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MINIMON: A soft monitor for the 7768 MON 1 board

MINIMON (mini-monitor) is a 13 command monitor that enables the 7768 to be attached to an asynchronous terminal via the 7768 MON 1 board. MINIMON can be loaded from cassett or paper tape into the memory on the MON 1 board (FCØØ-FFFF) using the bootstrap loader function.

The monitor supports the following commands:

1.	X,Z	Relative offset calculation
2.	M	Examine and modify memory
3.	A	Alter memory
4.	G	Go to user program and run it
5.	S	Set break point
6.	C	Continue running a program after a break point
7.	R	Print 6800 registers
8.	H	Gives headings to print out by command R
9.	B	Block move
10.	D	Dumps a block of data to the terminal
11.	P	Punch unformatted binary cassett or paper tape
12.	L	Load from tape produced by the punch command

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MINIMON: A soft monitor for the 7768 MON 1 board.

INTRODUCTION

MINIMON is a simple 1K monitor that allows the interface of the 7768 with an asynchronous data terminal and provides a method of entering, debuging and saving programs.

It occupies the 1K space on the MON 1 board (FCØØ-FFFF) and uses the locations FØDD-FØFE (on the CPU board) for temporary storage. The stack used by MINIMON (may also be used by user programs) extends from FØD1 Downwards.

The ASCII send/receive terminal (assumed to operate in a full duplex mode) must be connected to ACIA (a) , or ACIA (b) if locations FC18, FD34 and FF26 are changed from ØØ to Ø2, and locations FC11, [illegible], FDØ5, FD2D, FF2C and FF96 are changed from Ø1 to Ø3.

USE

MINIMON can be loaded using the MON 1 Bootstrap Loader function. It is then initiated by hitting the reset button. MINIMON will respond with an asterisk and will then wait for one of the following comands:

1.	X,Z	Relative offset calculation
2.	M	Examine and modify memory
3.	A	Alter memory
4.	G	Go-run user program
5.	S	Set break point
6.	C	Continue running a program after a break point
7.	R	Register print-6800 registers printed
8.	H	Header-gives titles to print out by function R
9.	B	Block move

10. D Dumps a block of data to the terminal
11. P Punch-unformatted binary dump
12. L Load from tape produced by the punch comand

COMMANDS

Z (Relative offset calculation)

This command enables the calculation of branch offsets to be done automatically. MINIMON is supplied with the address of the first byte of the brach instruction and the address of destination and the offset is then calculated according to the formula:

OFFSET = DESTINATION - (PC + 2)

Format (user input underlined)

```
*Z P aa D bb R=cc
```

where aa is the least significant two HEX digits of the branch instruction address, bb is the LSB of the destination address. cc is the offset.

Attempts to branch more than 127 bytes forward or 128 bytes back are indicated by RANGE! being printed.

X (Relative offset calculation)

This command is similar to Z except that the addresses are the full 16 bit, 4 HEX digits to be typed. eg:

```
*XP  ØØFØ D  Ø11Ø R=1E
```

A(Alter)

If A is typed while the monitor is waiting for a comand ('*'printed) MINIMON will reply with a space which is a prompt for an address. The user should type the address (in HEX) of the first location to be altered.The monitor will then print this address on the next line, The user can then type in the new contents of that location. The command can then be terminated by pressing full stop, or the next memory location can be altered by typing two HEX digits.

FORMAT

```
*A ØØØØ
ØØØØ aabbccdd...      Where aa, bb, cc, dd etc. are the data
                         entered into locations ØØØØ, ØØØ1, ØØØ2,
                      ØØØ3 etc. respectively.
```

When the end of a line is reached MINIMON will print the current address at the begining of the next line and the command is continued.

M (Modify)

The modify command can be used for both examining and altering memory.The function is entered by typing an M, MINIMON will respond with a space and then wait for the HEX address to be typed in. The monitor will print the contents of this location and then wait for further inputs which may be any of the following:

1 A space which will cause the monitor to print the contents of the next location.

2 A slash '/' which will cause the monitor to print the contents of the previous location and its address on the next line.

3 A carriage return (CR) which will cause MINIMON to print the contents of the next location and its address on the next line.

4 Two HEX digits to be stored in the location who's contents was last printed.

FORMAT

```
*M ØØØØ aa bb/         Where aa, bb are the contents of ØØØØ,
ØØØØ aa (CR)            ØØØ1 respectively. cc was entered into
ØØØ1 bbcc dd            location ØØØ1 in place of bb.
```

When the end of a line is reached MINIMON will continue the modify function at the beginning of the next line.

The modify function,as with all commands, can be left at any time by typing a full stop.

G (Go)

The G function enables the user program to be entered at the specified address and run from that point. After the G command has been entered the user should type the HEX address of the start of the program. This can then be checked and if it is incorrect type a full stop to exit the function (with no harm done). If it is correct any character (apart from a full stop) will cause the system to run the user program until it encounters a SWI (3F) or the system reset button is pressed.

FORMAT

*G aaaa£	Where aaaa is the address of the start of the user program. Any character was then typed to ruñ the program.

S (Set break point)

Using this command a program can be stoped at any predetermined point. The user selects this point and types in its address. MINIMON will then save the instruction at that point and replace it with a SWI (3F). Two break points may be set at any one time.

FORMAT

*S1 aaaa	Where aaaa is the address of break point 1
OR	
*S2 bbbb	Where bbbb is the address of break point 2

C (Continue)

After a program has been interrupted (using the S command) registers, memory, etc. may be examined and altered. Then to set the program running again from the point it left off type either C1 or C2 according to which break point was encountered.

FORMAT

```
*C1
   OR
*C2
```

R (Register print)

If a break point (SWI) is encountered while a user program is running,the 6800 registers will be pushed on to the stack, and control will be passed to MINIMON. Using the R command the registers can then be printed from the stack.

FORMAT

```
*R CC B  A   X    PC   SP
```

Where CC=Condition Codes, B and A are the accumulators, X=Index reg., PC=Program Counter, SP=Stack Pointer.

These registers can then be altered on the stack using the Modify command, the HEX address is SP+1.

FORMAT

```
*R CF ØB 34 ØØØ4 ØØ17 FØDØ
*M FØD1 CF_ØBØØ 34_ØØ Ø4.     Where acc. B was changed from
                              ØB to ØØ.
```

The values of these registers (Altered or not) will then be reloaded into the 6800 MPU when the next G or C command is given.

H (Header)

This command gives titles to the print out by the register print instruction.

FORMAT

```
*H CC B  A   X    PC   SP
*R CF ØB 34 ØØØ4 ØØ17 FØDØ
```

B (Block Move)

Using the Block move function a block of data or program of any size can be moved to any location. For example.

The block of data with starting address Ø1ØØ and finnishing address Ø11Ø could be moved one location up, so that its new starting address would be Ø1Ø1. This could be done as follows:

```
*B S Ø1ØØ F Ø11Ø TO Ø1Ø1
```

where S=Start address of block, F=Finnish address of block, and the last entry is the new start address of the block. (All entries are in HEX)

NOTE: Block move can also be used to move a block (say Ø1ØØ to Ø11Ø) one or more locations down (say to the new starting address ØØFF) as follows:

```
*B S Ø1ØØ F Ø11Ø TO ØØFF
```

In each case, although the origonal block will be overwritten, the relocated block will be faithfully reproduced.

D (Dump)

MINIMON will dump the contents of memory between two specified addresses to the terminal. There are 8 (typically but can be adjusted-see listing) Bytes per line with the address of the first Byte on each line printed first. The dump can be stoped at any time by typing any character at the terminal keyboard.

FORMAT

```
*D S aaaa F bbbb
aaaa cc cc cc cc ...
```

Where aaaa is the address of the first Byte, bbbb the add. of the last Byte of the area of data to be printed. cc was the data found.

PUNCH

Program or data can be dumped (unformatted binary) onto cassett or paper tape using this command. Note MINIMON will punch two ASCII S's at the begining of each data dump as a start of file indicator.

FORMAT

```
*P S aaaa F bbbb
```

Where aaaa, bbbb are the boundry addresses.

MINIMON will wait approximately 5 Seconds before dumping the data to allow a cassett or paper tape punch to be turned on.

After the dump type a full stop to return to MINIMON.

L (Load)

This command allows the loading of memory from tape produced by the Punch function.

FORMAT

*L S aaaa F bbbb — The program will be loaded at aaaa to bbbb.

After the load type a full stop to return to MINIMON.

THE PROGRAM

The program itself is arranged at three levels:

1) General subroutines
2) Functions (commands)
3) Control

The General subroutines can, ofcourse, be called by user programs and there are about 12 such routines.

The program listing now follows and this should make the program selfexplanatory.

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PROGRAM MINIMON	VERSION	AUTHOR ACH	DATE DEC. '78	PAGE 1 OF 14

ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
		CTRLA	EQU $F4Ø1	ACIA(a) CTRL/STATUS
		CTRLB	EQU $F4Ø3	ACIA(b) " "
		DATA A	EQU $F4ØØ	ACIA(a) DATA REG.
		DATA B	EQU $F4Ø2	ACIA(b) " "
		STACK	EQU $FØDØ	TOP OF MINIMON'S STACK
		JNMI	EQU $FØDD	SPACE FOR JUMP TO NMI SUB.
		JIRQ	EQU $FØEØ	" " " " IRQ "
		SAVE	EQU $FØE3	TEMP. STORAGE FOR NEWLINE
		P	EQU $FØE5	" " " Z,X
		X	EQU $FØE6	" " " SUB
		Y	EQU $FØE8	" " " SUB
		NEW	EQU $FØEA	" " " BLOCK MOVE
		M	EQU $FØEC	" " " 2OUT
		TEMPX	EQU $FØEØ	" " " PRX
		START	EQU $FØEF	" " " GETADDRESS
		STOP	EQU $FØF1	" " " GETADDRESS
		Z	EQU $FØF3	" " " . RDX
		R	EQU $FØF5	" " " PR
		Q	EQU $FØF6	" " " 2IN, DUMP
		ABYTE	EQU $FØF7	" " " SET BR. PT.
		BYTE	EQU $FØFB	" " " SET BR. PT.
		PSTACK	EQU $FØFØ	" " " SWI
FCØØ	BDFD2B	RD	JSR RDB	INPUT ONE CHARACTER
Ø3	27FB		BEQ RD	IGNOR PAPER TAPE FOLLOWER
Ø5	8DØ8		BSR PR	ECHO CHARACTER
Ø7	812E		CMP A #'.	WAS CHARACTER A FULLSTOP
Ø9	26Ø3		BNE END	
ØB	7EFF8F		JMP START	YES - GOTO START OF MINIMON
ØE	39	END	RTS	NO - RETURN
→ ØF	F6F4$\boxed{Ø1}$	PR	LDA B CTRLA	GET ACIA(a) CTRL BYTE
12	C5Ø2		BIT B #Ø2	IS ACIA(a) BUSSY?
14	27F9		BEQ PR	YES - TRY AGAIN
→ 16	B7F4$\boxed{ØØ}$		STA A DATAA	NO - SEND DATA
19	7CFØF5		INC R	CHARACTERS PRINTED +ONE
1C	39		RTS	RETURN TO CALLER

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PROGRAM MINIMON	VERSION	AUTHOR ACH	DATE DEC '78	PAGE 2 OF 4

ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FC1D	812F	VHEX	CMP A #2F	A < 3Ø;
1F	2FØE		BLE NO	NOT HEX
21	8139		CMP A #39	A > 39;
23	22Ø2		BHI N	NOT A NUMERAL
25	ØC	YES	CLC	ITS OK
26	39		RTS	SO RETURN
27	814Ø	N	CMP A #4Ø	A < 41
29	2FØ4		BLE NO	NOT HEX
2B	8146		CMP A #46	A ≤ 46
2D	2FF6		BLE YES	THEN ITS HEX
2F	ØD	NO	SEC	IF NOT SET CARRY
3Ø	39		RTS	AND RETURN
31	853Ø	BINARY	BIT A #3Ø	IS ACC A A LETTER?
33	27ØC		BEQ LETT	
35	48	RIDA	ASL A	ITS A NUMBER SO
36	48		ASL A	GET RID OF MOST
37	48		ASL A	SIGNIFICANT 4 BITS.
38	48		ASL A	
39	C53Ø		BIT B #3Ø	IS ACC B A LETTER?
3B	27Ø8		BEQ LETTER	
3D	C4ØF	RIDB	AND B #ØF	DESTROY MS 4 BITS.
3F	1B		ABA	FORM BINARY CHAR.
4Ø	39		RTS	RETURN
41	8BØ9	LETT	ADD A #Ø9	MAKE ACC A BINARY
43	2ØFØ		BRA RIDA	AS BEFORE
45	CBØ9	LETTER	ADD B #Ø9	MAKE ACC B BINARY
47	2ØF4		BRA RIDB	AS BEFORE
49	8DB5	ZIN	BSR RD	GET A CARACTER
4B	8DDØ		BSR VHEX	IS IT 0→9 or A→F?
4D	251Ø		BCS ?	NO - ITS RUBBISH SO ?
4F	B7FØF6		STA A Q	YES - ITS OK SO SAVE IT
52	8DAC		BSR RD	GET SECOND CHARACTER
54	8DC7		BSR VHEX	IS IT HEX
56	25Ø7		BCS ?	NO - PRINT A'?
58	16		TAB	YES - PUT IT INTO ACC B

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FC59	86FØF6		LDA A Q	RETRIEVE FIRST CHARACTER
5C	8D03		BSR BINARY	CONVERT ACCA,B TO BINARY
5E	39		RTS	RETURN
5F	863F	?	LDA A #'?	LOAD ACC A WITH ASCII '?'
61	8DAC		BSR PR	PRINT IT
63	2ØE4		BRA 2IN	GO BACK TO START
65	BDFD40	RDX	JSR PR▽	PRINT A SPACE (▽)
68	8D0F		BSR 2IN	INPUT TWO HEX CHARACTERS
6A	B7FØF3		STA A Z	SAVE BYTE IN MS. Z
6D	8D0A		BSR 2IN	GET LS. HEX CHARACTERS
6F	B7FØF4		STA A Z+1	STORE IN LS. Z
72	FEFØF3		LDX Z	X ← Z
75	39		RTS	RETURN
76	3Ø	STRING	TSX	POINT X AT LOCATION ON
77	EEØØ		LDX X	STACK WHERE RETURN
79	Ø9		DEX	ADD. IS HELD. LOAD X WITH
7A	Ø8	AGAIN	INX	RETURN ADD.
7B	A6ØØ		LDA A X	GET DATA TO BE PRINTED
7D	81FF		CMP A #FF	LAST BYTE?
7F	27Ø4		BEQ END	YES- GO TO THE END
81	8D8C		BSR PR	NO- PRINT BYTE
83	2ØF5		BRA AGAIN	
85	31	END	INS	CLEAN UP STACK
86	31		INS	
87	6EØ1		JMP X,Ø1	RETURN TO CALLER
89	8DEB	GETADD.	BSR STRING	PRINT:
8B	2Ø53FF			(SPACE), S
8E	8DD5		BSR RDX	INPUT 4 DIGIT HEX ADDRESS
9Ø	FFFØEF		STX START	STORE IT IN START
93	8DE1		BSR STRING	PRINT:
95	2Ø46FF			(SPACE), F
98	8DCB		BSR RDX	INPUT 4 DIGIT HEX ADDRESS
9A	FFFØF1		STX STOP	STORE IT IN STOP
9D	39		RTS	RETURN TO CALLER
9E	16	ASCII	TAB	ACCB ← ACCA

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FC9F	84FØ		AND A #FØ	
A1	44		LSR A	SHIFT MOST SIGNIFICANT
A2	44		LSR A	4 BITS DOWN.
A3	44		LSR A	
A4	44		LSR A	
A5	81Ø9		CMP A #Ø9	LETTER OR NUMBER?(MS)
A7	22ØB		BHI SUBT	
A9	8B3Ø		ADD A #3Ø	MAKE IT A NUMBER(ASCII)
AB	C4ØF	AND	AND B #ØF	GET RID OF MS 4 BITS
AD	C1Ø9		CMP B #Ø9	LETTER OR NUMBER ? (LS)
AF	22Ø7		BHI ADD	
B1	CB3Ø		ADD B #3Ø	MAKE IT AN ASCII NUMBER
B3	39		RTS	FINNISHED
B4	8B37	SUBT	ADD A #37	MAKE IT AN ASCII LETTER
B6	2ØF3		BRA AND	THEN DO LS CHARACTER
B8	CB37	ADD	ADD B #37	MAKE IT AN ASCII LETTER
BA	39		RTS	RETURN
BB	FFFØED	PRX	STX TEMPX	STORE THE INDEX REG.
BE	B6FØED		LDA A TEMPX$_H$	ACCA ← X$_H$
C1	8DØ6		BSR 2OUT	PRINT ACCA IN HEX
C3	B6FØEE		LDA A TEMAX$_L$	ACCA ← X$_L$
C6	8DØ1		BSR 2OUT	PRINT ACCA IN HEX
C8	39		RTS	RETURN
C9	8DD3	2OUT	BSR ASCII	ACCA(BINARY)→ACCA,B(ASCII)
CB	F7FØEC		STA B M	SAVE ACCB
CE	BDFCØF		JSR PR	PRINT ACCA
D1	B6FØEC		LDA A M	RETRIEVE ACCB
D4	BDFCØF		JSR PR	PRINT IT
D7	39		RTS	RETURN
D8	BDFC89	PUNCH	JSR GETADD	GET BOUNDRY ADDRESSES
DB	CEØØØØ		LDX #ØØØØ	WAIT APPROXIMATELY
DE	8DBE	LOOP	BSR ASCII	5 SECS.
EØ	Ø8		INX	
E1	26FB		BNE LOOP	
E3	8D14		BSR BEGIN	START OF RECORD

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FCE5	FEFØEF		LDX START	POINT X AT DATA TO
E8	Ø9		DEX	BE PUNCHED.
E9	Ø8	WRITE	INX	
EA	A6ØØ		LDA A X	GET BYTE
EC	BDFCØF		JSR PR	PUNCH IT *
EF	BCFØF1		CPX STOP	LAST BYTE?
F2	26F5		BNE WRITE	NO-THEN REPEAT
F4	8D35		BSR RDB	YES- WAIT FOR INPUT
F6	7EFF8F		JMP START	FROM TERMINAL; RETURN
F9	8653	BEGIN	LDA A #53	PUNCH TWO 'S' TO
FB	BDFCØF		JSR PR	INDECATE START OF
FE	BDFCØF		JSR PR	DATA BLOCK ON TAPE
FDØ1	8611	BIN	LDA A #11	SET UP ACIA(a) FOR:
Ø3	B7F4Ø1		STA A CTRLA	8 BITS + 2 STOP BITS +
Ø6	39		RTS	÷ 16 CLOCK.
Ø7	BDFC89	LOAD	JSR GETADD	GET BOUNDRY ADDRESSES
ØA	8D1F	NEXT	BSR RDB	BEGIN TO READ DATA
ØC	8153		CMP A #53	BUT DON'T STORE IT
ØE	26FA		BNE NEXT	UNTILL TWO 'S' (ASCII)
1Ø	8D19		BSR RDB	HAVE BEEN READ.
12	8153		CMP A #53	
14	26F4		BNE NEXT	
16	8DE9		BSR BIN	THEN SET UP ACIA(a)
18	FEFØEF		LDX START	POINT X AT PROGRAM
1B	Ø9		DEX	AREA
1C	Ø8	READ	INX	
1D	8DØC		BSR RDB	INPUT BYTE
1F	A7ØØ		STA A X	STORE IT
21	BCFØF1		CPX STOP	LAST BYTE?
24	26F6		BNE READ	NO - CARRY ON
26	7EFF8F		JMP START	YES-GOTO START OF MINIMON
29				
2B	B6F4Ø1	RDB	LDA A CTRLA	ACIA(a) RECIVED A CHAR.
2E	85Ø1		BIT A #Ø1	
3Ø	27F9		BEQ RDB	NO- TRY AGAIN

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FØ32	B6F4ØØ		LDA A DATAA	YES- GET IT
35	39		RTS	AND RETURN
36	8D15	REG.PRINT	BSR PR▽	PRINT A SPACE
38	FEFØFD		LDX PSTACK	POINT X REG. AT USERS STACK
3B	8D14		BSR PR2	PRINT CC
3D	8D1A		BSR PR2	" B
3F	8D18		BSR PR2	" A
41	8D1Ø		BSR PR4	" X
43	8DØE		BSR PR4	" PC
45	CEFØFD		LDX #PSTACK	POINT X AT 'STACK POINTER
48	8DØA		BSR 4PR	PRINT SP
4A	7EFF8F		JMP START	RETURN TO MINIMON
4D	862Ø	PR▽	LDA A #2Ø	LOAD ACCA WITH AN ASCII
4F	BDFCØF		JSR PR	SPACE AND PRINT IT
52	39		RTS	RETURN
53	Ø8	PR4	INX	X ← X+1
54	A6ØØ	4PR	LDA A X	GET DATA(X)
56	BDFCC9		JSR 2OUT	PRINT IT
59	Ø8	PR2	INX	X ← X+1
5A	A6ØØ		LDA A X	GET DATA(X)
5C	BDFCC9		JSR 2OUT	PRINT IT
5F	8DEC		BSR PR▽	PRINT A SPACE
61	39		KTS	RETURN
62	BDFC89	BLOCKMOVE	JSR GETADD	GET BLOCK LIMMITS
65	BDFC76		JSR STRING	PRINT:
68	2Ø544F			▽TO
6B	FF			
6C	BDFC65		JSR RDX	GET NEW START ADDRESS
6F	FFFØEA		STX NEW	STORE IT
72	FFFØE6		STX X	ALSO PUT IT IN X
75	FEFØEF		LDX START	LOAD X REG WITH START
78	FFFØE8		STX Y	TRANSFER IT TO Y
7B	8D59		BSR SUB	DO: X-Y
7D	2A23		BPL DOWN	IF RESULT IS +VE THEN ITS
7F	FEFØF1		LDX STOP	DOWN.

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
F082	Ø8		INX	ADD 1 to STOP
83	FFFØF1		STX STOP	AND STORE IT
86	FEFØEF	DO	LDX START	GET START
89	BCFØF1		CPX STOP	COMPARE IT WITH STOP
8C	26Ø3		BNE CARRYON	FINNISHED ?
8E	7EFF8F	END	JMP START	YES - RETURN TO MINIMON
91	A6ØØ	CARRYON	LDA A X	NO - GET DATA
93	Ø8		INX	INCREMENT START
94	FFFØEF		STX START	STORE IT
97	FEFØEA		LDX NEW	LOAD X REG WITH NEW
9A	A7ØØ		STA A X	STORE DATA
9C	Ø8		INX	INCREMENT NEW
9D	FFFØEA		STX NEW	STORE IT
AØ	2ØE4		BRA DO	ROUND AGAIN
A2	FEFØF1	DOWN	LDX STOP	LOAD XREG WITH STOP
A5	FFFØE6		STX X	PUT IT IN X
A8	8D2C		BSR SUB	ACCA,B ← X - Y
AA	BBFØEB		ADD A NEW$_L$	
AD	FBFØEA		ADD B NEW$_H$	NEW ← NEW + ACCA,B
BØ	B7FØEB		STA A NEW$_L$	
B3	F7FØEA		STA B NEW$_H$	
B6	FEFØEF		LDX START	GET START
B9	Ø9		DEX	DECREMENT IT
BA	FFFØEF		STX START	SAVE START
BD	FEFØF1	DOIT	LDX STOP	LOAD XREG WITH STOP
CØ	BCFØEF		CPX START	COMPARE IT WITH START
C3	27C9		BEQ END	IF EQUAL THEN END
C5	A6ØØ		LDA A X	ACC A ← X$_{STOP}$
C7	Ø9		DEX	STOP ← STOP - 1
C8	FFFØF1		STX STOP	
CB	FEFØEA		LDX NEW	LOAD XREG WITH NEW
CE	A7ØØ		STA A X	STORE DATA
DØ	Ø9		DEX	NEW ← NEW - 1
01	FFFØEA		STX NEW	STORE NEW
D4	2ØE7		BRA DOIT	AND AGAIN

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FDD6	CEFØE6	SUB	LDX #X	POINT XREG AT DATA-
D9	A6Ø1		LDA A XL	AREA. ACCA ← X_L
DB	E6ØØ		LDA B XH	ACCB ← X_H
DD	AØØ3		SUB A YL	ACCA ← ACCA − Y_L
DF	E2Ø2		SBC B YH	ACCB ← ACCB − Y_H − C
E1	39		RTS	RETURN
E2	8D4F	Z	BSR ▽P	PRINT ▽P▽ FOR PC
E4	BDFC49		JSR ZIN	GET PC ADDRESS
E7	B7FØE5		STA A P	SAVE IT
EA	8D4F		BSR ▽D	PRINT ▽D▽ FOR DESTINATION
EC	BDFC49		JSR ZIN	GET D ADDRESS
EF	BØFØE5		SUB A P	D ← D − P
F2	2317		BLS BACK	BRANCHING BACK OR FORWARD?
F4	8ØØ2	FORWARD	SUB A #Ø2	FORWARD: D ← D − 2
F6	2B17		BMI ERROR	IF D>127 THEN ERROR!
F8	B7FØE5	PRINT	STA A P	SAVE D
FB	BDFC76		JSR STRING	PRINT:
FE	2Ø523D			▽R=
FEØ1	FF			
Ø2	B6FØE5		LDA A P	RETRIEVE D
Ø5	BDFCC9		JSR ZOUT	PRINT IT
Ø8	7EFF8F	END	JMP START	RETURN TO MINIMON
ØB	8ØØ2	BACK	SUB A #Ø2	BACKWARDS: D ← D − 2
ØD	2BE9		BMI PRINT	IF D ≥ 128 THEN OK SO PRINT
ØF	BDFC76	ERROR	JSR STRING	PRINT:
12	2Ø5241			
15	4E4745			RANGE!
18	21FF			
1A	2ØEC		BRA END	FINNISH
1C	8D15	X	BSR ▽P	PRINT P FOR PC
1E	BDFC65		JSR RDX	GET P (16 BIT)
21	FFFØE8		STX Y	STORE P IN Y
24	8D15		BSR ▽D	PRINT D FOR DESTINATION
26	BDFC65		JSR RDX	GET D (16 BIT)
29	FFFØE6		STX X	STORE D IN X

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FE2C	BD FD 06		JSR SUB	ACC ← X−Y
2F	2B DA		BMI BACK	BACK OR FORWARD?
31	2Ø C1		BRA FORWARD	
33	BD FC 76	▽P	JSR STRING	PRINT:
36	2Ø 5Ø 2Ø			▽P▽
39	FF			
3A	39		RTS	RETURN
3B	BD FC 76	▽D	JSR STRING	PRINT:
3E	2Ø 44 2Ø			▽D▽
41	FF			
42	39		RTS	RETURN
43	BD FC 65	MODIFY	JSR KOX	GET ADDRESS
46	BD F0 40	STRT	JSR PR▽	PRINT A SPACE
49	7F FØ F5	~~START~~	CLR R	R←O
4C	A6 ØØ	PR	LDA A X	GET DATA
4E	BD FC C9		JSR ZOUT	PRINT IT
51	BD FC ØØ	WATBIT	JSR KØ	GET COMMAND
54	81 2Ø	WHAT	CMP A #2Ø	IS IT A SPACE ?
56	26 ØC		BNE /?	NO – WHAT THEN
58	Ø8	CARRYON	INX	YES – INC X
59	B6 FØ F5		LDA A R	ACC A ← R
5C	81 16		CMP A #16	AT END OF THE LINE?
5E	2F EC		BLE PR	NO – CARRY ON
6Ø	8D 35	NEW	BSR NEWLINE	YES – PRINT A NEW LINE
62	2Ø E2		BRA START	CARRY ON
64	81 2F	/?	CMP A #2F	IS IT A SLASH ?
66	26 Ø3		BNE CR?	NO – WHAT THEN?
68	Ø9		DEX	YES – X←X−1
69	2Ø F5		BRA NEW	CARRY ON
6B	81 ØD	CR?	CMP A #ØD	IS IT A CARAIAGE RETURN
6D	26 Ø3		BNE DATA?	NO – WHAT THEN?
6F	Ø8		INX	YES – X ← X + 1
7Ø	2Ø EE		BRA NEW	CARRY ON
72	BD FC 1D	DATA?	JSR VHEX	IS IT A VALID HEX CHAR.
75	25 19		BCS ?	NO – PRINT ?

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FE77	B7 F0 F6		STA AQ	YES - SO SAVE IT
7A	BD FC 00		JSR R0	GET SECOND CHARACTER
7D	BD FC 10		JSR VHEX	IS IT HEX ?
80	25 02		BCS WHAT	NO - THEN WHAT IS IT
82	16		TAB	YES - ARANGE FOR
83	B6 F0 F6		LDA A Q	CONVERSION TO BINARY
86	BD FC 31		JSR BINARY	CONVERT
89	A7 00		STA A X	STORE IT AT THE RIGHT
8C	BD FD 4D		JSR PR∇	PLACE, PRINT A SPACE
8E	20 C8		BRA CARRYON	CARRY ON
90	86 3F	?	LDA A #3F	ACCA ← ASCII ?
92	BD FC 0F		JSR PR	PRINT ACCA
95	20 BA		BRA WATIST	CARRY ON,
97	FF F0 E3	NEWLINE	STX SAVE	SAVE X REG
9A	BD FC 76		JSR STRING	PRINT:
9D	00 0A 00			CR, LF, NULL
A0	FF			
A1	FE F0 E3		LDX SAVE	RESTORE X REG
A4	BD FC BB		JSR PRX	PRINT IT
A7	39		RTS	RETURN
A8	BD FC 65	ALTER	JSR RDX	GET START ADDRESS
AB	7F F0 F5	NEW	CLR R	R ← 0
AE	8D E7		BSR NEWLINE	PRINT 'NEWLINE'
B0	BD F0 4D		JSR PR∇	PRINT SPACE
B3	BD FC 49	GET	JSR ZIN	GET DATA
B6	A7 00		STA A X	STORE IT
B8	08		INX	X ← X + 1
B9	B6 F0 F5		LDA A R	ACCA ← R
BC	81 26		CMP A #26	AT END OF LINE ?
BE	2F F3		BLE GET	NO - CARRY ON
C0	20 E9		BRA NEW	YES - PRINT A NEW LINE
C2	BD FC 65	GO	JSR RDX	GET PROGRAM START ADD.
C5	BD FC 00		JSR R0	RIGHT ADDRESS ?
C8	B6 F0 F4		LDA A Z_L	ACC ← ADDRESS
CB	F6 F0 F3		LDA B Z_H	

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FECE	FEFØFD	GOTO	LDX PSTACK	LOAD XREG WITH PSTACK
D1	A7Ø7		STA A X,Ø7	PUT NEW RETURN
D3	E7Ø6		STA B X,Ø6	ADDRESS ON STACK
D5	BEFØFD		LDS PSTACK	SET UP PROGRAMS STACK
D8	3B		RTI	GO TO USER PROGRAM
D9	BDFCØØ	CONTINUE	JSR RD	1 or 2
DC	8131		CMP A #31	IS IT A 1?
DE	261Ø		BNE 2?	NO- 2THEN
EØ	FEFØF7		LDX ABYTE1	YES- GET ADDRESS OF BR.PT.
E3	B6FØFB		LDA A BYTE1	GET SAVED OPP. CODE
E6	A7ØØ		STA A X	PUT IT BACK IN THE PROG.
E8	B6FØF8		LDA A ABYTE1L	GET ADDRESS AT WHICH
EB	F6FØF7		LDA B ABYTE1H	TO RE-ENTER PROGRAM
EE	2ØDE		BRA GOTO	GO TO USERS PROGRAM
FØ	8132	2?	CMP A #32	IS IT A 2?
F2	27Ø3		BEQ 2	YES-OK
F4	7EFF8F		JMP START	NO - RETURN TO MINIMON
F7	FEFØF9	2	LDX ABYTE2	GET ADDRESS OF BR. PT 2
FA	B6FØFC		LDA A BYTE2	GET OLD OPP. CODE
FD	A7ØØ		STA A X	PUT IT BACK
FF	B6FØFA		LDA A ABYTE2L	LOAD ADDRESS TO START
FFØ2	F6FØF9		LDA B ABYTE2H	RUNNING PROGRAM AT
Ø5	2ØC7		BRA GOTO	RUN USER PROGRAM.
Ø7	BDFC89	DUMP	JSR GETADD.	GET BOUNDARY ADDRESSES
ØA	FEFØEF		LDX START	
ØD	BDFE97	NEW	JSR NEWLINE	PRINT A NEW LINE
1Ø	86Ø8		LDA A #Ø8	
12	B7FØF6		STA A Q	Q ← 8
15	Ø9		DEX	
16	Ø8	NEXT	INX	
17	BDFD4Ø		JSR PRT	PRINT A SPACE
1A	A6ØØ		LDA A X	GET DATA
1C	BDFCC9		JSR 2OUT	PRINT IT
1F	BCFØF1		CPX STOP	FINNISHED ?
22	26Ø6		BNE CARRYON	NO-CARRY ON

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FF24	B6 F4 ØØ	END	LDA A DATAA	
27	7E FF 8F		JMP START	RETURN TO MINIMON
2A	B6 F4 Ø1	CARRYON	LDA A CTRLA	
2D	85 Ø1		BIT A #Ø1	STOP DUMP?
2F	26 F3		BNE END	YES-OK
31	7A FØ F6		DEC Q	NO-CARRY ON, NEW LINE?
34	26 EØ		BNE NEXT	NO-OK
36	Ø8		INX	YES- PRINT NEXT BYTE
37	2Ø D4		BRA NEW	ON A NEW LINE
39	BD FC ØØ	BR.PT.SET	JSR RD	IS IT A 1 OR A 2?
3C	81 31		CMP A #31	
3E	26 12		BNE 2?	
4Ø	BD FC 65		JSR RDX	ITS A1 SO GET THE ADD.
43	A6 ØØ		LDA A X	GET THE OPP CODE
45	B7 FØ FB		STA A BYTE1	SAVE IT
48	FF FØ F7		STX ABYTE1	ALSO SAVE THE ADDRESS
4B	86 3F	SAME	LDA A #3F	SET THE
4D	A7 ØØ		STA A X	BREAK POINT
4F	7E FF 8F	END	JMP START	FINNISHED
52	81 32	2?	CMP A #32	IS IT A 2?
54	26 F9		BNE END	NO - THEN ITS RUBBISH
56	BD FC 65		JSR RDX	YES- GET ADDRESS
59	A6 ØØ		LDA A X	GET OPP.CODE
5B	B7 FØ FC		STA A BYTE2	SAVE IT
5E	FF FØ F9		STX ABYTE2	SAVE ADDRESS
61	2Ø E8		BRA SAME	SET THE BREAK POINT
63	BD FC 76	HEADER	JSR STRING	PRINT THE FOLLOWING
66	2Ø 43 43			ASCII STRING WHICH
69	2Ø 42 2Ø			IS TERMINATED WITH
6C	2Ø 41 2Ø			HEX FF:
6F	2Ø 2Ø 58			
72	2Ø 2Ø 2Ø			CC B A X PC SP
75	2Ø 5Ø 43			
78	2Ø 2Ø 2Ø			
7B	53 5Ø FF			

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FF7E	7EFF8F		JMP START	RETURN TO MINIMON
81	8EF000	RESET	LDS #STACK	SET UP STACK FOR MINIMON
84	8603		LDA A #03	RESET:
86	B7F401		STA A CTRLA	ACIA (a)
89	B7F403		STA A CTRLB	ACIA (b)
8C	BFF0F0	SWI	STS PSTACK	SAVE PROGS. STACK PTR.
8F	8EF000	START	LDS #STACK	SET UP MINIMONS STACK
92	8601		LDA A #01	SET UP
94	B7F401		STA A CTRLA	ACIA (a)
97	BDFC76		JSR STRING	PRINT :
9A	0D0A00			CR, LF, NULL, *
* > 9D	2AFF			
9F	BDFC00		JSR RD	GET COMMAND
A2	8153		CMP A #53	
A4	2793		BEQ BK.PTSET	IS IT S
A6	8148		CMP A #48	
A8	27B9		BEQ HEADER	" H
AA	8150		CMP A #50	
AC	2603		BNE 1	" P
AE	7EFC08		JMP PUNCH	
B1	814C	1	CMP A #4C	
B3	2603		BNE 2	" L
B5	7EF007		JMP LOAD	
B8	8152	2	CMP A #52	
BA	2603		BNE 3	" R
BC	7EF036		JMP REGPR	
BF	8142	3	CMP A #42	
C1	2603		BNE 4	" B
C3	7EF062		JMP BLOCKM	
C6	815A	4	CMP A #5A	
C8	2603		BNE 5	" Z
CA	7EF0E2		JMP Z	
CD	8158	5	CMP A #58	
CF	2603		BNE 6	" X
D1	7EFE1C		JMP X X	

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ADDRESS	MACHINE CODE	LABEL	OPERATOR & OPERAND	COMMENTS
FFD4	8140	6	CMP A #40	IS IT M
D6	2603		BNE 7	
D8	7EFE43		JMP MODIFY	
DB	8141	7	CMP A #41	
DD	2603		BNE 8	" A
DF	7EFEA8		JMP ALTER	
E2	8147	8	CMP A #47	
E4	2603		BNE 9	" G
E6	7EFEC2		JMP GO	
E9	8143	9	CMP A #43	
EB	2603		BNE 10	" C
ED	7EFED9		JMP CONTINUE	
F0	8144	10	CMP A #44	
F2	269B		BNE START	" D
F4	7EFF07		JMP DUMP	
F7				
	x			
F8	F0E0		FDB JIRQ	IRQ VECTOR
FA	FF8C		FDB SWI	SWI "
FC	F0DD		FDB JNMI	NMI "
FE	FF81		FDB RESET	RESET "