

Application Note

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M68HC11 EEPROM
Programming from
a Personal Computer



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Introduction

This application note describes a simple and reliable method of programming either the M68HC11's internal EEPROM or the EEPROM connected to the MCU's external bus.

The data to be programmed is downloaded from any standard personal computer (PC) fitted with a serial communications port. In addition to the programming procedure, the software incorporates the facility to verify the contents of the MCU's internal or external memory against code held on a PC disc. Both program and verify options use data supplied in S record format, which is downloaded from the PC to the M68HC11 using the RS232 protocol supported by the MCU's SCI port.

The minimum MCU configuration required to program the M68HC11's internal EEPROM is shown in [Figure 1](#). This consists only of the MCU, an RS232 level-shifting circuit, plus an 8-MHz crystal and a few passive components.

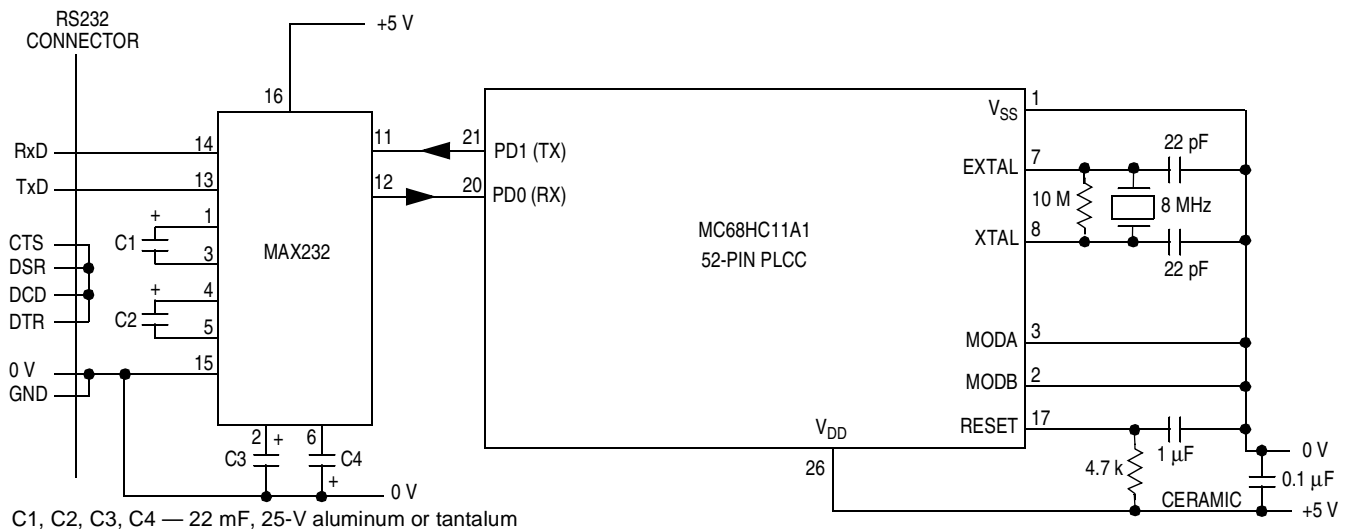


Figure 1. M68HC11 Bootstrap Mode Connection to RS232 Line

To initiate the download, the PC is connected to the M68HC11 SCI transmit and receive lines via a level shifter. The circuit in [Figure 1](#) uses a Maxim MAX232 to eliminate the need for additional ± 12 -volt supplies. The MCU's special bootstrap mode is invoked by applying a logic 0 to the MODA and MODB pins, followed by a hardware reset.

Removing the reset condition causes the MCU to start execution of its bootloader program, located in internal ROM, between addresses \$BF40 and \$BFFF. In normal single-chip or expanded modes, the boot ROM is not accessible, and reads from these memory locations will result, respectively, in irrelevant data or external memory fetches.

An additional consequence of bootstrap operation is that all vectors are relocated to the boot ROM area. With the exception of the reset vector, which points to the start of the boot ROM, the remaining interrupt vectors all point to an uninitialized jump table in RAM. Three bytes are reserved for each entry in the jump table to allow for an extended jump instruction. [Table 1](#) and [Table 2](#) detail the memory map of the bootstrap vectors and an example RAM jump table.

Table 1. Bootstrap Vector Assignments

Address	Vector	Description
BFFE	BF40	Bootstrap reset
BFFC	00FD	Clock monitor
BFFA	00FA	COP fail
BFF8	00F7	Illegal opcode
BFF6	00F4	SWI
BFF4	00F1	XIRQ
BFF2	00EE	IRQ
BFF0	00EB	Real-time interrupt
BFEE	00E8	Timer output capture 1
BFEC	00E5	Timer output capture 2
BFEA	00E2	Timer output capture 3
BFE8	00DF	Timer output compare 1
BFE6	00DC	Timer output compare 2
BFE4	00D9	Timer output compare 3
BFE2	00D6	Timer output compare 4
BFE0	00D3	Timer output compare 5
BFDE	00D0	Timer overflow
BFDC	00CD	Pulse accumulator overflow
BFDA	00CA	Pulse accumulator input edge
BFD8	00C7	SPI
BFD6	00C4	SCI

Table 2. RAM Jump Table

Internal RAM	
Address	Typical Instruction
00FD	JMP CLKMON
00FA	JMP COPFL
. . . etc.	

NOTE: *Before any interrupts are enabled in bootstrap mode, it is the software designer's responsibility to initialize all appropriate entries in the jump table.*

As this application note does not make use of the M68HC11's interrupt system, the jump table is not set up.

The bootstrap program continues by initializing the SCI transmitter and receiver to 7812 baud and proceeds to examine the state of the NOSEC bit in the CONFIG register. If this is at logic 0 (security enabled), the bootloader will erase the entire contents of internal EEPROM and also the CONFIG register.

This feature is particularly useful for security-conscious applications, where the internal EEPROM contains information of a proprietary or confidential nature. If the NOSEC bit is at logic 1, then the erasing sequence is not carried out.

Note also that erasing the CONFIG register disables the security feature.

The bootstrap program then issues a break condition on the SCI transmit line and waits for the reception of the first byte. In this application, no use is made of the break transmitted by the SCI.

At this point, it is necessary to initiate the PC S record downloader program, called EELOAD.BAS (written in BASIC). It will display a header message and prompt the user for the number of the COM channel (either one or two) which is connected to the M68HC11. A listing of EELOAD.BAS is given at the end of this application note.

The PC-resident program will now configure the appropriate COM channel to 1200 baud, one stop bit, no parity, and download the binary file EEPROGIX.BOO from the PC to the M68HC11.

The M68HC11's bootloader automatically will detect the fact that the first incoming character is received at a different baud rate and change its SCI rate to 1200 baud.

It will then proceed to load the binary file into all 256 RAM locations and then jump to address \$0000 (for instance, the first RAM location).

EEPROGIX.BOO consists of the M68HC11 executable code shown in the source listing at the end of this application note, with the addition of \$FF at the head of the file, and \$00 appended up to the 256th byte. This program is designed to receive S records from the PC and program the data fields into the appropriate EEPROM memory locations.

A point to note is that the initial \$FF byte in EEPROGIX.BOO is only used to detect the baud rate of the PC and is not echoed back, while the remaining 256 bytes are echoed by the M68HC11's SCI transmitter. However, during download of EEPROGIX.BOO, the PC does not detect the echo, as this feature is unnecessary at this stage.

Once the newly downloaded S record programmer starts execution in the M68HC11, it configures the SCI to 9600 baud, then waits for a control character from the PC. This character will determine the operating mode of the S record programmer. The options available are shown in [Table 3](#). Note that these programming utilities can be used to load and verify external RAM as well as external EEPROM.

Table 3. S Record Downloader Operating Mode Options

Control Character	Operating Mode
X	Program external EEPROM/RAM
I	Program internal EEPROM
V	Verify internal or external EEPROM/RAM

If the S record programmer has been downloaded successfully, the PC resident program will now:

1. Request whether the downloaded data must be echoed to the screen
2. Prompt the user for the required operating mode
3. Request the name of the S record file to be downloaded from the PC

Once the download starts, every character in the S record file is immediately echoed back to the PC. This ensures synchronism between the PC and the M68HC11, and at the same time it removes some of the overhead associated with the EEPROM programming delay time. It also removes the need for a hardware handshake.

Verify Option

If a verify error occurs, the actual stored byte value is returned to the PC, where it is displayed with a preceding colon delimiter. In this way, EEPROM data and address faults can be quickly identified by inspection.

At the end of the verify download, the total number of errors is displayed.

Internal or External Option

If a programming error occurs in either internal or external programming mode, for instance, if the read back data after programming does not correspond to the expected data, the M68HC11-resident software will hang up. This condition is detected by the PC-resident program, which will then abort the download and display an error message. This same error message is displayed if a fault or incorrect connection exists on the serial link between the PC and M68HC11.

The one exception to this operation stems from the fact that changes to the M68HC11's CONFIG register can be detected only after a subsequent hardware reset. If the CONFIG register address (\$103F) is detected, then the CONFIG register is not read directly after programming. This prevents premature termination of the download.

To allow programming of the CONFIG register in all mask set versions of the M68HC11A series and to permit expanded mode operation, the MCU resident program switches from bootstrap mode to special test mode by setting the MDA bit (bit 5) in the HPRIO register (address \$103C).

If the user wishes to maintain operation in bootstrap mode (to verify internal ROM code, for instance), then the BSET HPRIO,X,#MDA instruction on the eighth line of program code in EEPROGIX.ASC should be removed and the program reassembled.

Programming Internal EEPROM

The techniques for programming internal and external EEPROM are quite different.

With internal EEPROM, it is first generally necessary to erase the required byte (erased state is \$FF) and follow with a write of data to the same address.

The internal programming sequence involves accessing the PPROG register (address \$103B) to latch the EEPROM address and data buses for the duration that the programming voltage is applied. Also, the programming time delay must be implemented or initiated by software. In this application, a software timing loop is used, but one of the internal M68HC11 timer functions could equally well be used to provide the time delay.

Figure 2 and **Figure 3** show the flowcharts of the internal EEPROM erase and write sequences.

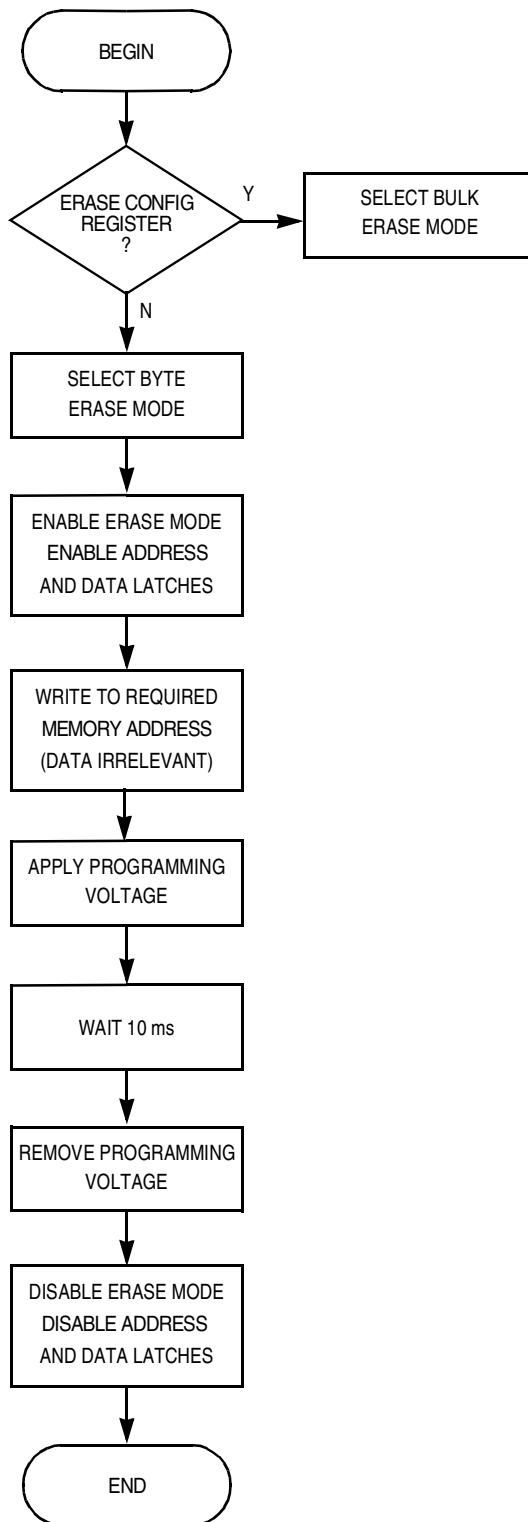


Figure 2. Internal EEPROM Erase Sequence

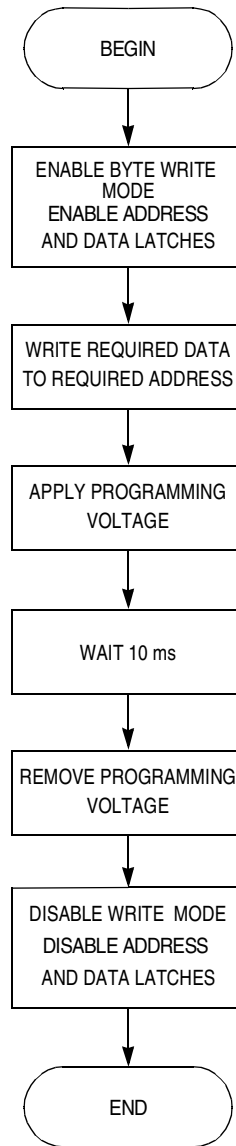


Figure 3. Internal EEPROM Write Sequence

Programming External EEPROM

Figure 4 shows the hardware needed to interface the M68HC11 to an external 2864 EEPROM, which provides a total of 8 Kbytes of reprogrammable memory. The addition of the MC68HC24 gives a minimal component count implementation of a circuit which accurately emulates the M68HC11A8 single-chip MCU. The added benefit of using the 2864 is that the software designer's program and/or data can be modified without removing the emulator from the target system. This can be particularly useful in applications where the emulator may be enclosed in a confined space or in an environmental chamber.

To program the 2864 from the PC, the external operating mode option (X) must be selected from the EELOAD menu.

Programming the 2864 involves fewer operations than are needed for internal EEPROM, as the former has no equivalent of the PPROG control register. In addition, the erase sequence and delay time are handled automatically by the 2864 on-chip logic.

A data polling technique is used to determine the end of the programming delay time. This involves examining the most significant bit of the data programmed by reading from the address just written to until the data becomes true. (During the programming delay time, the MS bit will read as the complement of the expected data.)

This means that the same software algorithm can be used to download code or data to external RAM as well as external EEPROM.

Emulator Address Decoding

The emulator circuit in **Figure 4** shows the M68HC11's address line A13 connected to pin 26 of the 2864. Although this pin is actually unused by the 2864, its inclusion permits the replacement of the 2864 with a 27128 16-Kbyte EEPROM memory.

An important outcome of this is that, when a 2864 is used, the memory range \$C000-\$DFFF is mapped over the normally used 8-Kbyte range of \$E000-\$FFFF. In practice, this should never pose a problem. When a 27128 memory is used, its full 16-Kbyte address range of \$C000-\$FFFF is available to the MCU.

Included in the S record programmer, irrespective of the selected programming mode, is a feature to force program execution at the address specified in the S9 S record address field, provided the address is not \$0000.

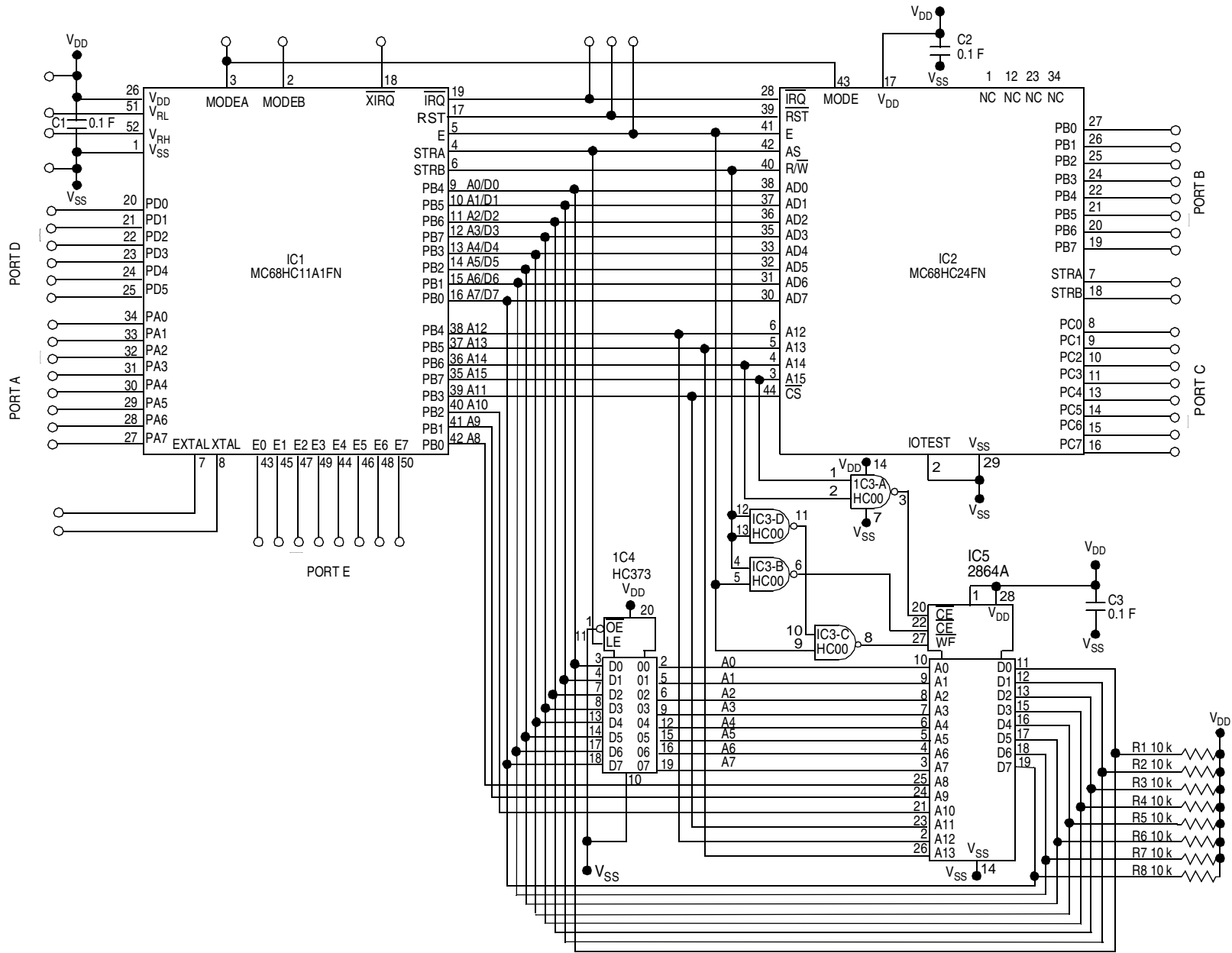
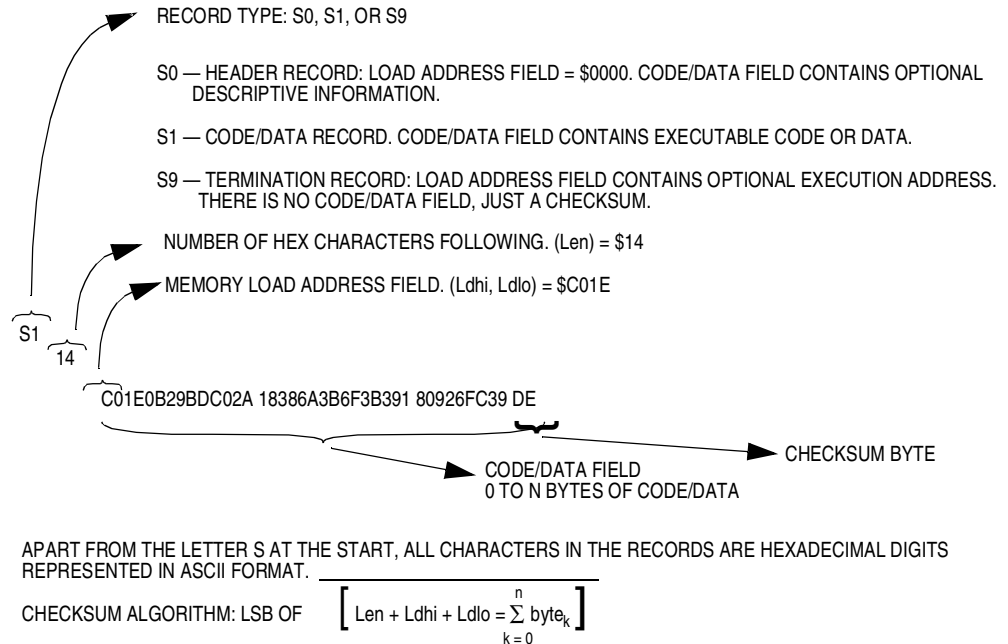


Figure 4. MC68HC11A8 Emulator Using 2864 EEPROM

Figure 5 shows the general format of S record files.



Note: The S record programmer in this application ignores the checksum byte.

Figure 5. S-Record Format

```

10 ' ***** EELOAD.BAS 20/3/87  Version 1.0 *****/
20 ' Written by R.Soja, Motorola East Kilbride'
30 ' Motorola Copyright 1987'
40 ' This program downloads S record file to the M68HC11 through special'
50 ' bootstrap program, designed to program either internal or external'
60 ' EEPROM in the 68HC11's memory map'
70 ' The loader can also verify memory against an S record file.'
80 ' Downloaded data is optionally echoed on terminal.'
90 ' =====
100 CR$=CHR$(13)
110 MIN$=CHR$(32)
120 MAX$=CHR$(127)
130 ERM$="Can't find "
140 LOADER$="EPROGIX.BOO"
150 CLRLN$=SPACE$(80)
160 VER$="1.0": 'Version number of EELOAD'
170 ERRTOT%=0: 'Number of errors found by verify operation'
180 CLS

```

```

190 PRINT " <<<<<<<          EELoad Version ";VER$;"          >>>>>>>"
200 PRINT " <<<<<<< 68HC11 Internal/External EEPROM loader/verifier >>>>>>>"
210 PRINT
220 PRINT "==> Before continuing, ensure 68HC11 is in bootstrap mode,"
230 PRINT "          RESET is off, and COM1 or COM2 is connected to the SCI"
240 PRINT
250 ' First make sure loader program is available'
260 ON ERROR GOTO 880
270 OPEN LOADER$ FOR INPUT AS #2
280 CLOSE #2
290 ON ERROR GOTO 0
300 CHAN$="0"
310 ROW=CSRLIN: 'Store current line number'
320 WHILE CHAN$<>"1" AND CHAN$<>"2"
330 GOSUB 1070
340 LINE INPUT "Enter COM channel number (1/2):",CHAN$
350 WEND
360 CM$="COM"+CHAN$
370 ' Now set baud rate to 1200 and load EEPROG through boot loader'
380 ' by executing DOS MODE and COPY commands'
390 SHELL "MODE "+CM$+":1200,N,8,1"
400 SHELL "COPY "+LOADER$+" "+CM$
401 GOSUB 1070
402 FOR I%=1 to 4:PRINT CLRLN$;:NEXT I%PRINT: 'Clear DOS commands from screen'
410 ECHO$=" "
420 WHILE ECHO$<>"Y" AND ECHO$<>"N"
430 GOSUB 1070
440 LINE INPUT "Do you want echo to screen (Y/N):",ECHO$
450 WEND
470 ROW=CSRLIN: 'Store current line number'
480 EEOPT$=" ": 'Initialise option char'
490 WHILE EEOPT$<>"X" AND EEOPT$<>"I" and EEOPT$<>"V"
500 GOSUB 1070
510 LINE INPUT "Select Internal, eXternal or Verify EEPROM option (I/X/V):",EEOPT$
520 WEND
530 OPT$="Verify"
540 IF EEOPT$="I" THEN OPT$="Internal"
550 IF EEOPT$="X" THEN OPT$="External"
560 ROW=CSRLIN: 'Store current line position in case of file error'
570 RXERR=0: 'Initialise number of RX errors allowed'
580 ON ERROR GOTO 910
590 GOSUB 1070

```

```

600 IF OPT$="Verify" THEN INPUT "Enter filename to verify: ",F$ ELSE INPUT "Enter filename to
download:",F$
610 CLOSE
620 OPEN F$ FOR INPUT as #2
630 ON ERROR GOTO 0
640 'COM1 or 2 connected to SCI on HC11'
650 OPEN CM$+":9600,N,8,1" AS #1
660 'Establish contact with HC11 by sending CR char & waiting for echo'
670 ON ERROR GOTO 860: 'Clear potential RX error'
680 PRINT #1,CR$;
690 GOSUB 990: 'Read char into B$'
700 'Transmit Internal,External or Verify EEPROM option char to 68HC11'
710 PRINT #1,EEOPT$;:GOSUB 990:          'No echo to screen'
720 ON ERROR GOTO 930
730 PRINT "Starting download of <"F$;"> to: ";OPT$;" Eeprom"
732 IF ECHO$="Y" THEN E%=1 ELSE E%=0
734 IF EOPT$="V" THEN V%=1 ELSE V%=0
740 WHILE NOT EOF(2)
750 INPUT #2,S$
751 L%=LEN(S$)
752 FOR I%=1 to L%
760 PRINT #1,MID$(S$,I%,1);:GOSUB 990:IF E% THEN PRINT B$;
770 IF V% THEN GOSUB 1030:IF C$<>" THEN PRINT ":";HEX$(ASC(C$));
785 NEXT I%
787 IF E% THEN PRINT
790 WEND
795 PRINT
800 PRINT "Download Complete"
810 IF V% THEN PRINT ERRTOT%;" error(s) found"
820 CLOSE #2
830 SYSTEM
840 END
850 ' -----'
860 IF RXERR>5 THEN 940 ELSE RXERR=RXERR+1:RESUME 610
870 ' -----'
880 PRINT:PRINT ERM$;LOADER$:PRINT "Program aborted"
890 GOTO 830
900 ' -----'
910 PRINT ERM$;F$;SPACE$(40)
920 RESUME 580
930 ' -----'
940 PRINT:PRINT "Communication breakdown: Download aborted"
950 GOTO 820

```

```

960 '-----'
970 '--SUB waits for received character, with time limit'
980 '-- returns with char in B$, or aborts if time limit exceeded'
990 T0%=0:WHILE LOC(1)=0:IF T0%>100 THEN 940 ELSE T0%=T0%+1:WEND
1000 B$=INPUT$(1,#1):RETURN
1010 '-----'
1020 '--SUB waits for received character, with time limit'
1025 '-- returns with char in C$, or null in C$ if time limit exceeded'
1030 T0%=0:C$="":WHILE LOC(1)=0 AND T0%<1:T0%=T0%+1:WEND
1040 IF LOC(1)>0 THEN C$=INPUT$(1,#1):ERRTOT%=ERRTOT%+1
1050 RETURN
1060 '-----'
1070 '--SUB Clear line '
1080 LOCATE ROW,1,1:PRINT CLRLN$
1090 LOCATE ROW,1,1:RETURN
1100 '-----'
1 A *****
2 A *          EEPROMIX.ASC 19/3/87      Revision 1.0
3 A *
4 A * Written by R.Soja, Motorola, East Kilbride *
5 A * Motorola Copyright 1987. *
6 A *
7 A * This program loads S records from the host to *
8 A * either a 2864 external EEPROM on the 68HC11 external bus, *
9 A * or to the 68HC11's internal EEPROM. It can also be used *
10 A * verify memory contents against an S record file or just *
11 A * load RAM located on the 68HC11's external bus. *
12 A * Each byte loaded is echoed back to the host. *
13 A * When programming a 2864, data polling is used to detect*
14 A * completion of the programming cycle. *
15 A * As the host software always waits for the echo before *
16 A * downloading the next byte, host transmission is suspended *
17 A * during the data polling period. *
18 A * Because the serial communication rate (~1mS/byte) is *
19 A * slower than the 2864 internal timer timeout rate (~300µs) *
20 A * page write mode cannot be used. This means that data *
21 A * polling is active on each byte written to the EEPROM, *
22 A * after an initial delay of approx 500µs. *
23 A *
24 A * When the internal EEPROM is programmed, instead of data *
25 A * polling, each byte is verified after programming. *
26 A * In this case, the 500µs delay is not required and is *
27 A * bypassed. *

```

```

28 A          * If a failure occurs, the program effectively hangs up. It *
29 A          * is the responsibility of the host downloader program to *
30 A          * detect this condition and take remedial action.      *
31 A          * The BASIC program EELOAD just displays a 'Communication *
32 A          * breakdown' message, and terminates the program.      *
33 A          *
34 A          * When used in the verify mode, apart from the normal echo *
35 A          * back of each character, all differences between memory *
36 A          * and S record data are also sent back to the host.    *
37 A          * The host software must be capable of detecting this, and *
38 A          * perform the action required.                          *
39 A          * The BASIC loader program EELOAD simply displays the *
40 A          * returned erroneous byte adjacent to the expected byte, *
41 A          * separated by a colon.                                  *
42 A          *
43 A          * Before receiving the S records, a code byte is received *
44 A          * from the host. i.e.:                                  *
45 A          *     ASCII 'X' for external EEPROM                    *
46 A          *     ASCII 'I' for internal EEPROM                    *
47 A          *     ASCII 'V' for verify EEPROM                      *
48 A          *
49 A          * This program is designed to be used with the BASIC EELOAD *
50 A          * program.                                             *
51 A          * Data transfer is through the SCI, configured for 8 data *
52 A          * bits, 9600 baud.                                     *
53 A          *
54 A          *     PAGE
55 A          * Constants
56 A          0080 TDRE EQU $80
57 A          0020 RDRF EQU $20
58 A          0020 MDA EQU $20
59 A          0040 SMOD EQU $40
60 A          0D05 ms10 EQU 10000/3 10ms delay with 8MHz xtal.
61 A          00A6 us500 EQU 500/3 500us delay.
62 A          *
63 A          * Registers
64 A          002B BAUD EQU $2B
65 A          002C SCCR1 EQU $2C
66 A          002D SCCR2 EQU $2D
67 A          002E SCSR EQU $2E
68 A          002F SCDR EQU $2F
69 A          003B PPROG EQU $3B
70 A          003C HPRI0 EQU $3C

```

```

71 A      103F      CONFIG      EQU      $103F
72 A
73 A      * Variables. Note: They overwrite initialisation code!!!!
74 A      0000      ORG      $0
75 P 0000 0001      EEOPT      RMB      1
76 P 0001 0001      MASK      RMB      1
77 P 0002 0001      TEMP      RMB      1
78 P 0003 0001      LASTBYTE  RMB      1
79 A
80 A      * Program
81 A      0000      ORG      $0
82 A 0000 8E00FF      LDS      #$FF
83 A 0003 CE1000      LDX      #$1000      Offset for control registers.
84 A 0006 6F2C      CLR      SCCR1,X      Initialise SCI for 8 data bits, 9600 baud
85 A 0008 CC300C      LDD      #$300C
86 A 000B A72B      STAA     BAUD,X
87 A 000D E72D      STAB     SCCR2,X
88 A 000F 1C3C20      BSET     HPRIO,X,#MDA      Force Special Test mode first,
89 A      *==>> MAINTAIN SPECIAL TEST MODE TO ALLOW B96D CONFIG REGISTER PROGRAMMING <<==
90 A      *          BCLR HPRIO,X,#SMOD and then expanded mode. (From Bootstrap mode)
91 A 0012 9F00      ReadOpt  STS      <EEOPT      Default to internal EEPROM: EEOPT=0;
                                MASK=$FF;
92 A 0014 8D7C      BSR      READC      Then check control byte for external or
93 A 0016 C149      CMPB     #'I'      internal EEPROM selection.
94 A 0018 2714      BEQ      LOAD
95 A 001A C158      CMPB     #'X'      If external EEPROM requested
96 A 001C 2609      BNE      OptVerf
97 A 001E 7C0000      INC      EEOPT      then change option to 1
98 A 0021 8680      LDAA     #$80
99 A 0023 9701      STAA     <MASK      and select mask for data polling mode.
100 A 0025 2007      BRA      LOAD
101 A
102 A 0027 C156      OptVerf  CMPB     #'V'      If not verify then
103 A 0029 26E7      BNE      ReadOpt    get next character else
104 A 002B 7A0000      DEC      EEOPT      make EEOPT flag negative.
105 A
106 A      002E      LOAD     EQU      *
107 A 002E 8D62      BSR      READC
108 A 0030 C153      CMPB     #'S'      Wait until S1 or S9 received,
109 A 0032 26FA      BNE      LOAD      discarding checksum of previous S1
                                record.
110 A 0034 8D5C      BSR      READC
111 A 0036 C131      CMPB     #'1
112 A 0038 2719      BEQ      LOAD1

```

113	A	003A	C139		CMPB	#'9	
114	A	003C	26F0		BNE	LOAD	
115	A	003E	8D5F		BSR	RDBYTE	Complete reading S9 record before terminating
116	A	0040	17		TBA		
117	A	0041	8002		SUBA	#2	# of bytes to read including checksum.
118	A	0043	8D6B		BSR	GETAD	Get execution address in Y
119	A	0045	8D58	LOAD9	BSR	RDBYTE	Now discard remaining bytes,
120	A	0047	4A		DECA		including checksum.
121	A	0048	26FB		BNE	LOAD9	
122	A	004A	188C0000		CPY	#0	If execution address =0 then
123	A	004E	27FE		BEQ	*	hang up else
124	A	0050	186E00		JMP	,Y	jump to it!
125	A			*			
126	A		0053	LOAD1	EQU	*	
127	A	0053	8D4A		BSR	RDBYTE	Read byte count of S1 record into ACCB
128	A	0055	17		TBA		and store in ACCA
129	A	0056	8003		SUBA	#3	Remove load address & checksum bytes from count
130	A	0058	8D56		BSR	GETADR	Get load address into X register.
131	A	005A	1809		DEY		Adjust it for first time thru' LOAD2 loop.
132	A	005C	2017		BRA	LOAD1B	
133	A			*			
134	A	005E	D600	LOAD1A	LDAB	EEOPT	Update CC register
135	A	0060	2B25		BMI	VERIFY	If not verifying EEPROM then
136	A	0062	2705		BEQ	DATAPOLL	If programming external EEPROM
137	A	0064	C6A6		LDAB	#us500	
138	A	0066	5A	WAIT1	DECB		then wait 500us max.
139	A	0067	26FD		BNE	WAIT1	
140	A	0069	18E600	DATAPOLL	LDAB	,Y	Now either wait for completion of programming
141	A	006C	D803		EORB	<LASTBYTE	programming cycle by testing MS bit of last data written to
142	A	006E	D401		ANDB	<MASK	last data written to memory or just
143	A	0070	26F7		BNE	DATAPOLL	verify internal programmed data.
144	A	0072	4A	LOAD1E	DECA		When all bytes done,
145	A	0073	27B9		BEQ	LOAD	get next S record (discarding checksum)
146	A	0075	8D28	LOAD1B	BSR	RDBYTE	else read next data byte into ACCB.
147	A	0077	1808		INY		Advance to next load address
148	A	0079	7D0000		TST	EEOPT	
149	A	007C	2B05		BMI	LOAD1D	If verifying, then don't program byte!
150	A	007E	2743		BEQ	PROG	If internal EEPROM option selected then program
151	A	0080	18E700		STAB	,Y	else just store byte at address.

152 A 0083 D703	LOAD1D	STAB	<LASTBYTE	Save it for DATA POLLING operation.
153 A 0085 20D7		BRA	LOAD1A	
154 A	*			
155 A 0087 18E600	VERIFY	LDAB	,Y	If programmed byte
156 A 008A D103		CMP8	<LASTBYTE	is correct then
157 A 008C 27E4		BEQ	LOAD1E	read next byte
158 A 008E 8D08		BSR	WRITEC	else send bad byte back to host
159 A 0090 20E0		BRA	LOAD1E	before reading next byte.
160 A	*			
161 A 0092	READC	EQU	*	ACCA, X, Y regs unchanged by this routine.
162 A 0092 1F2E20FC		BRCLR	SCSR,X,#RDRF,*	
163 A 0096 E62F		LDAB	SCDR,X	Read next char
164 A 0098 1F2E80FC	WRITEC	BRCLR	SCSR,X,#TDRE,*	
165 A 009C E72F		STAB	SCDR,X	and echo it back to host.
166 A 009E 39		RTS		Return with char in ACCB.
167 A	*			
168 A 009F 8DF1	RDBYTE	BSR	READAC	1st read MS nibble
169 A 00A1 8D17		BSR	HEXBIN	Convert to binary
170 A 00A3 58		LSLB		and move to upper nibble
171 A 00A4 58		LSLB		
172 A 00A5 58		LSLB		
173 A 00A6 58		LSLB		
174 A 00A7 D702		STAB	<TEMP	
175 A 00A9 8DE7		BSR	READC	Get ASCII char in ACCB
176 A 00AB 8D0D		BSR	HEXBIN	
177 A 00AD DA02		ORAB	<TEMP	
178 A 00AF 39		RTS		Return with byte in ACCB
179 A	*			
180 A 00B0	GETADR	EQU	*	
181 A 00B0 36		PSHA		Save byte counter
182 A 00B1 8DEC		BSR	RDBYTE	Read MS byte of address
183 A 00B3 17		TBA		and put it in MS byte of ACCD
184 A 00B4 8DE9		BSR	RDBYTE	Now read LS byte of address into LS byte of ACCD
185 A 00B6 188F		XGDY		Put load address in Y
186 A 00B8 32		PULA		Restore byte counter
187 A 00B9 39		RTS		and return.
188 A	*			
189 A 00BA	HEXBIN	EQU	*	
190 A 00BA C139		CMP8	#'9	If ACCB>9 then assume its A-F
191 A 00BC 2302		BLS	HEXNUM	
192 A 00BE CB09		ADDB	#9	
193 A 00C0 C40F	HEXNUM	ANDB	#\$F	

```

194 A 00C2 39          RTS
195 A                  *
196 A      00C3        PROG    EQU    *
197 A 00C3 36          PSHA          Save ACCA.
198 A 00C4 8616        LDAA    #$16    Default to byte erase mode
199 A 00C6 188C103F    CPY     #CONFIG    If byte's address is CONFIG then use
200 A 00CA 2602        BNE     PROGA
201 A 00CC 8606        LDAA    #$06    bulk erase, to allow for A1 &A8 as well
                    as A2.
202 A 00CE 8D10        PROGA   BSR     PROGRAM    Now byte erase or entire memory + CONFIG.
203 A 00D0 8602        LDAA    #2
204 A 00D2 8D0C        BSR     PROGRAM    Now program byte.
205 A 00D4 188C103F    CPY     #CONFIG    If byte was CONFIG register then
206 A 00D8 2603        BNE     PROGX
207 A 00DA 18E600        LDAB    ,Y    Load ACCB with old value, to prevent
                    hangup later.
208 A 00DD 32          PROGX   PULA          Restore ACCA
209 A 00DE 20A3        BRA     LOAD1D    and return to main bit.
210 A                  *
211 A      00E0        PROGRAM  EQU    *
212 A 00E0 A73B        STAA   PPROG,X    Enable internal addr/data latches.
213 A 00E2 18E700        STAB   ,Y    Write to required address
214 A 00E5 6C3B        INC    PPROG,X    Enable internal programming voltage
215 A 00E7 3C          PSHX
216 A 00E8 CE0D05        LDX    #mS10    and wait 10mS
217 A 00EB 09          WAIT2   DEX
218 A 00EC 26FD        BNE    WAIT2
219 A 00EE 38          PULX
220 A 00EF 6A3B        DEC    PPROG,X    Disable internal programming voltage
221 A 00F1 6F3B        CLR    PPROG,X    Release internal addr/data latches
222 A 00F3 39          RTS    and return
223 A                  *
224 A                  END

```

SYMBOL TABLE: Total Entries= 41

BAUD	002B	PROGA	00CE
CONFIG	103F	PROGRA	00E0
		M	
DATAPOLL	0069	PROGX	00DD
EEOPT	0000	RDBYTE	009F
GETADR	00B0	RDRF	0020
HEXBIN	00BA	READC	0092
HEXNUM	00C0	ReadOp	0012
		t	
HPRIO	003C	SCCR1	002C
LASTBYTE	0003	SCCR2	002D
LOAD	002E	SCDR	002F
LOAD1	0053	SCSR	002E
LOAD1A	005E	SMOD	0040
LOAD1B	0075	TDRE	0080
LOAD1D	0083	TEMP	0002
LOAD1E	0072	VERIFY	0087
LOAD9	0045	WAIT1	0066
MASK	0001	WAIT2	00EB
MDA	0020	WRITEC	0098
OptVerf	0027	mS10	0D05
PProg	003B	uS500	00A6
PROG	003C		

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ASIA/PACIFIC:

Motorola Semiconductors H.K. Ltd.;
Silicon Harbour Centre, 2 Dai King Street,
Tai Po Industrial Estate, Tai Po, N.T., Hong Kong
852-26668334

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1-800-521-6274

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