

*Timothy Swenson*

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# Z88

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*Source Book*

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*The Cambridge Z88 User Resource Reference*

Updated with Addendum #1

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## 1. INTRODUCTION

The Z88 Source Book is designed to be a good reference on the Z88, how to interface it with the world, how to do things with it, what products are/were available, and what dealers carry them. It is not designed to be a replacement for the Z88 User Guide, but as a supplement to it, filling in areas not covered by the User Guide.

This Source Book also comes with a number of utilities and files for the Z88 on QL or MS-DOS disks. Although the Z88 can interface with any computer with a serial port, these are two that I have chosen to focus on. Those who have interfaced the Z88 with other computers can submit the details so that they may be added to this book. All utilities that come with this book are either Shareware, Freeware, or Public Domain and may be freely distributed.

The reason for this book comes from when I was a new Z88 owner and did not know how to get it to interface with any computers. I initially got some help from Dave Bennett, but still had to fumble a bit in the dark. The Z88 documentation assumes that one purchased the QLink, PC-Link, or Mac-Link software and cable and does not discuss the ways to transfer files to another computer. From my initial lack of knowledge came the idea for a Source Book to assist new (and old) Z88 users, including utilities to help.

This book relies heavily on the work of others and their exploration of the Z88. A lot of the information in this book comes from a variety of publications and people. I am indebted to both Dave Bennett and Frank Davis for providing the back issues of various newsletters. Below is a list of publications and persons from which/whom this book is indebted.

Update Magazine, Z88 Fax News, PipeLine, Z88 EPROM, Dave Bennett, Frank Davis, Phil Wheeler, Chris Fenn, and other contributors of Z88 articles to the various newsletters.

Throughout this book I will reference various parts by their Radio Shack Part Number. I'm doing this not because I favor Radio Shack, but because Radio Shack is everywhere and the part number references a specific item.

One last item, if you have not read the Z88 Manual all the way through, then I recommend it. In the tradition of other Sinclair documentation, the manual is full of good information, but it's hiding. A cursory reading of the manual will not reveal all of the neat tricks the Z88 can do.

## 2. CONVENTIONS

There are a number of keys on the Z88 that are not on other computers. Below is the convention of how they will be used in this book:

[ ] - Square Key  
<> - Diamond Key

### 3. HISTORY

The Z88 started off as the "Pandora" project when Sir Clive Sinclair sold off Sinclair Research Ltd. to Amstrad. It was first introduced in England in June of 1987. It was sometime in 1988 that the Z88 was introduced in the US, being sold by Cambridge North America. The market life of the Z88 was rather limited. After coming on strong in 1988, a number of vendors and magazines started folding around 1990. The official Z88 magazine, "Z88 User", folded in 1989 after publishing for a year. Cambridge North America folded in 1990 after some rather complicated legal dealings.

When the Z88 was introduced to the US, the reviews in computer magazines seemed to be fairly polarized. Either the reviewer loved the Z88 (like Stan Veit) or wrote it off completely. Most reviewers cited the fact that the Z88 was not MS-DOS compatible as being a large reason why it would not sell. Despite the reviews, the Z88 did sell fairly well to Macintosh users, who did not care about it not being MS-DOS compatible, and were used to paying the high price that some dealers were selling the Z88 for.

### 4. PIPEDREAM TIPS

#### 4.1. Multiple Columns

Change the width of Column A with `<>W` to 40. Set a right margin of 38 with `<>H`. Goto Options with `<>O`. Set justify to Y. Set the page length to what you want. Set Header, Footer, and Bottom to 0 and Left to 2.

Editing is more difficult with multiple columns, so 99% of the editing is done with the text in column A. Any insertions and deletions of lines of text must use the commands `<>EIRC` and `<>EDRC`. `<>N` and the `<>Y` insert and delete in ALL columns.

Now you are going to separate and move your text into column B. There will be a jagged line across the column where you previously set the page length. Now move the cursor one line past this marker. Type `<>Z` and then move to the end of the text with `<>` and Down Arrow. Type `<>Z` again. All the selected text will be highlighted on the screen.

Press TAB to move your cursor to Column B and use the arrow keys to put the cursor where you want the moved text to start. Now type `<>BM` for Block Move. Your selected text will be moved to your cursor position.

### 5. BBC BASIC TIPS

The Z88 Manual is very terse on how to program in BBC Basic. It discusses the commands, functions, and operators of the language, but does not cover how to put these together to construct a program. For the experienced Basic programmer BBC Basic should be fairly familiar.

For the novice, it is a more daunting task to put together a program.

A full discussion of how to write a BBC Basic program is far beyond the scope of this book. One way to learn BBC Basic is to go over the Basic programs included with the Source Book. They should provide you with a fairly good set of examples of how to do various tasks in BBC Basic. There are a few books on BBC Basic:

"Using BBC Basic", P.J. Cockerell, 1983, John Wiley and Sons (ISBN 047190242X).

"BASIC Programming on the BBC Microcomputer", Neil & Pat Cryer, 1982, Prentice Hall.

"BBC Basic Reference Manual for the Z88", D.J. Mounter

The first two books were designed for the BBC Micro and some portions of the text will not apply to the Z88 version of BBC Basic. They are good starting points for the novice programmer. Optionally, a novice programmer could pick up a book on general Basic and translate the examples to BBC Basic.

## 5.1. Star Commands

There are some commands that are not documented in the Z88 User Manual that are covered in other Books.

\*CLI - Execute CLI Commands.

10 \*CLI #F - invokes the Filer.

\*DELETE - Delete Files.

10 \*DELETE pd/file - Deletes file in the pd subdirectory.

\*ERASE - Same as \*DELETE.

\*REANME - Renames a file. Execute it just like \*DELETE.

\*NAME - Assigns a name to a BASIC program.

## 5.2. The VDU Command

A number of less documented features of BBC Basic are accessed via the VDU command. The VDU command is almost equivalent to the CHR\$ command. VDU X = CHR\$(X). Using the command VDU 65 will print out the A character (A = ASCII 65). The ASCII codes from 0-31 and 127 will perform special tasks with the VDU command. Not all of these VDU commands are documented.

Some of the VDU commands are documented in the BBC Basic book by P.J. Cockerell. Most do not apply to the Z88 since they are graphics commands. One is completely different than that used on the Z88. The following VDU commands are not used on the Z88.

VDU 17	Color Control
VDU 19	Actual color to logical color
VDU 22	MODE Command
VDU 23	Create User Defined Characters (see below)

VDU 26	Restore Default Windows
VDU 28	Define Text or Scrolling Window
VDU 30	HOME the Cursor
VDU 31,x,y	TAB(x,y)

The following subsections document the known Z88 VDU commands. This includes screen controls, sound, and user defined graphics.

### 5.3. Screen Control Codes

The Z88 has a number of codes that are used to control the screen and to print special characters (ones not on the keyboard). Remember VDU X is the same as CHR\$(X).

VDU 8	Move cursor Left
VDU 9	Move cursor Right
VDU 10	Move cursor Down
VDU 11	Move cursor Up
VDU 1,32	Three Dots
VDU 1,33	Bell Symbol
VDU 1,39	Backwards Apostrophy
VDU 1,42	Square
VDU 1,43	Diamond
VDU 1,45	Shift Symbol
VDU 1,124	Upright Slash
VDU 1,142	Block
VDU 1,224	Space Symbol
VDU 1,225	Enter Symbol
VDU 1,226	Tab Symbol
VDU 1,227	Delete Symbol
VDU 1,228	ESC Symbol
VDU 1,229	Menu Symbol
VDU 1,230	Index Symbol
VDU 1,231	Help Symbol
VDU 1,240	Left Key Arrow
VDU 1,241	Right Key Arrow
VDU 1,242	Down Key Arrow
VDU 1,243	Up Key Arrow
VDU 1,244	Thick Left Arrow
VDU 1,245	Thick Right Arrow
VDU 1,246	Thick Down Arrow
VDU 1,247	Thick Up Arrow
VDU 1,248	Thin Left Arrow
VDU 1,249	Thin Right Arrow
VDU 1,250	Thin Down Arrow
VDU 1,251	Thin Up Arrow
VDU 1,ASC("B")	Bold Characters
VDU 1,ASC("C")	Toggles Cursor
VDU 1,ASC("D")	Slows the Display
VDU 1,ASC("F")	Flash Characters
VDU 1,ASC("G")	Bright Characters
VDU 1,ASC("R")	Inverts the Screen
VDU 1,ASC("S")	Screen Scrolls from Top to Bottom
VDU 1,ASC("T")	Small Characters
VDU 1,ASC("U")	Underlines Characters



## 5.4. Key Codes

Sometimes it is necessary to know the codes that keys generate. To find out what codes a key press generates, enter the following program:

```
10 PRINT "Hit Key or Combination";
20 Z$ = GET$
30 PRINT Z$,ASC(Z$)
40 GOTO 20
```

The Diamond <> Key acts like a CTRL key.

KEY	ALONE	SHIFT KEY	CTRL KEY <>
-----	-------	-----------	-------------

---

UP	0, 255	0, 251	0, 247
DN	0, 254	0, 250	0, 246
RT	0, 253	0, 249	0, 245
LT	0, 252	0, 248	0, 244

Other interesting codes:

CTRL TAB	0, 194	CTRL DEL	0, 195
CTRL \	28	CTRL =	0, 0
CTRL -	31	CTRL ]	29
CTRL '	96	CTRL [	27
CTRL ENTER	0, 193		

## 5.5. Line Graphics

The Z88 is capable of producing "IBM style" line graphics. These are generated by VDU commands in the following form:

```
VDU 1,ASC("2"),ASC("*"),ASC("char")
```

where char is a letter in the range A to O.

Here is an example program:

```
10 Z=65
20 REPEAT
30 VDU 1,ASC("2"),ASC("*"),Z
40 VDU 9
50 Z=Z+1
60 UNTIL Z=80
```

## 5.6. Sound

The Z88 is capable of limited sound. Variations can be made of the Z88's beep. Below are three examples to experiment with:

```
VDU 1,52,33,38,34,34
VDU 1,52,33,34,33,34
VDU 1,52,33,40,33,33
```

## 5.7. User Defined Characters

The Z88 has the ability to have up to 64 user defined characters. Characters can be defined from CHR\$(64), the @ symbol, to CHR\$(127), ESC. They are defined in the following format:

```
VDU 1,138,ASC"=",ASC"char",n0,n1,n2,n3,n4,n5,n6,n7
```

where char is the ASCII character that this new character is assigned to. n0 through n7 are the decimal equivalents to the binary code defining the character.

The characters are defined in a 6 column by 8 row matrix. The rows are defined by the numbers n1 to n7 in downward sequence (n7 is the bottom row) and the columns are defined by the six lower bits of the binary form of these numbers (bit 0 is the right-most bit). It appears that the setting of the two highest bits is not important.

Here is an example of a Smiley Face character:

```
Binary   Decimal
0 0 0 1 1 0 1 1 27  <-- n0
0 0 0 1 1 0 1 1 27
0 0 0 0 0 0 0 0  0
0 0 0 0 0 1 0 0  4
0 0 0 0 0 1 0 0  4
0 0 0 1 0 0 0 1 17
0 0 0 0 1 1 1 0 14
0 0 0 0 0 0 0 0  0  <-- n7
      |
      |--- Blank Column for space between characters
```

### *Printing HEX Values*

Using a tilde (~) with the ASC command in a print statement will print out the HEX value of the character being operated on. ~ASC"A" will print out the HEX value of the character A (41). ASC"A" is 65.

```
PRINT "A", ASC"A", ~ASC"A"
```

will produce: A 65 41

## 5.8. BASIC Inline Assembler

BBC BASIC on the Z88 comes with an inline assembler built in. The variable P% is used as a program counter. The user must set P% to the desired start point for the machine code before invoking the assembler. The assembler can be invoked with the [ symbol on a single line. It is uninvoked by a ] on a single line. Below is a sample program:

```
10 DIM code 100
20 P% = code
30 [
40 LD BC,50
50 RET
60 ]
```

It is recommended that the user have a good knowledge of Z80 machine code programming before trying the assembler. Locking up your Z88 could cause it to do a hard reset (take it to a "virginal" blank state).

### 5.9. A Hint on the OPENUP Command

The command OPENUP (OPEN for UPdate) is a little odd on the Z88. The typical syntax might be:

```
10 F% = OPENUP(F$)
20 PRINT #F%,G$
```

But this will result in the current contents of F\$ being overwritten, not appended. To OPEN for APPEND, you need to move the file pointer to the end of the file:

```
10 f% = OPENUP(F$)
20 PTR #F%=EXT #F%
30 PRINT #F%,G$
```

This will add G\$ at the end of the file, instead of overwriting the existing contents.

### 5.10. Reading the Serial Port

Here is a short BASIC routine that demonstrates how to read the serial port.

```
10 channel% = OPENIN(":COM.0")
20 BPUT# channel%,outputbyte% - set byte
30 inputbyte% = BGET# channel% - read byte
```

### 5.11. Testing the Speed of the Z88 in Basic

Benchmark speed tests are standard ways of comparing different computers in relation with each other. I have converted one benchmark program from the QL to the Z88. It's a fairly simple prime number calculating program, originally written by Duane Parker to test out different compilers and languages on the QL. I use it here to compare the Z88 with the QL.

The QL is known for having a slow display. I ran the benchmark on both computers with the output of the program being displayed and not displayed. The key thing I found out from this test is that the Z88 does not suffer a slow down when outputting information to the display. The results for the Z88 were the same on both runs.

The benchmark determines all of the prime numbers from 32767 to X, where X is less than 32767 and greater than 0. In the benchmark tests that I ran, I had the program determine the primes from 32767 to 29000. These were the same numbers used in earlier tests with the benchmark.

Using the fastest Z88 and QL times, the Z88 ran the benchmark in 326 seconds and the QL in 229 seconds. This means that the QL is 1.4 times faster than the Z88. Considering that the QL is running a 68008 at 7 MHz and the Z88 is using a Z80 at 3 MHz, the Z88 does fairly well.

The program is as follows:

```
10 PRINT "Stop Calculations at what value less than 32767"
20 INPUT V
30 P = 32767 DIV 100
40 IF V>32767 OR V<0 THEN PRINT "INVALID": GOTO 10
50 PRINT "Primes < 32767 & > ";V
60 A$ = TIME$
70 FOR I = 32767 TO V STEP -2
80   FOR J = 3 TO 191 STEP 2
90     IF (I MOD J) = 0 THEN GOTO 140
95   NEXT J
100  IF (I<P*100) THEN PRINT : P=P-1
110  PRINT I;" ";
140 NEXT I
150 B$ = TIME$
160 PRINT A$
170 PRINT B$
```

## 6. CABLES

The serial port is the primary way to get data into and out of the Z88. Below are cable diagrams for linking a number of computers, a modem, and a printer.

### 6.1. Cable Making Hints

I have found through experience that a cable may not turn out the way I feel it should. When I first made my Z88 cables, I used standard 9 wire cable ( about 3/8" wide). This was what I expected a cable to look like. Well, after using them for a few years, I found the cable too thick and unyielding to use.

After some thinking, I remembered some serial cables that were built with phone wire. Phone wire is flexible and easy to use. Since I had a few extra phone cords running around, I snipped off the RJ-11 jacks and soldered some 9-pin D ends and away I went.

Phone cable comes in 4-(RJ-11), 6-, and 8-wire (RJ-45). For connections to other computers, I found 4 wire to be fine. For a printer or modem cable, you will need either 6- or 8-wire, which may be harder to find.

Also, make your cables plenty long. I thought I had made mine long enough, but I found out how wrong I was when I went to use them. The distance from the back of your computer to a space right next to it (for the Z88) is longer than you think. Be on the safe side and make them long.

## 6.2. Cable Diagrams

```

Z88          Z88
---          ---
2 ----- 3
3 ----- 2
|-4         4-|
|-5         5-|
6
7 ----- 7
8 ----- 9
9 ----- 8

```

```

Z88          QL SER2
---          -----
2 ----- 3
3 ----- 2
|-4         ----- 4
|-5         |         5
6           |         6
7 -----|----- 7
|-8 -----|         8
|-9         |         9

```

```

Z88          MAC
---          ---
2 ----- 5
3 ----- 3
5 ----- 1
7 ----- 4
8 ----- 1
9 ----- 2

```

```

Z88          PC DB25
---          -----
2 ----- 3
3 ----- 2
|-4         4-|
|-5         5-|
6           6-|
7 ----- 7 |
8 -----| 8-|
          |
          |----- 20

```

```

Z88          PC DB9
---          -----
2 ----- 2
3 ----- 3
4 -|         |- 7
5 -|         |- 8
7 ----- 5
8 ----- 4
9 ----- 6

```

Another way to do it is to use the DB25 cable and a 25 pin to 9 pin adapter (on the PC end). These adapters are easy to find at most computer stores.

Z88		Modem
2	-----	2
3	-----	3
7	-----	7
5	-----	20
8	-----	20
9	-----	20

Here is an alternative modem connection.

Z88		Modem
2	-----	2
3	-----	3
4	-	
5	-	
7	-----	7
8	-	
9	-	

Modem cable to connect Z88 to USR WorldPort 14.4K Modem.

Z88		Modem
2	---- TxD -----	3
3	---- RxD -----	2
4	---- RTS -----	7
5	---- CTS -----	8
7	---- GND -----	5
8	---- DCD -----	1
9	---- DTR -----	4

Z88		Printer
2	-----	3
3	-----	2
4	-----	5
5	-----	20
7	-----	7
8	-----	20
9	-----	6,8

Z88		Amstrad CPC6128
2	-----	3
3	-----	2
4	-----	5
7	-----	7
5	-----	20
8	-----	

The Spectrum - Z88 pinout below assumes the Spectrum has an Interface 1 to provide a serial port.

Z88		Spectrum
----		-----
2	-----	3
3	-----	2
4	-----	5
5	-----	4
8	---	
7	-----	7
9	-----	9

For users of British QL's, the serial port is an RJ11 phone-like port. Here are the pin outs for both SER1 and SER2 for this type of serial port.

Z88		SER1	SER2
---		----	----
2	-----	2	3
3	-----	3	2
4	-----	4	5
5	-----	5	4
7	-----	1	1

Z88		Apple Super-Serial Nexus
---		-----
1	-----	1
2	-----	3
3	-----	2
4	-----	5
5	-----	20
8	--	
7	-----	7
9	-----	8

## 7. HOW THE Z88 STORES FILES

How the Z88 stores files is important to know when transferring files from the Z88 to other computers. This section helps in understanding how to translate Z88 files to be used on other computers.

The Z88 has three basic file types; PipeDream, CLI(ASCII), and BBC BASIC. PipeDream can store files in plain ASCII text format but normally stores them in a proprietary format. BBC BASIC files are stored in a tokenized format. There is a way to transfer BBC BASIC files into ASCII (Z88 User Guide P. 200). Other more specialized file types are Diary and PrinterEd files.

The Z88 uses CR (Carriage Returns) to stand for End-Of- Line (EOL). The QL uses LF (Line Feed), MS-DOS uses CR/LF. Some conversion is necessary to make these ASCII documents ready for the QL or PC. CRtoLF\_exe for the QL and ADDLF.EXE and RMCR.EXE for the PC will do the conversion. In going from the QL to the Z88 the

Program QLtoZ88\_exe has an option to convert LFs to CRs so that ASCII files can be easily sent to the Z88.

When PipeDream prints, it adds a LF to the CR that the printer is expecting. It also adds ESCAPE sequences that tell the printer what to do. One ESC sequence will be at the start of the file, others may be embedded in the document.

If you are going to transfer PipeDream documents to be used on the other computer, it is best to save them as ASCII documents. On the Save File screen, there is an option to save in ASCII.

Since most other computers do not use BBC BASIC, converting the files to ASCII is not necessary. But if you want the BASIC programs to be readable on the other computer, then you have to convert them to ASCII and store them in CLI files (Z88 User Guide P. 200). It only takes a few steps to make them runnable on the Z88.

## 8. TRANSFERRING FILES

Files can be transferred from Z88 to Z88 via EPROMs, but most files will be transferred via the serial port. The Z88 comes with file transfer software, but it has its limitations. Some people prefer to use a communications program like Z88COMM that supports XMODEM protocol and has error correction. PipeDream documents can be printed and captured on a remote computer.

Files are transferred for two reasons, 1) to use the other computer to store Z88 files on disk, 2) to import the Z88 files for use on the other computer. If you wish to only store Z88 files on another computer, then you need not worry about how to put the Z88 files into a form usable by the other computer. If you wish to use the Z88 files on the other computer, then you will need to change the Z88 files so that they can be used by the other computer.

Transferring Files with

### 8.1. Import-Export

The Z88 manual does not make big news of it, but the Import-Export pop-up has a protocol for transferring files. Any files sent through Import-Export will have some added bytes. At the beginning of a transferred file will be ESC N filename ESC F. At the end of the file will be ESC E. You will probably need to trim this data from the file.

On files that have non-ASCII data, the non-ASCII bytes are converted into a ESC B xx yy sequence. This means that to get these files back into the Z88, they must be imported through Import-Export to convert them back. In general, files transferred out of a Z88 with Import-Export need to be transferred in with Import-Export. Those coming out with XMODEM need to be sent in with XMODEM.

If wishing to use a PipeDream document on another computer, it is best to have the document as ASCII (on the save screen) before sending it. This will make importing into another application easier.



To a QL:

The QL serial ports are known for having problems at higher baud rates. There is a HERMES chip that fixes these problems. Without HERMES, I recommend using a baud rate of 1200. I've also noticed that when transferring files to disk instead of a RAM Disk, some errors creep into the file.

On the QL enter: COPY SER2 TO RAM1\_FILE\_EXT

On the Z88 do: <>X, S (for send), enter the file name and hit ENTER. The file will be sent to the QL, with the number of lines being displayed on the Z88. When the prompt returns on the Z88, hit CTRL-SPACE to stop the copy on the QL.

From a QL:

On the Z88, go to the Import-Export pop-up, type R to Receive, enter a file name, and then hit ENTER.

On the QL, EXEC QLtoZ88\_EXE, enter a file name, select the baud rate, and wait for the program to run.

On the Z88, you will see a countup of the lines as they are transferred. When the transfer is complete, the Import- Export Menu will return.

To a PC:

Due to the difficulty of accessing the serial port via Basic or C on a PC, I was not able to write any transfer programs for the PC. There was one on the Z88 BBS in California, but that BBS has been gone for a couple of years.

Instead you can use almost any communications software for the PC. I will use Procomm as an example. Procomm is one of the more popular communications programs and it has a Shareware version.

Once you have hooked up the computers via the serial cable, start Procomm. Set it to the same baud rate as the Z88. Set the Z88 to not use XON/XOFF.

Hit the PageDown key on the PC. Procomm will ask for a transfer type. Hit 7 for ASCII. Enter a file name and hit return. The PC will be waiting for the file to be sent. On the Z88, enter Import/Export by hitting [] X. Enter S for send. Enter the file name and hit return. You should see the text appear on the PC screen as it is being sent. Once the file transfer is complete, hit ESC on the PC to tell Procomm to stop the file transfer. You now have the file on the PC.

It is advisable to run the file through the program ADDLF.EXE so that the file will be fully MS-DOS compatible.

From a PC:

Before sending an ASCII document to the Z88, you should run it through the program RMLF.EXE so that the file will be Z88 compatible.

Using Procomm as above, set the baud rate on both computers. On the Z88 enter Import/Export with [ ] X. Enter R to receive. Enter a file name and hit return. The Z88 will be waiting for the file.

On the PC, hit the PageUp key to do an upload. Hit the 7 key to signify ASCII transfer. Enter the name of the file to send. The file will now be sent to the Z88. When the transfer is done the Z88 should beep and be asking what to do next. If not, hit the ESC key to tell it that the transfer is done.

## 8.2. Printer Capture

One way to get a PipeDream document without saving it as ASCII is to print it, but instead of having the Z88 hooked up to a printer, it is hooked up to a computer. Output from the Z88 is stored on the computer.

To a QL:

On the QL, type COPY SER2 TO RAM1\_FILENAME\_EXT and hit ENTER.

On the Z88, in PipeDream, hit <>PO to print.

On the QL, once the Z88 cursor is back, hit CTRL-SPACE to stop the copy. The transfer is complete.

To a PC:

Use the same procedure listed above for transferring files from the Z88 to the PC. Since PipeDream is sending the file to a printer, the file will have the necessary CR and LFs for the PC. You do not need to run it through ADDLF.EXE.

## 8.3. XMODEM Transfer

To a QL:

There are a number of QL communication programs that support XMODEM transfer. For demonstration purposes I'll use QLterm.

Once QLterm is load on the QL and Z88COMM on the Z88, make sure both systems are using the same baud rate. Hook up the cables and we're ready to go.

On the Z88, select R for Receive Xmodem. Enter the file to receive, but do not hit return. On the QL, hit F3 to get into command mode. Enter XS for XMODEM Send, enter a file name, but do not hit return. On the Z88 hit return and then hit return on the QL.

As each block is sent, you will see the progress on both computers. Once the transfer is complete, QLterm will go back to Terminal mode, and the Z88 will switch to VT52 Terminal. On the Z88, hit the Index key and select Z88COMM and you are back where you started.

From a QL:

On the QL, hit F3 to enter command mode. Enter XR for XMODEM Receive, enter a file name and do not hit return. On the Z88, hit S for send XMODEM. Enter a file name, but do not hit return. Hit return on the QL and then hit return on the Z88. As each block is sent you will see the progress on each computer.

On the QL, QLterm will return to Terminal mode. The Z88 will enter the VT52 Terminal. Hit the Index key and select Z88COMM.

To a PC:

Load up a communications package on the PC. As stated above, I'll use Procomm as an example. Run Z88COMM on the Z88.

On the Z88 enter S for Send XMODEM. Enter the file name, but do not hit enter yet. On the PC, hit PgDn for Download. Select 1 for XMODEM, enter the file name and hit return. Procomm will wait for the transfer to start. On the Z88 hit return.

Z88COMM will print the total number of blocks needed to transfer the file and will start counting up blocks as they are sent.

Once the transfer is complete, Z88COMM will put you into the Terminal. Hit the Index key and select BASIC to return to Z88COMM. On the PC, Procomm will know that the file transfer is done and return to it's normal screen.

From a PC:

Load up the software on both machines as stated above. Once in Z88COMM on the Z88, select R for Receive, enter a file name and hit return. Z88COMM will wait for the transfer. In Procomm on the PC, hit PgUp for Upload. Select 1 for XMODEM, type in a file name, and hit return. The file will now be transferred.

Once the file is transfered, Z88COMM will again put you in the Terminal. Hit the Index key and the select BASIC to return to Z88COMM. On the PC, Procomm will return you to it's normal screen.

## 8.4. Quill to the Z88

One user came up with a neat idea of how to transfer a text file from Quill to the Z88. Using INSTALL\_BAS, set up a printer driver that uses preamble codes of ESC,N,ESC,F and post-able codes of ESC,E,ESC,Z. These are commands for the Z88 Import/Export application.

To transfer the text, enter Import/Export and select Receive and enter a file name. Now have Quill print the file. Once the file is printed, the post-able code will tell the Z88 that the transfer is done.

## 8.5. Macintosh File Transfers

Since I do not have a Macintosh, I have to rely on the work of others, primarily Dave Bennett.

When the Z88 first came out, it was marketed to Macintosh owners as a portable Mac. Since Mac people were used to being a little different, it was assumed that they would not mind a laptop that was sort of non-standard. Cambridge sold Z88MacLink to make Z88 to Macintosh file transfers easy. The software even comes with file conversion, allowing text and spreadsheet files to be shared between the Z88 and Mac.

Z88MacLink comes on ROM and can be bought with the Mac to Z88 cable. Once the two computers are hooked up, all work is done on the Macintosh. The Mac treats the Z88 file system as an additional disk drive (but a slow one). The program works with the typical Mac look and feel.

File conversion is between MacWrite and PipeDream, PipeDream and Lotus WKS files (which most Mac spreadsheets should be able to handle), and Z88 BBC BASIC and Macintosh BBC BASIC (probably available from England). There is a no conversion option for straight text files or for storing Z88 files on the Mac hard disk in native Z88 form.

File transfers between a Mac and Z88 do not need Z88MacLink. Any communication software should do the trick. The only advantages to Z88MacLink is it's ability to transfer multiple files at once, and the ease of use.

There are some Public Domain Mac/Z88 programs written by Richard Haw. All are available on GENie or from Dave Bennett.

They are:

ZX: a Mac to Import/Export (Z88) transfer program.

Z-Image: Enables the Z88 to display Mac graphics.

ZHyper: Enables the Z88 to interface with the Mac Hypercard program.

Dave Bennett's address is: 329 Walton St.(rear), Lemoyne, PA, 17043.

## 8.6. T/S 2068 File Transfers

Once again I have to rely on others to help fill in this area of file transfers. Again Dave Bennett supplied information, along with John Shepard.

There is no commercial software available to transfer files to/from the T/S 2068 and the Z88. Both computers will need to use some sort of communications program. It has even been suggested to use a BBS program on the T/S 2068.

Two methods of hooking the computers up have been suggested. The most obvious is hooking up the serial ports on both machines. The problem with this is that the T/S 2068 does not come with a serial port. A serial port board must be added. These can be bought from some Sinclair dealers, or one can be added to a T/S 2050 modem. I have not found any information that describes the pin-outs in making a T/S 2068-Z88 cable.

The other method is hook the two computers up with two modems. A phone line is linked between the two modems. One modem is put in ORIGINATE mode and the other in ANSWER mode. Once they connect, anything you type on one computer will be displayed on the other. Now files can be transferred using the built-in file transfer options in Z88COMM and something like MTERM on the T/S 2068. Textfiles can be tranferred by doing a data capture. This is a feature of most communications programs that store any text going to the screen, in a file.

One user reported that he could not get the two modems to talk without first hearing a dial tone. Not wanting to alter the two modems to fake a dial tone, he plugged a line from each modem into a RJ-11 Y adapter and then plugged the adapter into the wall outlet. Now each modem would get a dial tone.

## 8.7. Easy QL to Z88 Transfers

Phil Borman has written a QL program that fully understands the Z88 Import/Export protocol. The program allows batch send and receive of Z88 files on the QL. The Z88 file names are imbedded into the file so that when they are sent back, you won't need to re-enter the file name. Because the QL can handle a variety of characters in file names, the program can save the Z88 file to the QL disk with a real Z88 file name (RAM:/letter.doc). The program comes with about 6 pages of good documentation and is included on the Z88 Source Book disk.

## 9. DOCUMENT CONVERSION

There are some commercial programs that will convert PipeDream documents into Quill or other word processors. PCLink, MACLink, and the other commercial Link packages have this software. Without having this software, the best way to use PipeDream documents with other word processors is to use plain ASCII to get the document from PipeDream to the other word processors.

Most word processors support the importing of ASCII files. Some will import by line or by paragraph. Experiment how each word processor imports text files. If the file has extra blank lines, some word processors will not allow you to delete these lines once the document is imported. Each program is different.

Converting PipeDream spreadsheets to Excel or Abacus can be a little difficult. The numeric and text data should be able to convert, but the formulas will not. The formulas are not compatible.

## 10. RAMS AND EPROMS

Memory on the Z88 can be increased by adding extra RAM cards into the slots on the front. Each of the three slots can address up to 1 Meg of RAM. Slots 1 and 2 should be used for RAM and Slot 3 for EPROMS. Adding RAM in Slot 3 will consume more power, thereby reducing battery life.

There is an add-on chip that will increase the internal memory of the Z88 from 128K to 512K. 512K is the highest that the internal memory can be.

The latest version of the ROM is 4.0. It is supposed to fix a few nagging bugs left in version 3.0. To see what ROM version you have, while in Index, hit the MENU key and then the left arrow key. The version of the ROM will be listed, along with other information about software dates and copyrights.

#### *Inserting a RAM or EPROM Card*

1. Turn the Z88 ON and have the INDEX displayed.
2. Open the clear plastic flap covering the slots.  
The Z88 will give a short beep and go blank.
3. Push the RAM pack into the slot, making sure the writing on the front is upright.
4. Close the flap. The Z88 will come back on.  
To check that the card is working, type <> CARD.

#### *Removing an EPROM Card*

1. Turn the Z88 on and have the INDEX displayed.  
You must not have any suspended activities which are making use of the EPROM.
2. Open the clear plastic flap.  
The Z88 will give a short beep and go blank.
3. Remove the EPROM.
4. Close the flap. The Z88 will come back on.  
DO NOT REMOVE AN EPROM WHILE THE Z88 IS TURNED OFF.

I have found that removing a RAM card is not good for the Z88, it can cause it to crash or act very flaky. If you are going to remove a RAM card, back up your files, use the same procedure as removing a EPROM card, and then do a hard reset on the Z88. It will now recognize all of your memory.

## 11. TECHNICAL SPECIFICATIONS

#### *Memory Organization*

The Z88 is based on a Z80 processor running at 3.2876 MHz. The Z80 has a 16-bit address bus and can directly address 64K of memory. The Z88 can use up to 4Meg of memory by having 256 banks of 16K. The Z88 can address 4 such banks at one time. The 64K logical address space is divided into the following 4 16K segments:

- Segment 0: Logical addresses &0000 - &3FFF
- Segment 1: Logical addresses &4000 - &7FFF
- Segment 2: Logical addresses &8000 - &BFFF
- Segment 3: Logical addresses &C000 - &FFFF

BASIC's program workspace is arranged in the following manner:

```

----- &FFFF
| BASIC Interpreter |
|-----|
.
.
.
|-----| &C000 or &4000 HIMEM
|   Stack         |
|-----|
.
. Unused Memory   .

|-----| Current limit of HEAP
|   Heap         | LOMEM
|-----|
.
.
|-----| TOP
|   Program      |
|-----| PAGE &2300
| Workspace for Interp. |
|-----| &2000

```

Memory	Page #'s	What	Max	Used
00 - 1F		Internal ROM	512K	128K
20 - 3F		Internal RAM 5	12K	32K
40 - 7F		Slot 1		1024K
80 - BF		Slot 2		1024K
C0 - FF		Slot 3		1024K

When a Z88 has 128K or more RAM it becomes an expanded machine. Below are the differences between an expanded and unexpanded machine.

Property	Expanded	Unexpanded
Size of BASIC	40K	8K
Max Map Width	256 pixels	80 pixels
User Chars	64	16
Value of EOF	-1	0

Putting RAM in Slot 2 or 3 does not expand the machine (only 8K for BASIC) but does increase memory size. The unexpanded machine can use 64 user characters, but if an 80 pixel map is used the last 48 of these will be overwritten by map information when PipeDream is used. Reducing the map width to 64 pixels, or not using the map at all allows for free use of all 64 user characters.

## 12. EPROMS

One key note about EPROMs that I ran across that is fairly important to note: when putting (blowing) files on an EPROM energy consumption is acutally less than when you are regularly using the Z88. The extra power needed to blow the EPROM is balanced by the fact that the screen is shutdown when blowing the EPROM. Most people felt that blowing EPROMs was a battery draining effort.

## 12.1. Devices

These devices are listed in the User Manual, but they are kind of hidden. This is a good place to bring them up again.

```
:INP.0  the keyboard
:OUT.0  the screen
:ROM.0  the 128K ROM built in
:COM.0  serial port
:PRT.0  serial port (output only)
:NUL.0  unknown
```

To see the list of all devices on the Z88 (including additional RAM), in Filer select Catalogue Files and give a file name of :\*/ . Use a file name of :ROM.0/\* to see what appears to be a list of Z88 applications. Even though the use of :NUL.0 is unknown, I'll guess that it is similar in usage to the Unix device known as /dev/null. /dev/null is a device to send all your unwanted output to the proverbial bit bucket. If a program provides output that you don't need, you can redirect it to /dev/null and it will never appear.

## 12.2. Z88 Internals

If you were to open up your Z88 (don't do this lightly), here is what you would see:

There are four chips in the Z88. From left to right they are:

128K ROM

32K RAM

ULA - Uncommitted Logic Array. This chip is a specially made chip for the Z88. It replaces a number of stock chips. Sinclair/Cambridge is known for having ULA chips in virtually every computer.

Z80 CPU - This is a CMOS version for the Z88 that uses less power than a regular Z80.

Next to the ROM chip is the Supercap Capacitor. This is the power reservoir when changing the batteries. Below the expansion port is the speaker (see the small ring of holes on the back of the computer). Next to the ULA are the two eight-way keyboard connectors into which go the ribbon cables from the keyboard. Unlike the membrane keyboard of the Spectrum, ZX81 and the QL, the plastic molded keyboard actually conducts electricity and makes the electrical connection. Below the keyboard connectors are the two crystals used for timing.

## 12.3. AC Power Supply

The Z88 has a plug-in for an external AC adapter. When the adapter is plugged in, power is taken from it and not the batteries. The specifications for the adapter are:

6 Volts

300 - 500 milliamps

Positive center

Most Radio Shack stores or other electronic stores should carry such an adapter. The one that I use is a universal adapter. It lets me switch the voltage and the polarity. It also has 4 different plugs. Radio Shack has two adapters that will work with the Z88. The Universal AC adapter ( #23-1635HT ) plugs into an AC wall outlet.



The Universal DC adapter ( #270-1560HT ) fits into your car lighter socket and allows you to externally power your Z88 while you ride in a car ( I don't recommend doing much with the Z88 while you drive :-). If you need the DC adapter to reach further there is a 10 ft 12VDC extension cord (#270-1536HT). Even with the car turned off, the Z88 should not be too much of a drain on the car battery.

## 12.4. Batteries

Some have suggested using rechargable batteries in the Z88. The standard NiCad batteries do not put out enough umph to keep the Z88 up and going for too long.

One partial solution was to use 2 regular AA batteries and three special 1/2 AA rechargable batteries from Sanyo. They would put out a total of 6.2 volts, just over the 6 volts of new batteries. Some adapters are needed to make the 1/2 AA batteries fit into a recharger. Spacers with 90 Ohm resistors were made to fit batteries into the recharger. This is detailed in the first issue of PipeLine, the Z88 magazine put out for a short time by Tim Woods.

There is a new type of rechargable alkaline battery available called Rayovac Renewal. These are real alkaline batteries that can be fully charged up to 25 times. They will give you the full power you need, better than NiCad batteries. I've never used them, but I'm sure they are more cost effective than buying new batteries all the time.

The external AC adapter port on the Z88 is designed to take 6 volts, just like it gets from the 4 AA batteries. This means that almost any 6 volt power source could be hooked up to the Z88. This includes such sources as a 6 volt Gel Cell, a pack of 4 1.5 volt D cells (see next section), or even a solar cell that generates 6 volts. The electrically inclined can work up almost any device.

## 12.5. Z88 External Battery Box

As mentioned above, an external battery pack can be made for the Z88. I have built such a pack using 4 D cells. I could have used a large rechargable 6 volt cell, but I wanted to keep to using standard batteries. To get the 6 volts for the Z88, all I needed was 4 1.5 volt batteries. Most standard batteries (A, AA, C, D) are 1.5 volts.

I went with D cells because they were about the biggest I could get and did not cost that much more than C cells.

After looking at various electronic surplus places, I found that good old Radio Shack had exactly what I needed. Basically I needed a battery holder, a box to keep it in, and an adapter plug to fit the Z88. Below is the parts list for this project:

270-627	Experimenter Box (6.25"x3.75"x2")
270-396	D Battery Holder (6 Volt)
274-1569A	Coaxial DC Power Plug (male) 5.5mm OD
	2 Lead wire (same gauge as on an AC adapter)
	3/8" thick Foam Rubber
	4 Screws
	4 Rubber Feet

The battery holder does not fit square in the box it fits in at a slight angle. The box is plastic with a metal cover. I wanted to call the metal cover the bottom. Since it would be easier to mount the plastic battery holder on the plastic box than the metal plate, I mounted the battery holder upside down in the box with plastic model cement (use lots).

To let the lead wires out, I drilled a small hole near the top of one end of the box. (Since I put this all together upside down, it looked like I drilled near the bottom of the box.)

The two wires coming from the battery holder are not long enough to reach out of the box, so I ran the other wire into the box and attached it to the battery wires. To make a good connection, I twisted the wires together, put some solder on the joint, and wrapped them with electrical tape. To keep the wire from being pulled out of the case, I wrapped some electrical tape on the 2 lead wire so it would not allow the wire to be pulled through the hole.

The length of the lead coming from the box to the plug can be as long as you want. I went with a fairly long lead about 20 inches. I connected the plug to the other end of the 2 lead wire. The Z88 requires that the inner part of the plug is positive ( be sure to get this right or you might blow your Z88 ). It would be useful to use 2 lead wire with one lead marked ( usually with a painted stripe down it's length ). The positive lead coming from the battery holder is the red one. I soldered the wires on and then ran some electrical tape around between the two connecting points. I wanted to make sure that I did not get a short in the system.

Once I had this all hooked up I put the batteries in the holder and, using a multimeter, checked to make sure that I was getting 6 volts on the plug. Since the batteries were fresh, I was actually getting about 6.5 volts.

I did not want the batteries to fall out, especially since they were going to be hanging upside down, so I put in some foam rubber to support the batteries and the battery holder. I did not glue the rubber to the metal cover, since some glue will eat foam rubber, plus I did not feel a need to have the rubber mounted.

The screws stuck out beyond the cover and would scratch a table surface, so I got some stick-on rubber feet to prevent this. The metal cover is fairly tight and fits the box well. To make it easier to get the lid off, I created a small notch in the cover with a metal file. I did it just big enough to get my fingernail in and be able to pry the cover off.

Total cost for the project (not including batteries and wire) was under 7 dollars. Since I took my time to get everything right, it took me about 1 hour to build the battery box.

Exactly how many hours I will get out of the 4 D cells, I'm not too sure. I do know it will be far more economical than using lots of AA's.

## 12.6. Lantern Batteries

I've found two different types of 6 Volt lantern batteries. The first is a square battery about 1.5 inches per side and about 2.5 inches tall. The second is about the same height as the first but about 3.5 inches wide ( like a tall brick). These batteries have either little springs or metal poles for the positive or negative leads.

Since they are 6 Volt, they are perfect for the Z88. What is needed to hook them to the Z88 is:

- DC Power Plug (same as mentioned above)
- 2 lead wire (same as mentioned above)
- Micro Alligator Clips

Solder the DC power plug to the wire the same as above. Then solder the micro alligator clips to the wire.

Be sure to mark which wire is positive and negative. You can buy color coded alligator clamps, but I prefer to mark each wire with some tape and the + and - symbol. This way I don't have to remember that the red lead is positive (or is that negative). Now just hook the clamps to the battery and plug into the Z88. I have no idea of how many hours you will get out of either battery (I'm guessing its lot's). If you can't find these batteries, try a local camping/outdoor store. They should have them.

## 13. CARE OF THE Z88

### 13.1. Cleaning

After having the Z88 a short time, you will probably notice that the keyboard seems to attract dust like a magnet. It's not easy to keep clean. I've heard some discussions on how best to clean it.

Some have suggested using a Q-tip and plain water. I like to use a Q-tip and rubbing alcohol. Others have suggested using a vinyl protectorant like Son-Of-A-Gun or Armor All. I don't know how these will affect the keyboard, so use at your own risk.

Just don't plan on keeping the keyboard clean always. Just a few days after I cleaned mine, it looked like I had never cleaned it.

As for the screen, ideas range from blowing on it, using compressed air, using tissue, and using the same stuff you use to clean a pair of glasses. I find a tissue and some clean water to be good enough.

There was mention of how sunlight affects the Z88. It seems that sunlight heats up the screen and takes more power to make the letters dark. Just blocking the screen from direct sunlight should fix this.

I have no concrete numbers on the temperature range that the Z88 can handle, but I would guess that it should not be allowed to get too hot or too cold. Leaving it in direct sun in a parked car is a definite no-no. I have read that letting a LCD panel get below

freezing causes bubbles in the panel and perminately damages the panel. Don't leave your Z88 in the car overnight in the dead of winter.

If the keyboard seems a bit sluggish or non-responsive, it could be the fault of the membrane beneath the keyboard being dirty. The entire rubber keyboard can be taken off and cleaned underneath. Do this at your own risk and don't do it during any warranty period.

The Z88 has been known to crash when having a constant pressure on it's keyboard for a long time while it is turned off. I've only experienced this with a Z88 that had other problems, but not my current Z88 (I have not tested it). I've picked up a "Topper" to prevent this from happening (see products below). The "Topper" is a plastic cover that fits over the Z88 and protects the keyboard and screen.

Of course, one of the biggest no-no's with the Z88 is dropping it. I do not know how much shock the Z88 is designed to take, but I doubt it is very much. The screen would probably be the first item to be damaged. LCD screens are fairly fragile and do not take well to being dropped. The motherboard can probably take a fair amount of shock. The biggest worry about the motherboard would be a drop on the edge of the Z88. This might cause some fair amount of cracking in the case and motherboard.

## 14. TRAVELING WITH THE Z88

I carry my Z88 as part of my briefcase. With it I carry a few extra items.

Batteries: Since it's hard to tell when the batteries will go out on me, I like to keep a set of fresh batteries around. It is nice to know that I can quickly pick up more batteries if I have to. In reading one book on laptops, one contributor mentioned that traveling with a laptop that used off-the-shelf batteries was better than traveling with a laptop with rechargeable batteries. Most off-the-shelf batteries are available almost anywhere in the world. With rechargeable batteries, you need to have a converter to plug the recharger into the local electrical system (which can be quite odd in some countries).

External Battery Pack: Since I sometimes use my modem with the Z88, I often find places where there is room to plug in the modem and a lamp, but not the Z88 AC adapter. The external battery pack is great for this. It is also good to run the Z88 almost anywhere for extended periods of time.

AC Adapter: Since I want to make the batteries last as long as possible, I like to use the AC adapter when I can. Especially if I am using the serial port, as this is one of the major power drains for the Z88.

Cables: I always carry a Z88-PC cable so that I can transfer any documents to/from the Z88 and my PC at work. I never know if I have to use my Z88 to keep meeting notes. Sometimes I carry a serial printer cable just in case I need to use a printer while on the road.

To keep the cables wrapped up fairly small I needed some cable ties that were reusable. Most cable ties are for single use only so they were out. I made my own cable ties by sewing two pieces of velcro together, hook on one side and pile on the other. When used, the inside pile will grip the outside hook (or vice versa). My wife's sewing machine could not handle the thick thread and the tough velco, so I had to do the sewing by hand. With a little patience I was able to make enough cable ties.

Procomm: Since most places have PCs, I like to carry a copy of Procomm on 5 1/4 and 3 1/2 disks. With the cable and software, I have all that I need to transfer documents.

Modem: I use the modem to dial into my Unix system at work with my Z88 so I can read my mail while I'm on the road.

Printer: I have an older Diconix inkjet printer that works with the Z88. Once I get it repaired I plan to carry it with the Z88.

Here are some other items to take into consideration when traveling with the Z88:

- Theft of the Z88. The main reason I bought the Z88 was because of it's size and weight.

This also means that it can be stolen fairly easily. Don't leave your Z88 just lying around. Besides the physical theft, having your Z88 stolen means that your files go with it, too. You no longer have access to those files, which can be critical if they were important to you. It also means that the thief now has your files. I doubt anyone will be keeping state secrets on a Z88, but this is something to consider.

- Lighting. Since the Z88 has no backlit screen you will need a light source wherever you use the Z88. Buying a laptop light will solve this problem.

- Airport Security. I keep my Z88 in my brief case when I pass it through airport security. So far no one has asked if I was carrying a laptop. When traveling with another laptop, I was asked to turn it on so they could see that it worked and was not a bomb. Just because I was not asked to turn my Z88 on, don't expect to be so lucky. Be ready to take it out and turn it on. There is also the worry about the X-rays from the scanner zapping the Z88. I've heard from a lot of people that the X-rays are fairly harmless. Your biggest worry is the motors driving the belt in the scanner. But, if you are concerned, take out your Z88 and ask for a hand laptop check. Airport security should be used to this.

## 15. EXTERNAL SERIAL DEVICES

If you are taking your Z88 on the road, it would be nice to also have a printer and/or modem. There are a number of portable printers and modems on the market that are designed to work with any laptop with a serial device. There are a couple of good magazines devoted to laptop users, like Portable Office and Mobile Computing, and carry ads for a lot of portable printers and modems. Check your local newsstand or library.

## 15.1. Printers

Most portable printers are battery powered and can be used anywhere. The only one that I've used is the Kodak Diconix ink jet printer. It's printer quality is just a bit better than normal dot matrix. Most portable printers will be of the ink jet type.

For serial printers, a Z88 cable can be made or bought for the Z88 (see the pinout listed earlier). For parallel printers a serial to parallel cable can also be bought. For QL users, the Miracle Serial to Parallel adapter will also work with the Z88. This adapter is designed to work on either SER1 or SER2 of the QL. Luckily it also works just fine on the Z88. Since I already had this adapter for my QL, I was really happy that it worked with the Z88. One less cable to buy.

If you don't want to carry a portable printer or can't afford one, then there are ways to be able to print while on the road. Carry a serial to parallel cable and a regular serial (9-25 pin) cable so that you can print to almost any printer. If you are staying in a hotel, ask them if they have a printer you can use. You could also carry cables to download the file to a PC and then print out. There are a number of commercial services that offer short term rental of computers and printers. MailBox Etc. and Kinko's usually have self-service computers and printers. Other copier places might have them.

## 15.2. Modems

There are a variety of modems called "pocket" modems. These are modems that plug directly to the serial port and are powered by a 9-volt battery. I have even heard of one that uses the power from the phone lines. Hooking one of these to the Z88 will require a small adapter cable but this need not be too long. There are even some battery powered FAX/modems available. Make sure that you get a plain text Fax modem. Most fax modems require input data be in the form of a CCITT Fax 3 image format. Some fax modems will take plain text, convert it to Fax 3 image format and send it. Check any of the more popular computer magazines for more info on small modems.

Using your modem on the road is getting easier. Some hotel rooms have data jacks built into the phones. For those that don't, the phones are on RJ-11 jacks, instead of being hard wired into the wall. Beware that the phone jacks might be in an out of the way place, like behind the headboard of the bed. Be sure to carry some length of phone wire and a female-female connector so you can hook together two phone lines. Pay phones are starting to have data jacks in them.

The newer credit card-only phones should have data jacks. Don't expect the phone in the phone booth to have data jacks. If you plan to use these type of phones, there are some acoustic handsets available that end in an RJ-11 jack.

In some of the "standard" laptop magazines I've read some discussion about hooking up modems to digital phone lines and how they can destroy your modem. When talking about digital phone lines, the topic of PBXs comes up. I don't know the specifics of digital phone lines and exactly why they would zap your modem, but there are a few products on the market that plug into the phone jacks to confirm that

they are in fact non-digital and are safe for your modem. These devices are not cheap, so you may want to research it further before buying one of them.

### 15.3. Other Serial Devices

The Z88 should be able to hook up to just about any serial device. The key factor is this, the serial device should not expect any special driver software to run on the computer. Things like scanners require software on the computer to convert the graphic image to text. Without this software, the scanner is only good for graphics. Even with this limitation, there are a number of serial devices that can be hooked up to the Z88.

One such device that I have is a speech converter box, originally designed for the QL, but since SER2 on the QL is almost wired exactly the same as the serial port on the Z88, it interfaces just fine. The speech box expects to receive ASCII text, just as if you were sending the text to a printer. The box then converts it to speech and you hear the results coming out of the speaker. I don't use it much, but it's kind of fun to play with. If a person were blind, they could have the Z88 read through a text file and output it to the speech box so that it could be heard.

## 16. TELECOMMUNICATIONS WITH THE Z88

One of the greatest limiting factors about the Z88 is the 8 rows of display. If you are dialing into a remote system they usually assume that you have 24 rows. And the VT52 terminal the Z88 emulates is defined as having 24 rows. When dialing into a Unix system, I have found a way around this limitation. Using the command "stty rows 8" I tell my Unix box that I now have only 8 rows of display. It will then give me formatted output in chunks of 8 rows at a time. This allows me to use vi (a Unix text editor), more, and read my Usenet News with my Z88.

### 16.1. Using Telecommunications to Save Files

I've done a few dumb things with my Z88 that have caused me to lose all of the files stored on it. Things like putting the batteries in backwards can have disastrous effects on your files. I would like to have a Z88 disk drive so that I could back up files to disk while I'm on the road. The cost of a disk drive has prevented me from doing this.

Since I have a modem and dial into my Unix account at work, I have figured out that this would be a good way to back up my files. When I have a file I want to back up I dial into my Unix account and upload the file to it. It may take a bit to transfer, but I will now have a copy of the file saved in a safe place. This does limit me to sending text-only files (no formatted PipeDream documents), but I can live with this limitation.

## 16.2. On-Line Services with the Z88

On-Line Services are the new hot topic in computers. America Online, Prodigy, Compuserve, Delphi, and GENie are all vying to get you to connect to their service to connect to the rest of the world.

Unfortunately, most of these services require that you use their special communications software that makes the most of their service. Of the major On-Line services, I believe that Compuserve is the only one still providing the old text-only interface.

## 16.3. Z88 and the Internet

### *Internet Services*

The Internet has a number of ways of getting information:

#### World Wide Web

Also known as the Web or WWW, the World Wide Web is accessed using a Web Browser. Data is in the form of documents, graphics, video, sound, etc. The interface is mouse driven and has "hot links" which when clicked on bring up another Web document/page.

#### Gopher

Kind of like the Web but uses a menu interface similar to that used by a BBS. The original Gopher interface was character based, but graphical ones were developed. Gopher has almost been taken over by the Web.

#### Telnet

Allows you to connect or login to another system and start using it. Connecting to a BBS is kind of like telnet-ing.

#### FTP - File Transfer Protocol

Allows you to transfer files to and from another computer. It only allows commands like GET and PUT. Does not allow you to run an application on another computer (like Telnet does).

#### Finger

Finger is a protocol/application that queries another computer for information about a person on the computer. Some people have useful information that is returned via the finger command.

#### Mail

Electronic mail is one of the primary reasons for getting on the Internet. Letters can take minutes instead of days to get where they are going.

#### USENET

USENET is kind of like the Internet News Service. It's a loose collection of computers sharing messages that their users write. USENET sends articles or "postings" around the world.



## *How to do this on the Z88*

With a little effort you can get your Z88 to access most of these services. The key thing that allows this for the Z88 is a VT52 terminal (emulated on the Z88 via Terminal). VT52 is not as popular as the VT100, but most Unix systems will support it.

To make all this work you will need to get a Unix account on a computer someplace. A number of local Internet Providers allow "shell" accounts. The Unix shell is what gives you a command line prompt (like QDOS or MS-DOS). Once you have access to your Unix account from your Z88, you are on the Internet.

### Accessing Web

There is a text-only Web browser called Lynx. I've tried it and it will support VT52, but it has a few problems. The biggest one being that because VT52 does not seem to support inverse characters, you do not know which "hot link" you have moved to. You use the Tab key to move from hot link item to hot link item. If you count the number of tabs and the hot links, you should be able to figure out where you are.

### Accessing Gopher

There are some text only gopher browsers. If one is executed off of your local system, it should understand that you only have 8 lines of display (see the STTY command mentioned above). If you are telneting to a gopher browser, then it will assume that you have 24 lines of display.

### Accessing USENET

USENET readers are mostly text-only and should be able to handle having only 8 lines of display. I use NN and it works just fine. Other readers are TIN and RN.

### Accessing Mail, Telnet, FTP, Finger

All of these services do not depend on having a certain type of display. They will scroll the data down the screen. These services are suitable for use with the Z88.

To use Lynx and Gopher, make sure your Internet Provider has these installed on your host. Even without them, there are ways to access the same information. Even with just an e-mail only account, a number of these services can still be accessed. Below is a list of more interesting sites for services.

### Telnet:

Archie ( a way to look up stuff available on FTP servers.)  
telnet archie.sura.net  
telnet archie.unl.edu

Newspapers Online  
telnet kanga.ins.cwru.edu

Weather Services  
telnet downwind.sprl.umich.edu 3000

### Gopher:

Catalog Mart  
gopher catalog.savvy.com

Census Information  
gopher gopher.census.gov

Currency Exchange  
Gopher caticsuf.csufresno.edu

Electronic Journals  
gopher gopher.eneews.com

Finger:

Almanac of Events  
finger copi@oddjob.uchicago.edu

Earthquake Info  
finger quake@gldfs.cr.usgs.gov

NASA Headline News  
finger nasanews@space.mit.edu

Mail:

Archie via E-Mail  
mail archie@archie.sura.net  
(with Subject of help)

Fax via Internet (send a fax via e-mail!!!)  
mail tcp-faq@town.hall.org (info)  
mail tcp-coverage@town.hall.org (where you can fax)

FTP via E-Mail  
mail ftpmail@decwrl.dec.com  
(in body of message put help or ftplist)

Finger via E-Mail  
mail infobot@infomania.com  
(with Subject of #HELP)

Gopher via E-Mail  
mail gophermail@calvin.edu

This is just a small listing of what is available. The key thing to get is that with a Z88 you can still reach a large percent of the information available on the Internet.

## 17. DOING THINGS WITH THE Z88

### 17.1. The Z88 as a PDA/PIM

The terms Personal Digital Assistant (PDA) and Personal Information Manager (PIM) have been used a lot in the press. A PDA has been used to define what is an Apple Newton or Psion Series 3. It can be considered to be a small hardware device that performs tasks like scheduling (with alarm), phone number list, etc.. Some PDAs are more limited (like the Casio Boss, or Sharp Wizard) where as some are more open ended (Newton and Series 3). A PIM is usually a piece of software for a standard PC that performs similar functions as a PDA.

After looking at my Z88, I've noticed that it seems to fall within the definition of a PDA. The Calendar, Diary, and Alarm applications can be used together to set up a nice time schedule and reminder. The Diary allows you to keep track of schedules by day and allows you to insert comments or memos about the day's events. Zipping between days is fairly fast with the Calendar.

## 17.2. Using the Z88 in a Home Office

One trend that I've been interested in in the last few years is the Home Office. A Home Office is a room or section of a room set up to do office-like work. It can be designed for doing office work at home, running a business out of your home, or keeping your personal/home life organized like a business. With the complexities of taxes, investments, home ownership, etc., your personal life is starting to look like you are running a business.

The Home Office is centered around a computer, it's software, and it's peripherals. Most Home Office computers are configured just like their counterparts at the office. There are also Home Office designed "appliances" like fax machines, answering machines, small copiers, etc.

The Z88 can be fairly functional when used to run a business or home. It's word processor is adequate for most uses. It's spread sheet can be used for most spreadsheet needs.

For the applications that are not built into the Z88, the BBC Basic facility allows you to write your own application. They don't need to be too fancy, just make them functional enough to do the job. Remember, short Basic programs take up less space than longer full-blown ones, and space is at a premium on the Z88.

Although I would not have a Z88 take on a full blown 486 system, it can still do well, despite it's limitations. If you only have a Z88, file storage can be a problem. EPROMs can get mighty expensive and Z88 disk drives are not exactly cheap. I feel the Z88 works best with another computer to be used as a file server. Dumping Z88 files on another computer keeps important files backed up and can free some much needed memory in the Z88.

The advantage of the Z88 is that your office computer can go with you on the road. If you have a tendency to travel, having your Z88 along will allow you to keep right on working.

If you are interested in Home Offices, there are a number of books out on the subject. One good one that covers more non-computer related items is "Organizing Your Home Office for Success" by Lisa Kanarek. It spends a lot of time discussing how to keep yourself organized. It does cover computers, but only at a more general level. One good magazine is "Home Office Computing." It covers PC's and Mac's, but also has some general information tips. Part of the fun is figuring out how to adapt what you read in the magazines to the Z88.

### 17.3. Things to Remember When Using The Z88

The Z88 comes with a few limitations besides the obvious ones. Keeping these limitations in mind should help in keeping a harmonious relationship with your Z88.

- Be Aware of Memory Constraints.

Unless you splurged on a couple 1 Meg add-ons, your Z88 memory can be a little cramped. Try not to do anything that would eat up a lot of memory. Don't make back ups of your Z88 files on the Z88. Put them on another computer or on disk.

- Use Short Hand Notations.

In using an application like the Diary, use short hand notations to stand for your more common phrases. P: can mean Phone, W: can mean to write a note or letter, F: can mean to send a fax, and FU can mean to Follow-Up. Notations like these can save bytes here and there.

- Back Up Often to Disk or another Computer.

The Z88 memory is volatile. One wrong or stupid move and ZAP, everything is gone. Back up your important files almost daily to either disk or to another computer. If you are using your Z88 for business, it is even more critical to back your files up (at least those that have changed since the last backup).

One little confession to show you how easy it is to ZAP your Z88. When the battery low warning came on, I grabbed my spare batteries, opened the back of the Z88, took out the old batteries, put in the new ones, buttoned it back up, and set the Z88 off to the side for a while. The next time I went to turn it on, it would not turn on. The reason: I put the new batteries in backwards. Result: I lost two important files. It can happen to you.

### 17.4. Tips that apply to Using the Z88 As a PDA/PIM

- Make Time to Use Your Z88 to Manage Your Time.

If you are going to use the Z88 to help manage your life, job, or business, take the time out of every day to update your Z88 for what happened today and prepare for the next day. Make sure to add all of the items on your schedule. What good is a personal management system if you don't use it

- Find a Good Time Management Book

Getting a hold of a good time management / personal planning book can help you get the most of using your Z88 as a PDA/PIM. You need to build a management system and use the Z88 to help automate that system. The Z88 can not create the system for you.

## 18. SOURCES

### 18.1. Suppliers

#### FDW Computing

Frank Davis  
513 East Main St.  
Peru, IN 46970  
(317) 473-8031  
fax 472-0783

#### W. N. Richardson & Co.

6 Ravensmead  
Chalfont-St-Peter  
Buckinghamshire, SL9 ONB  
UK

#### Rakewell Ltd

24 Putnams Dr  
Ashton Clinton, Aylesbury  
Buckinghamshire, HP22 5HH  
UK  
+44 (0) 1296 630 617

#### Interlogic (Gunther Strube)

GL. Kongevej 37, 2.TH.  
DK-1610 Kobenhaven V  
Denmark

#### Woodward Technology

P.O. Box 15  
Belper, Derbyshire  
UK PE56 OXE

#### Domino Cubes

Mike Fink  
352 7th Ave, 15th Floor  
New York, NY 10001

#### Roy Wisti

135 Sheldon Rd  
Voluntown, CT 06384

#### Ranger Computers Ltd

Ranger House  
2 Meeting Lane  
Duston  
Northampton NN5 6JG UK  
Fax (44) 604 589505

#### The Music Suite Ltd.

Cenarth  
Newcastle Emlyn  
Dyfed SA38 9JN UK

QHJ Freeware  
c/o Tim Swenson  
5615 Botkins Rd  
Huber Heights, OH 45424  
(513) 233-2178  
swensont@mail.serve.com  
Distributes both QL and Z88 Freeware

## 18.2. Repair/Parts

Computer Classics  
Dan Elliott  
RT 1, Box 117  
Cabool, MO 65689

All Electronics  
1-800-826-5432  
Z88 Screens \$16  
Part # LCD-28  
(These screens have been tested by a Z88 user)

## 18.3. Magazines

UPDATE Magazine  
P.O. Box 17  
Mexico, IN 46958

## 18.4. User Groups

The Z88 User's Club is no longer around.

## 18.5. BBS's

There was one BBS run by Phil Wheeler, has not been around for a number of years. At this time, I know of no BBS's specializing in the Z88.

## 18.6. Internet Resources

Anon-FTP:  
sun.soe.clarkson.edu (128.183.12.3)  
/pub/z88  
ftp.unit.nvg.no  
/pub/sinclair/z88

USENET  
comp.sys.sinclair

Web Pages  
Z88 Developers Notes v. 2  
<http://www.cl.cam.ac.uk/users/jrh/devnotes>

Z88 Forever Page  
<http://members.aol.com/Z88Forever/Z88home.htm>

Tim Swenson's Page  
<http://www.serve.com/swensont/>  
Z88 Source Book, Z88 Mailing List

Timothy Swenson  
[swensont@mail.serve.com](mailto:swensont@mail.serve.com)  
[tswenson@dgis.dtic.dla.com](mailto:tswenson@dgis.dtic.dla.com)

I (Tim Swenson) am keeping an up-to-date list of Z88 users with Internet access (this includes such on-line providers like Compuserve, GENie, etc). Please send an e-mail message to one of the above addresses and I will send you the latest list. If you wish, I can add you to the list. This list is designed to work like a phone book and is not a "true" mailing list or LISTSERV.

## 18.7. General Laptop Book

The book "The Complete Laptop Guide" by David Rothman is a good source for general laptop use. It focuses mostly on MS-DOS and MAC portables, but it has a couple of chapters applicable to all laptop users. These sections include traveling abroad with a laptop, getting your laptop through customs, telecommunications, on-line sources, and the basics of electronic mail.

## 18.8. Z88 Rumors and Tid Bits of Eclectic Information

This section is designed to cover the more interesting bits of the Z88 and who has used it.

### *Famous Z88 Users*

Douglas Adams - Writer of the famous "Hitchhiker's Guide to the Galaxy" books. He mentions the Z88 in his book "Last Change to See."  
Teller of the magic troupe Penn & Teller (serial # 034862).  
Marvin Minsky - Creator of Artificial Intelligence and LISP.

Jerry Pournelle - Science Fiction writer and columnist for Byte magazine.

Mel Torme - Jazz Singer.

Stan Veit - Senior Editor Emeritus of Computer Shopper Magazine and owner of one of the first computer stores in NY.

### *Z88 Rumors*

Rumor has it that the Z88 sparked the Apple Newton. The rumor says that a number of Apple execs were in a meeting when they all noticed that they were using Z88s. They wondered why they were not building something like it. This rumor may have some truth, since the Z88 was fairly popular with Mac users. They did not care that it was not PC (MS-DOS) compatible and they were used to high prices. (The Z88 was not real affordable when it first came out.)

Rumor has it that a Z88 was seen on the NBC TV show "Night Court" being used by Judge Stone ( Harry Anderson). The person that saw the episode remembers seeing a sleek black little laptop on the judge's bench.

## *Z88 Emulator For MS-DOS*

A Z88 emulator for MS-DOS is being worked on. I have received a copy of version 0.2. I have tried it out and it seems to work fairly well. There are still a few bugs in the system. It is not what I would call fully working. Once you leave the editor, all files stored in the emulator are lost. There is not way to save files to disk. When you start up the emulator, it does a hard reset. The author is working on this problem along with many more. You can contact the author at jeroen@login.iaf.nl. A copy of the current version of the emulator is included on the disks.

## 19. Z88 PRODUCTS

This section is an attempt at a comprehensive list of products that are/were available for the Z88. Those listed with a \* are known to be available from one of the above dealers.

### 19.1. Z88 Development Kit

[the following section is taken verbatim from Gunther Strube]

Since day one of the Z88, good developers software have been missing. However, a handful of software companies still managed to produce software; Wordmongers, Rakewell, Ranger Computers, Computer Concepts and a few others. They all probably had to use cross assemblers (either programmed by them selves or obiquious versions of old CP/M Z80 assemblers). Further, to blow the software on EPROM's, they were probably using a PC with EPROM programming hardware and a special Z88 EPROM card adapter. All in all a very difficult task which only professional companies could afford to obtain. Programmers with good application ideas but no cash have always been left in the cold by Cambridge Computer.

The only development environment was the limited inline assembler of the BBC BASIC standard application on the Z88.

Cambridge Computer never produced any high level language compilers, nor Z80 assemblers, only notes about the operating system. In fact these notes were in the first year only available to third party dealers who had to sign a non-disclosure agreement before getting a copy. In '91, four years after the birth of Z88, Cambridge Computer released the V2.0 of the Developers' Notes, a slightly improved version of the bug intensive first release 0.93. With a promising detail - they were going to supply a cross assembler with source files examples and modified RAM cards to produce applications. But shortly after this release, Cambridge decided to stop everything about Z88. The Developers project was dumped. Mathew Soar, the person responsible for the software, stopped working for Cambridge just before their move to Scotland. He managed to send the very first internal release of the "Z88 application Cook book" documentation to Vic Gerhardi of Rakewell Ltd. before leaving the company.



Vic lent me the copy recently (mid '95) - and sad to say the documentation referred to a cross assembler available through another company - if you could pay 100 pounds! The booklet only explained briefly how to compile Z88 software with a few examples and a reference of macros to 10ease programming. Nobody at the time would have paid that price anyway.

All in all there has never been any software for developers, except documentation of how to write programs for the operating system. I think this is the main reason for the very quick death of the computer. A computer with no new interesting software is an almost obsolete computer. I began my own developers project in '91 due to the frustration of not having any developers software for the Z88. I believed that to prolong the life of the Z88 it was necessary to have a set of software tool for programming application for the Z88. At the time the Z88 User's Club still were running successfully and it seemed to have an interest in keeping the Z88 alive. I believed in that and began the work. The basic idea of my software was to develop everything on the Z88 itself, with an additional help of a cross assembler on a stationary computer.

#### My story

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I have become a programmer with an interest for operating systems and nice programming languages and algorithms. As with many others, my interest began with ZX80 in primary school. Since then the ZX81 and Spectrum. With the introduction of the QL I was bitten by the elegant design of the operating system and beautiful visual design of the computer. QL is still my main machine (ported on the ATARI range of computers using the wonderful port by Tony Tebby, the designer of the original QL operating system QDOS).

I was lucky to get a job on the basis of my QL experience at Dansoft, the danish QL agent. Imagine that - your hobby has become your professional life!

At Dansoft we were working on the first QL clone - the CST THOR PC. We managed to develop a genius piece of software for the THOR to receive and manage news from the danish news agency Ritzaus Bureau. It was the first news program ever made on a personal computer. Even the ministry of state became our customer!

In '88 I was part of the team which made a danish version of the Z88 computer. In our collaboration with Cambridge Computer we managed to get one of the best versions of the operating system for our danish issue. The filing system even allowed ISO characters in filenames and we had a PipeDream application which could sort our danish characters in the correct order. No other foreign Z88 version were able to do that. I also translated the english manual with extensive additions. The Z88 became my favorite (portable) computer.

Since then I have been using the Z88. At the time we were extremely frustrated over Cambridge Computer's bad marketing strategy with no dealer support at all. I believe the Z88 could have been a much better and more popular machine if Cambridge would have investigated into further improvements of hardware and software of the Z88.

Due to the lack of developers software for the Z88 I have since '91 been working on my own developers project in spare time. Many months have gone by without any work on it. However, the software is now completed (late '95). However, time and mass market Z88 users have more or less gone with a good number of dedicated users spread around the world.

The good news

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All is not lost, though. The last stock of Z88's (about 4000 new computers and peripherals) are now being sold through Rakewell Ltd. and Bill Richardson of EEC Ltd. at very cheap prices. 99 pounds for a brand new Z88 and 120 pounds for a 1MB RAM Card! Many new users have already bought it...

I believe it to be the last opportunity for a new market of software development for the Z88.

10 I hope my software can contribute to a better software base for this nice little computer.

The Z88 Assembler Workbench

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This is the complete developing, testing and production software package for Z88 EPROM applications. You only need a Z88 to get started. Price of software: 150 DKK (about 15 pounds).

To obtain the software, a 128K EPROM must be sent to me. Application software will be blown to EPROM and returned to you.

You also get 720K discs containing:

- o Z88 Assembler Workbench documentation in PipeDream file format,
- o source files comprising native Z88 assembler application,
- o FFRREE executable Z80 cross assembler with ANSI C source files,
- o FFRREE standard routine library with corresponding source files,
- o FFRREE Z88 operating system manifest header files,
- o FFRREE Z88 Developers' Notes V3.
- o FFRREE OZ call definitions as on-line help for QD editor users (QL only)

\*\*\* PLEASE SPECIFY EITHER IBM OR QDOS DISC FORMAT. \*\*\*

Further, as an available option, we produce a write-protected

RAM card (emulated EPROM) for easy software development. The price is 150DKK. Please refer to (4). You have to send one of your own RAM cards.

I accept cash payment or cheque drawn on a danish bank.

Send order with EPROM/RAM Cards to:

Gunther Strube

Gl. Kongevej 37, 2.th.  
DK-1610 Kobenhavn V  
Denmark

If you have any questions, just mail me on <gunther@inet.uni-c.dk>

THE Z88 ASSEMBLER WORKBENCH EPROM EXECUTABLE APPLICATIONS WITH  
PIPEDREAM DOCUMENTATION ARE COPYRIGHT INTERLOGIC 1995. ALL OTHER FREE  
ITEMS ARE PUBLIC DOMAIN (InterLogic still holds the intellectual  
copyright).

The nitty gritty details of the package:

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<1> Module Assembler, native executable application on Z88 with  
integrated on-line help. Contains all the functions of the cross  
platform versions.

<1.a> Executable Z80 cross assembler on Intel PC, QL computers.  
The object file output of the assemblers is inter-platform  
compatible. The object file format is defined in the documentation.  
The Z80 cross assembler is supplied with free source files (written  
in the ANSI C language). The cross assembler is currently ported to  
MSDOS, LINUX and QDOS/SMSQ operating systems.

Z80 machine code source files to be compiled by the assemblers may  
be written in any editor on any computer. All line feed standards are  
supported on the Z88 native application assembler (CR, CRLF or LF).  
Cross assemblers convey to platform line feed standards.

The assemblers support modular file design with compilation of only  
updated source modules. All necessary identifier scoping rules have  
been applied. Linking object modules and code generation is an  
integrated part of the assemblers. Symbol-, Map- and Listing file  
output generation. Optional relocatable code generation (relocation  
program header and patch table added to code). Fast compilation:  
28000 lines pr. minute on 386 40Mhz Intel hardware.

The assemblers also support library file generation and library  
module inclusion into application code. A standard library file is  
included with the assemblers. The assemblers also support the famous  
non-documented Z80 instruction mnemonics.

<2> Debugger. Runs Z80 code both in RAM and EPROM! The  
debugger is supplied in four versions:

<2.a> Segment 0 file version (addressed for \$2000). This version  
enables you to single step in the Z88 operating system!

<2.b> Segment 1 file version (addressed for \$4000).

<2.c> Segment 2 file version  
(addressed for \$8000).

<2.d> Z88 debugger application version with 40K runtime  
application memory (equivalent to extended BBC BASIC application  
memory) and integrated on- line help. You can load machine code files  
into this application memory and issue all the necessary debugging.  
2.a to 2.c are made for inclusion on EPROM application cards. You  
simply allocate a bank for the debugger in your application system  
data structure header and call the debugger from the application  
code. The Z88 operating system automatically manages both the  
debugger code and application code (as any other external ordinary  
application EPROM). When the debugger is called it takes over control  
over the application and is still pre-emptable towards the rest of

the Z88 operating system. The Z88 doesn't see this and just executes the debugger (and indirectly application) code. When necessary, the debugger may be released from monitoring. The application will then be executed at full speed. The debugger contains all necessary features: single stepping, register dump, memory dump, disassembly, break points, keyboard break and much more. A special feature is to manipulate 256 individual CLI log files (screen output to file memory). The average debugger speed of executing Z80 instructions is about 11 times slower than the native Z80 processor.

<3> EPROM programming software to produce application cards, using slot 3 hardware on the Z88. Includes also commands to edit/view memory and EPROM card banks. Integrated on-line help for all commands and related topics. Special features are implemented to support loading of software into the modified RAM card. Even includes commands to clone application cards.

<4> A modified RAM card (implemented with read-switch) with magnet to emulate EPROM. The test software is dumped into the RAM card (write-enabled with magnet) and then write-protected (magnet removed for write-protection). Thereby you avoid tedious EPROM blowing and erasing during software development.

<4.a> In order to get a modified RAM you have to send us one of your own cards. All sizes may be used (32K, 128K, 512K and 1024K). I use a professional electronics engineer to make the modifications. A magnet is supplied as well. The price to do the work is 150DKK inclusive magnet. Please note that you cannot use it as a conventional RAM card afterwards, unless the magnet is mounted all the time!

The write-protected RAM card is not necessarily needed to develop EPROM application software, it just makes it much, much easier.

<5> File transfer software. PC-LINK II compatible, but capable of double speed transfer and on-line ASCII translation. Client program for PC or QL is part of the file transfer software package.

File transfer also supports multiple files in multiple directories, in both directions.

<6> FFRREE Developers' Notes V3 in PipeDream files (550K). Many improvements, e.g. new documented low-level calls not previously available. Better cross referencing, V2.0 text improved. Organized for easy downloading on Z88 for on-line documentation during software development.

<6.1> FFRREE Z88 operating system manifest header files. All definitions contained in the Developers' Notes V3 are stored as text files, ready to be included by your assembler source files for compilation.

<7> About 80 or more useful library routines for application development. You will find routine for managing dynamic data structures (balanced binary trees), easy memory management (allocation/de-allocation), complete set of PipeDream map graphics functions to plot & draw lines, scroll areas and move sprite objects.

All supplied as commented source files, ready for compilation in application projects. All library modules are compiled into supplied standard library file.

<8> The complete source files of the Z88 native module assembler (400K). This illustrates many good programming techniques on how to code applications for the Z88. Further, it illustrates heavy usage of the supplied standard library routines and how to build Z88 EPROM applications.

These files are only supplied with the Z88 Assembler Workbench EPROM, and are not for free distribution. Use them for learning not copying to others!

<9> All Z88 Assembler Workbench software documentation is supplied as PipeDream files. This is mainly to avoid additional costs (printing paper issues and expensive snail mailing).

However, this makes piracy easy. I hope you acknowledge this with honesty.

<10> QL users only: FFRREE OZ call definitions as on-line help files in Jochen Merz's QD editor. With this system you have all Z88 operating system calls as on-line reference. A wonderful feature when you need a quick look at parameter details for OZ system calls during programming in QD.

New game for the Z88  
-----

During the time of developing a graphics library for the Z88 PipeDream map I couldn't resist to produce a game that used the graphics.

After a completed graphics library, I began the work of ZetriZ - yes a Tetris version on the Z88 that exploits the full potential of the graphics area.

To play it, the Z88 must be turned 90 degrees anti-clockwise. All standard game features are implemented, plus shared high score file (among several ZetriZ applications), extended game bricks and configurable game parameters.

I'm working on an idea for a two-player version, which connects two Z88 with a serial 9-pin cable.

If you would like the game, send me a 32K EPROM and 50DKK.

Multiple Diary applications  
-----

One thing that has bothered me since I began using the Z88, was the annoying feature of having only a single Diary application. This implied many problems if you wanted to keep separate diary files (e.g. private and business diaries and other topics).

A simple modification of the 128K operating system EPROM makes it possible to create multiple Diary applications.

If you would like to have that, open your Z88, remove 128K EPROM and send it to my address (defined elsewhere in this document). Remember to include return postage. I have EPROM programming facilities to make a new modified EPROM.

When you receive the new EPROM, please remember to remove all power source (batteries and power supply) before inserting the EPROM. Even let the computer be left for 15 minutes to discharge the capacitor (which normally keeps limited power while changing batteries). Please remember to insert the EPROM with the small notch pointing towards the screen.

## 19.2. Mini-Reviews of Selected Products

### *ZN-DOS*

ZN-DOS is a disk operating system that allows the Z88 to use a modified Tandy TDD2 disk drive. The Tandy TDD2 is a portable, 3 1/2 inch, battery-operated, serial based disk drive designed for the Tandy Model 100 and 102 laptops. ZN-DOS comes with an EPROM, cable, and disk drive. ZN-DOS can be purchased without the disk drive if you already have one. The drive will need to be modified.

ZN-DOS has the following menu items:

Bank: Switches between two available "banks" on the TDD2 disk drive. Each bank can hold up to 40 files, with a total of 80 files per disk. Total disk storage is roughly 200K. The largest file size is 64K.

Directory: Provides a directory of Bank 0 or Bank 1.

Format: Formats a disk.

Kill: Delete a file.

Load: Move a file to the Z88.

Quit: Exit ZN-DOS.

Rename: Rename a file.

Save: Move a file to disk.

### *Rangerdisk Disk Drive*

The Rangerdisk is a 3.5" battery powered disk system. It formats a disk in 720K MS-DOS 2.1 format. Z88 files can easily be copied to a MS-DOS system. It's size is 18cm x 14cm by 67 mm. It comes with a cable to hook to the Z88, an AC adapter, and a 32K EPROM with the disk OS software. Performance of the disk drive is limited to 9600 baud transfer from the Z88 to the disk drive. The software is easy to use and allows selection of files the same as the Z88's Filer. The Rangerdisk commands are:

Catalogue Disk	<>DD
Catalogue Z88	<>CF
Select Z88 Device	<>SV
Select Z88 Directory	<>SI
Save to Disk	<>DS
Fetch from Disk	<>DF
Change Disk	<>DC
Erase Disk File	<>DE
Rename a Disk File	<>DR
Format Disk	<>FM
View Disk File	<>DV

## Hardware

Extra Memory: 32K, 128K, 256K, 512K, 1Meg\*  
EPROMS: 32K, 128K, 256K, 512K\*  
Portable Disk Drive w/ ZN-DOS\*  
    (This is a Tandy Model 102 Disk Drive with  
    software to make the Z88 work with it)  
SuperTwistalite by Aware Tech  
    (Add-on light to illuminate the Z88 screen in the dark)  
Topper: Plastic to cover top of Z88.\*  
RangerDisk: 3.5" 720K drive in MS-DOS 2.1 format.\*  
Battery Pack: External battery pack.  
ADAM, Ranger Computers Ltd: AD Acq. Module.  
Disc-88, XOB: Disk Drive System  
Z88 Barcode Reader, Ranger Computers Ltd.  
Miracle Systems Z88 v23 Modem

## Books

"Z88 Computing" by Ian Sinclair  
"Using Your Z88" by Patrick Hall  
"Z88 Developers' Guide"  
"Z88 Practical Applications Book"  
"BBC Basic Reference Manual (Z88)" by M-Tec  
"Z88 Dabhand Guide" by "authors of Z88 OS"  
"Z88 Magi" by Gerhardt, Gerhardt & Barry  
"Z88 Real Power Computing" by F. R. Flaig  
"Z88: A Dabhand Guide" by John Allen  
"Z88 Portable Computing" by Dave Osborne

## Software

AccountZ, S&S Computer Advice: Bank Account handling.  
BackupZ, S&S Computer Advice: Dump Z88 to Spectrum tape or  
    microdrive.  
CNC Link, Ranger Computers Ltd: Link to CNC Machine Tools.  
CountZ, S&S Computer Advice: Typing Test.  
DataOrganizer, Harvest Info. Systems: Database  
DreamWord: Z88 to Tasword 3 on Spectrum.  
Event Control System, Front Line Computers: Time swimming,  
    skiers, runners.  
EZ-Money, WordMongers: ZBase Application.  
FingerOrganizer, Harvest Info. Systems: Typing Tutor.  
Form7 Administrator, S&S Computer Advice: School Admin, zBase App.  
G-Term, WordMongers: Terminal for Telecom Gold.  
Golf, WordMongers: Golf game.  
Guardian, DanSoft: Password protection.  
Harvester Word Chip, Harvester Info. Systems: Spell Checker.  
IMPEXP80, C-Port: Transfer to different computer systems.  
LexLink, Ranger Computers Ltd: Link to PCs with Lex Word Processor.  
M-Term, WordMongers: Terminal for Mercury 7500 E-Mail Systems.  
MileZ, S&S Computer Advice: Car milage allowance claims.  
Old Scores, Simon Rockman: Text Adventure.  
Pilots Companion, Aviation Software Tools: Flight Planner.  
Phone Post System, WordMongers: PC-hosted e-mail system that  
    allows Z88's to link in using P-Term.  
PhoneZ, S&S Computer Advice: Phone call logger.  
QZ, Sector Software: Transfer program to QL.  
Scazble, WordMongers: Arcade game Scrammble.

School Administrator, S&S Computer Advice: Smaller version of Form 7 Admin.  
 SpellMaster, Aware Technology: QuickEdit editor + WordFinder spelling checker.\*  
 Squeez88, Rakewell: Compression program.  
 Stop Watches, Racing Car Computers: 14 Stopwatches.  
 T-Touch, S&S Computer Advice: Typing tutor.  
 TX, WordMongers: File transfer system to different computers.  
 Withered Toad, WordMongers: Text Adventure.  
 Vision 100, Ranger Computers Ltd: VT-100 terminal.  
 Z88-Amiga Link, Music Suite: Z88 to Amiga transfer program.  
 Z88-ST Link, Music Suite: Z88 to Atari ST transfer program.  
 Z88 Travel Base, Minerva Systems: Database Program.  
 zBase, WordMongers: Database program similar to dBase II.  
 zTape, WordMongers: Load and save to a tape recorder.  
 zTerm: Xmodem plus Terminal.  
 PCLink, Cambridge: PC to Z88 software & cable.\*  
 MacLink, Cambridge: Mac to Z88 software & cable.\*  
 QLink, Cambridge: QL to Z88 software & cable.\*  
 BBC Link, Camgridge: Link to BBC Micro.

## 20. NON-Z88 PRODUCTS THAT CAN BE USED WITH THE Z88

There are a number of different products that can be used with the Z88, even though they were not designed to.

### 20.1. Laptop Light

The "Notebook Computer Light" is a light designed to be used on non-backlit laptops and claims to be useable on all laptops. Essentially the unit is a battery pack and a light that peeps over your laptop screen and casts down it's light. It attaches above the laptop screen like a C-clamp. The light bulb is an "Ektron" bulb and looks to be the same bulb used in the ever-popular "Itty Bitty Book Light." In other words, It's a small high intensity bulb. The unit Weights just 7.8 oz. It comes with rechargeable AA NiCads, an AC Adapter/Charger, and a travel case (6" x 2.5" x 7/8"). It costs \$39.95 (plus \$3 USA shipping) and is available from ASF Assoc, Ltd, Box 625, Merrick, NY, 11566, 1-800-771-3600, and Fax 1-516-868-6897. I'm tempted to get one of these, but I don't have a pressing need for it.

### 20.2. Laptop Cases

A bunch of laptop cases are available through all sorts of sources. Most of these cases were designed for PC or Mac laptops, but can easily be used for the Z88. A number of them have some nice features. They have places to put disks, cables, printer paper, paper files, etc. Some are designed to be portable offices with storage space for pens, pencils, tape, small staplers, etc. Be careful of the prices. They can cost anywhere from \$30 to \$100. Other soft cases designed for other uses can be made to fit for the Z88. A creative use of rubber foam can create a custom fitted case.



## 20.3. Laptop Magazines

There are a number of laptop magazines available at your local magazine rack. They sometimes carry some general laptop articles that can be applied to the Z88. They carry a number of laptop products that can be used with the Z88 ( printers, modems, etc.). I found the above mentioned laptop light in one such magazine.

You may not find enough good information in each issue to warrant getting a subscription, but you may find one or more of these magazines at your local library.

## 21. INCLUDED UTILITIES AND FILES

The following files come with the Z88 Source Book:

z88pd_zip	- Original files from the 1st edition
z88pd2_zip	- Additional general Z88 files
z88ql_zip	- QL Specific Z88 files
devnotes_zip	- Z88 Developers' Notes version 3
ozdefc_zip	- OZ definitions
qlz80asm_zip	- Z80 Cross Assembler for QL
pcz80asm_zip	- Z80 Cross Assembler for MS-DOS
z80lib_zip	- Z80 Library for Cross Assembler
z80src_zip	- Source Code for Cross Assembler
z88em_zip	- Z88 Emulator for MS-DOS version 0.2

QL users get some additional Z88 User Group files. These files would not zip and the file names are not MS-DOS compatible. MS-DOS users will get some MS-DOS Z88 User Group files. There may be some duplication of files between some of the ZIP files. Since they came from different sources, I did not have a chance to go through every file.

### 21.1. Original Files

There are a number of Z88 utilities that have become classics over the years and are almost standard for most Z88 Users. Below is a description of these important utilities.

Z88COMM - As mentioned above Z88COMM is the standard communications program for the Z88. Like the built in VT52 program, Z88 provides the ability to log onto BBSs but it also supports ASCII And XMODEM file transfer. Since Z88COMM is written partially in Machine Code, there is a slight risk of Z88COMM crashing the Z88. Run your version without any important file, just in case. (I found this out the hard way.)

ZFU - This is an archive, compression, and backup utility, very similar to PKZIP. ZFU allows you to do full, differential, or incremental backups. Multiple files are compressed and stored in a single file, making it easier to transfer the file out of the Z88.

ZCP - This is another Z88 communications program. It supports ASCII and XMODEM file transfer. Since it has no documentation, I have to guess that some of the commands are for transferring files

between Z88s. Not having a second Z88 I have not tried this. It looks as though you can control one Z88 from the other (for file transfers only).

PAT2PCW - This BBC BASIC utility provides many important add-on's to BASIC on the Z88. New commands deal with graphics, allow line editing, text and graphics windows. For advanced BASIC programming, this utility is a must.

ROMDMP - ROMDMP (ROM Dump) is a utility that allows you to do a HEX and ASCII dump of the Z88's ROM. The included text file shows a sample dump of the BBC BASIC area.

ZRLE - This program allows the decoding, displaying, and printing of RLE files. An RLE file is a graphic file stored in a Run Length Encoded file. RLE files can be displayed on a number of computers. PAT2PCW is needed for this program to run.

Z88TOOLS - This is a sample BBC BASIC program that shows some of the features of the VDU command. It shows how to have bold text, underlines text, flashing text, etc. Shows you how to "pretty up" your BASIC programs. Many of the BASIC programs on the disk utilize the same features demonstrated in Z88TOOLS.

## 21.2. Other Utilities

Below is a list of the files that are included on the disk that comes with the book. All BBC Basic files have been converted to plain text CLI files ( at least those that I could convert). These files can be converted to tokenized BBC Basic on the Z88. Documentation files are in plain text. All files can be sent to the Z88, from the QL, with the utilities included. PCs will need a copy of a communications package like Procomm.

ADDLF.CLI	Add LineFeeds to each line to make it compatible with MS-DOS.
ANIMAL.CLI	AI Animal query/learning game.
BOMBER.CLI	Video game. Bomb buildings before hitting them.
CAMEL.CLI	Desert trekking with a Camel game.
CATERPIL.CLI	Video game. Eat fruits but don't eat the mushrooms.
CODEBRK.CLI	A version of the game Mastermind.
CRDFIL.CLI	Card File Utility.
CRDFIL.TXT	Document file for CRDFIL.
CRDFIL.INF	
CRLF.CLI	Like ADDLF.CLI with modifications.
DICONIX.PE	Printer file for Diconix printer.
EPCAT.CLI	Catalog EPROMs.
EPCHK.CLI	Check EPROMs for total erasure.
EPCHK.TXT	Doc file for EPCHK.
EPLOAD.CLI	Load file from EPROM.
EPSON.PE	Printer file for Epson printer.
FINANCE.CLI	Financial Calculations.
GLISSADE.CLI	Sample sound program.
GRAPH2.TXT	Describes GRAPHALL.CLI.
GRAPHALL.CLI	Graph PipeDream spreadsheets and printer them out.
HOUSE.CLI	Draws a house.
HX.CLI	Hex Import.
HX.TXT	document file.
KINGDOM.CLI	Rule a kingdom type game.
LABEL.CLI	Make mailing labels.
LABEL.DAT	Data file.

LINK.CLI	BBS like program to hook to a host computer.
LINK.TXT	Documentation.
PAT2PCW.CLI	Patch II.
PATCH.TXT	Documentation for Patch.
PATCH2.TXT	Documentation for Patch II.
PATCHDEM.CLI	Patch demo.
PHONE.LOG	Log file for Z88COM.
PRTCONV.ZFU	
ROMDMP.CLI	ROM Dump program.
ROMDMP.TXT	Documentation.
ROMDP2.CLI	ROM Dump version 2.
SOUND.TXT	Documentation
SOUND2.CLI	Sound demo program.
STAR.CLI	Draws a star.
WCHILL.CLI	Calculates wind chill factor.
WIZARD.CLI	Game.
Z88COM.CLI	Communications program.
Z88COM.TXT	Documentation
Z88PDRI.ZFU	
Z88TOOLS.CLI	Program shows some neat features of BBC BASIC.
ZCP.CLI	Z88 communications program.
ZFU202.CLI	Archive program (like PKZIP).
ZFU202.TXT	Documentation.
ZRLE.CLI	RLE file decoder, displayer, and printer.
ZRLE.TXT	Documentation.

### 21.3. Z88 User Group Files

Although the Z88 User Group is officially defunct, Ian Braby, the software librarian has not officially released the whole Z88 User Group library. Copies of the library have been available through various sources (other Z88 users, the Internet), but Ian has only approved a select few to be distributed with the Z88 Source Book.

Below are some instructions on how to transfer Z88 User Group files to the Z88. These instructions are PC specific, but the read should be able to adjust them to almost any platform. I have not tested these instructions, so I provide them with no warrenty.

#### *How to Transfer Z88 User Group Files*

At the MS-DOS prompt, type MODE COM1:96,n,8,1. This sets the serial port to 9600 baud with the correct parity. The Z88 should be similarly set from the SETUP Panel to 9600 baud and XOn/XOff set to "YES". Create the subdirectory LIBRARY on the Z88, into which the unpacked files will be sent, unless you have any of the following programs:

File	Directory Name
Z079	STATS
Z081	Z081
Z109	Z109
Z150	Z150
ZB01	STOCK
ZB02	FRONTEND
ZB03	BOXCHARS
ZB04	ZBASE/CARD2
ZB05	CLIBRARY
X022	X022

Connect the two computers and enter Imp-Export on the Z88 and press "B" for batch receive. On the PC type, for example:

```
COPY Z007 COM1
```

The Z88 should show that it is receiving at this point. When the list file is received, press ESCape on the Z88 and all's done.

### *QL Specific Files*

Z041 MORPH.BAS	- Metamorphose one shape into another.
Z042 PLOTFX.BAS	- General function plotter.
Z043 COMPARE.BAS	- Compares two files byte by byte.
Z044 HEXDUMP.BAS	- Dumps a file to the screen in ASCII and HEX.
Z045 FNBASES.BAS	- Converts numbers between bases.
Z046 FNINTEGRAL.BAS	- Calculate functions of X.
Z049 LISTER.BAS	- Prints out BASIC files in structured format.
Z050 EPLOAD.BAS	
Z051 Z88COMM.BAS	
Z052 FADDER & DTAB	- Add LF and Tab remover.
Z054 EPCAT.BAS	
Z055 FILDMP.BAS	
Z056 DISZ88	- Z88 Disassembler.
Z057 DECIDE.BAS	- Decision making program.
Z058 FINANCE.BAS	- Financial analysis program.
Z059 MAXIT.BAS	- A "screen-oriented" game.
Z060 WIZARD.BAS	- An adventure game.
Z110 Z88-IMPEXP	- Binary file for Spectrum to transfer files to/from the Z88.
Z111 COPYFILE	- Copies files from device to device.
Z112 LABEL PRINTER	- Prints labels.
Z113 XEROX 4045	- Laser Printer Driver.
Z118 STARTREK.BAS	- Classic game.
Z120 YAHTZEE.BAS	
Z133 SPECTRUM-LINK	- Another Spectrum program to transfer files to/from the Z88.
Z157 FCOMPARE.BAS	- Compares updated files to each other.
Z158 EPROMCAT.BAS	
Z159 ROMDMP6.BAS	
Z175 OTL	- Outliner program.
Z176 ZBSCR	- zBase screen generator.
Z177 ZBOPT	- zBase program optimizer.
Z178 ZBASOPT	- Optimises BASIC program by removing REMs.
Z179 PRTCONV	- Converts PipeDream to pure ASCII.
Z180 UNITS	- Convert between lots of units.
Z181 SOUND	- Sound Designer program.
Z182 CARDS	- Toolkit to generate suits and backs of cards.
Z183 CAMELS	- game.
Z215 EPCHK	- Checks EPROMS to see if they have been completely erased.
Z216 ZRLE	
ZS03 ZFU v. 2.02	
X010 BOOT.CLI	
X011 DELETE.RAM.-	- Erases files lurking in RAM.
X025 CLIs	- A collection of usefull CLIs.
ZB01 STOCK	- Demo database for zBase.
ZB02 FRONTEND	- Front end to zBase.
ZB03 BOXCHARS	- Allows lines and boxes to zBase.
ZB05 ADDRESS	- Address book database for zBase.

### *PC Specific Files*

- Z213 HX                - Allows you burn EPROMS and run them as if they were ROMs.
- Z214 CARDFILE       - Card file database.

*Timothy Swenson*

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# Z88

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*Source Book*

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*The Cambridge Z88 User Resource Reference*

*Addendum #1*

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## 1. INTRODUCTION

The Z88 Source Book Addendum is additional material for the Z88 Source Book. Instead of adding it to the Source Book to make a 4th edition, thus requiring owners of the 3rd edition to purchase another edition (which was done by owners of the 1st & 2nd editions when the 3rd edition came out), I felt it would be wiser to create a new document that could be combined with the Source Book in one binder.

As with the Z88 Source Book, the intent of the Addendum is to collect a bunch of information about the Z88 and publish it for Z88 users. This is the first Addendum. More will follow as additional information is found. This document, along with the Z88 Source Book can be found on my web page at:

<http://www.geocities.com/SiliconValley/Pines/5865/>

## 2. BOOK REVIEWS

Some Z88 books are still available from the various Z88 dealers. Others can be found in various places, including used book stores, garage sales, and other Z88 users. The Z88 Source Book listed only those books which were known at time. This section outlines the contents of the books that I have since come across.

*Z88 Real Power Computing*  
By Frank R. Flaig

The first thing that you notice about this book is its amaturish look. The book has been printed out on a Near-Letter Quality dot-matrix printer, reproduced using a photocopier, and bound with a plastic binding. It could have easily been written and printed directly from the Z88, which would demonstrate that the Z88 can do more than just short letters.

The reason behind the book is similar to that of this book, the author, after playing with the Z88 for a while, figured that other Z88 users might like to read what he has done with the Z88. The book is written as if you were sitting down with the author and he is chatting with you about what he has been doing. It is a very flowing discussion-like style of writing. I'm used to a more technical get-to-the-point style of writing, but for some people this discussion style may be more appealing.

Although the author does give an introduction to the Z88 and how to use some of the applications, the core part of the book is the sections on using the applications to accomplish tasks. The sections are as follows; Merger - two different ways to merge a database and a document to produce the same letters to different persons. Labels - printing out labels, such as address and product labels. Screen Display - how to better display a PipeDream database. Language - Using PipeDream to construct a document that helps translate between two languages using lookup functions. Currency Convertor - Using PipeDream to convert between different currencies. Trip Computer - Using PipeDream to figure out how long a journey will take and track fuel usage. Diet Calculator - Using PipeDream to work out food rations in terms of calories and cost. Invoicing - Using PipeDream to generate invoices or quotations. Graphic Bar Chart - Using PipeDream to create bar charts of data.



The book is fairly project centered and details what the author has done to use the Z88 to accomplish the tasks that he needed done. The tasks may not be exactly what you need to do, but the details can be changed to fit your needs.

This is not a very technical book full of more detail about the Z88. It is more of a "How I Use" the Z88 book. If there are tasks that you want to use the Z88 for but do not know how to get the Z88 to do them, this book might be just for you. Once you see how the author has accomplished his tasks, it might shed some light on how you could use the same tricks to get your tasks done.

#### *Using Your Z88*

By Patrick Hall

This book starts off pretty much as every other Z88 book by covering the main applications built-in to the Z88. The coverage of the applications is fairly thin compared to some other books. The book then makes a turn for the better starts talking about programming in BBS Basic. Over two thirds of the book is dedicated in covering BBC Basic starting with the idea that the reader is new to programming. The book does a fairly good job of teach BASIC by covering the essentials like Output & Display, Structured Programming, and Data Structures.

The chapters walk a reading through the process of learning BASIC. It starts off with simple concepts and works from there. It's fairly verbose and explains what you want to do and how it is accomplished, along with example code mixed in with the text. This is not a reference book for BBC Basic programming and I would not recommend it to anyone that already knows BASIC, but for those new to programming, this book is a good starting place.

#### *Z88 Computing*

By Ian Sinclair

This book approaches the Z88 a little differently than the other Z88 books I've seen. It's approach is purely learn by doing. It does not spend much time discussing the various applications and how one might use them in general. Instead it starts off by covering a few key points about the Z88 and its keys. It then walks you through the Pop-Ups and Applications step by step. Each section has a short paragraph covering the topic (such as Calendar or Clock) and then goes into steps (like 1,2,3) that show a point by having you do something on the Z88 or covering a single action (such as marking a block of text).

It has almost taken the task of learning the Z88 and broken it up into small managable chunks. With big bold numbers in the sections, you can read the book in shorts bursts and not worry about loosing you place. This is also a book that requires having a Z88 nearby. It re-enforces its points by having you perform actions on the Z88.

If you don't have the time to really read the Z88 manual or other Z88 books, this one may be for you. It will not teach you everything you need to know about the Z88, but it does give you a quick start and sets you on your way.

### 3. Z88 WORLD WIDE WEB LINKS

#### *Z88 Forever*

<http://www.netforward.com/deathdoor/?Dharking>

This is one of the key Z88 web pages and has a little bit of everything. The key sections are "About the Z88", "Using the Z88", "Hardware & Software", and "Other Z88 Resources." For Z88 users the section "About the Z88" covers what they already know. "Using the Z88" has subsections on Z88 Emulators, the Z88 User Group Library, Hints & Tips, etc. The "Hardware & Software" sections covers some items that are in this Addendum, such as the Internal Memory Expansion. The "Other Z88 Resources" lists the other key Z88 pages, including the links to both the 2nd and 3rd edition of the Z88 Developers' Notes.

#### *Dennis Gronings's Z88 Page*

<http://www.algonet.se/~dennisgr/z88.htm>

This page has a description of a number of Z88 utilities that Dennis has written for Windows95. These utilities are available for downloading from the page. These utilities will be discussed in a later chapter covering new software/utilities. One item about the page, it has a nice picture of Sir Clive Sinclair holding up a Z88.

#### *John Allen's Z88 Bits*

<http://www.bramber.demon.co.uk/z88/index.html>

This page has the following sections, "General Z88 Articles", "Z88 -> BBC Articles and Software", "Z88 -> Risc OS Articles and Software", and "Z88 Book". As you can tell, John has spent some time working the BBC Micro and the Acorn Risc OS computers. The section "Z88 Book" covers a few details about John's book "Z88 PipeDream: A Dabhand Guide." The Z88 to BBC Micro utilities are covered in a later section.

#### *John Allen's Software Showcase*

This pages covers some of the software programs that John Allen has written for Risc OS computers, which includes Z88Link and ZLink, which both link the Z88 to Risc OS computers. Both Z88Link and ZLink have been downloaded and included in the Addendum Companion.

#### *Really Good Software Company*

<http://www.tcp.co.uk/~tonyr/rgsc/>

This page covers the commercial software for Risc OS software from this company. For the Z88 they sell ZLink II (Z88 to Risc OS), a follow on to Zlink (see previous item above). It is available for 29.95 pounds.

#### *Z88 Developers' Notes*

<http://www.cl.cam.ac.uk/users/jrh/devnotes/index.html>

This page covers the 2nd edition of the Z88 Developers' Notes written by John Harrison and Matthew Elton. The entire Notes have been converted to HTML and are readable from this page. If you want to write Assembly programs for the Z88, this is the book to read. It covers all of the system calls and how to write applications.

#### *Rakewell Ltd*

<http://homepages.nildram.co.uk/~rakewell>

Rakewell carries a lot of stuff for the Z88, a number of items that I believe that only they carry. Their newest product is a flash EPROM that lets you delete files without needing an EPROM eraser.

#### *Club 100 / Web 100*

<http://dillernet.com/m100/index.html>

This web site is dedicated to the Tandy Model 100/102/200. This page applies to the Z88 because there is lots of information about the Tandy Portable Disk Drives (PDD), which are usable with the Z88. There is software that lets the PC read the PDD disks.

#### *My Z88 Page*

<http://www.xnet.com/~stuart/z88.shtml>

This small page has a couple good shots of the Z88 both inside and out.

## 4. NEW Z88 RELATED SOFTWARE

These Utilities are available off of the Web links listed above.

#### Z88 PipeDream Viewer (PIPEVIEW.ZIP)

This MS Windows program loads native Z88 PipeDream documents and displays them. Spreadsheet formulas are displayed but are not calculated. Columns are properly spaced. Underline, bold, italics, subscript, and superscript highlights are supported. Allows you to save PipeDream documents into Microsoft Rich Text Format (.RTF) to be exported to Word for Windows. This program is written by Dennis Groning and written in Visual Basic.

#### Z88 BBC Basic Viewer (Z88BASV.EXE)

This MS Windows program loads native Z88 BBC Basic programs and displays them. Menu commands support Save as Text, Cut, Copy, Paste, Delete, Find, Find Next, and Add CLI Header. This program is written by Dennis Groning and written in Visual Basic.

#### Z88 Import-Export File Transfer (Z88-Xport) (Z88XPORT.EXE)

This MS Windows program transfers files from Windows-based PC's and the Z88 using the standard Imp-Exp popup on the Z88. It supports the

backup of your entire Z88 by using the ":\*//\*" wildcard. Z88-Xport will create all directories needed during reception of the Z88 files. It also supports selecting multiple files from multiple directories on multiple drives and sending them to the Z88 in one batch. This program is written by Dennis Groning and written in Visual Basic.

#### CONVERT-BASIC (BASIC.ZIP)

This is a BBC Micro program that converts BBC BASIC programs from the Z88 and the BBC Micro. The utility sends and receives files from the Z88 and converts the BASIC programs as they are transferred. When converting from the BBC Micro to the Z88, BASIC commands that are not supported on the Z88 are converted into REM statements. The MODE command is replaced with CLS and a beep (VDU 7) is substituted for...

SOUND. When the transfer is finished a report is displayed on the BBC Micro screen that shows what conversions were made. When transferring from the Z88 to the BBC Micro, the utility does a straightforward transfer, changing the file format, but not checking the BASIC program. This program is written by John Allen.

#### ARCHIVE (ARCHIV.ZIP)

This utility takes all of your files on the Z88 and transfers them to an archive file stored on the BBC Micro disk drive. The utility is then used to selectively reload the files back onto the Z88.

The utility runs on the BBC Micro, using either the DFS or ADFS filing systems and links up to the Import/Export utility on the Z88. The BBC Micro does nothing more than send the data coming from the Z88 directly to disk. No conversion is done. This program is written by John Allen.

#### CONVERT (CONV.ZIP)

This utility converts simple PipeDream document files for use in Wordwise, Wordwise Plus, and Mini Office on the BBC Micro. Using a few pointers in creating your PipeDream documents, these files can be easily converted for use in BBC Micro word processors. This program is written by John Allen.

#### Z88 Printer SERVER (PRINT.ZIP)

The utility will allow the BBC Micro to act as a printer server for the Z88. With the Z88 linked to the BBC Micro via the serial port, when the Z88 prints to the serial port, the BBC Micro takes that data and sends it to its parallel port and the printer attached there. This program is written by John Allen.

#### Z88LINK (TRANS.ZIP)

This utility simply transfers files from the Z88 to/from the BBC Micro using the Z88's Imp-Exp utility. BASIC program line numbers are translated between the different forms. This program is written by John Allen.

Z88Link (Z88LINK.ZIP)

This Risc OS utility transfers single files between the Z88 and any Risc OS computer using the Imp-Exp utility on the Z88. A version 2 is available from the author (John Allen) for 5 pounds.

ZLink (ZLINK.ZIP)

This Risc OS utility transfers files between the Z88 and any Risc OS computer. It requires the PC Link II ROM to be installed in the Z88. This program is writtn by John Allen.

## 5. UNDER DEVELOPMENT

Here are some items that are reported to be under development.

### Multiple Diaries

This will allow you to keep more than one diary on the Z88. You can keep your work and home diaries separate. This is being worked on by Interlogic.

### PC Link Client

This is a command line PC client to connect to the Z88 program, PC Link and PC Link II. This allows files to transfer in both directions and using wild cards. It will even handle subdirectories, allowing transer of an entire device (RAM.1:) with a single command.

### WhatNow?

This application will allow the Z88 to use adventure files from the Spectrum game creator, "Graphic Adventure Creator (GAC)." Snapshots of adventure games can be downloaded off the Internet, transfered to the Z88, and then played.

## 6. VERSION 4 ROM

The V4 ROM contains the following fixes:

### Lost Handles

In V3, handles could be lost by pre-empting the Filer during a catalogue, resulting in a "File in Use" error which requires a soft reset to clear.

### ROM Cards

It is no longer possible to insert and remove cards while the Z88 is switched off. Doing this might cause the Z88 to get confused, since the Z88 now wakes up when the flap is opened.

### PrinterEd

When updating the PrinterEd settings user V3, it is common to encounter a "FAIL" condition. This has been fixed. Additionally, the "Allow line feeds" option now works correctly.

#### RAM.- Device

The system no longer gets confused if files are present in this useful device when the Z88 is reset.

#### Expanded Machines

The Z88 will now behave as an expanded machine (giving a full map in PipeDream, and 40K workspace in BASIC) if there is at 128K RAM anywhere in the system, and not just in Slot 1 as with V3.

#### Filer Display

In V3, a problem sometimes occurs with Filer when marking a file after scrolling the cursor. This causes the first letter of the filename to disappear. This is now fixed.

## 7. INTERNAL MEMORY EXPANSION

Don Waltermann has re-discovered a way of upgrading the internal memory of the Z88. In browsing through some old Z88 magazines Don noticed ads for internal memory expansion kits. He decided to figure out how this was done.

Don started with the Z88 Service Manual, which explains that the internal memory is pseudo-static. This type of memory is not common, but Don did manage to find a company that carries these types of memory chips. It is Microprocessors Unlimited (918) 267-4961. They stock the memory chips that the Z88 can use (512K and 128K in either 100ns or 80ns). The parts are:

128K pseudo-static RAM: Hitachi HM658128ALP	\$9.95
512K pseudo-static RAM: Hitachi HM658512LP	\$27-30

The Service Manual explains that the memory socket is pinned for the 128K memory chip. Every board that Don has seen has the memory chip soldered in, making for a more difficult project. Carefully unsolder the old memory chip and install a low-profile socket. Make sure to use a 32-pin socket. You will need to clean out the extra four holes above the 32K RAM, which only uses 28 pins. NOTE: A solder sucker or desoldering iron will come in handy here.

Don tried the 128K chip first and it worked right away. The Z88 recognised it without doing anything special. When Don installed the 512K chip only the first 128K was recognised. Don had to head back to the service manual.

The Service Manual explains that the Z88 is designed to access four blocks of one megabyte each. To access the full one megabyte, you need to use all the memory address lines. Memory address lines 17 and 18 don't go to the internal RAM socket. They do go to each of the card slots. It happens that there are three pads by each connector. Use the two pads next to each other that go to the second and the third pin from the end of the connector. These pads are memory address lines 17 and 18. They are perfect for this project. Solder a wire to each pad on the foil side of the board. Make sure the wire does not go through the pad too far. There is a metal bar that a long wire could short against.

There are a number of feed-through holes on each side of the internal RAM chip. Don prefers the feed-through hole by pins 3 and 18 of the memory chip. This allows you to run the wire right to the pins you want. Don't solder the wire to the feed-through holes, just run the insulated wire through it. Feed one of the wires through each feed hole. Don't use too much wire - you want to make sure none of the wires interferes with the option slots. Don left pins 1 and 30 bent out of the socket so that it would be easy to solder the extra memory lines to it.

After attaching the two memory lines, the Z88 woke up with 512K. It recognised all of it with no problems - despite reports that a V4 ROM is required for 512K internal memory.

One last detail - the clearance under the keyboard is tight. When Don put the Z88 back together, he noticed the keyboard bend a little. He looked at the bottom of the keyboard and saw that there was a clear space above the Z88 ROM. Use a sharp pair of wire cutters to trim the area on the bottom of the keyboard above the RAM just like it is over the ROM. Now the keyboard fits well. This is why it's better to use a low-profile socket if you have one.

Make sure to completely backup your Z88 before starting this project. You will probably need to do a hard reset to get the Z88 to check to see how much memory is installed. Don't be surprised if the Z88 makes a strange noise the first time you turn it on. Just perform a hard reset and it will be fine after that.

## 8. Z88-TO-MAC TRANSFERS

Some people have been having problems transferring files from the Z88 to a Macintosh running Systems 7.5 and 7.5.3. The problem has been tracked down to the Mac starting with Extensions Turned On. To get the transfer to work you need to start up the Mac with Extensions Off. To do this, hold down the shift key while starting until the message "Extensions Off" appears. It has not been determined which extension is causing the problem. This has been tested on a PowerMac with MacOS 7.5.3 and a Mac IIci running MacOS 7.5.

## 9. Z88 AND WORLDPORT MODEM

The WorldPort modem is a small, portable, and fairly popular battery powered modem. This section provides some details on configuring the modem to work with the Z88.

Setting on the Z88: Xmit Baud 9600, Rcv Baud 9600, no parity, and xon/xoff set to Yes.

Setting on the Z88: Xmit Baud 9600, Rcv Baud 9600, no parity, and xon/xoff set to Yes.

Settings on the WorldPort (from the ATi4 command)

B0	C1	E1	F1	M1	Q0	V1	X7	Y0
&A3	&B1	&C1	&D4	&G0	&H1	&I0	&K1	&L0
&M4	&N0	&P0	&R2	&S0	&T5	&X0	&Y1	

## 10. RAKEWELL

(This section is include primarily because Rakewell does not advertise in Sinclair circles and this information is not known to a number of Z88 users. )

Rakewell Ltd. carries a wide variety of Z88 items, plus is about the only dealer doing development. They also seem to have picked up the software sold previously by Ranger.

### Books:

Printer Drivers for the Z88	7.00
Z88 Developer Notes	40.00

PipeDream for MS-DOS (w/ spellcheck) 50.00

### Cables:

Z88 to Mac/Archimedes	15.00
Parallel Printer	34.00
Serial Printer	7.95

EPROM Eraser	21.27
Flash EPROM Pack	50.21
SwitZch Box (4 way w/ lead)	29.95
zPower System	35.00
zPower Pack Regcharg. Batt.	17.95

### Links:

Amiga Link	25.00
Achimedes Link	24.95
Archimedes Link PipeDream	34.00
BBC Link	8.95
Mac Link	32.95
PC Link II	29.79
PC Link II/EazyLink	51.06
PC Link II to EasyLink Upgrade	29.79
PC Link II ROM only	20.00
PCW Import/Export	29.95
QL Link	25.00
zTerm Software	43.47

## 11. Z88 DISK DRIVE

A number of disk drives have been made available for the Z88. Two of the systems, XOB and ZN-DOS, use the Tandy Portable Disk Drive 2 (PDD2) that was designed for the Tandy Model 100/102/200 laptop computers. Tandy created the PDD1 and PDD2, but only the PDD2 is currently used on the Z88. The Tandy Model 100/102/200 and the Z88 are ver similar in function and that they both do not have a disk drive controller built into them. The Tandy designers solved this problem by putting the drive controller on the disk drive and had all communications between the computer and the disk drive go across a serial line. All worries about the formating of the data on the disk is handled by the disk drive.

The computer communicates with the disk drive by sending commands or requests over the serial line. The disk drive then responds to these requests and returns the requested data to the computer. Given a



knowledge of the drive commands and a proper serial connection, any computer can interface with the PDD1 or PDD2. Although ZN-DOS and XOB only use the PDD2, it would not be a difficult task to write software to utilize the PDD1. The primary different between the two drives is that the PDD2 has two "banks" of files where as the PDD1 only has one "bank". Each "bank" stores 100K of information. For more technical differences, see below.

#### *Exchanging Files Between XOB and ZN-DOS*

This has not been tested, but since the two systems use the same disk drive, they should be able to exchange files easily. A XOB user has read the directory of a ZN-DOS disk, but has not tried to read any of the files.

#### *Reading PDD Files on other Computers*

Using the proper serial connections, it is possible to get any computer to communicate with the PDD disk drives. Two freeware programs are available for MS-DOS computers that let them read and save files to the PDD. This would allow Z88 users to transfer their files off of the PDD disks to an MS-DOS computer. These are available off of the Club 100 web page.

#### *Z88 to Portable Disk Drive Cable*

The ZN-DOS cable goes to the PDD2. The interface on the PDD2 is a special square 8 pin connector. The layout of the pins is below:

```

-----
!  1  2  3  4  !
-----
      !----!      <-- Plastic Nub on connector

```

The XOB cable is reported to be a 9-pin to 25-Pin D connector (I have not seen it). I don't know if the drive is a PDD2 or PDD1, but most likely a PDD1.

Cable from ZN-DOS		Cable from XOB	
Z88	PDD2	Z88	PDD?
-----		-----	
1		1	----- 13
2	----- 5	2	----- 12
3	----- 2	3	----- 11
4	----- 4	4	----- 10
5	----- 3	5	----- 9
6		6	----- 25
7	----- 8	7	----- 24
8	----- 7	8	----- 19 - 22 - 23
9	----- 6	9	----- 19 - 22 - 23

#### *Tandy Portable Disk Drive (PDD1 & PDD2) Command Reference*

This command reference is provided so that if a Z88 users gets a hold of a PDD1 or PDD2 without any Z88 drive software, they have the information necessary to communicate with the drive. It is also usefull is a Z88 user finds the existing drive software lacking in anyway and wishes to write their own.

## General Reference

Disks are single side 3.5 inch standard disks (DSDD will work).

PDD1 - 40 tracks, 2 sectors, 1280 bytes/sector, 100K/disk.

PDD2 - 80 tracks, 2 sectors, 1280 bytes/sector, 200K/disk.

Treated as two banks of 100K each.

Maximum file size = 64K

Maximum number of directory entries (files) is 40 for PDD1 and 80 for PDD2.

File names are maximum 24 characters (padded with trailing blanks) although Tandy always used 6 for filename and 2 for filetype, with period speperator (i.e. XXXXXX.TT).

All communications with drive are at 19,200 bps. Both drives have dip switches so this can drop to 9600, 4800, and 1200 bps. (ZN-DOS uses 9600 bps as this is the fastest the Z88 can go.)

## Command Format

All commands are in a request/return format (half-duplex).

General Request format:

preamble type length data checksum

General Return format:

type length data checksum

## Command Type

Command	Request	Return
Directory ref	00h	11h 12h
Open File	01h	12h
Close File	02h	12h
Read File	03h	10h 12h
Write File	04h	12h
Delete File	05h	12h
Format Disk	06h*	12h
Drive Status	07h*	12h
Drive Condition	0Ch*	15h
Rename File	0Dh	12h

## Request Command Details

Directory Reference -- 00h

2	1	1	24	1	1	1	Bytes
+-----+-----+-----+-----+-----+-----+-----+							
5A5A 00 1A		filename		attribute	search form		chksum
+-----+-----+-----+-----+-----+-----+-----+							

Preamble - 5A5A hex (always 'ZZ')

Request - 00 hex

Length - 1A hex

Filename - padded with blanks

Attribute - specify 'F' (not used normally)

Search Form -

00h - reference file for open or delete

01h - request first directory block

02h - request next directory block  
 03h - request previous directory block  
 04h - end directory reference  
 Checksum - (see below)

#### Open File -- 01h

```

    2   1   1   1       1       Bytes
+-----+-----+-----+-----+
|5A5A|01|01| mode |chksum|
+-----+-----+-----+-----+

```

Preamble - 5A5A hex (always 'ZZ')  
 Request - 01 hex  
 Length - 01 hex  
 Mode -  
     01h - open new file for WRITE  
     02h - open existing file for APPEND  
     03h - open existing file for READ  
 Checksum - (see below)

#### Close File -- 02h

```

    2   1   1       1       Bytes
+-----+-----+-----+-----+
|5A5A|02|00|chksum|
+-----+-----+-----+-----+

```

Preamble - 5A5A hex (always 'ZZ')  
 Request - 02 hex  
 Length - 01 hex  
 Checksum - (see below)

#### Read File -- 03h

```

    2   1   1       1       Bytes
+-----+-----+-----+-----+
|5A5A|03|00|chksum|
+-----+-----+-----+-----+

```

Preamble - 5A5A hex (always 'ZZ')  
 Request - 03 hex  
 Length - 00 hex  
 Checksum - (see below)

#### Write File -- 04h

```

    2   1   1       1 - 128       1       Bytes
+-----+-----+-----+-----+
|5A5A|04|01-80|   data   |chksum|
+-----+-----+-----+-----+

```

Preamble - 5A5A hex (always 'ZZ')  
 Request - 04 hex  
 Length - 01 - 80 hex (actual length of data)  
 Data - Actual data  
 Checksum - (see below)

Delete File -- 05h

```
      2   1   1   1           Bytes
+-----+-----+
|5A5A|05|00|chksum|
+-----+-----+
```

Preamble - 5A5A hex (always 'ZZ')  
Request - 05 hex  
Length - 00 hex  
Checksum - (see below)

Format Disk -- 06h

```
      2   1   1   1           Bytes
+-----+-----+
|5A5A|06|00|chksum|
+-----+-----+
```

Preamble - 5A5A hex (always 'ZZ')  
Request - 06 hex  
Length - 00 hex  
Checksum - (see below)

Drive Status -- 07h

```
      2   1   1   1           Bytes
+-----+-----+
|5A5A|07|00|chksum|
+-----+-----+
```

Preamble - 5A5A hex (always 'ZZ')  
Request - 07 hex  
Length - 00 hex  
Checksum - (see below)

Drive Condition -- 0Ch

```
      2   1   1   1           Bytes
+-----+-----+
|5A5A|0C|00|chksum|
+-----+-----+
```

Preamble - 5A5A hex (always 'ZZ')  
Request - 0C hex  
Length - 00 hex  
Checksum - (see below)

Rename File -- 0Dh

```
      2   1   1   24           1           1           Bytes
+-----+-----+-----+-----+-----+
|5A5A|0D|19| new name |attribute|chksum|
+-----+-----+-----+-----+-----+
```

Preamble - 5A5A hex (always 'ZZ')  
Request - 0D hex  
Length - 19 hex  
New Name - new name for the file  
Attribute - specify 'F' (not used normally)  
Checksum - (see below)

## Return Command Details

Read File Return -- 10h

```

  1  1    1    0 - 128      1      Bytes
+---+-----+---+-----+-----+
|10|00-80|1A| file data   |chksum|
+---+-----+---+-----+-----+

```

Return - 10 hex  
 Length - 00 - 80 hex (length of data)  
   If length is equal to 80h, there may be more data -  
     you must issue another read command.  
   If length is less than 80h then this is the last block.  
 File Data - data read from file  
 Checksum - (see below)

Directory Reference Return -- 11h

```

  1  1  24      1    2    1    1      Bytes
+---+---+-----+-----+---+---+---+
|11|1C| filename |attribute|size|free|chksum|
+---+---+-----+-----+---+---+---+

```

Return - 11 hex  
 Length - 1C hex (length of data)  
 Filename - padded with blanks  
 Attribute - specify 'F' (not used normally)  
 Size - size of file  
 Free - numbers of free sectors ( multiply by 1280 for  
       bytes)  
 Checksum - (see below)

Normal Return -- 12h

```

  1  1  1      1      Bytes
+---+---+-----+-----+
|12|01| error   |chksum|
+---+---+-----+-----+

```

Return - 12 hex  
 Length - 01 hex  
 Error Code -  
   00h - normal                      10h - file does not exist  
   11h - file exists                30h - no filename  
   31h - dir search error           35h - bank error  
   36h - parameter error            37h - open format mismatch  
   3Fh - end of file                40h - no start mark  
   41h - CRC error in ID            42h - sector length error  
   44h - format verify error        46h - format interruption  
   47h - erase offset error        49h - CRC error in data  
   4Ah - sector number error        4Bh - read data timeout  
   4Dh - sector number error        50h - disk write error  
   5Eh - un-initilized disk        60h - directory full  
   61h - disk full                  6Eh - file too long  
   70h - no disk                    71h - disk change error  
 Checksum - (see below)

Drive Condition Return -- 15h

```

  1  1  1          1          Bytes
+---+---+-----+-----+
|15|01| condition |chksum|
+---+---+-----+-----+
```

Return        - 00 hex  
Length       - 01 hex  
Condition    - bit values

```

    7 6 5 4 3 2 1 0   bit
+---+---+---+---+---+
|0|0|0|0|x|x|x|x|
+---+---+---+---+---+
                | | | |
                | | | +-- power (0=normal, 1=low)
                | | +---- write protect (0=not prot, 1=prot)
                | +----- disk out (0=disk in, 1=disk out)
                +----- disk change status (0=not changed, 1=changed)
```

Checksum     - (See below)

#### *Sequence of Events*

Get Directory    - req 00 search form 01  
                 - req 00 search form 02 (repeat as needed)

Write File       - req 00 search form 00  
                 - req 01 mode 01 or 02  
                 - req 04 (repeat as needed)  
                 - req 02

Read File       - req 00 search form 00  
                 - req 01 mode 03  
                 - req 03 (repeat as needed)  
                 - req 02

Rename File     - req 00 search form 00  
                 - req 0D

Delete File     - req 00 search form 00  
                 - req 05

#### *Calculating Checksum*

The checksum is "the one's compliment fo the least significant byte of the number of bytes from the block format through the data block." To make matters simple, below is the formula for the checksum:

checksum = (bytes MOD 256) XOR 255

where bytes equals the number of bytes including the Request Type, Length, and all Data fields (but not including the preamble).

```
close$="ZZ"+CHR$(2)+CHR$(0)+CHR$(253)
dir1$="ZZ"+CHR$(0)+CHR$(26)+
```

Source: [geocities.com/svenqhj](http://geocities.com/svenqhj)



