Two Line Mini-Terminal

The Two Line Mini-Terminal is an embedded microcontroller board designed to implement a limited but low cost terminal. The board was designed to be the same size as a 2 line by 40 character LCD such as the OPTREX DMC 40218. With mounting holes in the same pattern as the LCD the controller board can be piggy backed with the display. As an input device the terminal uses standard IBM compatible PC keyboard. In a normal full duplex mode the controller converts the keyboard scan codes to ASCII and transmits them to the RS-232 output. Input from the RS-232 is displayed on the LCD. The software does vertical and horizontal scrolling of the incoming characters.

The board uses a Motorola MC68HC11 as its controller. More specifically it can use either the MC68HC711E9 which has 12K of EPROM and 512 bytes of RAM or the MC68HC811E2 which has 2K of EEPROM and 256 bytes of RAM. The board also has a MAX232 chip for RS-232 interface and a LM7805 for power regulation. The board has a 6 position mini-DIN female connector for a PS-2 keyboard and a 14 pin header for a LCD.

The software consists of basically three independent subroutines; serial input-output, keyboard input and output to the LCD. After initialization, the main program loop checks for input from the serial port and from the keyboard and sends output to the serial port or the LCD. The main program loop is in an EEPROM area; see listing fragment.

The serial port input routine is interrupt driven and one of the differences between the software version for the MC68HC811E2 and the MC68HC711E9 is that the input queue is set to 32 characters in the E2 version while the E9 version has the queue set to 80 characters. The baud rate is fixed at 9600. With this version of the software there is no flow control; neither hardware nor software. There is provision on the PC board for RTS and CTS but they are not implemented in this version of the software.

The keyboard is also read using an interrupt routine; the keyboard scan codes are converted to ASCII using a lookup table. With this version of the software all of the alphanumeric keys as well as SHIFT and CAPS LOCK are read. The ALT, CTRL, F1-F12, arrow keys, and numeric keypad are ignored. Note that the keyboard software is only for AT style keyboards (the old XT style is quite different). Even with the AT style there seems to be different modes of operation and different timing requirements that prevent operation with, at least, this version of the software. At the end of this document is a table of various keyboards that have been tested. Users are encouraged to contribute their own observations.

The keyboard's clock line is connected to the 68HC11's PC0, IC3 and a pull up. The keyboard's data line is connected to PC1, IC2 and a pull up. Port C is set to the wire-or mode and these two pins are used as outputs when needed. IC3 and IC2 trigger interrupts when needed. The RTI is also used by the keyboard subroutine.

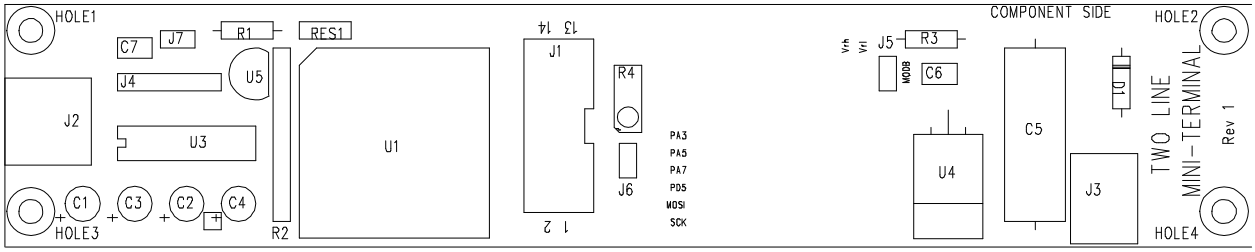
LCD's are not difficult to interface; there are many examples to be found on the Internet. Mostly you must be sure to allow sufficient setup time; LCD's are slow. The LCD subroutine used in this project maintains a 160 byte area in RAM organized as 2 lines by 80 characters. Using this RAM buffer the sub-

routine will horizontally scroll both lines of the display whenever an incoming line exceeds the 40 character width of the LCD. When a CR is received the second line will scroll to the top line and the cursor placed at the beginning of the second line. The 68HC711E9 version of the program implements a very small subset of the ANSI terminal emulation of escape sequences. ***Esc*[2J** will erase the whole screen (Ctrl Z will also). ***Esc*[*l*;*c*H** where "*l*" is the line number 0 or 1 ASCII and "*c*" is the column number 0 to 31 ASCII will position the cursor. See your MSDOS HELP screen for more information on ANSI.

The LCD's data lines are connected to the 68HC11's Port B also PC2 and PC3 control the LCD's Register Select and Enable lines. The R/W line is tied low. The routine also used the 68HC11's TOC5 timer in a polled mode.

The LCD display is connected to the controller board via a 14 pin header located near the center of the board. Use ribbon cable and a insulation displacement header. Some LCD's may already have a ribbon cable attached in which case female in line sockets may be a better connector choice than a male header. Buy your LCD before you solder a socket or header on the board. Be very careful with pin placement. The pin numbers on a LCD are not like an IC; all the even numbers are on one side, odd on the other.

Pin 3 of the LCD is for bias voltage that controls contrast. The LCD will work if this pin is tied to ground or a trim pot may be used to adjust contrast and viewing angle somewhat. Jumper J6 may be used to provide +5 volts to one end of the trimmer. Extended temperature range LCD's require a negative bias; in this case don't connect J6 to +5 volts but use a jumper wire to connect the pad nearest the trim pot to the negative voltage supply of the MAX232. There is a pad located near the edge of the board below pin 6 which is intended for this purpose.

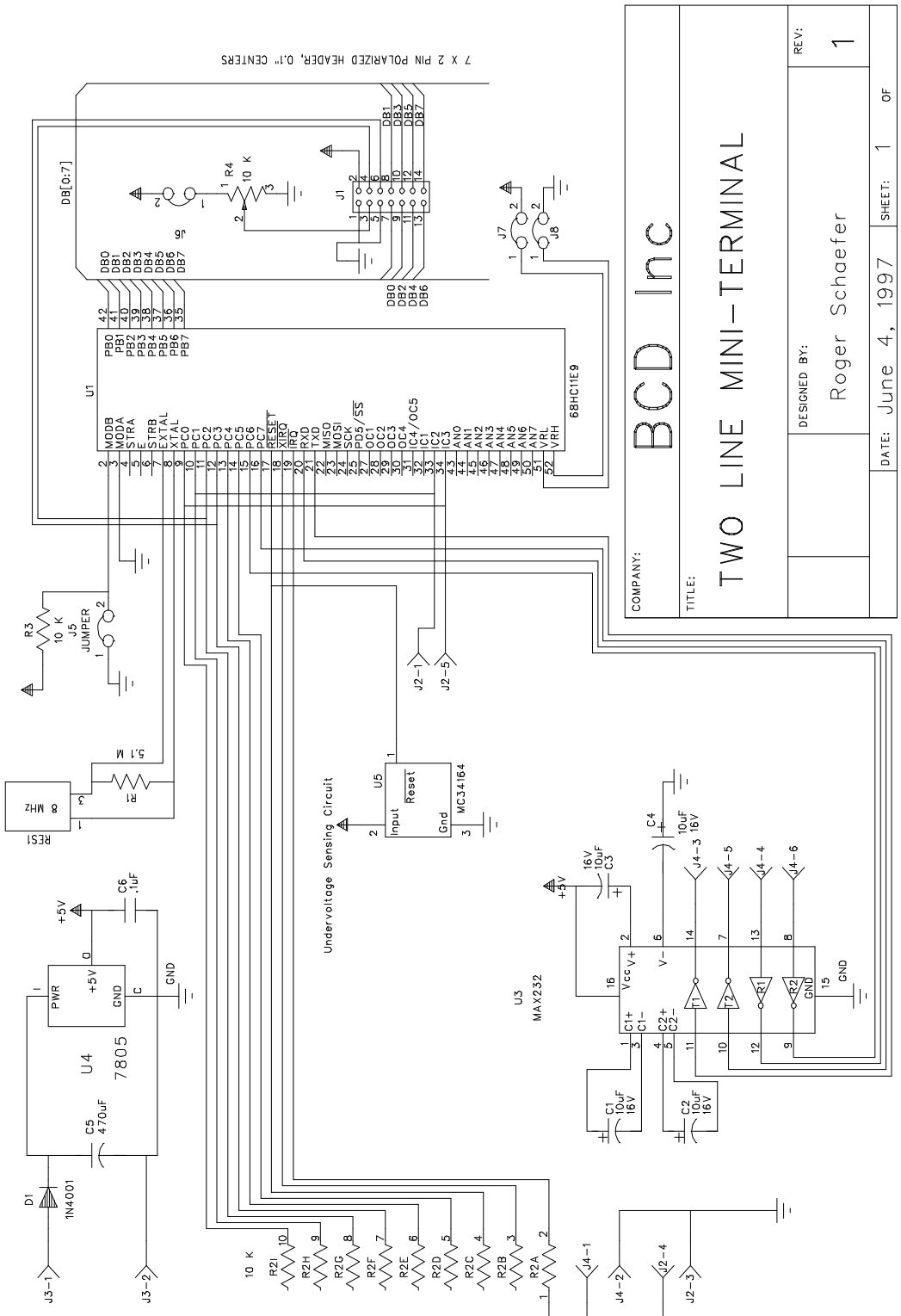


PARTS LAYOUT

Parts layout is according to the above diagram; there is no silkscreen overlay on the board. This is a project for an experienced technician. Pin 1 of the 68HC11 is toward the top of the board. Pin 1 of the LCD header is toward the bottom. J4 is a six pin polarized header for RS-232; only pins 2, 3, and 4 which connect to the MAX232 pins 15, 14, and 13 are really needed. Pin 2 is GND, pin 3 is transmit and pin 4 is receive. J3 is a two pin terminal block for power; use a small wall mounted DC power supply. Connect ground to the left. Use a heat sink for U4, the voltage regulator because some keyboards may draw up to 500 ma of current. J5 is a jumper for MODB used if you want to start the 68HC11 in bootstrap mode. J7 could be used for a RESET switch or ignored. U5 is a low voltage reset IC such

as Motorola's MC34164 or the Panasonic MN13811-S.

Not shown on the above parts layout is a 1" x 1" prototype area. Some of the unused pins from the 68HC11 are brought out to this area. Available are Port E, MOSI and CLK for the SPI and three of the Port A pins. The Two Line Mini-Terminal program is less than 3 K bytes long so if a MC68HC711 is used there would be 9 K bytes of EPROM available for other uses.


TWO LINE MINI-TERMINAL
BCD Inc
COMPANY:
TITLE:
DESIGNED BY:
Roger Schaefer
DATE: June 4, 1997
SHEET: 1 OF
REV: 1
7 X 2 PIN POLARIZED HEADER, 0.1" CENTERS
DB[0:7]
68HC11E9
MC34164
MAX232
7805
1N4001
Undervoltage Sensing Circuit
8 MHz
5.1 M
10 K
JUMPER

```
Assembler release TER_2.0 version 2.09
(c) Motorola (free ware)
0001                            *
0002                            *************************
0003                            *                       *
0004                            *      Mini Terminal    *
0005                            *                       *
0006                            *************************
0007                            *
0008                            * A two line by 40 character
0009                            * terminal using a LCD and a
0010                            * PC keyboard
0011                            *
0012                            * February, 1997
0013                            *
0014                            * Written by:
0015                            *          Roger Schaefer
0016                            *          BCD Inc.
0017                            *          3133 South Illinois
0018                            *          Belleville, IL 62220
0019                            *          rsch@ezl.com
0020                            *
0021                            *       http://www.ezl.com/~rsch
0022                            *

0053                                    IFD     E9
0054 d000                       ROMBS   EQU     $D000   start of rom
0055                                    ENDIF
0056                                    IFD     E2      MC68HC811E2
0057                            ROMBS   EQU     $F800   start of rom
0058                                    ENDIF

0264
0265                                    CODE
0266 d000                               ORG     ROMBS
0267                            *
0268 d000 7e d0 4e              COLD    JMP     MAIN
0269 d003 7e d5 98              .ONSCI  JMP     ONSCI           ;initialize SCI
0270 d006 7e d3 71              .ONLCD  JMP     init_lcd        ;initialize LCD
0271 d009 7e d0 ab              .ONKEY  JMP     keyint          ;initialize KB
0272 d00c 7e d5 7b              .INPUT  JMP     INPUT           ;from RS-232
0273 d00f 7e d0 83              .INKEY  JMP     INKEY           ;from keyboard
0274 d012 7e d5 83              .OUTPUT JMP     OUTPUT          ;to RS-232
0275 d015 7e d2 ca              .OUTLCD JMP     tx_lcd          ;REG B to LCD
0276 d018 7e d2 29              .OUTKEY JMP     send_status     ;to keyboard LED's
0277 d01b 7e d0 5a              .OUTSTR JMP     outst0          ;string to LCD
0278                            *
0279 d01e 20 20 20 20 20 20     BANNER  FCC     "         "
     20 20 20
0280 d027 54 57 4f 20 4c 49             FCC     "TWO LINE MINI-TERMINAL   "
     4e 45 20 4d 49 4e
     49 2d 54 45 52 4d
     49 4e 41 4c 20 20
     20
0281 d040 0d                            FCB     CR
0282 d041 04                            FCB     EOT
0283 d042 20 20 56 45 52 20     VERSION FCC     "  VER 1.02 "
     31 2e 30 32 20
0284 d04d 04                            FCB     EOT
0285                            *
0286 d04e                       MAIN    EQU     *
0287 d04e 0f                            sei
0288 d04f 8e 01 ff                      lds     #STACK
0289 d052 86 00                         ldaa    #PR1PR0
0290 d054 b7 10 24                      staa    TMSK2+REGBS
0291 d057 7e b6 02                      jmp     WARM
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1436                                    IFD     E9
1437 b600                               ORG     $B600
1438                                    ENDIF
1439                            *
1440                                    IFD     E2
1441                                    ORG     $FFA0
1442                                    ENDIF
1442                                    ENDIF

1448 b600 01                    AUTOLF  FCB     #1
1449 b601 00                    ECHO    FCB     #0
1450 b602 bd d0 03              WARM    jsr     .ONSCI          ;initialize SCI
1451 b605 bd d0 06                      jsr     .ONLCD          ;initialize LCD
1452 b608 bd d0 09                      jsr     .ONKEY          ;initialize KB
1453 b60b 0e                            cli                     ;clear irq mask
1454 b60c bd d0 18                      jsr     .OUTKEY         ;to keyboard LED's
1455 b60f ce d0 1e                      ldx     #BANNER         ;"TWO LINE MINI...
1456 b612 bd d0 1b                      jsr     .OUTSTR         ;put banner on LCD
1457 b615 bd d0 0c              LOOP    jsr     .INPUT          ;from RS-232
1458 b618 27 06                         beq     LOOP1           ;no input ck keybd
1459                            *       jsr     .OUTPUT         ;back to source
1460 b61a 16                            tab                     ;OUTLCD uses reg B
1461 b61b bd d0 15                      jsr     .OUTLCD         ;send input to LCD
1462 b61e 20 f5                         bra     LOOP            ;loop thru again
1463                            *
1464 b620 bd d0 0f              LOOP1   jsr     .INKEY          ;from keyboard
1465 b623 27 f0                         beq     LOOP            ;if no keyboard in
1466 b625 bd d0 12                      jsr     .OUTPUT         ;to RS-232
1467 b628 7d b6 01                      tst     ECHO
1468 b62b 27 e8                         beq     LOOP
1469 b62d 16                            tab
1470 b62e bd d0 15                      jsr     .OUTLCD
1471 b631 20 e2                         bra     LOOP
1472                            *
1473                                    IFD     E9
1474 b7c4                               ORG     VJTBL
1475                            *
1476                            *** Vector jump table ***
1477 b7c4 7e d6 10              JSCI    JMP     SCIIRQ
1478 b7c7 7e d0 4e              JSPI    JMP     MAIN
1479 b7ca 7e d0 4e              JPAIE   JMP     MAIN
1480 b7cd 7e d0 4e              JPAO    JMP     MAIN
1481 b7d0 7e d0 4e              JTOF    JMP     MAIN
1482 b7d3 7e d0 4e              JTOC5   JMP     MAIN
1483 b7d6 7e d0 4e              JTOC4   JMP     MAIN
1484 b7d9 7e d0 4e              JTOC3   JMP     MAIN
1485 b7dc 7e d0 4e              JTOC2   JMP     MAIN
1486 b7df 7e d0 4e              JTOC1   JMP     MAIN
1487 b7e2 7e d1 09              JTIC3   JMP     kbd_service
1488 b7e5 7e d0 4e              JTIC2   JMP     MAIN
1489 b7e8 7e d0 4e              JTIC1   JMP     MAIN
1490 b7eb 7e d0 fa              JRTI    JMP     RTI_SERVICE
1491 b7ee 7e d0 4e              JIRQ    JMP     MAIN
1492 b7f1 7e d0 4e              JXIRQ   JMP     MAIN
1493 b7f4 7e d0 4e              JSWI    JMP     MAIN
1494 b7f7 7e d0 4e              JILLOP  JMP     MAIN
1495 b7fa 7e d0 4e              JCOP    JMP     MAIN
1496 b7fd 7e d0 4e              JCLM    JMP     MAIN
1497                                    ENDIF
1498                                    END
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Ref.	Description	Digi-Key Part No.
C1-4	10 μF cap radial, 0.1" pin space	
C5	470 μF cap axial body: 1"	P6365
C6,7	.1 μF decoup cap	P4910
D1	1N4004 Diode	1N4004GICT
J1	7 x 2 pin polarized header, 0.1" centers	
J2	Mini DIN Receptacle 6 pos	CP-2460
J3	2-pin pcb connector	
J4	6 pin sip header .100 centers	
J5-7	Jumper block, 2 pins 0.1" spacing	
R1	5.1 M ohm ¼ watt resistor	5.1MQBK
R2	9 element 10 K ohm resistor network	Q9103
R3	10 K ohm ¼ watt resistor	10KQBK
R4	Vertical trimpot, 3 inline pins 0.1" spacing 10 K ohm	3386W-103
RES1	8 MHz ceramic resonator w/cap	PX800
U1	MC68HC11 MPU	
U3	MAX232 RS-232 driver/receiver	MAX232CPE
U4	LM7805 linear voltage regulator	
U5	Undervoltage Sensing Circuit	MN13811-S
	PLCC Socket 52 pin	A2123
	Heat sink	HS106
	M/F Aluminum spacer	J212

KEYBOARDS	SOURCE	TEST RESULTS
RT 101 by DEC	B. G. Micro	OK
RT4958TW 104 key by DEC	B. G. Micro	OK
103 key from HP #5182-5521	with HP Pavilion PC	hangs on power up but works after a re-set of 68HC11

B. G. Micro has, of this writing June 1997, a very nice new keyboard from DEC for less than $10. They also have 40 x 2 character LCD's for less than $10.