive not being able to respond to another command until it has finished some internal work thus causing it to miss the attention sequence from the computer. This takes a few milliseconds and it is best to wait at least 100 milliseconds before sending a new command. This is one reason for the countdown timer logic in program 4. That logic is also implemented since program 4 is executed on the interrupt and these interrupts occur every 16.7 milliseconds. It is necessary to prevent the routine from being called by a second interrupt that occurs while the routine is still executing. In most interrupt driven routines this is not a problem but the serial bus communication routines have a nasty habit of clearing the interrupt flag thus allowing further interrupts.

Something that is not specifically mentioned in the GUIDE is the fact that the KERNAL routines never call any routines in the BASIC ROM residing at $A000–$BFFF. This means that the BASIC rom may be turned off and the KERNAL used as much as you like. This allows you to use the 8k of RAM there for your own programs. Keep in mind that the BASIC ROM makes frequent use of the KERNAL so the converse is not true.

Another system characteristic that is not mentioned anywhere is that sprites MUST be turned off when the serial bus is used. It is not sufficient to hide them on the edge of the screen, they must be OFF! The VIC chip steals time from the 6510 cpu when sprites are turned on and this will clobber the serial bus timing routines, particularly the EOI (end of information) detection. Your computer will occasionally miss the EOI signal and then wait until the sun burns out to get it. Using sprites does not seem to affect the RS–232 routines since the timing windows are much wider.

When using the system RS–232 routines it is only necessary to OPEN a file to device number two and output with CHROUT or input with GETIN after setting the correct I/O channels. Do not use CHRIN with RS–232 since CHRIN is dependent on receiving a carriage return to terminate the routine. Also, the RS–232 interrupt system uses the non–maskable interrupt (NMI) as does the serial bus. Therefore, you cannot send or receive RS–232 data and serial bus data at the same time.

Another item of interest is the way the CLOSE routine handles the RS–232 channel. If CLOSE is called then the RS–232 file is killed along with the buffers. The user port will be set to default I/O values. If the RS–232 file is to be closed without affecting these things call the CLALL routine instead. This will wipe out the file table and set default I/O but the user port is unaffected and the buffers remain allocated. One problem with RS–232 is that when a RS–232 file is OPENed, the user port is set to a standard default condition. This means that if you were using some of the pins for certain non-implemented functions, such as telephone line control, your output conditions and port values may be disrupted. The only way to deal with this is to open the RS–232 file "manually". To do this you will have to setup all the table and file flags, allocate buffers, set interrupt timers etc. yourself. A full description of this process is beyond the scope of this article but may be the subject of a future article.

Full details of the entry, exit and error conditions to be considered are in the *Commodore 64 Programmers Reference Guide*. I have listed the KERNAL routines in TABLE I in order by address because the table in the GUIDE is in alphabetical order by label and that is very inconvenient when you are looking through a disassembly and trying to find out what routine is used.

Using the KERNAL is not difficult. Many of the operations are not much different from the way BASIC works. It saves time and will make life a lot easier for the programmer.

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TABLE I

Commodore 64 KERNAL Jump Table In Address Order

Label	Call addr	Vector addr	Target addr	Function Description	Register Usage entry	return	used
IOINIT	$FF84	–	$FDA3	initialize i/o	– – –	– x y	a x y
RAMTAS	$FF87	–	$FD50	ram test	– – –	– – –	a x y
RESTOR	$FF8A	–	$FD15	restore vectors	– – –	– – –	a x y
VECTOR	$FF8D	–	$FD1A	move vectors	– x y	– – –	a x y
SETMSG	$FF90	–	$FE18	control kernal msg	a – –	– – –	a – –
SECOND	$FF93*	–	$EDB9	send listener second	a – –	a – –	a – –
TKSA	$FF96*	–	$EDC7	send talker second	a – –	a – –	a – –
MEMTOP	$FF99	–	$FE25	set top ram pointer	– x y	– x y	– x y
MEMBOT	$FF9C	–	$FE34	set start ram point	– x y	– x y	– x y
SCNKEY	$FF9F	–	$EA87	scan keyboard	– – –	– – –	a x y
SETTMO	$FFA2	–	$FE21	set IEEE timeout	a – –	– – –	a – –
ACPTR	$FFA5*	–	$EE13	input serial byte	– – –	a – –	a x –
CIOUT	$FFA8*	–	$EDDD	output serial byte	a – –	a – –	– – –
UNTLK	$FFAB*	–	$EDEF	untalk serial bus	– – –	a – –	a – –
UNLSN	$FFAE*	–	$EDFE	unlisten serial bus	– – –	a – –	a – –
LISTEN	$FFB1*	–	$ED0C	listen serial device	a – –	a – –	a – –
TALK	$FFB4*	–	$ED09	serial device talk	a – –	a – –	a – –
READST	$FFB7	–	$FE07	read i/o status byte	– – –	a – –	a – –
SETLFS	$FFBA	–	$FE00	set–up logical file	a x y	– – –	a x y
SETNAM	$FFBD	–	$FDF9	set file name	a x y	– – –	a x y
OPEN	$FFC0	($031A)	$F34A	open a logical file	– – –	a – –	a x y
CLOSE	$FFC3	($031C)	$F291	close a single file	a – –	a – –	a x y
CHKIN	$FFC6	($031E)	$F20E	enable input channel	– x –	a – –	a x –
CHKOUT	$FFC9	($0320)	$F250	enable output chan	– x –	a – –	a x –
CLRCHN	$FFCC	($0322)	$F333	set chans to default	– – –	– – –	a x –
CHRIN	$FFCF	($0324)	$F157	input characters	– – –	a – –	a x –
CHROUT	$FFD2	($0326)	$F1CA	output a character	a – –	a – –	a – –
LOAD	$FFD5**	($0330)	$F49E	load to memory	a x y	a x y	a x y
SAVE	$FFD8**	($0332)	$F5DD	save from memory	a x y	a – –	a x y
SETTIM	$FFDB	–	$F6E4	set jiffy clock	a x y	– – –	a x y
RDTIM	$FFDE	–	$F6DD	read jiffy clock	– – –	a x y	a x y
STOP	$FFE1	($0328)	$F6ED	test stop key	– – –	a – –	a x –
GETIN	$FFE4	($032A)	$F13E	get char from chan	– – –	a – –	a x y
CLALL	$FFE7	($032C)	$F32F	clear/close files	– – –	– – –	a x –
UDTIM	$FFEA	–	$F69B	update jiffy clock	– – –	– – –	a x –

Notes:

Registers indicated as being used in the "used" column may contain the same value loaded to call the routine. If no usage is indicated, then the register is safe to use for other purposes, eg. indexing, counting, storing, etc. When GETIN is called for RS-232 input, the .x and .y registers are not affected. The processor status register and the accumulator carry bit are affected by nearly all KERNAL routines.

When sixteen-bit values are passed in or out of a routine, the .x register contains the low byte and the .y register contains the high-order byte.

Detailed information on using specific routines may be found in the Commodore 64 Programmer's Reference Guide.

* Serial I/O routine only, not compatible with some IEEE-488 adapters

** These routines use an indirect jump link AFTER being entered

Program 1

Keyboard input routine using GETIN and CHROUT with 255 character buffer and automatic BASIC variable access. Stores characters at $C000-$CFFF. The first variable in the BASIC program should be a string (eg. a$ = " "). When the program is called this variable will contain the input. The length of input is controlled by the second variable declared by the BASIC program. This variable must be an integer (eg. a% = 10) and have a value of 0-255.

```
        LDA  #$00      ;a zero in .a
        STA  $FE       ;index storage
        STA  $CC       ;flag to flash cursorvariable offset
        LDY  #$0A      ;variable offset
        LDA  ($2D),Y   ;get low byte of second var
        STA  $FD       ;save it
LOOP    JSR  $FFE4     ;"GETIN", go get a character
        CMP  #$00      ;is it a zero?
        BEQ  LOOP      ;if zero then loop
        CMP  #$0D      ;is it a return key?
        BEQ  END       ;exit if return pressed
        CMP  #$14      ;is it a delete key?
        BNE  NODEL     ;not delete then skip
        LDY  $FE       ;buffer pointer
        BEQ  LOOP      ;loop if buffer empty
        DEC  $FE       ;delete by decrementing pointer
        JMP  OUTPUT    ;jmp output
NODEL   TAX            ;save .a in the .x register
        AND  #$7F      ;remove high bit from char
        CMP  #$20      ;is it a control character?
        BCC  LOOP      ;if less than #$20 yes so loop
        TXA            ;restore character to .a reg
        LDY  $FE       ;retrieve buffer index
        CPY  $FD       ;check if limit reached
        BCS  LOOP      ;carry set, limit reached
        INC  $FE       ;increment buffer pointer
        BNE  PUT       ;if buffer not full skip to "PUT"
        DEC  $FE       ;oops, buffer full so back down one
        JMP  LOOP      ;loop
PUT     STA  $C000,Y   ;place byte in $c000 buffer
OUTPUT  JSR  $FFD2     ;"CHROUT" - print the character
        LDA  #$00      ;zero
        STA  $D4       ;disable quote mode
        JMP  LOOP      ;play it again sam
END     LDY  #$02      ;offset to string variable length
        LDA  $FE       ;buffer pointer
```

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```
        STA  ($2D),Y   ;put in first variable length byte
        INY            ;inc index y offset to pointer low byte
        LDA  #$00      ;low order byte buffer location
        STA  ($2D),Y   ;store it in string variable pointer
        INY            ;increment index
        LDA  #$C0      ;high order byte
        STA  ($2D),Y   ;store it in string variable pointer
        INC  $CC       ;turn off cursor
        LDA  #$20      ;a space to clear the cursor block
        JSR  $FFD2     ;print it,
        RTS            ;and return
```

PROGRAM 2

Dump screen contents to disk using name found in first variable declared in BASIC program calling this routine. The first variable should be a string variable or the name may be rather strange.

```
START   LDY  #$02      ;offset to string length
        LDA  ($2D),Y   ;get string length
        BEQ  EXIT      ;zero length, quit while ahead
        PHA            ;save length on stack
        INY            ;increment index
        LDA  ($2D),Y   ;get low address of string
        TAX            ;put in .x
        INY            ;increment index
        LDA  ($2D),Y   ;get high order pointer
        TAY            ;put in .y
        PLA            ;pull length from stack
        JSR  $FFBD     ;SETNAM: set file name
        LDA  #$01      ;logical file #1
        LDX  #$08      ;device #8
        LDY  #$02      ;secondary address
        JSR  $FFBA     ;SETLFS: set logical file
        JSR  $FFC0     ;OPEN
        BCS  EXIT      ;if carry set then error out
        LDX  #$01      ;file number
        JSR  $FFC9     ;CHKOUT: set output channel to file 1
        LDY  #$00      ;zero index
        STY  $FD       ;set pointer low byte
        LDA  #$04      ;start of screen high byte
        STA  $FE       ;set pointer high byte
LOOP    LDA  ($FD),Y   ;get screen character
        JSR  $FFD2     ;CHROUT: output a byte to disk
        INY            ;increment index
        BNE  LOOP      ;not 256 yet?
        INC  $FE       ;increment high byte of pointer
        LDA  $FE       ;get pointer high byte
        CMP  #$08      ;done four pages yet?
        BCC  LOOP      ;if carry clear then no
        LDA  #$01      ;file number 1
        JSR  $FFC3     ;CLOSE: close the file
EXIT    JSR  $FFE7     ;CLALL: restore default i/o channels
        RTS            ;return to BASIC
```

PROGRAM 3

Load screen contents from disk using name found in first variable declared in BASIC program calling this routine. The first variable should be a string variable.

```
START   LDY  #$02      ;offset to string length
        LDA  ($2D),Y   ;get string length
        BEQ  EXIT      ;zero length, quit while ahead
        PHA            ;save length on stack
        INY            ;increment index
        LDA  ($2D),Y   ;get low address of string
        TAX            ;put in .x
        INY            ;increment index
        LDA  ($2D),Y   ;get high order pointer
        TAY            ;put in .y
        PLA            ;pull length from stack
        JSR  $FFBD     ;SETNAM: set command string
        LDA  #$01      ;logical file #1
        LDX  #$08      ;device #8
        LDY  #$02      ;secondary address
        JSR  $FFBA     ;SETLFS: set logical file
        JSR  $FFC0     ;OPEN
        BCS  EXIT      ;if carry set then error out
        LDX  #$01      ;file number
        JSR  $FFC6     ;CHKIN: set input channel to file 1
        LDY  #$00      ;zero index
        STY  $FC       ;zero index temp
        STY  $FD       ;set pointer low byte
        LDA  #$04      ;start of screen high byte
        STA  $FE       ;set pointer high byte
LOOP    JSR  $FFE4     ;GETIN: get a byte from disk
        LDY  $FC       ;get index temp
        STA  ($FD),Y   ;store byte on screen
        INC  $FC       ;increment index
        BNE  LOOP      ;not 256 yet?
        INC  $FE       ;increment high byte of pointer
        LDA  $FE       ;get pointer high byte
        CMP  #$08      ;done four pages yet?
        BCC  LOOP      ;if carry clear then no
        LDA  #$01      ;file number 1
        JSR  $FFC3     ;CLOSE: close the file
EXIT    JSR  $FFE7     ;CLALL: restore default i/o
        RTS            ;return to BASIC
```

PROGRAM 4

Fetches disk status and displays on top line of screen when the control and Commodore keys are pressed together.

```
INIT    SEI            ;interrupts off
        LDA  #H,START  ;high order byte of start
        STA  $0315     ;change high order vector
        LDA  #L,START  ;low byte of start
        STA  $0314     ;low byte of vector
        CLI            ;interrupts on
        LDA  #$06      ;match value
        STA  $FE       ;save it
        RTS            ;return
START   LDA  $028D     ;load keyboard shift pattern
        CMP  $FE       ;6= control+Commodore key
        BEQ  BEGIN     ;if pressed then do it
        LDA  #$06      ;countdown limit
        CMP  $FE       ;reached yet?
        BEQ  EXIT      ;if yes then continue
        DEC  $FE       ;countdown one more jiffy
EXIT    JMP  $EA31     ;finish interrupt
BEGIN   LDA  #$2D      ;45 jiffys (.75 second)
        STA  $FE       ;countdown location
```

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```
        LDA  #$08      ;device number
        JSR  $FFB4     ;TALK: command disk to talk
        LDA  #$6F      ;secondary address 15
        JSR  $FF96     ;TKSA: send second
        BCS  EXIT      ;error abort
        SEC            ;set carry bit
        JSR  $FFF0     ;PLOT: fetch cursor location
        STX  $FB       ;save it
        STY  $FC       ;save it too
        LDA  #$13      ;home cursor character
        JSR  $FFD2     ;CHROUT: print it
        LDA  #$00      ;a zero
        STA  $90       ;clear the status word
NEXT    JSR  $FFA5     ;ACPTR: get error channel character
        JSR  $FFD2     ;CHROUT: print it
        JSR  $FFB7     ;READST: read status byte
        CMP  #$00      ;if zero
        BEQ  NEXT      ;get another character
        LDX  $FB       ;cursor x position
        LDA  $FC       ;cursor y
        CMP  #$28      ;short line?
        BCC  GOPLOT    ;if yes go plot
        SBC  #$28      ;subtract 40
GOPLOT  TAY            ;move to y register
        CLC            ;clear carry
        JSR  $FFF0     ;PLOT: set cursor back
        JSR  $FFAB     ;UNTLK: untalk serial devices
        JMP  EXIT      ;finish
```

TABLE II

Call Address For Programs 1, 2, 3 and 4

PROGRAM	HEX	DECIMAL
PROGRAM 1	$C100	49408
PROGRAM 2	$C15F	49053
PROGRAM 3	$C1A6	49574
PROGRAM 4	$C1F2	49650

All four programs are stored as a block occupying the space from $c100 to $C257. $C000 to $C0FF is used as buffer space by program 1.

Sample BASIC Programs

To call program 1

```
10 clr: a$ = " ": a% = 10
20 sys 49408
30 print:print a$
```

To call program 2

```
10 clr: a$ = "0:screen dump,s,w"
20 sys 49053
```

To call program 3

```
10 clr: a$ = "0:screen dump,s,r"
20 sys 49574
```

To call program 4

```
sys 49650
```

Program 5 is a BASIC program that will generate a machine language program on disk. This program contains the above four programs and will have the name "kernal who c100". Load this program with the command:

```
LOAD "kernal who c100",8,1
```

Then type NEW and press return.

PROGRAM 1-4 Generator

```
BO  100 rem object file creator for
KG  110 rem programs 1, 2, 3 and 4
PI  120 rem for article "KERNAL WHO?"
EA  130 rem "Evan Williams 1986
CC  140 print "Splace disk in drive and press return."
BL  150 get a$: if a$<>chr$(13)then150
MH  160 print "qok, please wait"
EP  170 for i=1to344: read a: ck=ck+a: next
CI  180 if ck<>50143 then print "qqerror in data
         statements": end
IL  190 print "qdata ok, creating disk program file"
DC  200 open1,8,2,"0:kernal who c100,p,w"
FG  210 restore: print#1,chr$(0);chr$(193);
EK  220 fori=1to344: reada
CB  230 print#1,chr$(a);
DF  240 next: close1
MM  250 print "qdone": end
IH  260 :
EE  270 data 169,   0, 133, 254, 133, 204, 160,  10
AF  280 data 177,  45, 133, 253,  32, 228, 255, 201
PO  290 data   0, 240, 249, 201,  13, 240,  49, 201
DL  300 data  20, 208,   9, 164, 254, 240, 237, 198
EL  310 data 254,  76,  62, 193, 170,  41, 127, 201
NK  320 data  32, 144, 225, 138, 164, 254, 196, 253
PH  330 data 176, 218, 230, 254, 208,   5, 198, 254
IE  340 data  76,  12, 193, 153,   0, 192,  32, 210
AH  350 data 255, 169,   0, 133, 212,  76,  12, 193
NM  360 data 160,   2, 165, 254, 145,  45, 200, 169
OF  370 data   0, 145,  45, 200, 169, 192, 145,  45
DI  380 data 230, 204, 169,  32,  76, 210, 255, 160
FI  390 data   2, 177,  45, 240,  61,  72, 200, 177
ED  400 data  45, 170, 200, 177,  45, 168, 104,  32
GN  410 data 189, 255, 169,   1, 162,   8, 160,   2
EF  420 data  32, 186, 255,  32, 192, 255, 176,  34
NF  430 data 162,   1,  32, 201, 255, 160,   0, 132
DD  440 data 253, 169,   4, 133, 254, 177, 253,  32
LN  450 data 210, 255, 200, 208, 248, 230, 254, 165
AK  460 data 254, 201,   8, 144, 240, 169,   1,  32
HC  470 data 195, 255,  32, 231, 255,  96, 160,   2
HB  480 data 177,  45, 240,  66,  72, 200, 177,  45
FF  490 data 170, 200, 177,  45, 168, 104,  32, 189
DH  500 data 255, 169,   1, 162,   8, 160,   2,  32
MI  510 data 186, 255,  32, 192, 255, 176,  39, 162
MM  520 data   1,  32, 198, 255, 160,   0, 132, 252
LI  530 data 132, 253, 169,   4, 133, 254,  32, 228
FF  540 data 255, 164, 252, 145, 253, 230, 252, 208
JF  550 data 245, 230, 254, 165, 254, 201,   8, 144
AE  560 data 237, 169,   1,  32, 195, 255,  32, 231
PK  570 data 255,  96, 120, 169, 194, 141,  21,   3
PG  580 data 169,   3, 141,  20,   3,  88, 169,   6
MA  590 data 133, 254,  96, 173, 141,   2, 197, 254
DF  600 data 240,  11, 169,   6, 197, 254, 240,   2
MC  610 data 198, 254,  76,  49, 234, 169,  45, 133
JO  620 data 254, 169,   8,  32, 180, 255, 169, 111
MD  630 data  32, 150, 255, 176, 237,  56,  32, 240
DN  640 data 255, 134, 251, 132, 252, 169,  19,  32
JO  650 data 210, 255, 169,   0, 133, 144,  32, 165
KK  660 data 255,  32, 210, 255,  32, 183, 255, 201
CG  670 data   0, 240, 243, 166, 251, 165, 252, 201
FP  680 data  40, 144,   3, 233,  40,  24, 168,  32
OG  690 data 240, 255,  32, 171, 255,  76,  18, 194
```

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Adding Functions to Basic

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Execute Machine Language programs inside your 1541

How would you like to be able to add functions to BASIC with as much ease as you are able to add commands through the use of wedge programs? It can be done. And, in fact, it is just as easy to implement a function wedge as it is to implement any other type of wedge program. The natural question is, of course, if it is so easy, why haven't we seen function wedges before? I think that the reason is simply because the types of wedges we are most familiar with are the ones which are least suitable for adding functions.

If you try to think of a CHRGET wedge or an IERROR wedge returning a function value, then, it does, indeed, look like a tough job, because these types of wedges are not really suitable for returning values. We need a whole new type of wedge. In this article and the two that will follow it, we will explore several different types of wedges which are not in common use, but which have great potential for opening up new avenues of programming for those who desire to enhance the working environment of their computer.

Why A Function Wedge?

Perhaps you're wondering why we even need a function wedge. After all, Commodore was good enough to include the USR function in BASIC 2.0 which allows us to add our own functions to BASIC. While it is very true that we can add almost any function we desire via the USR function, the advantages of a function wedge include the fact that many new functions can be defined at one time as well as the fact that with a function wedge, we are free to determine the number of parameters, method of input, etc. For example, take the program line:

```
10 print !cosh(.5),!sinh(.9),!sec(.12)
```

While the purist may argue that the line could be implemented with USR functions, it would take several lines to implement and would not be nearly as clear as the above line. Further, what if you need multiple arguments like:

```
20 z=!mod(x,y)
```

You could say Z=USR(X),Y I suppose, but it just isn't the same.

Create A New Environment

While the above are good enough reasons for using a function wedge, an even more novel way to use added functions is to change the BASIC programming environment. That is, give the illusion of adding new commands, and changing the capabilities of BASIC. For example, a function named @ that takes two parameters and returns a null string can be used to plot the cursor, thus creating a PRINT@(x,y) statement. And who says we need to enclose the function argument in parentheses? Suppose we make a function named '$' which converts from ASCII Hex characters to internal floating point. Then we can execute statements like:

```
10 poke $c000,$b4
20 x=$a000
30 print $d000,peek($d000)
```

or add a function named % for binary and you can

```
20 poke $033c,peek($033c)and%1111
```

Admittedly, the above could be done with a USR function but by using a function named '$' or '%' we create the illusion of a new operating system.

How To Implement The Wedge

Now that you are fully convinced that a function wedge is a worthwhile endeavor, let us examine how to implement one. It isn't hard at all. The vector we will be changing to point to our evaluation routine is named IEVAL and is located at $030A/$030B. In addition to just executing our routine, however, we must tell BASIC whether the result was string or numeric and where to find it. As far as the type goes, storing a zero at location $0D indicates numeric and tells BASIC to look for the result in the FAC (The floating point accumulator -- if you don't know where or what that is, don't worry, there are ROM routines that take care of all of that for you.). Storing a $FF at location $0D indicates that the result is of type string and BASIC looks on the temporary string stack to find it. If you don't understand how to set up a string, don't worry, we will use a ROM routine to do this for us, too. Our evaluation routine will default to type numeric and the ROM routines we will use to set up a string will set the type to string so we never have to worry about setting the type flag ourselves. In fact, the only thing out of the ordinary that we will have to do, is to set up the string descriptor if the result of our function is a string. You will see how this is done in the example program.

An Example Function Wedge

At the end of this article is a very useful example of a function wedge that you can use and add your own functions to. It is activated by SYS49152 and is immune to RUN/STOP-RESTORE. Here are the functions we will include and an example of how they are used:

The '@' function: Plot the cursor and return a null string. (Note: more than one @ is allowed in one print statement). Type: STRING

Ex.
```
print@(0,14)" my report ";@(2,12)" by john smith "
```

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The '$' and '%' functions: Convert HEX and BINARY characters to floating point. Type: NUMERIC

```
Ex.        poke$d016, peek($d016) and %11101111
```

The '#' function: Convert from LO/HI format to 16 bit floating point. (This routine is included just as an example to show how to convert your results to floating point if they aren't already). Type: NUMERIC

```
Ex.                print #(peek(43),peek(44))
```

could be used to read the start address of BASIC. To read any address, just PRINT #(LO,HI).

Finally, since all the above functions so far have been kind of off the wall, I will include a parser and some examples of functions similar to what you might add yourself; including a straightforward string function, !DSTAT, and a somewhat serious numeric function, !MOD, which shows that even YOU can do floating point operations from machine language.

The !DSTAT function returns the disk status as a string. The status is cleared once it is read so save it in a variable if you need it.

Ex. (Print A Sequential File)

```
   10 open2,8,2, "filename" : a$=!dstat: if val(a$)<>0 then
      print a$: end
   20 for i=0 to 1: get#2,b$: printb$: i=st: next: close2
```

The !MOD(X,Y) function returns the integer remainder from dividing X by Y. MOD has two sister functions, DIV and FRAC, which return the integer quotient and fractional remainder, respectively.

```
Ex.                    hi=!div(x,256)
                       lo=!mod(x,256)

                       zz=!frac(x,y)
```

Any functions that YOU may want to add can be included via the ! symbol which immediately causes parsing for the function name to execute.

Although the source code for this example is fully commented, I will briefly discuss some important points for those interested in adding their own functions with this code.

How It Works

The wedge itself is very simple. If not for the ! commands, the wedge would only be a few lines long. When a function name starting with ! is found, control is passed to the parser which looks through the command table for a match and jumps to the corresponding address via RTS. That is, it places the address of the routine (minus one) on the stack and then executes an RTS (at the end of CHRGET) to jump to the routine. The parser code is well worth studying. If you want to add your own funtions to BASIC, simply put the name of your function in the TABLE being sure to add $80 to the last byte of the name. Then put the address–1 in the ADRTAB and you are in business.

The !DSTAT function is straightforward and may be used as a model for adding your own string functions. It talks to the drive and then puts the length of the resulting string in .A and in line 2420 asks BASIC where to put the string. DLOOP2 copies the string there and we end our function in line 2500 by telling BASIC where the string can be found. (Note that XPLOT (The @ function) returns a null string by reserving space for a string of length zero before setting up the string descriptor.)

Writing numeric functions is easy. Just be sure to leave the final result in the FAC. If you were doing an integer calculation, you can convert the result to floating point in exactly the same way as the # function does it. See lines 2980–3020.

Final Notes

The function wedge is the best way possible to add functions to BASIC. It is immune to RUN/STOP–RESTORE, it is compatible with almost every other utility that I know of including the DOS wedge and Epyx Fastload Cartridge (no, the $ commands do not conflict) and it provides a natural way to pass the results back to BASIC. Any of these new functions can be used in any way that an old one can be used. I.E. the following statement is perfectly legal:

```
          a=$ff0d*%11011+sin(!mod($ffabcd,%11101))
```

There are a few very minor limitations to the functions presented here. If you are like me, the first test you will try with the $ function is PRINT $ABCDEF. This will result in a syntax error because the BASIC keyword DEF is embedded in the number. Adding a space before the F will solve the problem (The $ routine ignores spaces). The only other limitation is that the MOD/DIV/FRAC group is intended to be used with positive operands only. Don't forget when using the @ function in direct mode that the screen will scroll if you print too close to the bottom. This problem can be easily fixed with a WAIT statement. Try this line:

```
          print@(0,14) "my report" @(2,13) "by john
          doe" @(24,14) "page 1";:wait198,1
```

I hope that you will be able to use the functions presented here and that this example will provide you with the skills necessary to add any additional functions that you may need. The next article, "Command Wedge", will focus on a wedge for modifying existing BASIC commands. Before going there, try these relatively simple projects:

(1) Add two functions !HI(X) and !LO(X) which return the hi and lo bytes, respectively, of the number X.
(2) add a function, !SIZE, which returns the length of the BASIC program currently in memory.
(3) If you have two drives, make !DSTAT require a device number like !DSTAT8 or !DSTAT9.

HINTS: (Don't read unless you are stuck)

(1) Try something like this: Look at the definition of LO and HI in terms of !MOD and !DIV above. Use JSR $AEF1 to get parm into FAC. (This routine takes care of parentheses, etc.) Store FAC at TEMP. (See lines 4190–4210). Get 256 into FAC (See lines 2980–3020) Store at MODLUS (See lines 4260–4280) Set flag for MOD or DIV as required and JMP to line 4300.
(2) Easy. Subtract address of start of BASIC (found at locations 43/44) from address of start of variables (found at 45/46). Convert this result to FAC.
(3) Simply replace line 2220 with JSR GETBYT. Then add some checks so that no one can hang it up by giving it a crazy device number.

Have fun!

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```
NO 100 rem basic loader for function wedge
FK 110 rem by frank e. digioia  11/14/85
NL 120 rem sys 49152 to activate
GP 130 :
JC 140 for adr = 49152 to 49634:read ml
HG 150 cs = cs + ml:poke adr,ml:next
DJ 160 ifcs<>59800thenprint " error in data "
OB 170 :
FO 180 data 169,  11, 141,  10,   3, 169, 192, 141
IN 190 data  11,   3,  96, 169,   0, 133,  13,  32
AH 200 data 115,   0, 201,  36, 240,  22, 201,  37
HL 210 data 240,  21, 201,  64, 240,  20, 201,  35
HO 220 data 240,  19, 201,  33, 240,  18,  32, 121
ND 230 data   0,  76, 141, 174,  76,  29, 193,  76
OC 240 data  32, 193,  76, 213, 192,  76,  13, 193
EN 250 data 169,   0, 141, 132, 192, 170, 168, 200
ND 260 data 189, 136, 192, 240,  64, 232, 209, 122
DP 270 data 208,   2, 240, 243, 202, 189, 136, 192
NB 280 data  16,   8,  41, 127, 209, 122, 240,  19
NI 290 data 208,   8, 232, 189, 136, 192, 240,  37
PA 300 data  16, 248, 232, 238, 132, 192, 160,   0
II 310 data  76,  63, 192, 200, 152,  24, 101, 122
FB 320 data 133, 122, 144,   2, 230, 123, 173, 132
HN 330 data 192,  10, 170, 189, 153, 192,  72, 189
DD 340 data 152, 192,  72,  96,   0,  76,   8, 175
HB 350 data  77,  79, 196,  70,  82,  65, 195,  68
ND 360 data  73, 214,  68,  83,  84,  65, 212,   0
MO 370 data 142, 193, 145, 193, 139, 193, 159, 192
GP 380 data 162,   8, 134, 186, 138,  32, 180, 255
LJ 390 data 169, 111, 133, 185,  32, 150, 255, 162
GI 400 data   0,  32, 165, 255, 157,  60,   3, 232
LK 410 data 201,  13, 208, 245,  32, 171, 255, 202
HL 420 data 138, 141,  12, 193,  32, 125, 180, 172
LP 430 data  12, 193, 185,  60,   3, 145,  98, 136
IJ 440 data  16, 248,  76, 202, 180,  32, 115,   0
AO 450 data  32, 242, 192, 224,  25, 144,   3,  76
JC 460 data  72, 178, 192,  40, 176, 249,  24,  32
OO 470 data 240, 255, 169,   0,  32, 125, 180,  76
JB 480 data 202, 180,  32, 250, 174,  32, 158, 183
JG 490 data 142,  12, 193,  32, 253, 174,  32, 158
IC 500 data 183, 138,  72,  32, 247, 174, 104, 168
JL 510 data 174,  12, 193,  96,   0,  32, 115,   0
ML 520 data  32, 242, 192, 134,  99, 132,  98, 162
LF 530 data 144,  56,  76,  73, 188, 169,   0,  44
CE 540 data 169,   1, 141, 139, 193,  32,  62, 193
PD 550 data  32, 115,   0, 240,  14,  32,  72, 193
PG 560 data  32, 114, 193,  32, 126, 189,  76,  40
FC 570 data 193, 104, 104,  76, 121,   0, 169,   0
FF 580 data 162,   5, 149,  97, 202,  16, 251,  96
CM 590 data 144,  16, 174, 139, 193, 208,  24, 201
EJ 600 data  65, 144, 230, 201,  71, 176,  16,  56
AG 610 data 233,   7, 174, 139, 193, 240,   4, 201
BI 620 data  50, 176,  12,  56, 233,  48,  96, 201
FB 630 data  65, 144, 206, 201,  91, 176, 202,  76
DA 640 data  72, 178, 166,  97, 240,  15,  72, 174
BA 650 data 139, 193, 189, 137, 193,  24, 101,  97
JL 660 data 176,   4, 133,  97, 104,  96,  76, 126
JL 670 data 185,   4,   1,   0, 169,   0,  44, 169
MJ 680 data   1,  44, 169, 255, 141, 139, 193,  32
NN 690 data 250, 174,  32, 138, 173, 162, 230, 160
BG 700 data 193,  32, 212, 187,  32, 253, 174,  32
DA 710 data 138, 173,  32, 247, 174, 162, 225, 160
IC 720 data 193,  32, 212, 187, 169, 230, 160, 193
BN 730 data  32,  15, 187,  32,  12, 188,  32, 204
AH 740 data 188, 173, 139, 193, 240,  23, 165,  97
MA 750 data  32,  83, 184, 173, 139, 193,  48,  13
JJ 760 data 169, 225, 160, 193,  32,  40, 186,  32
LE 770 data  73, 184,  32, 204, 188,  32,  27, 188
FG 780 data  96,   0,   0
```

Function Wedges Source Code

```
OF 1000 ;
BH 1010 ;function wedge
JK 1020 ;by frank e. digioia
OM 1030 ;11/12/85
GI 1040 ;
HM 1050 *          =     $c000      ;convenient start
KJ 1060 ;
OJ 1070 chrget     =     $0073      ;get byte of text
JG 1080 chrgot     =     $0079      ;get same byte
IA 1090 ieval      =     $030a      ;evaluation vector
JN 1100 type       =     $0d        ;type flag
MM 1110 ;
GP 1120 init       =     *          ;initialize routine
PD 1130            lda   #<fwedge
MD 1140            sta   ieval
PE 1150            lda   #>fwedge
JC 1160            sta   ieval + 1
OH 1170            rts
CB 1180 ;
NM 1190 fwedge     =     *          ;this is the wedge
ND 1200            lda   #$00       ;flag for numeric
BD 1210            sta   type       ;set type flag
KD 1220 ;
DD 1230            jsr   chrget     ;see what we've got
DC 1240            cmp   #'$'       ;hex conversionprint
EJ 1250            beq   jump
DD 1260            cmp   #'%'       ;binary conversionprint
IL 1270            beq   jump + 3
PC 1280            cmp   #'@'       ;plot functionprint
CN 1290            beq   jump + 6
GE 1300            cmp   #'#'       ;the # commandprint
MO 1310            beq   jump + 9
AK 1320            cmp   #'!'       ;use the parserprint
GM 1330            beq   parser
BN 1340 ;not one of ours
ID 1350            jsr   chrgot     ;set flags again
MM 1360            jmp   $ae8d      ;use original routine
AN 1370 ;
ID 1380 jump       =     *          ;jump table for fns
DA 1390            jmp   hex
BP 1400            jmp   bin
JK 1410            jmp   xplot
CG 1420            jmp   expand
MA 1430 ;
HP 1440 parser     =     *          ;parse & execute
MI 1450            lda   #$00       ;clear all regs
BH 1460            sta   count      ;and counter
JI 1470            tax
HJ 1480            tay
IE 1490 ;
AG 1500 ploop      iny              ;incr text index
NJ 1510            lda   table,x    ;get table byte
HH 1520            beq   error      ;end of table
FJ 1530            inx              ;incr table pointer
MA 1540            cmp   ($7a),y    ;cmpare with text
OG 1550            bne   next       ;find next word
IH 1560            beq   ploop      ;match/keep looking
IJ 1570 ;
EN 1580 next       dex              ;bump .x down once
PN 1590            lda   table,x    ;end of table wordprint
EI 1600            bpl   find       ;no/find end of word
CC 1610            and   #$7f       ;yes/mask flag
ID 1620            cmp   ($7a),y    ;is it a matchprint
CA 1630            beq   found      ;hooray!!!
JH 1640            bne   x1         ;go back for more
IO 1650 ;
BO 1660 find       inx              ;find end of word
HL 1670            lda   table,x    ;look for negative
HB 1680            beq   error      ;end of table
IL 1690            bpl   find       ;keep looking
KB 1700 ;
ED 1710 x1         inx              ;point to next word
FJ 1720            inc   count      ;word # in table
FC 1730            ldy   #$00       ;reset text index
BK 1740            jmp   ploop      ;search some more
ME 1750 ;
BJ 1760 found      =     *          ;execution routine
GB 1770            iny              ;point to next byte
JJ 1780            tya              ;update text pointer
EH 1790            clc
HL 1800            adc   $7a
NA 1810            sta   $7a
BB 1820            bcc   * + 4
GA 1830            inc   $7b
GK 1840 ;
PF 1850            lda   count      ;get offset in table
HA 1860            asl   a          ;multiply by two
LN 1870            tax              ;use as index
GA 1880            lda   adrtab + 1,x;hi byte adr
EP 1890            pha              ;as return adr hi
```

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```
AB 1900          lda  adrtab,x    ;lo byte adr
OB 1910          pha              ;as return adr lo
ND 1920          rts              ;execute routine
AA 1930 ;
DN 1940 count    .byte $00
MM 1950 error    jmp  $af08       ;syntax error
OB 1960 ;
JJ 1970 ;data tables -- add your own
CD 1980 ;routine names and addresses
AM 1990 ;here. be sure to add $80 to
CF 2000 ;last character of name and
JD 2010 ;subtract 1 from the address
KF 2020 ;
CB 2030 table    .byte 'mo',$c4,'fra',$c3
JC 2040          .byte 'di',$d6,'dsta',$d4,$00
IH 2050 ;
LK 2060 adrtab   .word mod-1,frac-1,div-1,dstat-1
MI 2070 ;
GJ 2080 ;
EG 2090 ;function calculation routines
KK 2100 ;
LC 2110 ;dstat function
OL 2120 ;
MP 2130 acptr    =    $ffa5       ;get byte from serial port
BL 2140 fa       =    $ba         ;device number
BK 2150 sa       =    $b9         ;secondary address
MD 2160 wbuf     =    $033c       ;buffer for string
DE 2170 talk     =    $ffb4       ;tell device to talk
KC 2180 tksa     =    $ff96       ;send 2nd adr for talk
LK 2190 untalk   =    $ffab       ;free serial bus
OA 2200 ;
CC 2210 dstat    =    *
KM 2220          ldx  #$08        ;device number (disk)
AE 2230          stx  fa          ;first address
EH 2240          txa
GD 2250          jsr  talk        ;tell drive to speak
OH 2260          lda  #$6f        ;channel 15 (or $60)
HK 2270          sta  sa          ;secondary address
NJ 2280          jsr  tksa        ;send it to drive
BH 2290          ldx  #$00
CH 2300 ;
KH 2310 dloop    =    *           ;read command channel
IG 2320          jsr  acptr       ;get byte from drive
EH 2330          sta  wbuf,x      ;store character
AA 2340          inx
BK 2350          cmp  #$0d        ;carriage returnprint
PA 2360          bne  dloop
EM 2370          jsr  untalk      ;free serial port
CM 2380 ;
IC 2390          dex              ;forget the <cr>
OB 2400          txa              ;put length in .a
NH 2410          sta  len         ;save it
FC 2420          jsr  $b47d       ;reserve space for string
   2430          ldy  len         ;use length for index
OP 2440 ;
GM 2450 dloop2   =    *           ;copy string for basic
LB 2460          lda  wbuf,y      ;get byte of string
HE 2470          sta  ($62),y     ;put in string mem.
CP 2480          dey              ;bump pointer down
HB 2490          bpl  dloop2
BP 2500          jmp  $b4ca       ;put dscrptr on stack
EE 2510 ;
OE 2520 ;
GB 2530 ;@(row,col) function - plot
MI 2540 ;cursor and return null string
MG 2550 ;
IC 2560 chklft   =    $aefa       ;check left paren
KH 2570 chkrht   =    $aef7       ;check right paren
LI 2580 chkcom   =    $aefd       ;check on comma
GE 2590 getbyt   =    $b79e       ;get byte into .x
HO 2600 plot     =    $fff0       ;plot/fetch cursor
IK 2610 ;
JM 2620 xplot    =    *
DE 2630          jsr  chrget      ;get next byte
MH 2640          jsr  getprm      ;get row/col in x/y
LJ 2650          cpx  #$19        ;row less than 25print
PO 2660          bcc  chky        ;yes/check column
DB 2670 bad      jmp  ilegal      ;no/illegal quant.
NE 2680 chky     cpy  #$28        ;col less than 40print
CE 2690          bcs  bad         ;no/trash it.
AH 2700          clc              ;just for looks
CF 2710          jsr  plot        ;plot the cursor
AO 2720          lda  #$00        ;set len to zero
KD 2730          jsr  $b47d       ;reserve space
ND 2740          jmp  $b4ca       ;put descrptr on stack
ED 2750 ;
MC 2760 getprm   =    *           ;get (a,b) into .x/.y
IC 2770          jsr  chklft      ;check open paren
EK 2780          jsr  getbyt      ;get first parm
BE 2790          stx  len         ;save it here
JP 2800          jsr  chkcom      ;check on comma
CO 2810          jsr  getbyt      ;get second byte
FF 2820          txa              ;put in .a
EA 2830          pha              ;keep it safe
EP 2840          jsr  chkrht      ;check closing paren
CF 2850          pla              ;retrieve 2nd parm
IP 2860          tay              ;put in .y
PC 2870          ldx  len         ;retrieve 1st parm
MC 2880          rts
CF 2890 len      .byte $00
KM 2900 ;
EN 2910 ;
NG 2920 ;the #(lo,hi) command -- convert
EN 2930 ;lo/hi to 16 bit number.
CP 2940 ;
BI 2950 expand   =    *
KD 2960          jsr  chrget      ;get next byte of text
OG 2970          jsr  getprm      ;get parms into x/y
JO 2980          stx  $63         ;lo byte in $63
BO 2990          sty  $62         ;hi byte in $62
LD 3000          ldx  #$90        ;set exponent to 15
PE 3010          sec              ;don't invert mantissa
JK 3020          jmp  $bc49       ;convert to fac
ME 3030 ;
GF 3040 ;
OO 3050 ;hex/binary conversion routine --
BP 3060 ;this routine converts ascii
AE 3070 ;hex or binary numbers to floating
LL 3080 ;point.
II 3090 ;
EJ 3100 addbyt   =    $bd7e       ;add .a to fac
GA 3110 ilegal   =    $b248       ;illegal quantity
MJ 3120 oflow    =    $b97e       ;overflow error
AO 3130 exp      =    $61         ;exponent of fac
KL 3140 ;
NC 3150 hex      lda  #$00        ;flag for hex
HM 3160          .byte $2c        ;skip next instr.
EO 3170 bin      lda  #$01        ;flag for binary
DA 3180          sta  flag        ;save flag
IJ 3190          jsr  zero        ;set fac to zero
GP 3200 ;
EE 3210 loop     jsr  chrget      ;get next char.
FE 3220          beq  cdone       ;end of statement
NF 3230          jsr  convrt      ;convert from ascii
AO 3240          jsr  incexp      ;incr. fac exponent
MI 3250          jsr  addbyt      ;add the byte to fac
OI 3260          jmp  loop
MD 3270 ;
EG 3280 quit     pla              ;pull return adr.
CG 3290          pla
PK 3300 cdone    jmp  chrgot      ;set flags & rts
EG 3310 ;
AD 3320 ;hex/bin subroutines
IH 3330 ;
MF 3340 zero     =    *           ;set fac to zero
LN 3350          lda  #$00        ;here's the zero
DP 3360          ldx  #$05        ;5 bytes + sign
AK 3370 ;
EP 3380 zilch    sta  exp,x       ;zero out byte
DL 3390          dex              ;bump index down
DC 3400          bpl  zilch       ;counter roll overprint
OD 3410          rts
CN 3420 ;
DP 3430 convrt   =    *           ;ascii digit to true value
CG 3440          bcc  digit       ;chrget flag/digitprint
AJ 3450          ldx  flag        ;hex or binaryprint
EO 3460          bne  chkerr      ;binary non-digit
GM 3470          cmp  #'a'        ;check lower limit
HN 3480          bcc  quit        ;less than 'a'
EA 3490          cmp  #'g'        ;check upper limit
MF 3500          bcs  chkerr      ;bigger than 'f'
HD 3510          sec
AL 3520          sbc  #$07        ;account for extra 7
IA 3530 digit    ldx  flag        ;hex or binaryprint
IG 3540          beq  okay        ;hex/any digit is fine
FE 3550          cmp  #'2'        ;bin/check upper limit
NG 3560          bcs  err2        ;bigger than 1
PE 3570 okay     sec
CM 3580          sbc  #$30        ;convert to true value
CP 3590          rts
GI 3600 ;
GK 3610 chkerr   =    *           ;check illegal quant.
NH 3620          cmp  #$41        ;compare with 'a'
NG 3630          bcc  quit        ;less than 'a'
MA 3640          cmp  #$5b        ;compare with '['
DA 3650          bcs  quit        ;greater than 'z'
NG 3660 err2     jmp  ilegal      ;illegal quantity
MM 3670 ;
GN 3680 ;
IN 3690 incexp   =    *           ;increment exponent
HJ 3700          ldx  exp         ;get exponent
CP 3710          beq  exit        ;fac=0, don't incr.
CD 3720          pha              ;save byte in .a
EK 3730          ldx  flag        ;use flag for offset
EH 3740          lda  incr,x      ;get incr in .a
MB 3750          clc
AG 3760          adc  exp         ;add exp to incr.
CL 3770          bcs  err1        ;overflow error
MO 3780          sta  exp         ;update exponent
OJ 3790          pla              ;retrieve byte to .a
OM 3800 exit     rts
IF 3810 ;
CP 3820 err1     jmp  oflow
JE 3830 incr     .byte $04,$01
LH 3840 flag     .byte $00
AI 3850 ;
KI 3860 ;
CO 3870 ;div/mod/frac -- these routines respectively
BI 3880 ;return the integer-quotient,
IL 3890 ;integer-remainder, or fractional
LE 3900 ;part of the quotient a/b.
ML 3910 ;
GL 3920 exp      =    $61         ;adr of exp of fac
LN 3930 facarg   =    $bc0c       ;copy fac to arg
EN 3940 facmem   =    $bbd4       ;store fac at adr in (x/y)
LA 3950 mdiv     =    $bb0f       ;divide fac by mem
CI 3960 subtrt   =    $b853       ;subtract fac from arg
MI 3970 mmult    =    $ba28       ;mult fac by mem (a/y)
CM 3980 facint   =    $bccc       ;convert fac to integer
MA 3990 round    =    $bc1b       ;round the fac
FC 4000 add5     =    $b849       ;add .5 to fac
MM 4010 frmnum   =    $ad8a       ;get numeric parm into fac
KC 4020 ;
ED 4030 ;
ON 4040 div      =    *           ;entry for div
DD 4050          lda  #$00        ;flag for div
NB 4060          .byte $2c        ;skip next instr
EL 4070 mod      =    *           ;entry for mod
GH 4080          lda  #$01        ;flag for mod
LD 4090          .byte $2c        ;skip next instr
CI 4100 frac     =    *           ;entry for frac
EK 4110          lda  #$ff        ;flag for frac
JO 4120          sta  flag        ;set the flag
IJ 4130 ;
ND 4140 ;get first parm in fac and 2nd
BB 4150 ;parm in arg.
GL 4160 ;
KH 4170          jsr  chklft      ;open parenprint
BG 4180          jsr  frmnum      ;get first value
PD 4190          ldx  #<temp      ;lo byte of address
DD 4200          ldy  #>temp      ;hi byte of address
JG 4210          jsr  facmem      ;place in temp
EC 4220          jsr  chkcom      ;commaprint
OC 4230          jsr  frmnum      ;get 2nd parm
NK 4240          jsr  chkrht      ;closing parenprint
AB 4250 ;
DO 4260          ldx  #<modlus    ;get adr of modlus
EF 4270          ldy  #>modlus    ;in .x/.y
JB 4280          jsr  facmem      ;store fac at modlus
ID 4290 ;
AE 4300          lda  #<temp      ;adr of 1st parm (lo)
GJ 4310          ldy  #>temp      ;adr of 1st parm (hi)
DH 4320          jsr  mdiv        ;fac = temp/fac
OL 4330          jsr  facarg      ;arg = fac
CL 4340          jsr  facint      ;fac = int(fac)
EH 4350 ;
LE 4360 ;check flag. if div function
PI 4370 ;then done, else continue.
CJ 4380 ;
LE 4390          lda  flag
MP 4400          beq  done
AL 4410 ;
JJ 4420          lda  exp         ;must have exp in .a
KJ 4430          jsr  subtrt      ;fac = arg - fac
OM 4440 ;
BA 4450 ;check flag. if frac function
JO 4460 ;then done, else continue.
MO 4470 ;
FK 4480          lda  flag
OE 4490          bmi  done
KA 4500 ;
BB 4510          lda  #<modlus    ;get address of the
AN 4520          ldy  #>modlus    ;modulus in .a/.y
PJ 4530          jsr  mmult       ;fac = fac * modlus
GJ 4540          jsr  add5        ;add .5 for roundoff
BO 4550          jsr  facint      ;truncate garbage
GE 4560 ;
MP 4570 done     jsr  round       ;round the fac
AN 4580          rts
EG 4590 ;
KA 4600 modlus   * = * +5
PC 4610 temp     * = * +5
CI 4620 ;
CP 4630 .end
```

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Command Wedge

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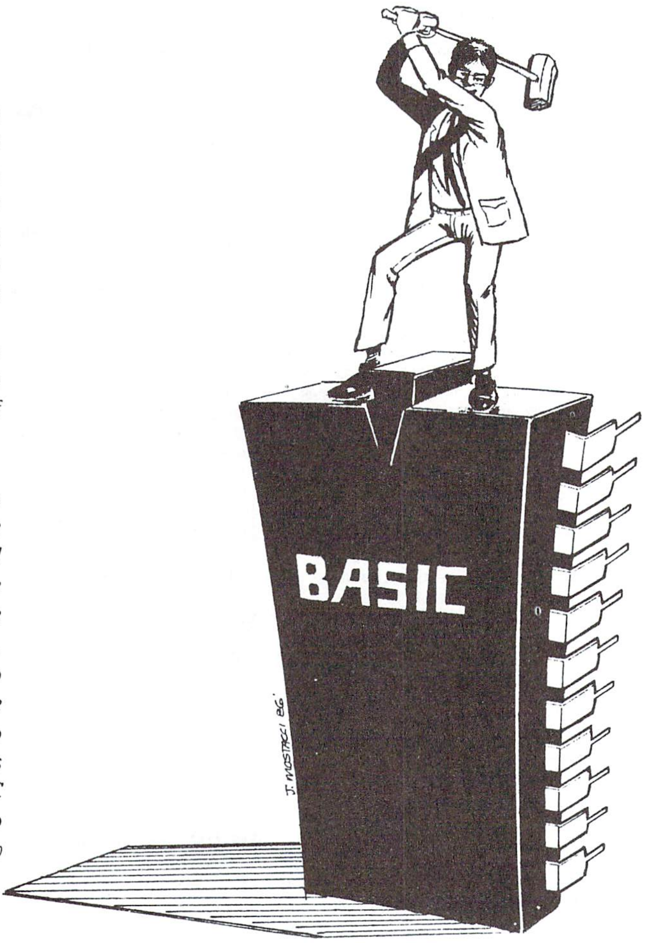
Modifying BASIC's Commands



Everyone has their own ideas on how the BASIC interpreter should carry out certain commands. We've all caught ourselves thinking, "If I had written this interpreter, I would have done thus and so. . .". The fact of the matter is that whoever DID write the BASIC interpreter didn't write it just for you and me. They designed the interpreter anticipating what the needs of the AVERAGE user would be. Unfortunately, it was written some years back, when they expected the average user to own a tape drive and not be a particularly sophisticated programmer. Well, times have changed, and thus it seems only fitting that in this issue, which is dedicated to the ROM routines, we should discuss how to modify the existing BASIC commands in order to create a version of BASIC which is perfectly customized to OUR needs today.

In the previous article we explored a new wedge which allowed us to easily add functions to BASIC. The vector that we used for that wedge is named IEVAL and is located at $030A/$030B. In this issue, we will be using IEVAL's twin sister, IGONE located at $0308/$0309. These two vectors are almost identical in purpose, the only difference between them being that IEVAL is used for evaluation of functions, and IGONE is used to execute commands. Therefore, before we go any further, please note that all of the material from last issue's article on adding functions through the vector IEVAL can be applied to adding commands through the vector IGONE. The converse is true as well: Everything that we do in this article to modify existing BASIC commands, through the use of IGONE, can be directly applied to modifying existing BASIC functions through the vector IEVAL. Now that we've got that straight, let us begin our example.

Implementing A Command Wedge

While modifying the built-in commands of the BASIC interpreter may sound like quite a job, let me assure you that it is really quite easy to do. Whenever BASIC wants to execute a command, it JMPs through the vector named IGONE at $308/$309. The execution routine calls CHRGET to get the token of the command into the accumulator. Bit 7 of this token is then masked off and the resulting value is multiplied by two. This result is the offset into the address table for the address (minus 1) of the routine to execute. This address is then placed on the stack and a JMP is made to CHRGET to get the next byte of text. The RTS in CHRGET causes the PC to be loaded with the address of the routine to execute since this address was just placed on the stack. (Note: This method is almost exactly the same as the one I used in the parser for our function wedge in the last issue.) Armed with this knowledge, we can easily wedge into the execution routine, get the command token and decide if it is one of the ones that we wish to modify. If it is, then we will place the address of OUR routine on the stack, thus executing the new routine instead of the old one. If it is not one that we wish to change, we will give the token back to BASIC for further processing.

An Example Wedge

As an example of this technique, I have written a wedge which changes the action of several of the most commonly used BASIC commands. The source code is provided and should be studied in order to gain a full understanding of the technique. Even if you have no interest in learning the techniques described here, you should find this example command wedge most useful in your own program developement.

Listing 1 contains a BASIC loader for the wedge. Listing 2 is the source code. Listing 3 is an example program which illustrates the use of some of the modified commands. This short program may give you ideas for your own applications in addition to allowing you to test your copy of the wedge.

The commands that we will modify are:

```
RESTORE   GOSUB    GOTO    WAIT
LIST      LOAD     SAVE    VERIFY
IF/THEN   INPUT    NEW
```

In addition, we will make the apostrophe (') act like the REM command and the English pound sign act like an ELSE statement. It is noteworthy that each modified command will work exactly like the original command when the original syntax is used. This feature is very important in maintaining compatibility with older programs. What follows is a description of the modified commands with an example of each one.

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(1) The first change in our modified BASIC is that the apostrophe is now treated as a REM statement. This provides much neater looking listings.

```
Ex.     10 'this is a comment
```

(2) The RESTORE command originally accepted no parameters and was used to set the data pointers back to the beginning of the program. However, there was no means provided to access a particular element of data when needed. The NEW RESTORE command provides TRUE RANDOM ACCESS to your data statements. It takes from zero to two parameters. If no parms are given, the original RESTORE is used.

```
Ex.     10 read,a,b,c:data 2,4,6,8,10
        20 data "PAM","PAUL","KELLY"
        30 restore 20:read a$
        40 restore 10,4:read x
```

The RESTORE command in line 30 sets the data pointer to line 20 and A$ will be assigned the value "PAM". In line 40, the RESTORE command sets the data pointer to the 4th data element of line 10, so X will be assigned the value 8. Attempting to RESTORE to a line# or data element that doesn't exist will result in an informative error. (Try this with the example program in listing 3)

(3) The new GOTO and GOSUB commands allow variable expressions as arguments.

```
Ex.     10 if x>0 then goto x*10
        20 draw = 1000:paint = 2000
        30 gosub draw:gosub paint
```

(4) The new WAIT command does exactly what the name implies. It simply waits until a key is pressed. This command is incredibly handy and as an added bonus, once a key is pressed, the new WAIT command leaves the ASCII value of the key at location 2.

```
Ex      10 print "Touch any key to continue"
        20 wait:print "ascii value ";peek(2)
```

(5) The new INPUT command is called INPUT$ and, as the name implies, is used to input string variables. What sets this command apart from the OLD INPUT is the fact that INPUT$ will accept any character including quotes, colons and commas with no problems. This capability is extremely important in writing any kind of data processing program. (How many public domain database and mailer programs have you seen that crash if you try to include a comma or colon in an entry?)

```
Ex.     10 print "enter datA: ";:input$ a$
```

(6) The main point of the new IF command is the fact that it is compatible with the modified commands presented here. Since I had to write this routine anyway, I went ahead and added the capability to execute an ELSE clause in the event that the expression evaluates to false. Rather than using the word ELSE, however, the English pound sign (next to CLEAR/HOME) is used as a 'token' for the word ELSE. Be sure to place a colon before the pound sign. In the example below, <L> represents the english pounds sign.

```
Ex.     if x>10 then print "greater":<L>print "less than"
```

(7) The new LIST command is exactly like the old, except that it can be used in a program. The old list, you will recall, always returns to direct mode when finished. The new LIST command is invoked by adding an exclamation point after the word LIST. In order to preserve the integrity of the stack, the STOP key is not honored by the new LIST command.

```
Ex.     open4,4:cmd4:list!:print#4:close4
```

You could use a FOR/NEXT loop to list multiple copies of your program (to give to the members of your user's group, etc.). Another way to use this new capability would be in writing a programming tutorial. You could list the lines before executing them. For example:

```
10 print "this code moves the sprite"
20 list!1000-1030:wait:gosub1000
```

(8) LOAD/SAVE/VERIFY -- A radical change for these three commands! Not only do you no longer need to specify the device number, you don't even need to specify a name! Suppose you LOAD "STAT1 and after modifying the program, you want to save the updated copy. Just type SAVE (with no name) and the program will automatically be replaced for you. But this is not a simple scratch & save. The new SAVE first backs up the old file and THEN replaces it. The backup filename will be the first two letters of the original filename followed by the suffix ".BAK".

Ex. Suppose we load STAT1, then we modify it and type SAVE. It will create a file named ST.BAK which is the OLD STAT1 and then it will replace the old STAT1 with the new, updated copy. Therefore, you can safely and confidently type SAVE when you finish modifying a program knowing that a backup will be made in case the modifications are wrong. The program can then be verified by just typing the word VERIFY. (Note: Only one quote is required when a filename is used with any of these commands)

Ex. (All of these are legal)

```
load "$
load "stat
load "stat"
load "stat",8,1
save:REM save & replace
save "name":rem save (no replace)
etc.
```

If you type LOAD, SAVE, or VERIFY with no filename and no name has yet been defined, you'll get a 'MISSING NAME' error (Unless you have Epyx FASTLOAD in place -- it defaults to a filename of M or something on LOAD). Note: Once a name is defined by using it in either LOAD, SAVE or VERIFY, this name will be the default for all three commands until a new one is defined. While LOAD & VERIFY don't mind a filename with a * in it, SAVE is unable to backup such a file and will abort.

Also note: A program can be LOADED and RUN by depressing the SHIFTED RUN/STOP key.

(9) The NEW command has been modified so that it clears the default name when you type NEW so that you don't accidentally try to save an empty workspace.

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Final Notes

The above is just a glimpse of what you can do with the vector IGONE. In addition to just modifying commands, this vector is one of the best places to ADD commands to BASIC. Don't forget, you can add COMMANDS through this vector using exactly the same technique that we used to add FUNCTIONS to BASIC through IEVAL in the last issue. (Likewise, you can modify existing BASIC functions through the vector IEVAL just as we modified existing BASIC commands through the vector IGONE in this issue.)

Up until now, we have been examining wedges which make our lives as programmers a bit easier. In my next article, we will examine a very useful, though somewhat unusual, special purpose wedge which makes makes USING a program easier. Until then, I will leave you with the following simple projects:

(1) Add a command or a function (your choice) called !NAME which either prints or returns the name of the file currently in memory. Use the article from last issue as a guide.
(2) Add a command called !SEND which will send any command to the disk drive. For example !SEND "S0:DATA" will scratch the file named DATA.
(3) Modify the LIST command so that if you type LIST#n it will do a listing to the previously opened file number n. For example:

```
OPEN 1,8,1,"PROG.L" : LIST#1 : CLOSE1
```

Hints:

(1) You can do this without a hint.
(2) See last issue how to install new commands then just store the DOS command string in a place named CMD and call SEND (see listing 2) as a subroutine.
(3) This code at the beginning of the routine should do it for you:

```
cmp #'#'          ;number sign?
bne  wherever     ;no/do whatever
jsr   $b79b       ;get file# in .x
jsr   $ffc9       ;set output device
etc. . .          ;same as list!
```

As was the case with our function wedge, this wedge is immune to RUN/STOP-RESTORE and is compatible with most utilities including the DOS Wedge, the Function Wedge and Epyx Fastload Cartridge.

Command Wedge BASIC Loader

```
FK  100 rem basic loader for command wedge
MK  101 rem by frank e. digioia 12/18/85
EM  102 rem sys 49664 to activate
LN  103 :
CA  104 for adr = 49664 to 50356:read ml
KD  105 cs = cs + ml:poke adr,ml:next
NG  106 ifcs<>85465thenprint "error in data"
PN  107 :
KK  108 data 169,  11, 141,   8,   3, 169, 194, 141
IK  109 data   9,   3,  96,  32, 115,   0,  32,  23
EG  110 data 194,  76, 174, 167,  76,  59, 169, 201
IK  111 data  39, 240, 249, 201,  92, 240, 245, 170
AK  112 data  16,  32, 162,   0, 141,  72, 194, 189
IP  113 data  73, 194, 240,  22, 205,  72, 194, 240
NL  114 data   3, 232, 208, 243, 138,  10, 170, 189
AN  115 data  86, 194,  72, 189,  85, 194,  72,  76
AH  116 data 115,   0,  32, 121,   0,  76, 237, 167
DF  117 data   0, 133, 139, 140, 137, 141, 155, 146
JA  118 data 147, 148, 149, 162,   0, 149, 195,  90
OK  119 data 195, 106, 194,   4, 195,  13, 195,  39
PJ  120 data 195, 247, 195,   7, 196,  14, 196,   4
AN  121 data 196, 249, 194, 208,   3,  76,  29, 168
CO  122 data  32, 212, 194, 165,  95, 164,  96,  56
HG  123 data 233,   1, 176,   1, 136, 133,  65, 132
OI  124 data  66,  32, 121,   0, 240,  50,  32, 253
AO  125 data 174,  32, 158, 183, 138, 240,  41, 202
EL  126 data 240,  38, 160,   4, 177,  65, 201, 131
CP  127 data 208,  31, 200, 177,  65, 240,  44, 201
BH  128 data  58, 240,  40, 201,  34, 240,  21, 201
KA  129 data  44, 208, 239, 202, 208, 236, 152,  24
HI  130 data 101,  65, 133,  65, 144,   2, 230,  66
CE  131 data  96, 169, 131,  44, 169,  34, 133, 251
CB  132 data 200, 177,  65, 240,   6, 197, 251, 240
LJ  133 data 209, 208, 245, 169, 227, 133,  34, 169
BN  134 data 194,  76,  69, 164,  32, 138, 173,  32
CL  135 data 247, 183,  32,  19, 166, 176,   3,  76
HB  136 data 227, 168,  96,  68,  65,  84,  65,  32
CD  137 data  69,  76,  69,  77,  69,  78,  84,  32
IB  138 data  78,  79,  84,  32,  70,  79,  85,  78
DO  139 data  68, 128, 169,   0, 141, 170, 196,  32
DK  140 data 121,   0,  76,  66, 166,  32, 138, 173
AP  141 data  32, 247, 183,  76, 163, 168, 169,   3
PM  142 data  32, 251, 163, 165, 123,  72, 165, 122
PN  143 data  72, 165,  58,  72, 165,  57,  72, 169
EO  144 data 141,  72,  32,   5, 195,  76, 174, 167
AA  145 data 201,  33, 240,   6,  32, 121,   0,  76
GN  146 data 156, 166, 169,  52, 141,  20,   3, 169
JG  147 data  71, 141,   0,   3, 169, 195, 141,   1
NJ  148 data   3,  32, 115,   0,  32, 156, 166, 169
KK  149 data 139, 141,   0,   3, 169, 227, 141,   1
NA  150 data   3, 169,  49, 141,  20,   3, 169,  13
GC  151 data  76, 210, 255,  32, 158, 173,  32, 121
NF  152 data   0, 201, 137, 240,   5, 169, 167,  32
BG  153 data 255, 174, 165,  97, 208,  11, 162,  92
GL  154 data  32,  11, 169, 170, 208,  24,  76, 251
FM  155 data 168,  32, 121,   0, 176,   3,  76, 160
DD  156 data 168, 165, 122,  56, 233,   1, 133, 122
IH  157 data 176,   2, 198, 123, 160,   0,  32, 251
DH  158 data 168, 104, 104, 108,   8,   3, 201,  36
BJ  159 data 240,   3,  76, 191, 171,  32, 115,   0
ML  160 data 240,  15, 162,   0,  32, 207, 255, 201
BJ  161 data  13, 240,  32, 157,  60,   3, 232, 208
GE  162 data 243, 169, 186, 133,  34, 169, 195,  76
IK  163 data  69, 164,  77,  73,  83,  83,  73,  78
NP  164 data  71,  32,  86,  65,  82,  73,  65,  66
MO  165 data  76,  69, 128, 142, 170, 196,  32,  86
JH  166 data 195,  32, 139, 176, 133,  73, 132,  74
LB  167 data  32, 163, 182, 173, 170, 196,  32, 117
OO  168 data 180, 160,   2, 185,  97,   0, 145,  73
LB  169 data 136,  16, 248, 172, 170, 196, 136, 185
GC  170 data  60,   3, 145,  98, 136,  16, 248,  96
FN  171 data 240,   3,  76,  45, 184,  32, 228, 255
AN  172 data 240, 251, 133,   2,  96, 169,   1,  44
ML  173 data 169,   0, 133,  10, 169,   0,  44, 169
LL  174 data   1, 141, 197, 196, 169,   0,  32, 189
FD  175 data 255, 162,   8,  32, 219, 225, 165, 183
NL  176 data 240,  19, 141, 170, 196, 168, 169,   0
NC  177 data 153, 181, 196, 136, 177, 187, 153, 181
DA  178 data 196, 208, 248, 240,  38, 173, 170, 196
```

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```
LD  179 data 240,  33, 173, 197, 196, 240,  18, 173
LE  180 data 181, 196, 141, 174, 196, 173, 182, 196
NB  181 data 141, 175, 196,  32, 114, 196,  32, 127
IE  182 data 196, 173, 170, 196, 162, 181, 160, 196
CP  183 data  32, 189, 255, 173, 197, 196, 208,   3
OH  184 data  76, 111, 225, 166,  45, 164,  46, 169
NM  185 data  43,  32, 216, 255, 144,   3,  76, 249
BC  186 data 224,  96, 169,  83, 141, 171, 196, 169
PA  187 data   0, 141, 180, 196,  76, 140, 196, 169
EC  188 data  82, 141, 171, 196, 169,  61, 141, 180
NL  189 data 196,  76, 140, 196, 169,   8, 133, 186
FF  190 data  32, 177, 255, 169, 111, 133, 185,  32
AO  191 data 147, 255, 162,   0, 189, 171, 196, 240
HN  192 data   6,  32, 168, 255, 232, 208, 245,  76
KM  193 data 174, 255,   0,  83,  48,  58,   0,   0
DE  194 data  46,  66,  65,  75,   0
```

Command Wedge Demo Program

```
IF  10 '
OF  20 ' command wedge demo
MG  30 '
NK  40 ' by frank e. digioia
BO  50 ' 11/17/85
KI  60 '
EJ  70 '
AC  80 print " press any key to start " :wait
NL  90 print:print " key found! ascii " peek(2)
CE  100 print " q touch any key to test list "
CF  110 wait:list!:print " q list done! "
CE  120 print " q choose a subroutine 1, 2 ,3 "
JK  130 wait:subr = peek(2)-asc(" 0 ")
ED  135 if subr<1 or subr>3 then goto 120
LD  140 gosub subr*300 + 50:'computed gosub
AD  142 print:print " type any chars:  " ;:input$ z$:print " you typed:  " z$
GB  150 print:input " goto 170, 180 or 190 " ;a
IB  155 ifa<>170 and a<>180 and a<>190 then150
FH  160 goto a
FN  170 print " q line #170 " :goto200
CO  180 print " q line #180 " :goto200
II  190 print " q line #190 "
AO  200 print " qq touch any key for restore demo "
AA  210 wait:data 1,2,3,4,5,6,7,8,9,10
HP  220 print " qq data in line 210 printed backwards " :print
LE  230 fori = 10to1step-1:restore210,i:reada:printa;:next:print
JH  240 data  " georgia " , " clemson " , " usc "
DH  250 data  " colons::: " , " commas,,, " , " dot. "
CG  260 data  " c64 " , " 1541 " , " mps801 "
GP  270 print:print " choose a data line: "
LN  280 input " 240, 250 or 260 " ;line
EA  285 if li<>240 and li<>250 and li<>260 then 270
HH  290 print:print " choose a data element: "
EM  300 input " 1, 2 or 3 " ;de:ifde<1then300
ID  310 restore line,de:read a$
AM  320 print  " q element is:  " a$:goto270
BG  350 print " executing subr #1 " :return
PI  650 print " executing subr #2 " :return
NL  950 print " executing subr #3 " :return
```

Command Wedge Source Code

```
1000 ;
1010 ;command wedge
1020 ;by frank e. digioia
1030 ;11/17/85
1040 ;
1050 *        =    $c200
1060 ;
1070 init     lda  #<cwedge   ;install wedge
1080          sta  $0308
1090          lda  #>cwedge
1100          sta  $0309
1110          rts
1120 ;
1130 cwedge =      *          ;this is the wedge
1140          jsr  chrget     ;get next byte
1150          jsr  chktok     ;what is it?
1160          jmp  $a7ae      ;interpreter loop
1170 ;
1180 rem      jmp  $a93b      ;basic rem command
1190 ;
1200 chktok   cmp #$27        ;single quote?
1210          beq rem         ;new rem command
1220          cmp #$5c        ;'else' pseudo-token
1230          beq rem         ;handle as rem
1240          tax             ;set flags
1250          bpl  wexit      ;not a token
1260 ;
1270          ldx  #$00       ;use .x as index
1280          sta  token      ;save for compare
1290 tloop    lda  toktab,x   ;byte from table
1300          beq  wexit      ;end of table
1310          cmp token       ;a match?
1320          beq  exec       ;yes/execute it
1330          inx             ;no/bump index
1340          bne  tloop      ;keep looking
1350 ;
1360 exec     txa             ;put offset in .a
1370          asl  a          ;mult by two
1380          tax             ;use as index
1390          lda  newadr + 1,x ;put address
1400          pha             ;of new routine
1410          lda  newadr,x   ;on stack.
1420          pha
1430          jmp  chrget     ;next byte & rts
1440 ;
1450 wexit    jsr  chrgot     ;get byte again
1460          jmp  $a7ed      ;give it to basic
1470 ;
1480 token    .byte $00
1490 ;
1500 toktab   .byte $85,$8b,$8c,$89,$8d
1510          .byte $9b,$92,$93,$94,$95,$a2,$00
1520 ;
1530 newadr   .word inp-1,if-1,restor-1
1540          .word goto-1,gosub-1,list-1,wait-1
1550          .word load-1,save-1,verfy-1,new-1
1560 ;
1570 ;restore x,y -- all parms optional
1580 ;
1590 chrget   =    $0073      ;get next byte
1600 chrgot   =    $0079      ;get last byte
1610 frmnum   =    $ad8a      ;get numeric parm
1620 facint   =    $b7f7      ;change fac to int
1630 ;
1640 restor   =    *          ;new restore cmd
1650          bne  * + 5      ;any parms?
1660          jmp  $a81d      ;no/use rom routine
1670          jsr  getprm     ;yes/get line & adr
1680          lda  $5f        ;address lo
1690          ldy  $60        ;address hi
1700          sec
1710          sbc  #$01       ;subtract 1
1720          bcs  * + 3      ;decr hi byte?
1730          dey
1740          sta  $41        ;data pointer lo
1750          sty  $42        ;data pointer hi
1760          jsr  chrgot     ;another parm?
1770          beq  rdone      ;no/we're done
1780 ;
1790          jsr  $aefd      ;yes/check comma
1800          jsr  $b79e      ;get byte into .x
1810          txa
1820          beq  rdone      ;0'th element???
1830          dex
1840          beq  rdone      ;1'st element/done
1850          ldy  #$04       ;.y is text index
1860          lda  ($41),y    ;get byte of text
1870          cmp #$83        ;data statement?
1880          bne  findat     ;no/find it
1890 ;
1900 loop     iny             ;comma search loop
1910          lda  ($41),y    ;get byte from line
1920          beq  notfnd     ;end of line
1930          cmp #':'        ;colon?
1940          beq  notfnd     ;end of data stmnt
1950          cmp #$22        ;quote?
```

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```
1960          beq finqte      ;find closing quote
1970          cmp #','        ;comma?
1980          bne loop        ;no/try again
1990          dex             ;found one!
2000          bne loop        ;need .x more
2010 ;
2020          tya             ;put offset in .a
2030          clc             ;update the data
2040          adc $41         ;pointers
2050          sta $41
2060          bcc *+4
2070          inc $42
2080 rdone    rts
2090 ;
2100 findat   lda #$83        ;token for data
2110          .byte $2c       ;skip next instr.
2120 ;
2130 finqte   lda #$22        ;ascii for quote
2140          sta $fb         ;save byte to find
2150 ;
2160 bloop    =   *           ;find byte at $fb
2170          iny
2180          lda ($41),y     ;get byte of text
2190          beq notfnd      ;end of line
2200          cmp $fb         ;found it?
2210          beq loop        ;yes/goto main loop
2220          bne bloop       ;no/keep looking
2230 ;
2240 notfnd   =   *           ;print mesg & die
2250          lda #<msg
2260          sta $22
2270          lda #>msg
2280          jmp $a445       ;output err mesg
2290 ;
2300 getprm   =   *           ;get parm & check it
2310          jsr frmnum      ;get parm in fac
2320          jsr facint      ;convert to int.
2330          jsr $a613       ;get adr of line
2340          bcs found       ;line found?
2350          jmp $a8e3       ;no/undef'ed line
2360 found    rts
2370 ;
2380 msg      .byte 'data element not found'
2390 eom      .byte $80
2400 ;
2410 ;new -- clear default name
2420 ;
2430 new      lda #$00        ;set length zero
2440          sta len         ;to clear name
2450          jsr chrgot      ;get last byte
2460          jmp $a642       ;basic new command
2470 ;
2480 ;goto -- computed goto statement
2490 ;
2500 goto     jsr frmnum      ;get parm in fac
2510          jsr facint      ;convert to integer
2520          jmp $a8a3       ;that's all folks!
2530 ;
2540 ;gosub - computed gosub statement
2550 ;
2560 gosub    lda #$03        ;half # of bytes
2570          jsr $a3fb       ;enough stack space?
2580          lda $7b         ;text pointer hi
2590          pha
2600          lda $7a         ;text pointer lo
2610          pha
2620          lda $3a         ;line number hi
2630          pha
2640          lda $39         ;line number lo
2650          pha
2660          lda #$8d        ;token for gosub
2670          pha             ;as i.d. on stack
2680          jsr goto        ;do a goto
2690          jmp $a7ae       ;interpreter loop
2700 ;
2710 ;list - a list subroutine
2720 ;
2730 list     cmp #'!'        ;our command?
2740          beq l1          ;yes/use our routine
2750          jsr chrgot      ;no/reset flags &
2760          jmp $a69c       ;use normal list
2770 ;
2780 l1       lda #$34        ;disable stop key
2790          sta $0314       ;lo byte of irq
2800          lda #<rtrn      ;point error
2810          sta $0300       ;vector at return
2820          lda #>rtrn      ;address for list
2830          sta $0301
2840          jsr chrget      ;get next byte
2850          jsr $a69c       ;real list cmd
2860 ;
2870 rtrn     lda #$8b        ;set error
2880          sta $0300       ;vector back to
2890          lda #$e3        ;normal.
2900          sta $0301
2910          lda #$31        ;enable stop key
2920          sta $0314       ;lo byte of irq
2930 cr       lda #$0d        ;carriage return
2940          jmp $ffd2       ;output it
2950 ;
2960 ;if -- allows extended statements
2970 ;
2980 if       jsr $ad9e       ;evaluate expression
2990          jsr $0079       ;get last char
3000          cmp #$89        ;"goto" token?
3010          beq chkexp      ;yeah/check result
3020          lda #$a7        ;"then" token
3030          jsr $aeff       ;check on "then"
3040 chkexp   lda $61         ;expression true?
3050          bne doit        ;yes/execute cmd
3060          ldx #$5c        ;psuedo token for 'else'
3070          jsr $a90b       ;look for "else"
3080          tax             ;eoln?
3090          bne cmmd        ;no/do else clause
3100          jmp $a8fb       ;yes/update txtptr
3110                          ;and return to interp
3120 doit     jsr chrgot      ;get last char
3130          bcs decptr      ;not digit/execute it
3140          jmp $a8a0       ;digit/execute goto
3150 ;
3160 decptr   lda $7a         ;decrement txtptr
3170          sec
3180          sbc #$01
3190          sta $7a
3200          bcs *+4
3210          dec $7b
3220          ldy #$00        ;clear .y for update
3230 ;
3240 cmmd     jsr $a8fb       ;update text pointer
3250          pla
3260          pla
3270          jmp ($0308)     ;execute via vector
3280 ;
3290 ;input$ -- input any string
3300 ;
3310 wbuf     =   $033c
3320 ;
3330 inp      cmp #'$'        ;our command?
3340          beq *+5         ;yes/it's ours
3350          jmp $abbf       ;no/old input
3360          jsr chrget      ;next byte
3370          beq x1          ;missing parameter
3380 ;
3390          ldx #$00
3400 getit    jsr $ffcf       ;input byte
3410          cmp #$0d        ;carriage return?
3420          beq eoi         ;yes/end of input
3430          sta wbuf,x      ;save it
3440          inx
3450          bne getit       ;absolute jump
3460 ;
3470 x1       lda #<noprm     ;set up error mesg
3480          sta $22
3490          lda #>noprm
3500          jmp $a445       ;output mesg
3510 noprm    .byte 'missing variable',$80
3520 ;
3530 eoi      stx len         ;save len
3540          jsr cr          ;output <cr>
3550          jsr $b08b       ;look up variable
3560          sta $49         ;save address
3570          sty $4a         ;as pointer
3580          jsr $b6a3       ;free string
3590          lda len         ;get length
3600          jsr $b475       ;reserve space
3610          ldy #$02        ;3 bytes to copy
3620 i4       lda $61,y       ;copy string dscrptr
3630          sta ($49),y     ;to variable table
3640          dey             ;bump counter
3650          bpl i4          ;till done
3660 ;
3670          ldy len         ;get length
3680          dey             ;bump down
3690 i5       lda wbuf,y      ;copy string data
3700          sta ($62),y     ;to reserved loc.
3710          dey             ;bump counter
3720          bpl i5          ;till done
3730          rts
3740 ;
3750 ;wait -- pause until key pressed
3760 ;
3770 wait     beq *+5         ;any parms?
3780          jmp $b82d       ;yes/use old wait
3790 wloop    jsr $ffe4       ;get character
3800          beq wloop       ;buffer empty?
3810          sta $02         ;save character
3820          rts
3830 ;
3840 ;load/save -- all parms optional
3850 ;
3860 setnam   =   $ffbd       ;set name parameter
3870 setlfs   =   $ffba       ;set file parameter
3880 ;
3890 verfy    lda #$01        ;verify flag
3900          .byte $2c       ;skip next instr.
3910 load     lda #$00        ;flag for load
3920          sta $0a         ;store system flag
3930          lda #$00        ;act like load now
3940          .byte $2c       ;skip next instr.
3950 save     lda #$01        ;flag for save
3960          sta lsflag      ;store our flag
3970          lda #$00        ;default length
3980          jsr setnam      ;set default name
3990          ldx #$08        ;default device#
4000          jsr $e1db       ;get any parms
4010          lda $b7         ;length of name
4020          beq noname      ;no name specified
4030 ;
4040          sta len         ;store new name
4050          tay             ;use .y as index
4060          lda #$00        ;end name with 0
4070          sta name,y
4080 ;
4090 nloop    dey             ;copy new filename
4100          lda ($bb),y     ;get byte of name
4110          sta name,y      ;save it
4120          bne nloop       ;keep it up
4130          beq exit        ;continue command
4140 ;
4150 noname   =   *           ;no name specified
4160          lda len         ;is name defined?
4170          beq exit        ;no/error coming up
4180          lda lsflag      ;load or save?
4190          beq setup       ;load/finish up
4200 ;
4210          lda name        ;set up two char
4220          sta abr         ;abbreviation of
4230          lda name+1      ;filename for
4240          sta abr+1       ;easy backup
4250 ;
4260          jsr scrach      ;scratch old backup
4270          jsr rename      ;create backup copy
4280 ;
4290 setup    lda len         ;get parameters
4300          ldx #<name      ;for filename to
4310          ldy #>name      ;load or save
4320          jsr setnam      ;set parameters
4330 ;
4340 exit     lda lsflag      ;load or save?
4350          bne save2       ;save command?
4360          jmp $e16f       ;continue load cmd
4370 ;
4380 save2    ldx $2d         ;end adr of save
4390          ldy $2e         ;i.e. start of vars
4400          lda #$2b        ;point to start adr
4410          jsr $ffd8       ;continue save cmd
4420          bcc *+5         ;normal termination
4430          jmp $e0f9       ;no/"break" error
4440          rts
4450 ;
4460 scrach   =   *           ;scratch backup
4470          lda #'s'        ;'s' for scratch
4480          sta cmd         ;set command
4490          lda #$00        ;end of buffer
4500          sta equal       ;no equal sign
4510          jmp send        ;send dos command
4520 ;
4530 rename   =   *           ;rename old file
4540          lda #'r'        ;'r' for rename
4550          sta cmd         ;set command
4560          lda #'='        ;equal sign
4570          sta equal       ;where else?
4580          jmp send        ;send dos command
4590 ;
4600 ;
4610 ;send -- this routine can be used
4620 ;to send any dos command to drive
4630 ;be sure to end command with zero
4640 ;
4650 ciout    =   $ffa8       ;send serial port
4660 listen   =   $ffb1       ;tell drive listen
4670 second   =   $ff93       ;send 2nd adr lstn
4680 unlstn   =   $ffae       ;quit listening
4690 ;
4700 send     lda #$08        ;device number
4710          sta $ba         ;store for system
4720          jsr listen      ;listen to command
4730          lda #$6f        ;ch # or'ed w/$60
4740          sta $b9         ;secondary adr
4750          jsr second      ;send it to drive
4760 ;
4770          ldx #$00        ;use .x as index
4780 dloop    lda cmd,x       ;get byte of cmd
4790          beq exit1       ;0 byte marks end
4800          jsr ciout       ;output to drive
4810          inx             ;bump pointer
4820          bne dloop       ;jmp to dloop
4830 ;
4840 exit1    jmp unlstn      ;all done!
4850 ;
4860 len      .byte $00
4870 cmd      .byte 's0:'
4880 abr      .byte $00,$00,'.bak'
4890 equal    .byte $00
4900 name     *=*+16
4910 lsflag   .byte $00
4920 .end
```

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Improving The SYS Command

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. . .make use of those machine language routines supplied free by Commodore.

The SYS command in BASIC is very useful – it gives the programmer access to the fast, precise world of machine language. The writers of the Commodore BASIC interpreter realized that programmers often wish to transfer values from BASIC to machine language, so they included the USR command, a specialized form of SYS. Unfortunately, the USR command is limited to transfering one numeric value. A useful extension of the SYS command would allow the passing of multiple parameters in the form of values, variables, equations and strings. A simple method of doing this would be to calculate the values in BASIC and poke them into memory, then SYS to the ML program and have it read the values. Effective, but awkward, slow and clumsy.

A faster and more elegant method is to make use of some of the machine language routines supplied free by Commodore – those in the BASIC interpreter and the KERNAL. There are routines for converting floating point values to integer and back, for evaluating BASIC expressions, for manipulating strings, for printing data in numeric or string form, for storing data in variables, and for printing interpreter or KERNAL error messages. In addition, all mathematical functions handled by the Commodore 64 can be used from a machine language program. These routines are fairly simple to use, and open up innumerable opportunities.

The data which can be passed back and forth between the two languages usually takes one of three forms: string, integer or floating point. Strings are fairly straightforward, and are handled much the same way in each language. Integers, too, are fairly simple, but can be stored in one, two or more bytes. Numbers outside the range of BASIC integers (–32768 to 32767), or those with decimal points, are stored in floating point format, and require 5 or 6 bytes. One advantage of using the interpreter routines rapidly becomes apparent: floating point values can easily be converted to integer and back. Thus, data can be converted from one form to another, manipulated, and converted back, effortlessly (well, almost).

The real problem lies in transferring the parameters from one program to the other. A simple method of doing this using these routines takes the following format:

```
SYS PA, value1, value2, value3
```

where PA is the starting address of the ML routine, and value1–3 are the parameters to be passed. For each parameter, ML routines must be called to check for the comma and to evaluate the parameter. The routine at $AEFD checks for a comma and returns an error message if it is not found. The value following the comma can be evaluated by the routine at $AD9E. The value can be anything that BASIC can evaluate: strings and string functions, integer or real or boolean equations, variables, etc. If the value is a string or a string function, the result is stored at $0100, and if numeric, it is stored in floating point format in FAC1. FAC1, or floating point accumulator #1, is located at $62 to $65, and is used by the BASIC interpreter for floating point value manipulation. If the type of data to be passed is unknown, reference to two flags will sort this out. The location $0C is used to indicate the type of data – 255 for string, and 0 for numeric. The type of numeric data is indicated at $0D – 128 for integer and 0 for floating point. An alternate evaluation routine exists at $B79E. Following this evaluation, the expression is stored as a one–byte integer (range 0–255) in the X register.

I wrote the following relocatable ML program to demonstrate this method of extending the SYS command. The program is a PRINT AT routine which allows the programmer to specify the column and row of his/her output to the screen. This is simpler and cleaner than fiddling about with embedded cursor controls. The format is:

```
SYS PA, col, row, value
```

PA	– the address of the start of the ML routine
col	– the number of cols from the left screen border (0–39)
row	– the number of rows from the top of the screen (0–24)
value	– anything the PRINT command can handle

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In this example, the SYS command is followed by the parameters to be passed, separated by commas. This line SYS's to PA, the location of the ML routine. The ML program then checks for a comma, evaluates the next parameter, col, and stores the value in the X register. If it is within the acceptable range, it is stored on the stack. The row parameter is placed in the X register in the same manner, and checked for size. The col parameter is pulled from the stack, transfered to the Y register, and the KERNAL Plot routine is used to relocate the cursor. Should either parameter be out of range, the error message "ILLEGAL QUANTITY" is printed.

```
      jsr  $aefd  ;check for comma after SYS
      jsr  $b79e  ;evaluate expression for column number
                   (col), store in .X
      cpx  #$28   ;must be less than 40 ($28)
      bcs  error  ;if not, print error message
      txa
      pha         ;store column value on stack
      jsr  $aefd  ;check for comma after col
      jsr  $b79e  ;evaluate expression for row number (row),
                   store in .X
      cpx  #$19   ;must be less than 25 ($19)
      bcs  error  ;if not, print error message
      pla         ;retrieve col from stack and
      tya         ;store in .Y
      clc         ;clear carry for KERNAL plot routine
      jsr  $fff0  ;Kernal plot - put cursor at location speci-
                   fied in .X and .Y
      jsr  $0073  ;setup for BASIC interpreter print routine
      jmp  $aaa0  ;BASIC PRINT routine - print following
                   expression

error ldx  #$0e   ;error #14 - illegal quantity

      jmp  $a437  ;print error specified by value in .X
```

The following BASIC source program will place the program at memory location PA:

```
AB  100 rem  print at - source program
KA  110 pa=49152: rem location of ml program
AB  120 forj=patopa+38:reada:pokej,a:next
CB  130 data  32, 253, 174,  32, 158, 183, 224,  40
DM  140 data 176,  24, 138,  72,  32, 253, 174,  32
GO  150 data 158, 183, 224,  25, 176,  12, 104, 168
DK  160 data  24,  32, 240, 255,  32, 115,   0,  76
DG  170 data 160, 170, 162,  14,  76,  55, 164
```

Possible locations for the ML program are unused Page Two RAM $02A7 (679), the tape buffer $033C (828) or free RAM $C000 (49152). In the program, let PA equal your choice of location and it will be stored there.

One convenient but unusual place to store a short (less than 75 byte) ML program is in a REM statement. To do this, delete line 110 from the source program, and add the line 10 listed below. Line 10 sets PA equal to the memory address of the first of the 39 spaces in the REM statement and line 120 stores the ML program in the REM statement. RUN the program, then use line 10 as the first line of your program. The remaining lines can be erased, and line 10 can be renumbered, used and stored as wished, but it must remain the first line in the program if PA is kept as location 2063.

```
10 pa=2063:rem "                    " <39 spaces>
```

Example: sys pa,4,6,"*";pa;sqr(144)+12*6

This example will print an asterisk in column 4 row 6, followed by the value stored in PA (starting location of the ML program), and then the value of the equation (84).

Following is a short list of some of the more useful data manipulation routines in the BASIC interpreter and KERNAL:

Routines used in passing parameters:

$aefd	checks for a comma in the BASIC statement.
$ad9e	evaluates any expression in the BASIC statement and, if numeric, leaves the results in FAC1. If the expression is a string, it is stored starting at $0100, and ends with a zero.
$b79e	evaluates the expression in the BASIC statement, stores the value in FAC1, then converts FAC1 into a an integer in the range 0 to 255, and stores the result in the X register.

Routines to convert floating point values in FAC1 to integer values:

$bc9b	converts a floating point value in FAC1 to a four-byte integer in FAC1.
$b1bf	converts a floating point value in FAC1 to a fixed point integer stored in $64 and $65, range -32768 to 32767.
$b7a1	converts a floating point value in FAC1 to a fixed point integer in the X register, range 0 to 255.
$b1aa	converts a floating point value in FAC1 to a 2-byte integer leaving the high byte in the accumulator and the low byte in the Y register.

Routines to convert integer values to floating point values in FAC1:

$bc44	converts a 2-byte integer in $62 and $63 to a floating point value in FAC1.
$bc3c	converts the accumulator to a floating point value in FAC1.
$b3a2	converts the Y register to a floating point value in FAC1.
$b391	converts a 2-byte integer, high byte in the accumulator and low byte in the Y register, to a floating point value

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in FAC1.

Routine to convert a floating point value in FAC1 to an ASCII string:

$bddd converts a floating point value in FAC1 to an ASCII string starting at $0100.

Other useful routines:

$a437 prints the error message (from the table at $A19E) corresponding to the value in the X register. For example, loading a 14 in the X register and then jumping to this routine produces the error message "ILLEGAL QUANTITY".

$aaa0 PRINT command – prints whatever follows, checking for TAB, SPC, commas and semicolons. A jsr to the CHRGET routine is needed before jumping to this routine.

Useful routines and flags from Zero Page and the KERNAL:

$73	– CHRGET – gets the next character in a BASIC statement.
$0c	– flag: type of data. A value of 255 indicates a string, and a zero indicates numeric data.
$0d	– flag: type of numeric data. A value of 128 indicates an integer, and a zero indicates a floating point value.
$fff0	– KERNAL plot routine – if the carry flag is cleared, the cursor is placed at the column in the X register and the row in the Y register.

Reference locations:

FAC1	–$62–$65 (floating point accumulator)
FAC2	–$69–$6E
accumulator	–$30c (780) (.A)
X register	–$30d (781) (.X)
Y register	–$30e (782) (.Y)

Using these BASIC interpreter routines opens many possibilities in combining BASIC and ML programs. All forms of BASIC data, equations, and variables can be passed to ML programs, and ML data can easily be passed back. For a more complete description of these routines, I refer the reader to "Compute!'s VIC-20 and Commodore 64 Tool KIT: BASIC" by Dan Heeb, which has been the source of innumerable ideas for me.

Thanks also to Sheldon Leemon and his invaluable book, "Mapping the Commodore 64", for descriptions of these routines. For those more interested in the actual code for these routines, it can be found in "The Anatomy of the Commodore 64" from Abacus Software.

```
OM  100 rem printer version
GD  120 open4,4
GC  130 print#4,chr$(27) " p " chr$(66)
IG  140 close4
CE  150 open4,4,2
BH  160 sys700
KH  170 .opt oo,p4
KC  180 ;
CG  190 ;ml print at
OD  200 ;
IE  210 ;
KG  220 chrget  =    $73       ;get next character
OC  230 errprt  =    $a437     ;print error type .x
GH  240 print   =    $aaa0     ;basic print
KD  250 comchk=      $aefd     ;check for comma
JK  260 evalxr  =    $b79e     ;put exp in .x 0–255
GL  270 setcrs  =    $fff0     ;kernal–place cursor
JA  280 *       =    $c000
IJ  290 ;
OC  300             jsr  comchk  ;check for comma
OC  310             jsr  evalxr  ;evaluate col in .x
LN  320             cpx  col
GE  330             bcs  error   ;branch if col >= 40
IA  340             txa
HO  350             pha          ;store col on stack
KG  360             jsr  comchk  ;check for comma
ML  370             jsr  evalxr  ;evaluate row in.x
HE  380             cpx  row
NL  390             bcs  error   ;branch if row >= 25
AH  400             pla          ;get col from stack
JG  410             tay
KB  420             clc
PF  430             jsr  setcrs  ;set cursor at x,y
EH  440             jsr  chrget  ;first char for print
GB  450             jmp  print
IL  460             rts
MO  470 error       ldx  toobig  ;parameter too big
GE  480             jmp  errprt  ;print error .x
AH  490 col         .byte 40     ;# of columns
DP  500 row         .byte 25     ;#of rows
HA  510 toobig      .byte 14     ;illegal quantity
```

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Autoload & the EPROM

by Tom Hughes & Steve McCrystal
Milwaukee, Wisconsin

When the power comes up, so does your application program!

Imagine you're using your Commodore 64 to operate a computerized bulletin board and one stormy day a stray lightning bolt knocks out the local power station. Your BBS crashes. Of course you're not around to pick up the pieces, so when power finally is restored your 64 sits idly, flashing its cursor, while your modem keeps answering and answering and answering those incoming phone calls.

If your 64 had been equipped with Autoload, the computer would have automatically loaded and run the first disk program (your BBS loader) immediately after power was restored. You could have been miles away.

Autoload is a short routine that resides in the 64's KERNAL. Think of Autoload as a "hard" wedge as opposed to the "soft" DOS 5.1 wedge which vanishes as soon as the 64 is turned off. Since it is designed to become a permanent part of the computer's operating system, the only practical way to use Autoload is to burn it into an EPROM (along with the rest of the KERNAL) and then replace your old KERNAL with the Autoload EPROM.

Autoload is able to load and run a disk file because it bypasses the 64's normal start-up or RESET routine. Normally, on power-up or a cold start the 64 jumps to the RESET vector at $FFFC-FFFD which points to $FCE2. This routine sets the VIC II chip and the operating system's soft vectors at $0300, initializes BASIC, resets the stack, and finally turns control of the 64 over to the BASIC interpreter. Autoload performs all of these housekeeping functions, but it also does a LOAD "0:*",8 and then stuffs the keyboard buffer with the BASIC command RUN. Finally, it jumps to BASIC, which sees it has a RUN command waiting, and that's that.

What if you're not running a BBS? If you're 64 isn't a "dedicated" or single–purpose computer, Autoload could become quite a nuisance. Each time you flipped on the 64's power the computer would always - repeat always - try to load and run. To get around this potentially annoying feature, Autoload pauses about 1 minute before loading, and at any time during this delay you can abort the load by simply pressing the Commodore logo key. This delay also serves a second purpose; it allows a disk drive enough time to reset itself. For some drives that do a self–initialization, like the 4040, there's a chance of a "device not present" error occurring if the drive is accessed too soon.

Nothing's free . . . you'll need to get a suitable EPROM and have access to an EPROM burner, for example, the Promenade (see section below). Also, forget about using a cassette with Autoload because Autoload resides at $F72C and effectively erases part of a KERNAL cassette routine. However, patches have been placed in the KERNAL which protect you from attempting any cassette operations. One final note: Replacing the KERNAL that came with your 64 with the Autoload custom KERNAL will void your computer's warranty.

If you're willing to part with the use of a cassette, then there's a fair amount of "free space" in the KERNAL for other customizing. For example, the cassette locations between $F72C–FB8D and $FB97–FCD0 seem to be ripe territory. Since all this space is available, why not make use of it?

Other KERNAL modifications might include:

- writing your own power-up message at $E479.
- adding a "hard" DOS wedge.
- an IEEE KERNAL.
- a routine to read and set the time–of–day clocks.
- or any number of short, general purpose programs that you use repeatedly.

Thanks to the bank–switching capabilities of the Commodore 64, custom KERNAL routines can usually be soft tested; that is, run without using an EPROM. The source code for Autoload, for example, includes a conditional assembly variable, called EPROM, that allows Autoload to be soft run "under" the KERNAL ROM itself.

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Here are the steps involved for soft running Autoload:

(1) Assemble Autoload with the variable EPROM = 0.
(2) Load a machine language monitor and run it.
(3) Using the monitor, save the KERNAL ($E000–FFFF) as a disk file. Then load it back. You now have an exact copy of the KERNAL in the RAM under the KERNAL.
(4) Transfer BASIC to itself. For example, most monitors have a transfer command such as 'T A000 BFFF A000'. This moves BASIC to the RAM under itself.
(5)* Load the assembled Autoload from disk. This adds Autoload to the RAM KERNAL.
(6) Create this bank switching routine with the monitor:

```
START SEI
      LDA #$35
      STA $01
      CLI
      RTS
```

This short machine language routine will flip out both the KERNAL and BASIC ROMs when it is called and transfer control of the 64 over to the customized Autoload KERNAL.

(7) Exit the monitor and do a SYS to START. Autoload is now in place. Next, type SYS 64738 (a RESET) and Autoload should do its stuff.

* NOTE: Commodore's assembler won't allow its object code to be directly assembled to ROM. However, CBM's HILOADER64 and LOLOADER64 programs can be modified to assemble into ROM with a few pokes which place 6502 NOP instructions in a comparison routine:

For LOLOADER64, POKE 2388,234 and POKE 2389,234
For HILOADER64, POKE 51525,234 and POKE 51526,234

Using the Promenade EPROM Programmer

Making a modified KERNAL can be done using any of several EPROM programmers or "burners" available to home users. I use the Promenade sold by Jason–Ranheim Co. of San Jose, California, and recommend it highly because it's inexpensive, simple to operate and very versatile.

Until recently, I used the 2764-type EPROM as a KERNAL replacement chip because of its low cost. However, this is a 28-pin chip. Since the KERNAL ROM has a 24-pin configuration, the 2764 requires an adapter socket and some jumper wires before it can be plugged into the 64's circuit board.

But because of recent price decreases in the Motorola MCM-68764, this chip is now my EPROM of choice. The Motorola EPROM, unlike the 2764, is pin compatible with Commodore's KERNAL chip. The additional cost of the MCM-68764 is offset by not having to fool around with an adapter socket interface.

To program a custom KERNAL with the Promenade, the modified machine code must be loaded into the 64's memory. For example, I relocate the custom KERNAL at $2000 simply because it's easy to remember. The EPROM is then programmed or "burned" by the EPROM programmer. Using the Promenade (with the Promenade software) with the KERNAL at $2000 and the 68764 chip, the programming command has the following syntax:

```
π 8192,16383,0,48,0
```

"8192"	= decimal start address of the code to be burned ($2000).
"16383"	= decimal end address of the code ($3FFF).
"0"	= first byte of the EPROM to be programmed. (Remember, computers start counting from zero).
"48"	= Promenade "control word" which tells the burner what type of EPROM it's burning.
"0"	= Promenade "program method word" or PMW. This gives the Promenade instructions on how the 68764 should be programmed.

Promenade owners take note: You won't find the above PMW listed in your documentation. I was forced to develop my own PMW because the suggested ones failed to work on the 68764 about 90% of the time.

EPROM burning takes about 4 minutes. If the error light isn't flashing on the Promenade after the burning, then the customized KERNAL is ready to install.

Motorola MCM-68764 EPROMs are available from JAMECO Electronics in the United States as well as other sources. Besides being a direct replacement for the KERNAL, this EPROM can also replace BASIC as well as the 1541 disk drive's ROM.

Autoload Kernal Patch (CBM Assembler format)

```
;put "@:s/kauto"
.opt nosym
;********************************
;*                              *
;*        autoload kernal       *
;*        ---------------       *
;*                              *
;*  on powerup or reset, loads  *
;*   the 1st file from drive 0  *
;*  and then runs the program.  *
;*  however, a delay period is  *
;*  provided allowing the user  *
;*   time to abort the load by  *
;*  pressing the cmdr logo key. *
;*                              *
;*  - by tom hughes v240685 -   *
;*                              *
;********************************
```

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```
.skip      (; sends line feed(s) to printer )
;
;c64 equates
;
basic   =     $0801        ;basic starts here
basini  =     $e3bf        ;initialize basic
basmsg  =     $e422        ;print powerup message
clall   =     $ffe7        ;close all files
close   =     $ffc3        ;close one file
clrchn  =     $ffcc        ;i/o to defaults
dobas   =     $a474        ;basic warm start
keyd    =     $0277        ;keyboard buffer
load    =     $ffd5        ;load ram from disk
ndx     =     $c6          ;# of chars in keybrd buff
setlfs  =     $ffba        ;set file parameters
setnam  =     $ffbd        ;set file name
settim  =     $ffdb        ;set jiffy clock
shflag  =     $028d        ;shift pattern register
time    =     $a0          ;jiffy clock (3)
vartab  =     $2d          ;basic variable start (2)
vec300  =     $e453        ;set page 3 o.s. vectors
.skip
;
;constants
;
eprom   =     0            ;1=eprom/0=soft kernal
wait    =     3            ;wait * 4 = delay in secs
.page 'diversions'
;------------------------------
;cassette routine patches
;------------------------------
.skip
;note: attempted use of a cassette routine
;will result in "illegal device #"
.skip
*       =     $f2ce
        jmp   $f271        ;fix cassette close
*       =     $f38b
        jmp   $f713        ;fix cassette open
*       =     $f539
        jmp   $f713        ;fix cassette load
*       =     $f65f
        jmp   $f713        ;fix cassette save
.skip 2
*       =     $fcef
;------------------------------
;divert system reset
;------------------------------
.skip
.if n eprom <
        stx   $d016        ;reset vicii chip,
        jsr   $fda3        ;initialize i/o,
        jsr   $fd50        ;memory pointers,
        jsr   $fd15        ;soft i/o vectors,
        jsr   $ff5b        ;screen & keyboard
        cli
        jmp   autold       ;go to autoload
.page 'autoload'
*       =     $f72c
;------------------------------
;powerup autoload
;------------------------------
.skip
autold  jsr   vec300       ;set $0300 vectors,
        jsr   basini       ;initialize basic,
        jsr   basmsg       ;print powerup message,
        ldx   #251         ;and reset stack
        txs
        lda   #0           ;zero jiffy clock
        jsr   settim
auto10  lda   shflag
        cmp   #2           ;if cmdr key pressed,
        beq   auto30       ;skip the load
        lda   time+1
        cmp   #wait        ;else wait till delay is up
        bne   auto10
        jsr   clall        ;then close all files
        lda   #2
        ldx   #8
        ldy   #0           ;ignore file header
        jsr   setlfs
        lda   #3
        ldx   #<filnam
        ldy   #>filnam
        jsr   setnam
        lda   #0           ;load "0:*",8
        ldx   #<basic
        ldy   #>basic
        jsr   load
        stx   vartab       ;set end-of-basic ptrs
        sty   vartab+1
        lda   #2           ;close load channel
        jsr   close
        jsr   clrchn
.skip
;autorun routine
;
        ldy   #0
auto20  lda   runit,y      ;write "run" + cr
        sta   keyd,y       ;to keyboard buffer
        iny
        cpy   #4
        bne   auto20
        sty   ndx          ;and set buffer size
auto30  jmp   dobas        ;then run the program
.skip
filnam  .byt  '0:*'
runit   .byt  'run',13
.end
```

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SYMASS: A Symbolic Assembler For The Commodore 64

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Now Assemble Any Transactor Program, Anytime!

Symbolic assemblers, used to assemble machine language programs, are essential tools for serious programmers. The merits of machine language need not be discussed here. If you haven't broken down and bought one yet, you've probably been using a monitor such as Supermon. Monitors were never meant for program development. After trying to insert a couple of instructions into a long program with a monitor, you must also readjust the rest of your program properly. Then you think very hard about alternatives.

Unfortunately there were very few choices until now. SYMASS was written to fill the gap. It is a very fast, compact, easy to use assembler with enough features for serious programs. Besides, it's in the public domain. After experiencing SYMASS in action, you will gladly demote your monitor to debugger.

You're likely already familiar with SYMASS syntax, since it is totally compatible with PAL. PAL source code is published often in each issue of The Transactor. SYMASS syntax evolved through many changes from its beginning as a BASIC program (which would take over twenty minutes to assemble early versions.) It now includes most of PAL's features, including the ones most often used in Transactor programs. PAL has no problems assembling SYMASS itself, but SYMASS is faster. SYMASS source code is about 18 K bytes long and PAL takes about 17 seconds to assemble it. SYMASS assembles itself in six seconds.

Type in SYMASS 3.0.GEN, then run it. (It's not long, but you might consider getting the Transactor disk for this issue, especially if you want the source code.) It will create the final program, SYMASS 3.0, on disk. (The generator program could also be modified for tape, since SYMASS doesn't use the disk drive.) The SYMASS 3.0 loader will relocate itself at the top of memory when it is run. Source code is entered with the BASIC editor; use 'sys 700' alone on the first line to call SYMASS. Leave out the PAL's .opt xx statement since SYMASS assembles to memory only. Type 'run' and save the object code with a monitor.

Probably the major limitation of SYMASS is both source and the resulting object code must reside in memory along with SYMASS. SYMASS doesn't take up much room, (about 2.6 K) but you will have problems if the source is too long to fit with the object code.

A partial list of SYMASS/PAL compatible features follows:

```
*=$c000        ;define start of program
name=$ff       ;assign a value to a symbol
*=*+n          ;skip n bytes for storage
;              ;comments follow
$              ;hexadecimal value, default is decimal
%              ;binary value
'              ;ASCII value of character
!              ;force absolute addressing
>high, <low    ;low or high byte of word
+, -           ;add, subtract
.byte $ff      ;store bytes
.word $ffff    ;store words
.asc "text"    ;store string of characters
.end           ;end assembly
```

You can use SYMASS without knowing how it works, but the explanation will help you get the most out of it.

SYMASS itself is composed of small modules, each performing a specific function. In general, each module could be replaced by another section of code, if it performs the function correctly. This makes it easier to modify small sections without any side effects. SYMASS was debugged that way.

SYMASS makes two passes over the source code. During the first pass, SYMASS builds a symbol table of all the symbols which appear in the program. It then stores the object code to memory on the second pass, after all unknown symbol values have already been defined. A variable called FLAG is set to 0 or 1, depending which pass SYMASS is currently on.

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The source code has already been tokenized by the BASIC editor, but this causes no problems. It even reduces the amount of memory needed for the source. Opcodes such as 'and' are already stored as tokens internally, as are custom pseudo–ops like '.end'.

WORD is the most basic routine to find the next word. WORD defines a word as a sequence of characters ending with a space, colon, semi–colon, or equal sign. It also ignores leading spaces, and has a quote mode that accepts any character except the end of line.

A pointer, AD, and the .y register is always used to access the source code. When WORD is called, the pointer AD is advanced over leading spaces, then the .y register is advanced to the end of the word and the result is stored in LEN. Therefore, LEN is the length of the word, '(ad),y' gives the stop character when .y equals LEN, and the first character when .y equals zero. Two routines, NEXTWORD and NEWWORD, set up AD and call WORD. NEXTWORD starts at the current stop character, so will only get another word if a space separates them. NEWWORD, on the other hand, skips over the stop, and is used to get the expression after an equals sign.

It's important to understand how those routines work if you wish to use them in your own additions to SYMASS.

SYMASS creates a symbol table which starts at the top of memory and grows downward to the end of the source code. A symbol table overflow results if not enough memory is available. Each entry takes ten bytes; eight to store the name, and another two for the value. If tokens are embedded in the name, its actual length could be longer than eight characters, but it's not a good idea.

CRSYM creates a symbol table entry. It decides if there is enough room, then copies the current word into the table. It is your responsibility to make sure a symbol isn't defined twice. Whenever the value of a symbol is needed, FINDSYM is called. FINDSYM returns with the value in the .a and .x registers, or prints an 'undefined symbol' message.

FINDSYM uses the simplest possible search method, searching from beginning to end. It might be worthwhile to use a different method, such as a hash function, to save time. (Calculate the storage address with a special function, such as the remainder of table size / ASCII sum of name.)

The opcode table makes up 728 bytes of SYMASS. Again, FINDOP does a linear search. The more commonly used opcodes are close to the beginning. You could fine–tune the table to your style by counting the number of times each opcode appears in your programs, then rearranging the table in that order. If you do so, change the brk op# and bit op# in DOOP and PUTOP to their new positions. You could also easily add extra opcodes such as skb (skip byte) to the table, changing NOPS to reflect the change.

Two other major routines are EVAL and PUTOP.

EVAL takes the current word, an expression containing no spaces, evaluates it, and returns the result. It can add or subtract symbols, decimal, and hexadecimal numbers. A character enclosed in single quotes will return its ASCII value. A > or < can be placed at the beginning of the expression to return either the high or low byte of the result. The number conversion routines only convert from BASIC's format as a string of characters to a useful two–byte binary number, not both ways. This is why SYMASS gives the end of assembly as a decimal number instead of hex. The BASIC ROM routine that prints 'in xxxxx' is used.

During the first pass DOOP keep track of the current object address with a pointer called PTR. PUTOP is used on the second pass to store the machine code into memory. It recognizes all addressing modes. Since there is no difference in syntax between zero and absolute modes, the correct mode may sometimes be ambiguous.

Suppose you are storing variables in memory after the end of your program, with a label to identify the location. On the first pass, an instruction such as 'lda variable' would normally cause FINDSYM to give an undefined symbol error. FINDSYM therefore tries to guess your meaning by returning the value of PTR for undefined symbols on the first pass. Other assemblers may use zero, and cause an instruction like 'lda variable+1' to produce a phase error. A phase error results when the assembler makes the wrong guess, and reserves an incorrect number of bytes for an instruction.

SYMASS doesn't have phase errors. You can force SYMASS to use absolute mode with a ! prefix, or to zero page by a <, which works by returning the low byte.

You can add your own specialized commands to SYMASS by adding them to the CUSTOP routine. One such command, '.pad' will add a zero to the object code if the current address is odd. You might use it sometime to make sure a jump table doesn't cross a page boundary.

SYMASS leaves room for optimization; the major goals in its design were simplicity, speed and ease of use. WORD, since it is used so often, is a good candidate. PAL doesn't seem to recognize '=' as the end of a word. If the relevant parts of SYMASS were changed, the check could be taken out of WORD. A useful, but probably more complicated improvement is assembly to disk.

SYMASS's hidden strength is the ease with which it can be modified, compared to commercial programs which do not provide source code. You can also study SYMASS just to learn how to write an assembler. In the end though, SYMASS is a tool which will enable you to write machine language programs as complex as your growing skills allow.

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SYMASS Source Listing

The source code for SYMASS 3.1 has not been verified – it's here for reference only – we couldn't imagine anyone entering it by hand. If you want source we suggest you type in the loader and unassemble it, otherwise get Disk #12 for this issue.

```
100 sys700
110 ;     < < < < symass 3.1 > > > >
120 ;               symbolic assembler
130 ;     robert huehn june, october 1985
140 ;                    sm3.103
150 * = $c000
160 ;
170 ;zero page equates
180 stasrc    =     $50         ;start of source
190 stavar    =     $2d         ;end of source
200 memsiz    =     $37         ;top of symbol table
210 link      =     $4e         ;basic line link
220 line      =     $39         ;current line number
230 ad        =     $7a         ;current source address
240 symptr    =     $52         ;symbol value pointer
250 symend    =     $57         ;bottom of symbol table
260 ptr       =     $59         ;current object address
270 opptr     =     $5b         ;opcode table pointer
280 len       =     $5d         ;length of word
290 t1        =     $26         ;temporary number
300 t2        =     $28         ;storage for eval
310 ss        =     $2a         ;sign save
320 t3        =     $5e
330 t4        =     $5f
340 t5        =     $60
350 flag      =     $02         ;first or second pass
360 ;constants
370 nops      =     55          ;number of instructions
380 ready     =     $a474       ;basic ready
390 inline    =     $bdc2       ;print 'in line'
400 contbas   =     $a7ae       ;continue basic
410 list      =     $a6c9       ;list line
420 findline  =     $a613       ;find basic line
430 ;
440 ;main program
450 ;
460 init      =     *           ;begin first pass
470 ;
480           lda   #0
490           sta   flag
500           ldx   #<messstar ;start
510           ldy   #>messstar
520           jsr   printmsg
530           ldx   $3a
540           inx
550           bne   it1
560           jmp   ready       ;since in direct mode
570 it1       ldx   #<messfir   ;first pass
580           ldy   #>messfir
590           jsr   printmsg
600           lda   memsiz      ;init symbol table
610           sta   symend
620           lda   memsiz+1
630           sta   symend+1
640           inc   ad
650           bne   it2
660           inc   ad+1
670 it2       lda   ad
680           sta   stasrc
690           sta   link
700           lda   ad+1
710           sta   stasrc+1
720           sta   link+1
730 ;
740 newline   =     *           ;start next line
750 ;
760           jsr   nextline
770           bne   getword
780           jmp   secpass
790 ;
800 getword   =     *           ;process word
810 ;
820           jsr   word
830           bne   gw1
840           cmp   #$b2        ;= token
850           bne   next
860           jmp   addval
870 gw1       ldx   #0          ;check for * = * + 1
880           lda   (ad,x)
890           cmp   #$ac        ;* token
900           bne   gw2
910           jsr   doptr
920           jmp   next
930 gw2       lda   (ad),y
940           cmp   #$b2        ;=
950           bne   gw3
960           jmp   addsym
970 gw3       jsr   findop
980           bcc   gw4
990           jmp   doop
1000 gw4      ldy   #0
1010          lda   (ad),y
1020          cmp   #" "
```

```
1030          bne   label
1040          jmp   custop
1050 ;
1060 label    =     *           ;save word, current address
1070 ;
1080          jsr   crsym
1090          ldy   #0
1100          lda   ptr
1110          sta   (symptr),y
1120          iny
1130          lda   ptr+1
1140          sta   (symptr),y
1150 ;
1160 next     =     *           ;get ready for next word
1170 ;
1180          ldy   len
1190          lda   (ad),y
1200          cmp   #" "
1210          beq   nl
1220          cmp   #":"
1230          beq   nl
1240          jmp   newline
1250 nl       iny
1260          tya
1270          clc
1280          adc   ad
1290          sta   ad
1300          bcc   n
1310          inc   ad+1
1320 n        jmp   getword
1330 ;
1340 secpass  =     *           ;begin second pass
1350 ;
1360          inc   flag
1370          ldx   #<messsec ;second pass
1380          ldy   #>messsec
1390          jsr   printmsg
1400          lda   stasrc      ;put link at start
1410          sta   link
1420          lda   stasrc+1
1430          sta   link+1
1440 ;
1450 newline2 =     *           ;start next line
1460 ;
1470          jsr   nextline
1480          bne   getword2
1490          jmp   finish
1500 ;
1510 getword2 =     *           ;process word
1520 ;
1530          jsr   word
1540          beq   next2
1550          ldx   #0
1560          lda   (ad,x)
1570          cmp   #$ac        *
1580          bne   g2w1
1590          jsr   doptr
1600          jmp   next2
1610 g2w1     jsr   findop
1620          bcc   g2w2
1630          jmp   putop
1640 g2w2     ldy   #0
1650          lda   (ad),y
1660          cmp   #"."
1670          bne   next2
1680          jmp   custop
1690 ;
1700 next2    =     *           ;get ready for next word
1710 ;
1720          ldy   len
1730          lda   (ad),y
1740          cmp   #$20
1750          beq   n2x1
1760          cmp   #$3a
1770          beq   n2x1
1780          jmp   newline2
1790 n2x1     iny
1800          tya
1810          clc
1820          adc   ad
1830          sta   ad
1840          bcc   n2x
1850          inc   ad+1
1860 n2x      jmp   getword2
1870 ;
1880 finish   =     *           ;end
1890 ;
1900          ldx   #<messac    ;assembly complete
1910          ldy   #>messac
1920          jsr   printmsg
1930          lda   ptr
1940          sta   line
1950          lda   ptr+1
1960          sta   line+1
1970          jsr   inline
1980          jmp   ready
1990 ;
2000 ;subroutines used by main program
2010 ;
2020 addsym   =     *           ;save symbol with value
```

```
2030 ;
2040          jsr   crsym
2050          jsr   newword
2060          jsr   eval
2070          ldy   #0
2080          sta   (symptr),y
2090          iny
2100          txa
2110          sta   (symptr),y
2120          jmp   next
2130 ;
2140 addval   =     *           ;change label into symbol
2150 ;
2160          jsr   newword
2170          jsr   eval
2180          ldy   #0
2190          sta   (symptr),y
2200          iny
2210          txa
2220          sta   (symptr),y
2230          jmp   next
2240 ;
2250 crsym    =     *           ;create symbol table entry
2260 ;
2270          lda   symend      ;lower symend to
2280          sec               ;make room
2290          sbc   #10
2300          sta   symend
2310          bcs   cs1
2320          dec   symend+1
2330 cs1      cmp   stavar      ;check for
2340          lda   symend+1
2350          sbc   stavar+1
2360          bcs   cs2
2370          ldx   #<messsto   ;symbol table
2380          ldy   #>messsto   ;overflow
2390          jsr   printmsg
2400          jsr   inline
2410          jmp   listline
2420 cs2      clc               ;point symptr to
2430          lda   symend      ;symbol value address
2440          adc   #8
2450          sta   symptr
2460          lda   symend+1
2470          adc   #0
2480          sta   symptr+1
2490          ldy   #8          ;erase space for name
2500          lda   #0
2510 cs4      dey
2520          sta   (symend),y
2530          bne   cs4
2540          ldy   len         ;max length is 8
2550 cs5      dey               ;copy symbol name
2560          lda   (ad),y
2570          sta   (symend),y
2580          tya
2590          bne   cs5
2600          rts
2610 ;
2620 doop     =     *           ;move ptr past instruction
2630 ;
2640          ldy   #0
2650          lda   (ad),y
2660          cmp   #"j"
2670          beq   do3
2680          cmp   #"b"
2690          bne   do1
2700          cpx   #$21        ;brk op#
2710          beq   do1
2720          cpx   #$20        ;bit op#
2730          beq   do1
2740          jsr   nextword
2750 dol2     lda   #2
2760          bne   do
2770 do3      jsr   nextword
2780          lda   #3
2790          bne   do
2800 do1      jsr   nextword
2810          bne   do2
2820          lda   #1
2830          bne   do
2840 do2      ldy   #0
2850          lda   (ad),y
2860          cmp   #"#"
2870          beq   dol2
2880          cmp   #"("
2890          beq   dol2
2900          ldy   len
2910          dey
2920          beq   do5
2930          dey
2940          beq   do5
2950          lda   (ad),y
2960          cmp   #","
2970          bne   do5
2980          iny               ;recognize intended absolute
2990          lda   (ad),y
3000          ldy   #7
3010          cmp   #"x"
3020          beq   do7
```

```
3030          iny
3040 do7      lda   (opptr),y
3050          cmp   #$fa
3060          beq   dol3
3070          ldy   len
3080          dey:dey
3090          sty   len
3100          jsr   eval
3110          inc   len
3120          inc   len
3130          cpx   #0
3140          jmp   do6
3150 do5      jsr   eval
3160 do6      beq   dol2
3170 dol3     lda   #3
3180 do       clc
3190          adc   ptr
3200          sta   ptr
3210          bcc   do4
3220          inc   ptr+1
3230 do4      jmp   next
3240 ;
3250 doptr    =     *           ;change ptr eg. * = * + 2
3260 ;
3270          jsr   nextword
3280          jsr   newword
3290          jsr   eval
3300          sta   ptr
3310          stx   ptr+1
3320          rts
3330 ;
3340 ;eval routines begin here
3350 ;
3360 literal  =     *           ;return single ascii value
3370 ;
3380          iny
3390          lda   (ad),y
3400          sta   t1
3410          lda   #0
3420          sta   t1+1
3430          iny:iny
3440          jmp   last
3450 ;
3460 sym      =     *           ;find end and call findsym
3470 ;
3480 sy1      iny
3490          cpy   len
3500          beq   sy
3510          lda   (ad),y
3520          cmp   #$aa        ;+
3530          beq   sy
3540          cmp   #$ab        ;-
3550          bne   sy1
3560 sy       sty   t1
3570          jsr   findsym
3580          ldy   t1
3590          sta   t1
3600          stx   t1+1
3610          jmp   last
3620 ;
3630 eval     =     *           ;evaluate single expression
3640 ;
3650          lda   #0
3660          sta   t2
3670          sta   t2+1
3680          sta   ss
3690          sta   t4
3700 ev1      ldy   #0
3710          lda   (ad),y
3720          cmp   #"$"
3730          bne   ev8
3740          jmp   hex
3750 ev8      cmp   #$22        ;"
3760          beq   literal
3770          cmp   #$ac        ;*
3780          beq   ptrval
3790          cmp   #$b1        ;>
3800          beq   hilo
3810          cmp   #$b3        ;<
3820          beq   hilo
3830          cmp   #"%"
3840          bne   ev9
3850          jmp   bin
3860 ev9      sec
3870          sbc   #$30
3880          bcc   sym
3890          cmp   #$0a
3900          bcs   sym
3910          jmp   deci
3920 ;
3930 hilo     =     *           ;> or < byte extractions
3940 ;
3950          sta   t4
3960          inc   ad
3970          bne   hl
3980          inc   ad+1
3990 hl       dec   len
4000          bne   ev1
4010 ;
4020 ptrval   =     *           ;give current address
```

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```
4030 ;
4040          iny
4050          lda   ptr
4060          sta   t1
4070          lda   ptr+1
4080          sta   t1+1
4090 ;
4100 last     =     *          ;perform last sign
4110 ;
4120          lda   ss
4130          bne   ev3
4140          lda   t1         ;no sign
4150          sta   t2
4160          lda   t1+1
4170          sta   t2+1
4180          jmp   sign
4190 ev3      cmp   #$aa       ;+
4200          bne   ev4
4210          clc
4220          lda   t1
4230          adc   t2
4240          sta   t2
4250          lda   t1+1
4260          adc   t2+1
4270          bcc   sign
4280          jmp   iq
4290 ev4      sec              ;- (default)
4300          lda   t2
4310          sbc   t1
4320          sta   t2
4330          lda   t2+1
4340          sbc   t1+1
4350          sta   t2+1
4360          bcc   iq
4370 ;
4380 sign     =     *          ;save sign or stop
4390 ;
4400          cpy   len
4410          beq   ev
4420          lda   (ad),y
4430          sta   ss
4440          iny
4450          tya
4460          clc
4470          adc   ad
4480          sta   ad
4490          bcc   ev5
4500          inc   ad+1
4510 ev5      sec
4520          lda   len
4530          sty   len
4540          sbc   len
4550          sta   len
4560          jmp   ev1
4570 ev       lda   t4
4580          bne   ev6
4590          lda   t2
4600          ldx   t2+1
4610          rts
4620 ev6      cmp   #$b1       ;>
4630          bne   ev7
4640          lda   t2+1
4650          ldx   #0
4660          rts
4670 ev7      lda   t2         ;<
4680          ldx   #0
4690          rts
4700 ;
4710 hex      =     *          ;convert hex number
4720 ;
4730          iny
4740          lda   #0
4750          sta   t1
4760          sta   t1+1
4770 hx1      lda   (ad),y
4780          sec
4790          sbc   #$30
4800          bcc   hx
4810          cmp   #$0a
4820          bcc   hx2
4830          sbc   #$11
4840          bcc   hx
4850          cmp   #$06
4860          bcs   hx
4870          adc   #$0a
4880 hx2      asl   t1
4890          rol   t1+1
4900          bcs   iq
4910          asl   t1
4920          rol   t1+1
4930          bcs   iq
4940          asl   t1
4950          rol   t1+1
4960          bcs   iq
4970          asl   t1
4980          rol   t1+1
4990          bcs   iq
5000          adc   t1
5010          sta   t1
5020          lda   t1+1
5030          adc   #0
5040          sta   t1+1
5050          bcs   iq
5060          iny
5070          bne   hx1
5080 hx       jmp   last
5090 ;
5100 iq       =     *          ;illegal quanity
5110          ldx   #<messiq
5120          ldy   #>messiq
5130          jsr   printmsg
5140          jsr   inline
5150          jmp   listline
5160 ;
5170 deci     =     *          ;convert decimal
5180 ;
5190          lda   #0
5200          sta   t1
5210          sta   t1+1
5220 de1      lda   (ad),y
5230          sec
5240          sbc   #$30
5250          bcc   de
5260          cmp   #$0a
5270          bcs   de
5280          pha
5290          lda   t1
5300          ldx   t1+1
5310          asl   t1
5320          rol   t1+1
5330          bcs   iq
5340          asl   t1
5350          rol   t1+1
5360          bcs   iq
5370          adc   t1
5380          sta   t1
5390          txa
5400          adc   t1+1
5410          sta   t1+1
5420          bcs   iq
5430          asl   t1
5440          rol   t1+1
5450          bcs   iq
5460          pla
5470          adc   t1
5480          sta   t1
5490          lda   t1+1
5500          adc   #0
5510          sta   t1+1
5520          bcs   iq
5530          iny
5540          bne   de1
5550 de       jmp   last
5560 ;
5570 bin      =     *          ;convert binary
5580 ;
5590          iny
5600          lda   #0
5610          sta   t1
5620          sta   t1+1
5630 bn1      lda   (ad),y
5640          sec
5650          sbc   #$30
5660          bcc   bn
5670          cmp   #2
5680          bcs   bn
5690          asl   t1
5700          rol   t1+1
5710          bcs   iq
5720          adc   t1
5730          sta   t1
5740          lda   t1+1
5750          adc   #0
5760          sta   t1+1
5770          iny
5780          bne   bn1
5790 bn       jmp   last
5800 ;
5810 findop   =     *          ;set carry if opcode,
5820 ;opptr points to position,63999
5830 ;.x holds opcode number
5840 ;
5850          lda   #<optab    ;opcode table
5860          sta   opptr
5870          lda   #>optab
5880          sta   opptr+1
5890          ldx   #0
5900 fo1      ldy   #0
5910 fo2      lda   (opptr),y
5920          beq   fo3
5930          cmp   (ad),y
5940          bne   fo4
5950          iny
5960          cpy   #3
5970          bcc   fo2
5980 fo3      cpy   len
5990          bne   fo4
6000          sec
6010          rts
6020 fo4      inx
6030          lda   opptr
6040          clc
6050          adc   #$0d
6060          sta   opptr
6070          bcc   fo5
6080          inc   opptr+1
6090 fo5      cpx   #nops
6100          bne   fo1
6110          clc
6120          rts
6130 ;
6140 findsym  =     *          ;find symbol, return
6150 ;        value in .a .x
6160 ;
6170          lda   memsiz
6180          sta   symptr
6190          lda   memsiz+1
6200          sta   symptr+1
6210 fs1      lda   symptr
6220          sec
6230          sbc   #10
6240          sta   symptr
6250          bcs   fs2
6260          dec   symptr+1
6270 fs2      cmp   symend
6280          lda   symptr+1
6290          sbc   symend+1
6300          bcs   fs3
6310          lda   flag
6320          bne   fs8
6330          lda   ptr        ;return ptr on 1st pass
6340          ldx   ptr+1
6350          rts
6360 fs8      ldx   #<messus   ;undefined symbol
6370          ldy   #>messus
6380          jsr   printmsg
6390          jsr   inline
6400          jmp   listline
6410 fs3      ldy   #0
6420 fs4      lda   (symptr),y
6430          beq   fs7
6440          cmp   (ad),y
6450          bne   fs1
6460          iny
6470          cpy   #8
6480          bcc   fs4
6490 fs7      cpy   t1         ;length
6500          bne   fs1
6510 fs9      ldy   #9         ;found it
6520          lda   (symptr),y
6530          tax
6540          dey
6550          lda   (symptr),y
6560          rts
6570 ;
6580 listline =     *          ;list offending line
6590 ;
6600          lda   line
6610          sta   $14
6620          lda   line+1
6630          sta   $15
6640          jsr   findline
6650          jsr   list
6660          jmp   ready
6670 ;
6680 nextline =     *          ;ready for next line
6690 ;
6700          lda   link       ;move ad to next line
6710          sta   ad
6720          lda   link+1
6730          sta   ad+1
6740          ldy   #0         ;new link
6750          lda   (ad),y
6760          sta   link
6770          iny
6780          lda   (ad),y
6790          sta   link+1
6800          beq   nl         ;end of source return z set
6810          iny              ;new line number
6820          lda   (ad),y
6830          sta   line
6840          iny
6850          lda   (ad),y
6860          sta   line+1
6870          clc              ;move ad over link and line
6880          lda   ad
6890          adc   #4
6900          sta   ad
6910          bcc   nl
6920          inc   ad+1       ;return z clear
6930 nl       rts
6940 ;
6950 newword  =     *          ;get next word past =
6960 ;
6970          ldy   len
6980          iny
6990          .byte $2c
7000 ;
7010 nextword =     *          ;get next word
7020 ;
7030          ldy   len
7040          tya
7050          clc
7060          adc   ad
7070          sta   ad
7080          bcc   nw
7090          inc   ad+1
7100 nw       jmp   word
7110 ;
7120 printmsg =     *          ;print message
7130 ;
7140          stx   t1
7150          sty   t1+1
7160          ldy   #0
7170 pm1      lda   (t1),y
7180          beq   pm
7190          jsr   $ffd2      ;print character
7200          iny
7210          bne   pm1
7220 pm       rts
7230 ;
7240 ;putop routines begin here
7250 ;
7260 relative =     *          ;calculate offset
7270 ;
7280          ldy   #3
7290          lda   (opptr),y
7300          jsr   putoutop
7310          jsr   nextword
7320          jsr   eval
7330          sec
7340          sbc   #1
7350          bcs   rl1
7360          dex
7370 rl1      sec
7380          sbc   ptr
7390          sta   t1
7400          txa
7410          sbc   ptr+1
7420          tax
7430          clc
7440          lda   t1
7450          adc   #$80
7460          txa
7470          adc   #0
7480          beq   rl
7490          ldx   #<messboor ;branch out of
7500          ldy   #>messboor ;range
7510          jsr   printmsg
7520          jsr   inline
7530          jmp   listline
7540 rl       lda   t1
7550          jsr   putout
7560          jmp   next2
7570 ;
7580 imm      =     *          ;do immediate mode '#'
7590 ;
7600          inc   ad
7610          bne   im1
7620          inc   ad+1
7630 im1      ldy   #$0a
7640          lda   (opptr),y
7650          jsr   putoutop
7660          dec   len
7670          jsr   eval
7680          jsr   putout
7690          jmp   next2
7700 ;
7710 indirect =     *          ;do (,x) else (),y
7720 ;
7730          inc   ad
7740          bne   ind1
7750          inc   ad+1
7760 ind1     lda   len
7770          sec
7780          sbc   #4
7790          tay
7800          sty   len
7810          lda   (ad),y
7820          ldy   #11
7830          cmp   #","
7840          beq   ind2
7850          iny
7860 ind2     lda   (opptr),y
7870          jsr   putoutop
7880          jsr   eval
7890          jsr   putout
7900          inc   len
7910          inc   len
7920          inc   len
7930          jmp   next2
7940 ;
7950 putop    =     *          ;generates machine code
7960 ;
7970          ldy   #0
7980          lda   (ad),y
7990          cmp   #"j"
8000          bne   pop5
8010          jmp   jump
8020 pop5     cmp   #"b"
```

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```
8030            bne  pop1
8040            cpx  #$21        ;brk op#
8050            beq  pop1
8060            cpx  #$20        ;bit op#
8070            beq  pop1
8080            jmp  relative
8090 pop1       jsr  nextword
8100            bne  pop2
8110            ldy  #9
8120            lda  (opptr),y
8130            jsr  putoutop
8140            jmp  next2
8150 pop2       ldy  #0
8160            lda  (ad),y
8170            cmp  #"#"
8180            bne  pop3
8190            jmp  imm
8200 pop3       cmp  #"("
8210            bne  pop4
8220            jmp  indirect
8230 pop4       cmp  #"!"
8240            bne  absolute
8250 ; forced absolute by ! prefix
8260            inc  ad
8270            bne  fr
8280            inc  ad+1
8290 fr         dec  len
8300            .byte $2c
8310 ;
8320 absolute   =    *           ;three byte mode
8330 ;
8340            lda  #0
8350            sta  t5
8360            ldx  #3
8370            ldy  len
8380            dey
8390            beq  ab1
8400            dey
8410            beq  ab1
8420            lda  (ad),y
8430            cmp  #","
8440            bne  ab1
8450            sty  len
8460            inx
8470            iny
8480            lda  (ad),y
8490            cmp  #"x"
8500            beq  ab1
8510            inx
8520 ab1        stx  t3
8530            jsr  eval
8540            beq  ab2
8550 ab4        ldy  t3
8560            lda  (opptr),y
8570            jsr  putoutop
8580            lda  t2
8590            jsr  putout
8600            txa
8610            jsr  putout
8620            jmp  ab3
8630 ab2        lda  t5
8640            bne  ab4
8650            ldy  t3
8660            iny:iny:iny
8670            lda  (opptr),y
8680            cmp  #$fa
8690            beq  ab4
8700            jsr  putoutop
8710            lda  t2
8720            jsr  putout
8730 ab3        ldy  t3
8740            dey:dey:dey
8750            beq  ab
8760            inc  len
8770            inc  len
8780 ab         jmp  next2
8790 ;
8800 jump       =    *           ; jmp, jsr and jmp ()
8810 ;
8820            jsr  nextword
8830            ldy  #0
8840            lda  (ad),y
8850            cmp  #"("
8860            beq  jp1
8870            ldy  #3
8880            lda  (opptr),y
8890            jsr  putoutop
8900            jsr  eval
8910            jsr  putout
8920            txa
8930            jsr  putout
8940            jmp  next2
8950 jp1        inc  ad
8960            bne  jp2
8970            inc  ad+1
8980 jp2        dec  len
8990            dec  len
9000            ldy  #4
9010            lda  (opptr),y
9020            jsr  putoutop
9030            jsr  eval
9040            jsr  putout
9050            txa
9060            jsr  putout
9070            inc  len
9080            jmp  next2
9090 ;
9100 putoutop   =    *           ;verify op mode
9110 ;
9120            cmp  #$fa
9130            bne  putout
9140            ldx  #<messim ;illegal mode
9150            ldy  #>messim
9160            jsr  printmsg
9170            jsr  inline
9180            jmp  listline
9190 ;
9200 putout     =    *           ;output object code
9210 ;
9220            ldy  #0
9230            sta  (ptr),y
9240            inc  ptr
9250            bne  pt
9260            inc  ptr+1
9270 pt         rts
9280 ;
9290 word       =    *           ;basic routine to get word
9300 ;(ad) must point to start
9310 ;ignores leading spaces
9320 ;" :;=  " copied only in quote mode
9330 ;return .y-length, stop char in .a
9340 ;
9350            ldx  #0
9360            ldy  #0
9370 w1         lda  (ad),y
9380            beq  w5          ;end of line
9390            cmp  #$22        ;"
9400            beq  w4
9410            cpx  #$80
9420            beq  w2
9430            cmp  #":"
9440            beq  w5
9450            cmp  #";"
9460            beq  w5
9470            cmp  #$b2        ; =
9480            beq  w5
9490            cmp  #" "
9500            beq  w3
9510 w2         iny  ;copy
9520            bne  w1
9530 w3         cpy  #0          ;leading space
9540            bne  w5
9550            inc  ad
9560            bne  w1
9570            inc  ad+1
9580            bne  w1
9590 w4         txa  ;toggle
9600            eor  #$80
9610            tax
9620            jmp  w2
9630 w5         sty  len
9640            cpy  #0
9650            rts
9660 ;
9670 custop     =    *           ;custom pseudo-ops
9680 ;
9690            iny
9700            lda  (ad),y
9710            cmp  #"b"
9720            bne  cp1
9730            jmp  byte
9740 cp1        cmp  #"w"
9750            bne  cp2
9760            jmp  byte+2
9770 cp2        cmp  #$c6        ;asc
9780            bne  cp3
9790            jmp  asc
9800 cp3        cmp  #$80        ;end
9810            bne  cp4
9820            jmp  end
9830 cp4        cmp  #"p"
9840            bne  cp5
9850            jmp  pad
9860 cp5        ldx  #<messip ;illegal
9870            ldy  #>messip ;pseudo-op
9880            jsr  printmsg
9890            jsr  inline
9900            jmp  listline
9910 ;
9920 cp         lda  flag
9930            bne  cp6
9940            jmp  next
9950 cp6        jmp  next2
9960 ;
9970 byte       =    *           ;.byte and .word
9980 ;
9990            lda  #0
10000            sta  t5
10010            jsr  nextword
10020            sty  t3
10030 by1       ldy  #0
10040 by2       lda  (ad),y
10050           cmp  #","        ;split up expressions
10060           beq  by3
10070 by9       iny
10080           cpy  t3
10090           bne  by2
10100 by3       lda  flag
10110           beq  by6
10120           sty  len
10130           iny
10140           lda  t3
10150           sty  t3
10160           sec
10170           sbc  t3
10180           sta  t3
10190           bcs  by4
10200           lda  #0
10210           sta  t3
10220 by4       jsr  eval        ;eval and
10230           jsr  putout      ;putout one byte
10240           lda  t5
10250           beq  by5
10260           txa
10270           jsr  putout      ;or one word
10280 by5       lda  t3
10290           beq  by
10300           ldy  len
10310           iny
10320           tya
10330           clc
10340           adc  ad
10350           sta  ad
10360           bcc  by1
10370           inc  ad+1
10380           bne  by1
10390 by6       clc
10400           lda  t5
10410           beq  by7
10420           lda  #1
10430 by7       adc  #1
10440           adc  ptr         ;inc ptr on first pass
10450           sta  ptr
10460           bcc  by8
10470           inc  ptr+1
10480 by8       cpy  t3
10490           bne  by9
10500 by        jmp  cp
10510 ;
10520 asc       =    *           ;.asc
10530 ;
10540           jsr  nextword
10550           ldy  #1
10560 as1       lda  (ad),y
10570           cmp  #$22        ;"
10580           beq  as
10590           ldx  flag
10600           beq  as3
10610           sty  t3
10620           jsr  putout
10630           ldy  t3
10640 as2       iny
10650           cpy  len
10660           bne  as1
10670 as        jmp  cp
10680 as3       inc  ptr
10690           bne  as2
10700           inc  ptr+1
10710           bne  as2
10720 ;
10730 end       =    *           ;.end
10740 ;
10750           lda  flag
10760           bne  en
10770           jmp  secpass
10780 en        jsr  nextword
10790           ldx  #<messac
10800           ldy  #>messac
10810           jsr  printmsg
10820           lda  ptr
10830           sta  line
10840           lda  ptr+1
10850           sta  line+1
10860           jsr  inline
10870           jmp  contbas
10880 ;
10890 pad       =    *           ;pad object with a 0 if at
10900 ;odd byte to keep jmp tables safe
10910           lda  ptr
10920           and  #1
10930           beq  pa
10940           lda  flag
10950           beq  pa1
10960           lda  #0
10970           jsr  putout
10980 pa        jmp  cp
10990 pa1       inc  ptr
11000           bne  pa
11010           inc  ptr+1
11020           bne  pa
11030 ;
11040 optab     =    *           ;opcode table
11050 ;
11060 .asc "lda"  :.byte $ad, $bd, $b9, $a5, $b5, $fa,  $fa,  $a9, $a1, $b1
11070 .asc "sta"  :.byte $8d, $9d, $99, $85, $95, $fa,  $fa,  $fa,  $81, $91
11080 .asc "bne"  :.byte $d0, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11090 .asc "beq"  :.byte $f0,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11100 .asc "cmp"  :.byte $cd, $dd, $d9, $c5, $d5, $fa,  $fa,  $c9, $c1, $d1
11110 .asc "jsr"  :.byte $20, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11120 .asc "ldx"  :.byte $ae, $fa,  $be, $a6, $fa,  $b6, $fa,  $a2, $fa,  $fa
11130 .asc "rts"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $60, $fa,  $fa,  $fa
11140 .asc "ldy"  :.byte $ac, $bc, $fa,  $a4, $b4, $fa,  $fa,  $a0, $fa,  $fa
11150 .asc "bmi"  :.byte $30, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11160 .asc "dec"  :.byte $ce, $de, $fa,  $c6, $d6, $fa,  $fa,  $fa,  $fa,  $fa
11170 .byte $af,0,0,$2d,$3d,$39,$25,$35,$fa,$fa,$29,$21,$31 ;and
11180 .asc "bcs"  :.byte $b0, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11190 .asc "inc"  :.byte $ee, $fe,  $fa,  $e6, $f6,  $fa,  $fa,  $fa,  $fa,  $fa
11200 .asc "bcc"  :.byte $90, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11210 .asc "tya"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $98, $fa,  $fa,  $fa
11220 .asc "bpl"  :.byte $10, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11230 .asc "asl"  :.byte $0e, $1e, $fa,  $06, $16, $fa,  $0a, $fa,  $fa,  $fa
11240 .asc "clc"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $18, $fa,  $fa,  $fa
11250 .asc "adc"  :.byte $6d, $7d, $79, $65, $75, $fa,  $fa,  $69, $61, $71
11260 .byte $45,$b0,0,$4d,$5d,$59,$45,$55,$fa,$fa,$49,$41,$51 ;eor
11270 .asc "txa"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $8a, $fa,  $fa,  $fa
11280 .asc "cpx"  :.byte $ec, $fa,  $fa,  $e4, $fa,  $fa,  $fa,  $e0, $fa,  $fa
11290 .asc "jmp"  :.byte $4c, $6c, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11300 .asc "tax"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $aa, $fa,  $fa,  $fa
11310 .asc "iny"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $c8, $fa,  $fa,  $fa
11320 .asc "sty"  :.byte $8c, $fa,  $fa,  $84, $94, $fa,  $fa,  $fa,  $fa,  $fa
11330 .byte $b0,$41,0,$0d,$1d,$19,$05,$15,$fa,$fa,$09,$01,$11 ;ora
11340 .asc "dey"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $88, $fa,  $fa,  $fa
11350 .asc "dex"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $ca, $fa,  $fa,  $fa
11360 .asc "stx"  :.byte $8e, $fa,  $fa,  $86, $fa,  $96, $fa,  $fa,  $fa,  $fa
11370 .asc "sbc"  :.byte $ed, $fd, $f9, $e5, $f5, $fa,  $fa,  $e9, $e1, $f1
11380 .asc "bit"  :.byte $2c, $fa,  $fa,  $24, $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11390 .asc "brk"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $00, $fa,  $fa,  $fa
11400 .asc "bvc"  :.byte $50, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11410 .asc "bvs"  :.byte $70, $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $fa
11420 .asc "cld"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $d8, $fa,  $fa,  $fa
11430 .asc "cli"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $58, $fa,  $fa,  $fa
11440 .asc "clv"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $b8, $fa,  $fa,  $fa
11450 .asc "cpy"  :.byte $cc, $fa,  $fa,  $c4, $fa,  $fa,  $fa,  $c0, $fa,  $fa
11460 .asc "inx"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $e8, $fa,  $fa,  $fa
11470 .asc "lsr"  :.byte $4e, $5e, $fa,  $46, $56, $fa,  $4a, $fa,  $fa,  $fa
11480 .asc "nop"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $ea, $fa,  $fa,  $fa
11490 .asc "pha"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $48, $fa,  $fa,  $fa
11500 .asc "php"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $08, $fa,  $fa,  $fa
11510 .asc "pla"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $68, $fa,  $fa,  $fa
11520 .asc "plp"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $28, $fa,  $fa,  $fa
11530 .asc "rol"  :.byte $2e, $3e, $fa,  $26, $36, $fa,  $2a, $fa,  $fa,  $fa
11540 .byte $52,$b0,0,$6e,$7e,$fa,$66,$76,$fa,$6a,$fa,$fa,$fa ;ror
11550 .asc "rti"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $40, $fa,  $fa,  $fa
11560 .asc "sec"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $38, $fa,  $fa,  $fa
11570 .asc "sed"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $f8,  $fa,  $fa,  $fa
11580 .asc "sei"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $78, $fa,  $fa,  $fa
11590 .asc "tay"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $a8, $fa,  $fa,  $fa
11600 .asc "tsx"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $ba, $fa,  $fa,  $fa
11610 .asc "txs"  :.byte $fa,  $fa,  $fa,  $fa,  $fa,  $fa,  $9a, $fa,  $fa,  $fa
11620 ;
11630 ;symass messages
11640 ;
11650 messstar  .asc "█symass 3.10 robert huehn feb 1986" :.byte 13.0
11660 messfir   .byte 13:.asc "first pass. . ." :.byte 0
11670 messsec   .asc "second pass. . ." :.byte 0
11680 messac    .byte 13:.asc "assembly complete" :.byte 0
11690 messsto   .byte 13:.asc "symbol table overflow" :.byte 0
11700 messiq    .byte 13:.asc "illegal quantity" :.byte 0
11710 messus    .byte 13:.asc "undefined symbol" :.byte 0
11720 messboor .byte 13:.asc "branch out of range" :.byte 0
11730 messim    .byte 13:.asc "illegal mode" :.byte 0
11740 messip    .byte 13:.asc "illegal pseudo-op" :.byte 0
```

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SYMASS Loader

Generates diskfile "symass 3.1" which you then load and run. Don't forget to save this program first.

```
PF  100 open1,8,1,"0:symass 3.1"
NM  110 print#1,chr$(1)chr$(8);
PO  120 fora=2049to5253:readd:c=c+d
BL  130 print#1,chr$(d);:next
PF  140 close 1
NI  150 ifc<>400792thenprint"data error"
AK  160 end
MM  1000 data  11,   8,  10,   0, 158,  50,  48,  54
HO  1010 data  49,   0,   0,   0, 165,  55, 133,  40
OC  1020 data 165,  56, 133,  41, 165,  45, 133,  38
OC  1030 data 165,  46, 133,  39, 160,   0, 165,  38
KC  1040 data 208,   2, 198,  39, 198,  38, 177,  38
ND  1050 data 201,   3, 176,  79,  72, 165,  38, 208
MD  1060 data   2, 198,  39, 198,  38, 177,  38, 201
KB  1070 data   3, 144,  50, 170, 165,  38, 208,   2
IL  1080 data 198,  39, 198,  38, 177,  38,  24, 101
LK  1090 data  55, 133,  42, 138, 101,  56, 170, 104
GF  1100 data 208,  16, 165,  40, 208,   2, 198,  41
MJ  1110 data 198,  40, 138, 145,  40, 165,  42,  24
NI  1120 data 144,  10, 201,   1, 208,   4, 138,  24
HG  1130 data 144,   2, 165,  42,  72, 165,  40, 208
JE  1140 data   2, 198,  41, 198,  40, 104, 145,  40
NN  1150 data  24, 144, 163, 201, 127, 208, 237, 169
LP  1160 data  76, 141, 188,   2, 165,  40, 141, 189
DK  1170 data   2, 133,  55, 165,  41, 141, 190,   2
MC  1180 data 133,  56,  32,  99, 166, 169, 255, 133
AP  1190 data  58,  76, 188,   2, 127, 169,   0,   0
FF  1200 data 133,   2,   2, 162,  58, 255,   2, 160
PA  1210 data  58, 255,   1,  32, 150, 249,   0, 166
DD  1220 data  58, 232, 208,   3,  76, 116, 164, 162
FI  1230 data  94, 255,   2, 160,  94, 255,   1,  32
DA  1240 data 150, 249,   0, 165,  55, 133,  87, 165
DA  1250 data  56, 133,  88, 230, 122, 208,   2,   2
GC  1260 data 230, 123, 165, 122, 133,  80, 133,  78
LE  1270 data 165, 123, 133,  81, 133,  79,  32,  88
PJ  1280 data 249,   0, 208,   3,  76, 201, 245,   0
JB  1290 data  32,  38, 251,   0, 208,   7, 201, 178
KM  1300 data 208,  59,  76,  78, 246,   0, 162,   0
CL  1310 data   0, 161, 122, 201, 172, 208,   6,  32
OI  1320 data  26, 247,   0,  76, 172, 245,   0, 177
BF  1330 data 122, 201, 178, 208,   3,  76,  58, 246
NE  1340 data   0,  32, 201, 248,   0, 144,   3,  76
HD  1350 data 160, 246,   0, 160,   0,   0, 177, 122
PC  1360 data 201,  46, 208,   3,  76,  97, 251,   0
NH  1370 data  32,  95, 246,   0, 160,   0,   0, 165
JK  1380 data  89, 145,  82, 200, 165,  90, 145,  82
KK  1390 data 164,  93, 177, 122, 201,  32, 240,   7
HF  1400 data 201,  58, 240,   3,  76,  96, 245,   0
EG  1410 data 200, 152,  24, 101, 122, 133, 122, 144
JC  1420 data   2,   2, 230, 123,  76, 104, 245,   0
JJ  1430 data 230,   2,   2, 162, 109, 255,   2, 160
CH  1440 data 109, 255,   1,  32, 150, 249,   0, 165
GL  1450 data  80, 133,  78, 165,  81, 133,  79,  32
DJ  1460 data  88, 249,   0, 208,   3,  76,  37, 246
DA  1470 data   0,  32,  38, 251,   0, 240,  33, 162
PM  1480 data   0,   0, 161, 122, 201, 172, 208,   6
LN  1490 data  32,  26, 247,   0,  76,   8, 246,   0
AI  1500 data  32, 201, 248,   0, 144,   3,  76,  37
HL  1510 data 250,   0, 160,   0,   0, 177, 122, 201
GN  1520 data  46, 208,   3,  76,  97, 251,   0, 164
OB  1530 data  93, 177, 122, 201,  32, 240,   7, 201
ED  1540 data  58, 240,   3,  76, 218, 245,   0, 200
CK  1550 data 152,  24, 101, 122, 133, 122, 144,   2
NM  1560 data   2, 230, 123,  76, 226, 245,   0, 162
```

```
PN  1570 data 124, 255,   2, 160, 124, 255,   1,  32
GF  1580 data 150, 249,   0, 165,  89, 133,  57, 165
FH  1590 data  90, 133,  58,  32, 194, 189,  76, 116
LF  1600 data 164,  32,  95, 246,   0,  32, 131, 249
AE  1610 data   0,  32,  83, 247,   0, 160,   0,   0
HA  1620 data 145,  82, 200, 138, 145,  82,  76, 172
HL  1630 data 245,   0,  32, 131, 249,   0,  32,  83
IK  1640 data 247,   0, 160,   0,   0, 145,  82, 200
JK  1650 data 138, 145,  82,  76, 172, 245,   0, 165
HM  1660 data  87,  56, 233,  10, 133,  87, 176,   2
PM  1670 data   2, 198,  88, 197,  45, 165,  88, 229
BM  1680 data  46, 176,  13, 162, 143, 255,   2, 160
KJ  1690 data 143, 255,   1,  32, 150, 249,   0,  32
CP  1700 data 194, 189,  76,  71, 249,   0,  24, 165
HA  1710 data  87, 105,   8, 133,  82, 165,  88, 105
EK  1720 data   0,   0, 133,  83, 160,   8, 169,   0
PM  1730 data   0, 136, 145,  87, 208, 251, 164,  93
HB  1740 data 136, 177, 122, 145,  87, 152, 208, 248
ED  1750 data  96, 160,   0,   0, 177, 122, 201,  74
CA  1760 data 240,  19, 201,  66, 208,  22, 224,  33
AA  1770 data 240,  18, 224,  32, 240,  14,  32, 135
DA  1780 data 249,   0, 169,   2,   2, 208,  83,  32
FD  1790 data 135, 249,   0, 169,   3, 208,  76,  32
HB  1800 data 135, 249,   0, 208,   4, 169,   1,   1
LB  1810 data 208,  67, 160,   0,   0, 177, 122, 201
OC  1820 data  35, 240, 228, 201,  40, 240, 224, 164
PK  1830 data  93, 136, 240,  43, 136, 240,  40, 177
FD  1840 data 122, 201,  44, 208,  34, 200, 177, 122
HJ  1850 data 160,   7, 201,  88, 240,   1,   1, 200
HN  1860 data 177,  91, 201, 250, 240,  23, 164,  93
GD  1870 data 136, 136, 132,  93,  32,  83, 247,   0
MN  1880 data 230,  93, 230,  93, 224,   0,   0,  76
BB  1890 data  10, 247,   0,  32,  83, 247,   0, 240
OI  1900 data 171, 169,   3,  24, 101,  89, 133,  89
KJ  1910 data 144,   2,   2, 230,  90,  76, 172, 245
PG  1920 data   0,  32, 135, 249,   0,  32, 131, 249
IP  1930 data   0,  32,  83, 247,   0, 133,  89, 134
JA  1940 data  90,  96, 200, 177, 122, 133,  38, 169
MK  1950 data   0,   0, 133,  39, 200, 200,  76, 160
PJ  1960 data 247,   0, 200, 196,  93, 240,  10, 177
OJ  1970 data 122, 201, 170, 240,   4, 201, 171, 208
AO  1980 data 241, 132,  38,  32, 250, 248,   0, 164
IC  1990 data  38, 133,  38, 134,  39,  76, 160, 247
AL  2000 data   0, 169,   0,   0, 133,  40, 133,  41
HP  2010 data 133,  42, 133,  95, 160,   0,   0, 177
JD  2020 data 122, 201,  36, 208,   3,  76,   8, 248
FB  2030 data   0, 201,  34, 240, 188, 201, 172, 240
MC  2040 data  39, 201, 177, 240,  23, 201, 179, 240
MD  2050 data  19, 201,  37, 208,   3,  76, 161, 248
MN  2060 data   0,  56, 233,  48, 144, 178, 201,  10
FF  2070 data 176, 174,  76,  91, 248,   0, 133,  95
KC  2080 data 230, 122, 208,   2,   2, 230, 123, 198
OB  2090 data  93, 208, 198, 200, 165,  89, 133,  38
GG  2100 data 165,  90, 133,  39, 165,  42, 208,  11
DH  2110 data 165,  38, 133,  40, 165,  39, 133,  41
JG  2120 data  76, 210, 247,   0, 201, 170, 208,  16
BH  2130 data  24, 165,  38, 101,  40, 133,  40, 165
NJ  2140 data  39, 101,  41, 144,  18,  76,  78, 248
AJ  2150 data   0,  56, 165,  40, 229,  38, 133,  40
BA  2160 data 165,  41, 229,  39, 133,  41, 144, 124
EB  2170 data 196,  93, 240,  27, 177, 122, 133,  42
GG  2180 data 200, 152,  24, 101, 122, 133, 122, 144
DM  2190 data   2,   2, 230, 123,  56, 165,  93, 132
CP  2200 data  93, 229,  93, 133,  93,  76,  93, 247
CN  2210 data   0, 165,  95, 208,   5, 165,  40, 166
KJ  2220 data  41,  96, 201, 177, 208,   5, 165,  41
HO  2230 data 162,   0,   0,  96, 165,  40, 162,   0
AL  2240 data   0,  96, 200, 169,   0,   0, 133,  38
DI  2250 data 133,  39, 177, 122,  56, 233,  48, 144
AM  2260 data  53, 201,  10, 144,  10, 233,  17, 144
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DG  2270 data  45, 201,   6, 176,  41, 105,  10,   6
MD  2280 data  38,  38,  39, 176,  36,   6,  38,  38
DN  2290 data  39, 176,  30,   6,  38,  38,  39, 176
CL  2300 data  24,   6,  38,  38,  39, 176,  18, 101
FK  2310 data  38, 133,  38, 165,  39, 105,   0,   0
LG  2320 data 133,  39, 176,   6, 200, 208, 196,  76
KC  2330 data 160, 247,   0, 162, 166, 255,   2, 160
PC  2340 data 166, 255,   1,  32, 150, 249,   0,  32
OJ  2350 data 194, 189,  76,  71, 249,   0, 169,   0
NB  2360 data   0, 133,  38, 133,  39, 177, 122,  56
GG  2370 data 233,  48, 144,  54, 201,  10, 176,  50
KC  2380 data  72, 165,  38, 166,  39,   6,  38,  38
KP  2390 data  39, 176, 215,   6,  38,  38,  39, 176
HO  2400 data 209, 101,  38, 133,  38, 138, 101,  39
JC  2410 data 133,  39, 176, 198,   6,  38,  38,  39
FM  2420 data 176, 192, 104, 101,  38, 133,  38, 165
ON  2430 data  39, 105,   0,   0, 133,  39, 176, 179
DD  2440 data 200, 208, 195,  76, 160, 247,   0, 200
DO  2450 data 169,   0,   0, 133,  38, 133,  39, 177
GI  2460 data 122,  56, 233,  48, 144,  23, 201,   2
FP  2470 data   2, 176,  19,   6,  38,  38,  39, 176
PE  2480 data 149, 101,  38, 133,  38, 165,  39, 105
JA  2490 data   0,   0, 133,  39, 200, 208, 226,  76
HL  2500 data 160, 247,   0, 169,  98, 252,   2, 133
NA  2510 data  91, 169,  98, 252,   1, 133,  92, 162
KL  2520 data   0,   0, 160,   0,   0, 177,  91, 240
JJ  2530 data   9, 209, 122, 208,  11, 200, 192,   3
CG  2540 data 144, 243, 196,  93, 208,   2,   2,  56
GD  2550 data  96, 232, 165,  91,  24, 105,  13, 133
JJ  2560 data  91, 144,   2,   2, 230,  92, 224,  55
JD  2570 data 208, 219,  24,  96, 165,  55, 133,  82
EG  2580 data 165,  56, 133,  83, 165,  82,  56, 233
GK  2590 data  10, 133,  82, 176,   2,   2, 198,  83
DK  2600 data 197,  87, 165,  83, 229,  88, 176,  22
FL  2610 data 165,   2,   2, 208,   5, 165,  89, 166
MH  2620 data  90,  96, 162, 184, 255,   2, 160, 184
HE  2630 data 255,   1,  32, 150, 249,   0,  32, 194
EJ  2640 data 189,  76,  71, 249,   0, 160,   0,   0
GP  2650 data 177,  82, 240,   9, 209, 122, 208, 205
NO  2660 data 200, 192,   8, 144, 243, 196,  38, 208
KA  2670 data 196, 160,   9, 177,  82, 170, 136, 177
JJ  2680 data  82,  96, 165,  57, 133,  20, 165,  58
LI  2690 data 133,  21,  32,  19, 166,  32, 201, 166
FP  2700 data  76, 116, 164, 165,  78, 133, 122, 165
DM  2710 data  79, 133, 123, 160,   0,   0, 177, 122
CA  2720 data 133,  78, 200, 177, 122, 133,  79, 240
JN  2730 data  21, 200, 177, 122, 133,  57, 200, 177
PL  2740 data 122, 133,  58,  24, 165, 122, 105,   4
FK  2750 data 133, 122, 144,   2,   2, 230, 123,  96
FO  2760 data 164,  93, 200,  44, 164,  93, 152,  24
JL  2770 data 101, 122, 133, 122, 144,   2,   2, 230
JO  2780 data 123,  76,  38, 251,   0, 134,  38, 132
CD  2790 data  39, 160,   0,   0, 177,  38, 240,   6
OD  2800 data  32, 210, 255, 200, 208, 246,  96, 160
GA  2810 data   3, 177,  91,  32,  10, 251,   0,  32
JI  2820 data 135, 249,   0,  32,  83, 247,   0,  56
NO  2830 data 233,   1,   1, 176,   1,   1, 202,  56
OM  2840 data 229,  89, 133,  38, 138, 229,  90, 170
IE  2850 data  24, 165,  38, 105, 128, 138, 105,   0
MM  2860 data   0, 240,  13, 162, 202, 255,   2, 160
IC  2870 data 202, 255,   1,  32, 150, 249,   0,  32
FJ  2880 data 194, 189,  76,  71, 249,   0, 165,  38
GE  2890 data  32,  27, 251,   0,  76,   8, 246,   0
KE  2900 data 230, 122, 208,   2,   2, 230, 123, 160
MI  2910 data  10, 177,  91,  32,  10, 251,   0, 198
IO  2920 data  93,  32,  83, 247,   0,  32,  27, 251
IP  2930 data   0,  76,   8, 246,   0, 230, 122, 208
KK  2940 data   2,   2, 230, 123, 165,  93,  56, 233
LG  2950 data   4, 168, 132,  93, 177, 122, 160,  11
DM  2960 data 201,  44, 240,   1,   1, 200, 177,  91
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LJ  2970 data  32,  10, 251,   0,  32,  83, 247,   0
IN  2980 data  32,  27, 251,   0, 230,  93, 230,  93
CN  2990 data 230,  93,  76,   8, 246,   0, 160,   0
JL  3000 data   0, 177, 122, 201,  74, 208,   3,  76
BK  3010 data 203, 250,   0, 201,  66, 208,  11, 224
HF  3020 data  33, 240,   7, 224,  32, 240,   3,  76
PL  3030 data 167, 249,   0,  32, 135, 249,   0, 208
DA  3040 data  10, 160,   9, 177,  91,  32,  10, 251
FH  3050 data   0,  76,   8, 246,   0, 160,   0,   0
ND  3060 data 177, 122, 201,  35, 208,   3,  76, 226
IP  3070 data 249,   0, 201,  40, 208,   3,  76, 250
MN  3080 data 249,   0, 201,  33, 208,   9, 230, 122
ME  3090 data 208,   2,   2, 230, 123, 198,  93,  44
DM  3100 data 169,   0,   0, 133,  96, 162,   3, 164
NK  3110 data  93, 136, 240,  20, 136, 240,  17, 177
GJ  3120 data 122, 201,  44, 208,  11, 132,  93, 232
KC  3130 data 200, 177, 122, 201,  88, 240,   1,   1
AD  3140 data 232, 134,  94,  32,  83, 247,   0, 240
EG  3150 data  19, 164,  94, 177,  91,  32,  10, 251
EN  3160 data   0, 165,  40,  32,  27, 251,   0, 138
HC  3170 data  32,  27, 251,   0,  76, 189, 250,   0
AM  3180 data 165,  96, 208, 233, 164,  94, 200, 200
MJ  3190 data 200, 177,  91, 201, 250, 240, 222,  32
BJ  3200 data  10, 251,   0, 165,  40,  32,  27, 251
DE  3210 data   0, 164,  94, 136, 136, 136, 240,   4
CG  3220 data 230,  93, 230,  93,  76,   8, 246,   0
HD  3230 data  32, 135, 249,   0, 160,   0,   0, 177
IJ  3240 data 122, 201,  40, 240,  20, 160,   3, 177
LB  3250 data  91,  32,  10, 251,   0,  32,  83, 247
AL  3260 data   0,  32,  27, 251,   0, 138,  32,  27
DF  3270 data 251,   0,  76,   8, 246,   0, 230, 122
DP  3280 data 208,   2,   2, 230, 123, 198,  93, 198
HB  3290 data  93, 160,   4, 177,  91,  32,  10, 251
CP  3300 data   0,  32,  83, 247,   0,  32,  27, 251
PD  3310 data   0, 138,  32,  27, 251,   0, 230,  93
BE  3320 data  76,   8, 246,   0, 201, 250, 208,  13
LP  3330 data 162, 223, 255,   2, 160, 223, 255,   1
KF  3340 data  32, 150, 249,   0,  32, 194, 189,  76
CF  3350 data  71, 249,   0, 160,   0,   0, 145,  89
EO  3360 data 230,  89, 208,   2,   2, 230,  90,  96
DD  3370 data 162,   0,   0, 160,   0,   0, 177, 122
FK  3380 data 240,  46, 201,  34, 240,  35, 224, 128
DF  3390 data 240,  16, 201,  58, 240,  34, 201,  59
GM  3400 data 240,  30, 201, 178, 240,  26, 201,  32
BD  3410 data 240,   3, 200, 208, 225, 192,   0,   0
MF  3420 data 208,  15, 230, 122, 208, 217, 230, 123
BB  3430 data 208, 213, 138,  73, 128, 170,  76,  70
IH  3440 data 251,   0, 132,  93, 192,   0,   0,  96
CM  3450 data 200, 177, 122, 201,  66, 208,   3,  76
HK  3460 data 158, 251,   0, 201,  87, 208,   3,  76
MH  3470 data 160, 251,   0, 201, 198, 208,   3,  76
NO  3480 data   3, 252,   0, 201, 128, 208,   3,  76
HC  3490 data  41, 252,   0, 201,  80, 208,   3,  76
IJ  3500 data  72, 252,   0, 162, 237, 255,   2, 160
JL  3510 data 237, 255,   1,  32, 150, 249,   0,  32
CD  3520 data 194, 189,  76,  71, 249,   0, 165,   2
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HN  3540 data   8, 246,   0, 169,   0,   0, 133,  96
CD  3550 data  32, 135, 249,   0, 132,  94, 160,   0
GI  3560 data   0, 177, 122, 201,  44, 240,   5, 200
EE  3570 data 196,  94, 208, 245, 165,   2,   2, 240
FB  3580 data  51, 132,  93, 200, 165,  94, 132,  94
LE  3590 data  56, 229,  94, 133,  94, 176,   4, 169
LO  3600 data   0,   0, 133,  94,  32,  83, 247,   0
IM  3610 data  32,  27, 251,   0, 165,  96, 240,   4
FC  3620 data 138,  32,  27, 251,   0, 165,  94, 240
BJ  3630 data  36, 164,  93, 200, 152,  24, 101, 122
OF  3640 data 133, 122, 144, 192, 230, 123, 208, 188
FH  3650 data  24, 165,  96, 240,   2,   2, 169,   1
ND  3660 data   1, 105,   1,   1, 101,  89, 133,  89
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NM  3680 data 175,  76, 148, 251,   0,  32, 135, 249
IJ  3690 data   0, 160,   1,   1, 177, 122, 201,  34
NK  3700 data 240,  16, 166,   2,   2, 240,  15, 132
KK  3710 data  94,  32,  27, 251,   0, 164,  94, 200
PO  3720 data 196,  93, 208, 234,  76, 148, 251,   0
FO  3730 data 230,  89, 208, 244, 230,  90, 208, 240
EA  3740 data 165,   2,   2, 208,   3,  76, 201, 245
NI  3750 data   0,  32, 135, 249,   0, 162, 124, 255
MI  3760 data   2, 160, 124, 255,   1,  32, 150, 249
EL  3770 data   0, 165,  89, 133,  57, 165,  90, 133
KG  3780 data  58,  32, 194, 189,  76, 174, 167, 165
MP  3790 data  89,  41,   1,   1, 240,   9, 165,   2
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BA  3810 data 251,   0,  76, 148, 251,   0, 230,  89
GL  3820 data 208, 249, 230,  90, 208, 245,  76,  68
BH  3830 data  65, 173, 189, 185, 165, 181, 250, 250
JL  3840 data 169, 161, 177,  83,  84,  65, 141, 157
KD  3850 data 153, 133, 149, 250, 250, 250, 129, 145
OJ  3860 data  66,  78,  69, 208, 250, 250, 250, 250
FO  3870 data 250, 250, 250, 250, 250,  66,  69,  81
CG  3880`data 240, 250, 250, 250, 250, 250, 250, 250
CN  3890 data 250, 250,  67,  77,  80, 205, 221, 217
OE  3900 data 197, 213, 250, 250, 201, 193, 209,  74
OJ  3910 data  83,  82,  32, 250, 250, 250, 250, 250
KB  3920 data 250, 250, 250, 250,  76,  68,  88, 174
KL  3930 data 250, 190, 166, 250, 182, 250, 162, 250
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KD  3950 data 250, 250,  96, 250, 250, 250,  76,  68
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MM  4000 data 250, 250, 250, 250, 250, 175,   0,   0
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LB  4020 data 250,  41,  33,  49,  66,  67,  83, 176
MP  4030 data 250, 250, 250, 250, 250, 250, 250, 250
PF  4040 data 250,  73,  78,  67, 238, 254, 250, 230
ND  4050 data 246, 250, 250, 250, 250, 250,  66,  67
EP  4060 data  67, 144, 250, 250, 250, 250, 250, 250
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OH  4150 data 250, 105,  97, 113,  69, 176,   0,   0
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MH  4170 data  65,  81,  84,  88,  65, 250, 250, 250
DH  4180 data 250, 250, 250, 138, 250, 250, 250,  67
IF  4190 data  80,  88, 236, 250, 250, 228, 250, 250
AM  4200 data 250, 224, 250, 250,  74,  77,  80,  76
BK  4210 data 108, 250, 250, 250, 250, 250, 250, 250
PP  4220 data 250,  84,  65,  88, 250, 250, 250, 250
AP  4230 data 250, 250, 170, 250, 250, 250,  73,  78
MJ  4240 data  89, 250, 250, 250, 250, 250, 250, 200
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KN  4260 data 250, 132, 148, 250, 250, 250, 250, 250
KO  4270 data 176,  65,   0,   0,  13,  29,  25,   5
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NL  4290 data  69,  89, 250, 250, 250, 250, 250, 250
DJ  4300 data 136, 250, 250, 250,  68,  69,  88, 250
CA  4310 data 250, 250, 250, 250, 250, 202, 250, 250
BG  4320 data 250,  83,  84,  88, 142, 250, 250, 134
HE  4330 data 250, 150, 250, 250, 250, 250,  83,  66
AH  4340 data  67, 237, 253, 249, 229, 245, 250, 250
CE  4350 data 233, 225, 241,  66,  73,  84,  44, 250
LA  4360 data 250,  36, 250, 250, 250, 250, 250, 250
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KG  4380 data 250,   0,   0, 250, 250, 250,  66,  86
OP  4390 data  67,  80, 250, 250, 250, 250, 250, 250
AN  4400 data 250, 250, 250,  66,  86,  83, 112, 250
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LA  4430 data 250, 216, 250, 250, 250,  67,  76,  73
BI  4440 data 250, 250, 250, 250, 250, 250,  88, 250
NP  4450 data 250, 250,  67,  76,  86, 250, 250, 250
LJ  4460 data 250, 250, 250, 184, 250, 250, 250,  67
OG  4470 data  80,  89, 204, 250, 250, 196, 250, 250
JE  4480 data 250, 192, 250, 250,  73,  78,  88, 250
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JK  4520 data  80, 250, 250, 250, 250, 250, 250, 234
ID  4530 data 250, 250, 250,  80,  72,  65, 250, 250
EM  4540 data 250, 250, 250, 250,  72, 250, 250, 250
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AL  4560 data 250,   8, 250, 250, 250,  80,  76,  65
FA  4570 data 250, 250, 250, 250, 250, 250, 104, 250
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NP  4620 data 110, 126, 250, 102, 118, 250, 106, 250
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AH  4640 data 250, 250, 250,  64, 250, 250, 250,  83
LB  4650 data  69,  67, 250, 250, 250, 250, 250, 250
BJ  4660 data  56, 250, 250, 250,  83,  69,  68, 250
AI  4670 data 250, 250, 250, 250, 250, 248, 250, 250
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JA  4710 data 250, 250, 250,  84,  83,  88, 250, 250
NL  4720 data 250, 250, 250, 250, 186, 250, 250, 250
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HE  4740 data 250, 154, 250, 250, 250,  18,  83,  89
AP  4750 data  77,  65,  83,  83,  32,  51,  46,  49
AC  4760 data  48,  32,  82,  79,  66,  69,  82,  84
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JB  4780 data  69,  66,  32,  49,  57,  56,  54,  13
EP  4790 data   0,   0,  13,  70,  73,  82,  83,  84
GB  4800 data  32,  80,  65,  83,  83,  46,  46,  46
JF  4810 data   0,   0,  83,  69,  67,  79,  78,  68
KC  4820 data  32,  80,  65,  83,  83,  46,  46,  46
EE  4830 data   0,   0,  13,  65,  83,  83,  69,  77
EI  4840 data  66,  76,  89,  32,  67,  79,  77,  80
BF  4850 data  76,  69,  84,  69,   0,   0,  13,  83
GJ  4860 data  89,  77,  66,  79,  76,  32,  84,  65
JK  4870 data  66,  76,  69,  32,  79,  86,  69,  82
NF  4880 data  70,  76,  79,  87,   0,   0,  13,  73
IK  4890 data  76,  76,  69,  71,  65,  76,  32,  81
LG  4900 data  85,  65,  78,  84,  73,  84,  89,   0
CH  4910 data   0,  13,  85,  78,  68,  69,  70,  73
IN  4920 data  78,  69,  68,  32,  83,  89,  77,  66
NK  4930 data  79,  76,   0,   0,  13,  66,  82,  65
PM  4940 data  78,  67,  72,  32,  79,  85,  84,  32
KN  4950 data  79,  70,  32,  82,  65,  78,  71,  69
EL  4960 data   0,   0,  13,  73,  76,  76,  69,  71
NL  4970 data  65,  76,  32,  77,  79,  68,  69,   0
MK  4980 data   0,  13,  73,  76,  76,  69,  71,  65
AB  4990 data  76,  32,  80,  83,  69,  85,  68,  79
LF  5000 data  45,  79,  80,   0,   0
```

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News BRK

Submitting NEWS BRK Press Releases

If you have a press release which you would like to submit for the NEWS BRK column, make sure that the computer or device for which the product is intended is prominently noted. We receive hundreds of press releases for each issue, and ones whose intended readership is not clear must unfortunately go straight to the trash bin. It should also be mentioned here that we only print product releases which are in some way Applicable to Commodore equipment.

Transactor News

Transactor on Microfiche

We now have 18 Transactor Magazines on microfiche! – all of Volume 4, Volume 5, and Volume 6. According to Computrex, our fiche manufacturer, the strips are the "popular 98 page size", so they should be compatible with every fiche reader.

To keep things simple, we're making the price of the fiche the same as magazines, with one exception. A single back issue will be $4.50 (remember, you can now get those 5 Transactors that are no longer available on paper!), and subscriptions will also be the same price as shown on the order card. The exception? A complete set of 18 (Volumes 4, 5, and 6) will cost just $39.95!

Transactor Mail Order News

Our mail–order department is expanding nicely, but our mail–order card isn't. Seems we just can't find any more room to put more text without making it so small that you can't read it. So, if you're using the card to order, we suggest you pull it out and cross–reference with the list below for more details.

■ Inner Space Anthology $14.95
This is our ever popular Complete Commodore Inner Space Anthology. Even after a year, we still get inquiries about its contents. Briefly, The Anthology is a reference book – it has no "reading" material (ie. "paragraphs"). In 122 pages, there are memory maps for 5 CBM computers, 3 Disk Drives, and maps of COMAL; summaries of BASIC commands, Assembler and MLM commands, and Wordprocessor and Spreadsheet commands. Machine Language codes and modes are summarized, as well as entry points to ROM routines. There are sections on Music, Graphics, Network and BBS phone numbers, Computer Clubs, Hardware, unit-to-unit conversions, plus much more. . . about 2.5 million characters total!

■ The Toolbox (PAL and POWER) $79.95
PAL and POWER from Pro-Line are two of the most popular programs for the Commodore 64. PAL is an easy-to-use assembler (most assembler listings in The Transactor are in PAL format), and POWER is a programmer's aid package that adds editing features and useful commands to the programming environment. They come with two nice manuals, and our price is $50 less than suggested retail!

■ The GLINK C64 to IEEE Interface $49.95
The GLINK plugs into the cartridge port, but doesn't extend the port for more cartridges (for that you'll need a "motherboard" of some kind). The other side of the GLINK is a IEEE card-edge suitable for a PET–IEEE cable. From there, any IEEE device can be accessed including disk drives, modems, printers, etc. The GLINK is "transparent" – that means it won't interfere with programs, except those that rely on the serial routines which it replaces (ie. programs with built-in "fastloaders" for the 1541 won't like the presence of the GLINK). It has no manual (aside from one page of installation instructions) because it alters nothing and leaves everything unchanged! An on-board switch allows you to select Serial or IEEE. GLINK works with both the C64 and the C128 in 64 mode.

■ The TransBASIC Disk $9.95
This is the complete collection of every TransBASIC module ever published. There are over 120 commands at your disposal. You pick the ones you want to use, and in any combination! It's so simple that a summary of instructions fits right on the disk label. The manual describes each of the commands, plus how to make your own commands.

■ Jim Butterfield's 1986 Diary $5.95 (plus 50¢ p&h)
Jim has put together a handy pocket reference that includes the most-used areas of memory maps, command summaries, equipment summaries, some short programs, sound and video, machine language, and a glossary, followed by a pocket diary and a neat colour map of the London England Underground, in case you're going there.

■ The SM Compiler $39.95 US, $49.95 Cdn
This compiler is for BASIC 7.0 on the Commodore 128. We've compared it with two others, and this is the one we like. Watch for that comparison in an upcoming issue.

■ Super Kit 1541 $29.95 US, $39.95 Cdn
Super Kit is, quite simply, the best disk file utility there is. No more losing those valuable copy-protected originals (like what's happened to me twice in the last month). See the News BRK item ahead.

■ Paperback Writer	C64	$39.95 US, $49.95 Cdn
■ Paperback Planner	C64	$39.95 US, $49.95 Cdn
■ Paperback Filer	C64	$39.95 US, $49.95 Cdn
■ Paperback Writer	C128	$49.95 US, $69.95 Cdn
■ Paperback Planner	C128	$49.95 US, $69.95 Cdn
■ Paperback Filer	C128	$49.95 US, $69.95 Cdn
■ Paperback Dictionary		$14.95 US, $19.95 Cdn

In our opinion, the Paperback packages from Digital Solutions are the best you can get on their own – the fact that they work with each other makes them even better. Planner and Filer data can be loaded into the Writer, Writer text can be sent to the Filer, and etcetera. The Dictionary spell checker works with both versions of the Writer.

As mentioned earlier, all issues of The Transactor from Volume 4 Issue 01 forward are now available on microfiche. Some issue are ONLY available on microfiche – these are marked "MF only". This list also shows the "themes" of each issue. "Theme issues" didn't start until Volume 5, Issue 01.

■ Vol. 4, Issue 01	(■ Disk 1)	■ Vol. 4, Issue 04 – MF only	(■ Disk 1)
■ Vol. 4, Issue 02	(■ Disk 1)	■ Vol. 4, Issue 05 – MF only	(■ Disk 1)
■ Vol. 4, Issue 03	(■ Disk 1)	■ Vol. 4, Issue 06 – MF only	(■ Disk 1)

■ Vol. 5, Issue 01 – Sound and Graphics	(■ Disk 2)
■ Vol. 5, Issue 02 – Transition to Machine Language	(■ Disk 2)
■ Vol. 5, Issue 03 – Piracy and Protection – MF only	(■ Disk 2)
■ Vol. 5, Issue 04 – Business & Education – MF only	(■ Disk 3)
■ Vol. 5, Issue 05 – Hardware & Peripherals	(■ Disk 4)
■ Vol. 5, Issue 06 – Aids & Utilities	(■ Disk 5)
■ Vol. 6, Issue 01 – More Aids & Utilities	(■ Disk 6)
■ Vol. 6, Issue 02 – Networking & Communications	(■ Disk 7)
■ Vol. 6, Issue 03 – The Languages	(■ Disk 8)
■ Vol. 6, Issue 04 – Implementing The Sciences	(■ Disk 9)
■ Vol. 6, Issue 05 – Hardware & Software Interfacing	(■ Disk 10)
■ Vol. 6, Issue 06 – Real Life Applications	(■ Disk 11)
■ Vol. 7, Issue 01 – ROM / Kernel Routines	(■ Disk 12)

Notes: The Transactor Disk #1 contains all program from Volume 4, and Disk #2 contains all programs from Volume 5, Issues 1–3. Afterwards there is a separate disk for each issue. Disk 8 from The Languages Issue contains COMAL

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0.14, a soft-loaded, slightly scaled down version of the COMAL 2.0 cartridge. And Volume 6, Issue 05 published the directories Transactor Disks 1 to 9.

The Viewtron Starter Kit

Since Viewtron is now shipping starter kits for free ($2.50 US. p&h), we've discontinued distribution. See the ad this issue for more details.

Transactor Open On Viewtron!

Remember, any of the above items can be ordered from our Transactor Section on Viewtron. Just sign on, enter "transactor", and proceed to the order section. We'll respond to confirm, and usually have your order out the same week. See the "Viewtron Keywords" article on page 26 of this issue for more info.

In the next Transactor we'll have a complete rundown on using the Transactor section, which, for the most part, will apply to just about any Viewtron section. If you get on before that, leave us some mail – we'll be happy to hear from you!

The Transactor Communications Disk

We're currently working on a "Transactor Communications Disk". We already have permission from Viewtron to include their software and hope to include many more. When finished it could host as many as 15 different modem programs and may even require two diskettes. We also plan an "all-in-one" manual to go with it so you'll never be without a telecommunications program for virtually any host computer and protocol. But it's not ready yet so don't send any orders. More next issue.

Industry News

Workshops In Computer-Assisted Instruction In Music

The lab for Computer-Assisted Instruction In Music at Brooklyn College will be offering two workshops this summer for music teachers who are interested in using computers as a teaching tool. Each workshop will last five days and include 15 hours of classroom instruction on the Commodore 64 computers and their applications in teaching music. The cost: $200.00/workshop. The dates are July 7-11, 1986 and July 14-18, 1986.

These workshops are offered in affiliation with the Center for Computer Music at Brooklyn College. For further information and application, contact:

Gary S. Karpinski, Director
Lab for CAI in Music
Conservatory of Music
Brooklyn College, Brooklyn, NY 11210
(718) 780-5286

Distressed Commodore Users Hotline

On January 1st, 1986, David Bradley began operating a brand new Freeware service for new Commodore computer users. It is a hotline for users to call when they are having trouble(s) with their new machines. The hotline operates Monday to Friday from 2:00 PM to 10:00 PM and the number for users to call is (416) 488-4776. Users that want more information about the service can write to:

Distressed Commodore Users Hotline
147 Roe Avenue
Toronto, Ontario, Canada
M5M 2H8

Or they can call any line of the Bradley Brothers Bulletin Board System at (416) 487-5833, (416) 481-8661, (416) 481-9047 or (416) 277-9991. All four lines operate 24 hours a day, 7 days a week.

The 1541 Revealed

"The 1541 Revealed" is a 48-page booklet from Write Protect Publishing. Written by Felix Rivera and Evelio Quiros, the book contains information and diagrams concerning the 1541 disk drive's internals, and practical tips to prolong the unit's life. Sections of the book include: An overview of the 1541, how and why problems arise, "The Naked 1541", Cleaning, lubricating, adjusting and aligning. A section on modifications explains how to: change device numbers, add a front-mounted power switch, change the head end-stop to a "springy" one, and add a write-protect switch. The writing style is informal and easy to understand.

A labelled general board layout of the 1541 is found in the centre of the booklet, and a "track checker" program and a list of references is included at the end. Price of the booklet is $5.00. For more information, contact:

Write Protect Publishing Company
Suite 4E, 135 Charles Street
New York, NY 10014

Used Computer Listing Service

Due to widespread demand, Comp-Used, which has helped buyers and sellers of used computer equipment in the North East for two years, is expanding its services.

Comp-Used is a listing service that facilitates the sale and purchase of used computer equipment. Anyone with equipment worth over $100 can contact the Comp-Used computer to register the product for sale. In the same vein, anyone in the market to purchase equipment can call the Comp-Used computer for information. Comp-Used connects the buyer and seller and they finalize the sale. When a transaction takes place, the seller pays Comp-Used a small commission; there is no charge to buy.

To talk with the Comp-Used telephone computer, call (203) 762-8677

Comp-Used
85 Rivergate Drive
Wilson, CT 06897

Steve Jobs and Pixar Employees Buy Pixar

San Raphael, CA. -- Pixar, the computer graphics division of Lucasfilm Ltd., has announced that it has been acquired by Steven P. Jobs and the employees of Pixar. Pixar, now an independent company, will design, manufacture and market high performance computers and software specifically tailored for state of the art computer graphics and image processing applications.

The new firm has a product, the Pixar Image Computer, ready for market. Developed during the last three years at Lucasfilm Ltd., the Pixar Image Computer is nearly 200 times faster than conventional minicomputers at performing complex graphic and image computations. At these specialized tasks, the Pixar Image Computer is also faster than a $6 million supercomputer. The Pixar Image Computer will be introduced to the commercial and scientific markets within the next 90 days and will sell for approximately $125,000.00.

Pixar was originally formed in 1979 by George Lucas to bring high technology to the film industry. Lucasfilm Ltd. will continue to use the Pixar Image Computer and other technologies to produce computer animation for films through its special effects division, Industrial Light & Magic (ILM), and for home entertainment through its Games Group.

MSD Disk Drive Information Exchange

Now that Micro System Development, the maker of MSD Disk Drives, is no longer in business, an information exchange is being set up to serve the needs of MSD disk drive users. The first project is a database of compatible software.

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Users of MSD disk drives are encouraged to participate in the exchange.

The MSD Information Exchange is a no fees, not-for-profit, user service. Those who contribute information to the exchange will be provided the following services:

1. For a self-addressed stamped envelope, a printout of available information in one selected category.
2. For a blank disk with mailer and return postage, a copy of the Information Exchange data disk in Superbase 64 format (data disk only).

Typical entries in the exchange data base include--

Word Processor, PaperClip 64, Batteries Included, 64C Edition
SD-2: Fully compatible serial or parallel (Quicksilver interface)

Spreadsheet, Multiplan 64, Hesware, v. 1.06
SD-2: Partially compatible. Data files may not be saved.

Backup, MSD Shure Copy, Megasoft
SD-2: Serial compatible. Parallel: Incompatible with Quicksilver

Entertainment, Flight Simulator II, Sub Logic
SD-2: Incompatible

The information exchange will also maintain files on the availability of technical information on MSD disk drives including parts, service, service or maintenance manuals, wiring diagrams, memory maps, etc. as provided by users.

Software News

Introducing Super Kit/1541

Prism Software is proud to introduce Super Kit/1541 for the Commodore 64. Super Kit is the most full-featured 1541 utility package to be found today. Just look at the features offered:

Single/Dual Normal Copier: Copies a disk with no errors in 32.68 seconds. Dual version has graphics and music.

Single/Dual Nibble Copier: Nibble copies a disk in 34.92 seconds. Dual version has graphics and music.

Single/Dual File Copier: 6 times normal DOS speed. Includes multi-copy, multi-scratch, view-edit BAM, and new Super DOS Mode.

Track and Sector Editor: Full editing of t&s in hex, dec, ascii, bin. Includes monitor/disassembler with printout commands.

GCR Editor: Yes disk fans, a full blown sector by sector or track by track GCR editor. Includes Bit Density Scan.

Super DOS I: Fast boot for Super DOS. 150 blocks in 10.12 seconds.

Super DOS II: Screen on and still loads 150 blocks in 14.87 seconds.

Super Nibbler: Quite frankly, if it can be copied on a 1541, this will do it! Including Abacus, Timeworks, Accolayde, Epyx, Acti-vision, Electronic Arts.

The price, $29.95 plus $3.00 shipping and handling.

Prism Software
401 Lake Air Drive, Suite D
Waco, Texas 76710
Orders (817) 757-4031 (or use order card at center)
Tech (817) 751-0200

DISKORGANIZER For The C64

You probably bought your computer, at least partially, to help you get organized. And you probably started with a handful of disks on which you stored all your files. But now you have boxes and boxes of disks with directories that look like they were organized by a not particularly bright chimpanzee. You like elegance and order, and you wish you could organize your disks, but this seems such a gargantuan task that you keep putting it off. The order of the files on a Commodore disk directory seems to be engraved in stone. (The same stone holds the header.) The only way to reorganize the directory is through laborious file copying to a fresh disk, right? Wrong! We have good news: DISKORGANIZER for the C-64.

With this ultimate disk utility for the C-64 you can quickly and easily sort and rearrange the disk directory of any unprotected disk to meet your own specifications, and the new directory is actually written back onto the disk! Using a convenient screen editor you can also change the header, scratch files, copy files of any size to another disk, rename files, add 'fences' to mark off sections of the disk for easy reading and independent sorting, 'scratch-protect' any file, position individual files anywhere in the directory, and, of course, print out copies of your revised directories.

You may have a copier utility or utility to rename the header or you may use the wedge for common disk commands. But you don't have a single program that will take care of all your disk housekeeping (even housekeeping you didn't think possible) quickly and easily. But you will, if you get DISKORGANIZER and get organized. DISKORGANIZER is available for $29.95 from:

The G.A.S.S. Company
970 Copeland
North Bay, Ontario, Canada
P1B-3E4
(705) 474-9602

Amiga Spreadsheet, Telecommunications and BBS

Micro-Systems Software Inc. has released three new software tools for the Amiga. The first is a spreadsheet called Analyse!. Similar in concept to Lotus 1-2-3, the $99.95 program takes maximum advantage of Amiga's capabilities (pull down menus, mouse, workbench) and can produce professional sized spreadsheets (256 columns x 8,156 rows).

The second package, Online!, is a full-featured telecommunications system for the Amiga that retails for $69.95. The third package, BBS-PC, is a versatile electronic bulletin board system that transforms any Amiga into an online information network.

The $99.95 program easily interfaces to a hard disk or keeps up with a 2400 bps modem. In addition, BBS-PC works in the "background", so the Amiga can answer the phone and take messages while users are working on other projects.

All three packages are being distributed by Softeam, National Software Distributors and Computer Software Services in the U.S, and in Canada by Phase 4 Distributors. For additional information contact:

Brown-Wagh Publishing
100 Verona Court
Los Gatos, California 95030 (408) 395-3838

The Sourcerer 6500 Series Disassembler

The Sourcerer is a multi-pass disassembler which converts 6500 series machine language (object code) into Assembly Language (source code). It operates disk-to-disk, disk-to-screen, or disk-to-printer. The commented Assembly Language which is produced can be immediately re-assembled with the Commodore assembler, or loaded for editing with the Commodore editor. Any specified

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range of code within a program can be disassembled. Long programs automatically produce linked disk files for easy editing. All addresses referenced in the code are converted to labels, in several sorted catagories. The Sourcerer is written in 100% machine language for fast operation, and will disassemble a 20k program with several thousand address labels in less than 13 minutes. The time required for the final output of source code depends on the speed of the output device (disk, screen, or printer).

The Sourcerer is only $29.95 ppd. on a 1541 disk complete with operating instructions. Order from:

Chessoft Ltd.
723 Barton Street
Mt. Vernon, IL 62864

Help Master For The Commodore 64

Help Master 64 is a software/book package that will aid Basic programmers. Help Master 64 provides instant, on-line help screens on each and every Basic command used by the Commodore 64 computer.

Once loaded, Help Master 64 remains hidden in memory until you need it. It takes up absolutely none of the Basic RAM, is completely compatible with the DOS wedge, and has no effect on your ability to write, edit, load, save or run any Basic program.

When you need help, typing the quote mark plus the name of the command will instantly produce a half-screen overlay showing the Commodore abbreviation for the command, the proper syntax, a description of the command and reference page numbers in various manuals which will provide more information than is available on-screen. This half-screen format will allow you to view both your actual program line and the Help Master example at the same time so you can see what the differences are.

After viewing the help screen, you may restore the information that was on the top half of the screen, or you can correct your program line while the help screen is still being displayed.

Help Master 64 comes with the 'Handbook Of Basic for the Commodore 64', an excellent 368 page reference manual on Commodore Basic by Frederick E. Mosher and David I. Schneider, published by Bradey Communications, Inc. The package has a retail price of $29.95. For more information contact:

Master Software
6 Hillery Court
Randallstown, MD 21133 (301) 922-2962

Hardware News

RESWITCH from Compusave

Reswitch is a reset switch/power-on indicator for the Commodore 64 which replaces the existing power-on LED. Installation requires no drilling or cutting, as the unit pops into the same hole as the existing LED. The Reswitch is a transparent pushbutton containing an LED and acts exactly like the original LED except that pushing down on it causes the 64 to reset. The package comes with detailed installation instructions and everything needed to hook up. Price is $10.00. Contact:

Comp U Save
115 Essex St. Suite #146
New York, NY 10002

Uninterruptible Power Supply

An on-line, sine wave Uninterruptible Power Supply is being introduced by Electronic Specialists. Capable of supplying up to 20 minutes power during extended power outages, the on-line unit operates without disruptive switching transients. Automatic internal battery recharge is incorporated.

Wide band EMI/RFI filtering and High-Speed, High-Current Spike Suppression provide extended protection. Added protection is provided by an integral overload/short-circuit proof configuration.

A front panel TEST switch permits convenient power removal to check front panel monitors and complete system operation.

Line phase lock, automatic Blackout illumination, Battery-Saver automatic shut-down option and external battery option are featured. Available in 250 and 500 watts. For more information, contact:

Electronic Specialists Inc.
171 South Main Street
Natick, Massachusetts
01760 1-800-225-4876

80 Column Mono Cable For The C-128

This is the cable for an 80 column monochrome display as described in many Commodore specific magazine. It eliminates the need for an RGB monitor and allows the use of any composite color or monochrome monitor. Excellent for data base and word processing applications. (See next item for address)

40/80 Column Switch Cable For The C-128

A flip of a switch on the connector is all that's needed to change from 40 to 80 column display and back again. Plus a simple keystroke (ESC X). In 40 column mode all 16 colors are available on your color monitor.

It's small and easy to install, with no bulky switches, boxes or exposed components.

The 80 Column Mono Cable retails for $9.95. The 40/80 Column Switchable cable retails for $23.95. For more information contact:

Innovative Computer Accessories
1249 Downing Street, PO Box 789
Imperial Beach, CA 92032-0837 (619) 224-1177

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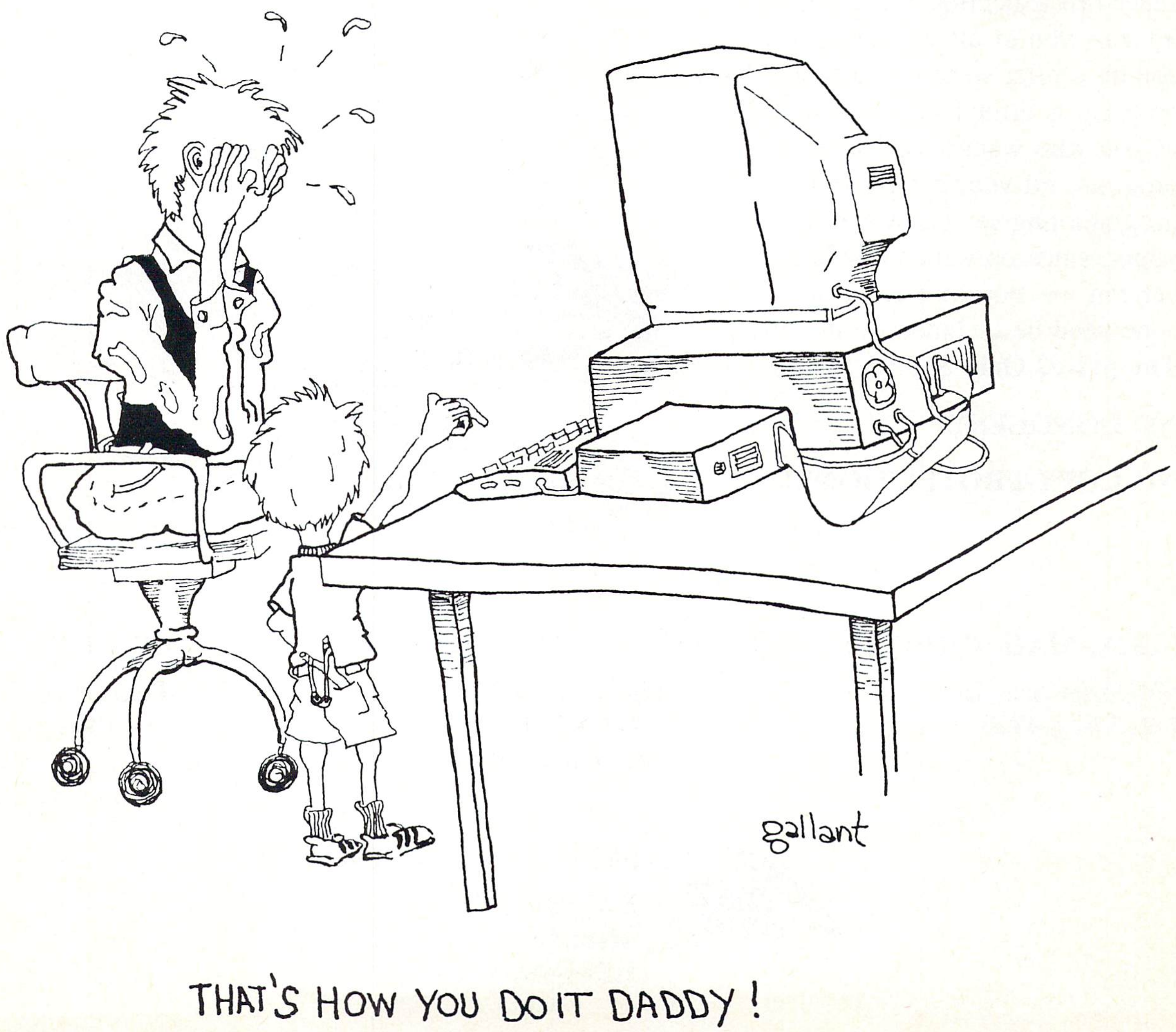
Volume 6 Editorial Schedule

Issue#	Theme	Copy Due	Printed	Release Date
1	More Aids & Utilities	Feb 1	Mar 22	April 1/85
2	Communications & Networking	Apr 1	May 24	June 1
3	Languages	Jun 1	Jul 26	August 1
4	Implementing The Sciences	Aug 1	Sep 20	October 1
5	Hardware & Software Interfacing	Oct 1	Nov 22	December 1
6	Real Life Applications	Dec 1	Jan 24	February 1/86

Volume 7 Editorial Schedule

Issue#	Theme	Copy Due	Printed	Release Date
1	ROM Routines / Kernel Routines	Feb 1	Mar 21	April 1
2	Games From The Inside Out	Apr 1	May 23	June 1
3	Programming The Chips	Jun 1	Jul 25	August 1
4	Gadgets and Gizmos	Aug 1	Sep 26	October 1
5	Simulations and Modelling	Oct 1	Nov 21	December 1
6	Programming Techniques	Dec 1	Jan 23	February 1/87

Advertisers and Authors should have material submitted no later than the 'Copy Due' date to be included with the respective issue.



THAT'S HOW YOU DO IT DADDY!

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While driving deep into the Black Forest of Germany, our slow and unreliable Volkswagen started sputtering and puttering and then to our dismay, just quit running. After hours of unrelentlous tinkering, our poor little mobile was running, slowly, but running. And we wanted to get out of that dank and dark forest quickly. Befuddled and confused, we were ecstatic to see a strange little Gnome emerge from behind a tree. This creature, who called himself Hacker, used his infinite wisdom and wizardry to fix our Volkswagen and get us speedily on our way. Well, we were so impressed with Hacker Gnome's wizardry, that we convinced him to reveal his secrets for speed and reliability. **And we are passing these secrets along to you so that you can write the very best Basic Programs.**

INTRODUCING–GNOME SPEED
(A Basic 7.0 Compiler for your Commodore 128)

Gnome Speed allows you to transform virtually any Basic 7.0 Program into a compiled version that is as sophisticated and fast as if it were written in machine code. Simply compiling your program with **Gnome Speed** not only gives you super-fast execution speed, but also informs you of all your program coding errors, so that your compiled program is error-free. And for those of you who want to sell your program, all your efforts and programming secrets will remain yours, since only the compiled version — not your Basic source code need be included on the disk. **The price?** Only $59.95 (U.S.)

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NO COPY-PROTECTION!!!

U.S.A. MAIL ORDERS:
SM Software, Inc.
1-215-682-4920

CANADIAN MAIL ORDERS:
The Transactor
1-416-878-8438
(see order card)

DEALER INQUIRIES:
Micro-Pace, Inc.
1-217-356-1884

SM SOFTWARE, INC.
P.O. Box 27
Mertztown, PA. 19539-0027
1-215-682-4920

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I N T R O D U C I N G

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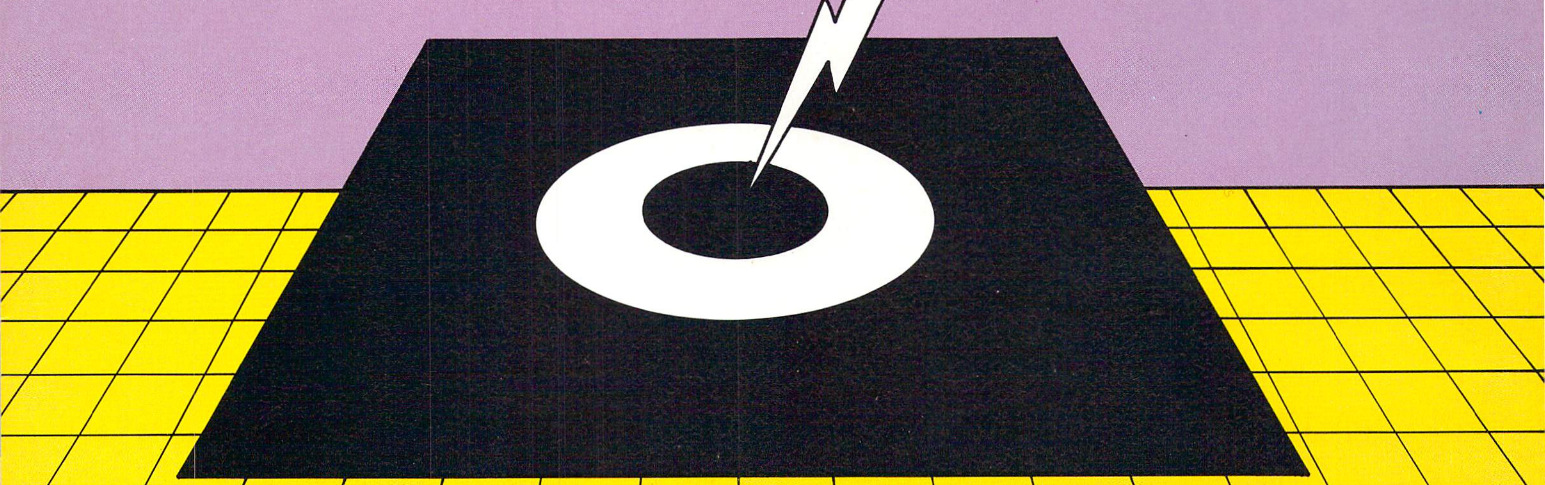

BY MARTY FRANZ & JOE PETER

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Nibble Copies a disk in 34.92 seconds. Dual version has graphics & music.

SINGLE/DUAL FILE COPIER
7 times normal DOS speed. Includes multi-copy, multi-scratch, view/edit BAM, & NEW SUPER DOS MODE. In Super DOS Mode, it transfers 7-15 times normal speed, copies 150 blocks in 23 seconds.

TRACK & SECTOR EDITOR
Full editing of t&s in hex, dec, ascii, bin. Includes monitor/disassembler with printout commands.

GCR EDITOR
Yes disk fans, a full blown sector by sector or track by track GCR Editor. Includes TRUE Bit Density/Track Scan.

3 SUPER DOS FAST LOADERS
Over 15 times normal DOS speed. Super DOS Files are still Commodore DOS compatible. Imagine loading 150 blocks in 10 seconds.

SUPER NIBBLER/ SUPER DISK SURGEON
Quite frankly, these will provide you the user with the backup you need! Even copies itself.

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