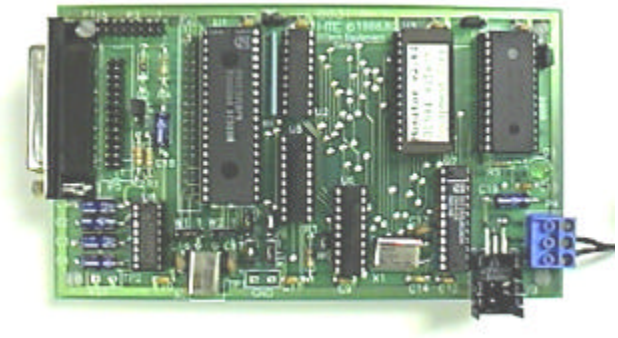
8031SDK

Software Development Kit

User's Manual



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Manual Revision 2.1

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THE FINE PRINT

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Trademarks

Table of Contents

Introduction

If you're anxious to start using the SDK, you can skip ahead to the "Getting Started" section on PAGE 12 right now!

For those few people who actually read the instructions first, this manual provides a description of the 8031SDK Software Development Kit, which can operate as an In Circuit Emulator (ICE) or as an 8031 Single Board Computer (SBC). This manual has been written for the reader who is familiar with digital logic and microprocessors or microcontrollers. A specific knowledge of the 8051/8031 family is not assumed, but it would be advisable for anyone not familiar with this microprocessor family to obtain and read a description of the 8051 family architecture and instruction set. A large number of useful documents and sample programs are available from many different web sites, listed on the HTE website and many others listed in Appendix I.

The term "Development Board" is used throughout this manual for the 8031SDK.

The term 8051 is used throughout this manual to represent the immediate 8051 and derivative processors. The family is derived from the original 8051 and 8052 CPUs with 4k or 8k of ROM on-chip, the 8031 and 8032 which require off-chip ROM, and the 8751 or 8752 which have 4k or 8k of UV erasable PROM on-chip. Enhancements to the basic 8051 architecture (such as the 80C552) are not included.

Features

- Operates as a stand alone single board computer (SBC)
- Functions as a simple 8032 In Circuit Emulator (ICE) in External Address mode
- Monitor ROM for program development
- Connects to COM port of PC or CRT terminal
- The on-chip 8051 serial port is available
- 8032 serial port RS-232 compatible on DB-25 connector
- Program download and debug via independent serial link
- Help feature displays available commands
- Quick program development
- User programs stored in static RAM
- Includes RAM for user data
- Independent serial port used for code development
- 8032 timers, serial port, and external interrupts available to user
- Optional high level language
- Disassembly of instruction opcodes
- Low cost OEM version for dedicated applications

The Development Board consists of an 8032 microcontroller, user program RAM, a powerful EPROM-based monitor/debugger that controls emulator operation and the user serial interface.

The Development Board provides the user with the ability to debug code for a prototype system. The OEM version of the board is usually the target for the final application. The Development Board has an additional serial port, a monitor ROM and RAM for program development.

This board doubles as in In Circuit Emulator, using a 40 pin cable and DIP plug to replace the CPU in the target system. This allows the user to develop code on the SDK in advance of having a working target board (your hardware design). Later, when the target board is ready, you simply plug the emulator cable into the target board and run your programs to debug and test your application.

The Development Board permits reading and writing of system memory, and control of program execution. The Development Board also allows interactive debugging of the prototype software and can externally control program execution. The Development Board's on-board RAM memory permits software debugging without having to program EPROMs.

It provides powerful functions to assist the designer in the integration, debug and test phase of 8031SDK hardware/software project development. The Development Board provides utility commands such as: disassembly, trace, execute to breakpoint, modification of registers/memories and downloading programs from another computer.

In addition, the Development Board can prove invaluable as an educational tool for learning the instruction set, since instructions can be executed interactively, and the effects are immediately apparent on the display.

The user can easily:

- Interpret the results of program activity.
- Disassemble program memory to mnemonics.
- Examine/modify 8032 internal registers/RAM, external memory, or port contents.

In conjunction with any computer capable of running an 8051 assembler, the Development Board becomes a powerful, stand-alone, program development system. The board is capable of supporting up to 64k of program memory and 64K of data memory in two, 28 pin JEDEC sockets. The board also supports two full Asynchronous RS-232 Serial I/O ports. The first is used by the monitor to communicate with the PC. The second is the serial port built into the 8032 processor.

Specifications

CPU
Intel 8032 (or other pin compatible) Microcontroller clocked by an 11.0592 MHz crystal. This frequency makes it easy to generate standard baud rates using the CPU's internal serial port. When used as an ICE, jumpers allow selection of the on-board crystal or the crytal on the user's target system. Other crystal values can be used, subject to component timing constraints, without affecting the serial interface to the Development Board (the monitor interface uses a separate UART and crystal).

Memory
Two JEDEC 28 pins sockets - 1) Monitor program EPROM and 2) External 32k static RAM for user programs and data.

Serial I/O Ports
Two serial ports are available on connector P1 (the 8051 internal serial port) and connector P5 (an external UART). P5 is connected to a ribbon cable with a DB-25 at the end. The cable on connector P5 is connected to the COM port of a PC running a communication program, and is used for downloading programs from a PC and debugging them independent of the 8051's port. Both ports are RS232 serial. Automatic baud rate detection is used for the PC connection, and it supports 75 to 38.4k baud, with 7 or 8 data bits and no parity. Intel Hex down load format. 8032 serial port available as RS-232 serial from second DB-25 connector. A third TTL level serial port is optionally available when using the Dallas 80C320 controller on connector P3.

Parallel I/O Port
Port 1 of the 8032 is available for user I/O on connector P3.

In Circuit Emulation and External bus expansion
Connector P2 can be used for expansion of the memory and I/O on the board. By using a 40 conductor cable and 40 pin DIP plug, the board can be plugged into the target system's 8032 compatible socket. Internal or external crystal selectable via jumpers on the board. Generally, when the board is used in stand-alone mode, Jumpers W1, W2, W8, W9, W10, and W11 have a jumper plug installed between pins 1 and 2. For use in the ICE mode, the same jumpers the shorting plugs are installed between pins 2 and 3. See Appendix D for details. The on-board monitor ROM can download user programs into RAM for debugging, eliminating the need to program UV or flash EPROM during development.

Power
Requires single +5 volt supply at 100-150 mA typical. Wall mount AC adapter supplied.

Dimensions
6.0 inches by 3.5 inches by 1 inch height.

Environmental
Storage temperature range -25 to +100°C. Operating temperature range 0 to +50°C.

Design Considerations and Limitations

If a user program is to be run under the control of the Development Board, care must be taken to avoid conflicts in the utilization of the Development Board's resources. A description of the Development Board's use of resources follows:

The Development Board code program address space used for the monitor starts at 0000h. User program RAM is located starting at 4000h. User programs must be relocated and assembled starting at 4000h, including interrupt vectors. The interrupt service vectors are re-mapped to the external RAM with an offset of 4000h. For example, the external interrupt 0 vector, normally at 0003h is relocated to location 4003h, the Timer 0 interrupt, normally located at 000Bh is remapped to 400Bh, etc. The development board also uses External RAM area from FFE0h to FFFFh for the external RS-232 port. User memory may reside in this area, but cannot be accessed.

All but one of the interrupts have been mapped up to begin at location 4000h (user RAM space). This is the beginning of user RAM space, and programs should be ORG'd to begin here. Only the power-up reset interrupt vector has not been mapped into user RAM space. User interrupt service routines are delayed in the Execute mode, since there is a code in the monitor ROM which redirects execution to the user program memory starting at location 4000h.

The Development Board utilizes 128 bytes from 80 (hex) through FF(hex) in the Internal RAM area of the 8032. In addition, the Development Board requires 8 bytes of user stack space.

The Development Board uses the one of the interrupts for its trace and breakpoint facility. The interrupt used by the monitor can be selected with the monitor’s INTR command. The default interrupt used by the monitor is displayed as part of the sign-on message displayed when the SDK is first powered up or reset. The corresponding interrupt enable and priority register bits affecting operation of the selected interrupt should not be modified, or the single-step and breakpoint features will not work. The user's program should avoid changing these bits.

The Development Board is configured for expanded (multiplexed address/data bus) mode (/EA pin grounded). It can be used in the single chip mode only if it is used with a special version of the CPU, such as the 8052AHBASIC chip. Because of this, ports P0 and P2 are not available for I/O.

Port bits P3.6 and P3.7 are used for Read and Write lines, and may not be used as discrete port bits. Clearing either of these bits will disrupt operation of the monitor.

Operating the Development Board

Note: This board has MOS devices which can be damaged if exposed to electrostatic fields and discharges. Grounded conductive workstations and standard precautions should be used to prevent device damage.

A typical configuration for debugging/development purposes would include:

- 8032 SDK Development Board
- RS-232 cable
- Dumb terminal or IBM PC/XT/AT with a terminal program.
- An 8051 Assembler or Compiler

Serial I/O Connection

The 8051 serial port is available for use in your application, as the PC communicates with the development board using a separate “PC debug” serial port. This allows you to develop programs which make use of the 8051’s on chip serial port without interference with monitor operations. Once your design is complete, the final hardware can be implemented without the “PC debug” serial port to reduce cost and complexity.

The monitor program communicates with the PC terminal via the second serial port (not P1 since it is connected to the 8032's on-chip serial port). The second port, used for connecting to the PC during development is available on connector P5.

The monitor program communicates through the PC debug port on the Development Board. It will interface to any standard DTE RS-232 asynchronous serial I/O device set up with 7 or 8 data bits and no parity. The baud rates supported are:

38400	7200	2000	1050	200	110
19200	4800	1800	600	150	75
9600	2400	1200	300	134.5	50

Use of the higher baud rates will usually work, but rates above 9600 may cause problems with some computers and operating systems, because the PC program may not be able to keep up with the incoming data rate. If the display of large blocks of data, such as a memory dump, are uneven or missing characters, reduce the baud rate to 9600 and try again.

The default configuration of the Development Board's serial I/O port is 8 data bits, 1 stop bit, no parity. This will work with most configurations, including those set for 7 data bits. However when a long serial data stream is sent to the Development Board, such as with the 'Load' command, problems may occur if there is a mismatch in the data bits setting.

Serial Cable wiring:

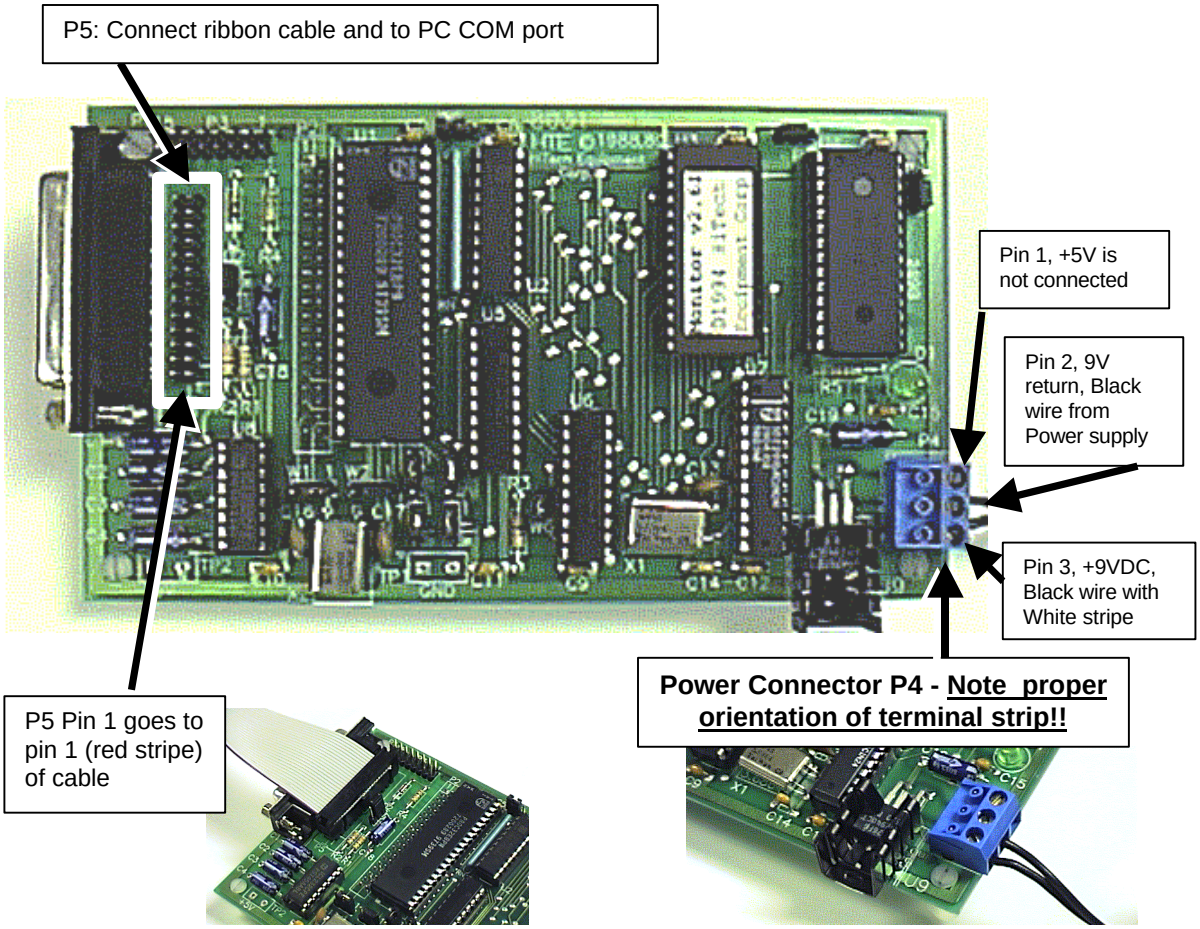
DB-25	CRT Terminal Function
2	Receive Data
3	Transmit Data

4	Clear to Send
5	Ready to Send
7	Signal Ground

The Development Board does not use hardware or XON/XOFF software handshake.

The 8032's serial port is made available on the connector mounted on the short side of the Development Board (P1). The included 11.0592 MHz crystal is chosen to allow standard baud rates to be generated by the 8032's timers.

Getting Started



1) Attach the ribbon cable to the board connector P5. Be careful to orient the ribbon connector so that pin 1 of the connector is near R2. The female DB-25 connector should be plugged into the PC's COM (serial) port. If your PC's COM port has a 9-pin connector, you will need to use a 25 pin (male) to 9 pin (female) adapter. DO NOT use a null-modem adapter. Your PC should be running a terminal emulation program, such as PROCOMM or Windows Terminal program. Win95/98's Hyperterminal program may also work, but some versions contain bugs that can be problematic, and it may lose characters on some computers. The terminal program should initially be set to the COM port (usually COM1 or COM2) you plugged the board into, 9600 bps, no parity, 8 data bits, and one stop bit. (9600-N-8-1)

2) Apply power to the Development Board by attaching a power supply to the power connector. **The power connector should be oriented so that the terminal screws are visible when looking straight down on the board when it is lying flat. If power is connected properly, the green LED (D1) will light up.**

****IMPORTANT!!**** **If the power connector is inserted incorrectly the board WILL BE DAMAGED! Please make sure that the power supply connection is correct! When using the wall mount power supply, PIN 1 of P4 should NOT be connected to anything.**

P4 is the power connector on the board. The wall mount power supply must be connected to pins 2 (9v return/ground/wire with no stripe) and pin 3 (+9 volts/wire with stripe).

The pins on the power connector are assigned as follows:

Pin	Description
1.	+5v in. This pin is if you already have a regulated +5v supply available.
2.	Ground (to wall mounted 9VDC power supply common).
3.	+6v to +12v in. (to wall mounted 9VDC power supply positive wire.) This voltage is regulated down to +5v by the on board regulator.

3) Type a Enter to trigger the automatic baud rate detection. The sign on message "8032 Development Board V x.y", and a prompt (#) will appear on the terminal. At this prompt, any of the Development Board commands may be entered. Type a question mark (?) at the prompt for a list of commands.

At this point, you have correctly installed and setup the board with your PC.

The development cycle is usually as follows:

1. On the PC, edit the program (source file) using an ASCII text editor.
2. Translate the source file into object (Hex) using an assembler or compiler.
3. Load the Hex file into SDK program memory with the LOAD command.
4. Test the program, using breakpoints and single step to find errors.
5. Edit the source file to correct the errors, and return to step 2 above.

When developing code to be programmed into a non-volatile memory such as Flash or uV eraseable EPROM, the development cycle is different for step 3. Instead of loading the program into the SDK's program RAM, you must load the Hex file into a device programmer, erase the device, place the device to be programmed into a special programmer, and program the device. Then turn off the power, remove the SDK monitor ROM and replace it with your program EPROM. This process takes quite a bit longer than simply loading a file into the SDK memory, so you will want to wait to program a device until after you have a working program.

For most of the development process, you will want to download your program from the PC into the SDK's program RAM to test it. An example of this process is detailed, using the "Hello World" program that follows, to demonstrate the development of assembly language programs on the SDK. This example shows code that will send messages to the PC's display, which allows you to see diagnostic and debug information while your program is executing.

The examples that follow use the shareware Metalink 8051 family assembler to translate assembly language source code into a Hex object file for downloading to either the SDK or a device programmer.

Example Program: "Hello World"

The following program is a very simple example intended to show how an assembly program should be written to run on this board. It simply prints the message "Hello World." On the display of the PC it is connected to.

```
;
;       Hello world -  8031SBC demo program
;
;
;  Primary controls
;
      $MOD52         ; for the 80C32 CPU register definitions etc.
      $TITLE(Hello world demo program)
      $PAGEWIDTH(132)
;
;       Monitor entry points
;
monitor equ     03F00H    ; Go to the monitor
getchar equ     03F03H    ; Get character in Acc
sendchar equ    03F06H    ; Sends char in Acc to monitor display
sendstr equ     03F09H    ; Sends a string to the display
;
;  Variable declarations
;
;
base    equ     4000H     ; beginning of program RAM on SBC
;
;base   equ     0H        ; alternate equate to burn in EPROM
;
reset:
      org     base+0H         ; reset vector
;
      ajmp    start
;
start:
      mov     dptr,#message   ; point to the string
      lcall   sendstr         ; print it
      lcall   monitor         ; show results in regs
      jmp     0               ; and return
;
;       This is where the data is stored
;
message:
      db      0dh, 0ah, 'Hello there!', 0dh, 0ah, '$'

      END
```

NOTE: The program above was written to run with the freeware assembler from Metalink, both of which are available on the HTE web/ftp site.

ftp://ftp.hte.com/uconline/ecd/51code/

Step-by-Step Instructions

First you must create or edit an 8051 assembly language source file using an unformatted ASCII text editor, such as Windows Notepad. Next, invoke the assembler at a DOS prompt and include the source file name after the command. The assembler then translates

the 8051 source code into machine code which can be loaded into the SDK board. The output file should be in Intel hex format (file type .HEX), as documented in Appendix E. Most 8051 assemblers and compilers generate this type of file. Then you will issue the LOAD command to the SDK monitor, and use your terminal emulator program on the PC to send the HEX file to the SDK in ASCII format. Once the program is loaded into the development board, you can use the monitor Go, Step, and Execute commands to run your program. Here are the steps to edit and load the "Hello World" program into the development board and execute the program.

Before you begin, you must have the following files in the default directory (named C:/51TOOLS in the example below) you will be using to develop your program:

HELLO31.ASM	The sample program
ASM51.EXE	8051 Assembler program
MOD52	A file that contains predefined register names & addresses
PROCOMM.EXE	Procomm or equivalent terminal emulation program

From the DOS prompt you should see something like the following after a directory command:

```
C:\51TOOLS>DIR

Volume in drive C is CDRIVE
 Directory of C:\51TOOLS
ASM51    EXE        56,453  04-27-90 12:48p ASM51.EXE
HELLO31  ASM         1,047  09-26-98 10:54p HELLO31.ASM
MOD52                3,761  04-27-90 12:44p MOD52
PROCOMM  EXE       167,072  12-20-88  9:36a PROCOMM.EXE
         4 file(s)        228,333 bytes
         2 dir(s)      70,844,416 bytes free
```

Open the file HELLO31.ASM in Notepad or an equivalent text editor. In order to know that you have successfully modified the program when you run it, change the line that reads:

```
        db      0dh, 0ah, 'Hello there!', 0dh, 0ah, '$'
```

to:

```
        db      0dh, 0ah, 'Hello World!', 0dh, 0ah, '$'
```

Then save the file as HELLONEW.ASM -- note that this must be a plain, unformatted ASCII text file, without special embedded formatting characters as would be found in a word proccessing program document file.

Next, at a DOS prompt, type the Assembler command and file name:

```
C:/51TOOLS/ASM51  HELLONEW
8051 Cross-Assembler, Version 1.2h
     (c) Copyright …
         by MetaLink Corporation
     First pass
     Second pass
     ASSEMBLY COMPLETE, 0 ERRORS FOUND
```

In this case, there were no syntax errors detected by the assembler, so you can proceed. If there had been any errors, you would have to look at the list file (.LST) generated by the assembler. Then you will have to edit the .ASM file and correct any errors indicated by the assembler.

Now there will be several new files in the directory:

```
HELLONEW ASM         1,047  10-11-98  3:36p HELLONEW.ASM
HELLONEW HEX           101  10-11-98  3:39p HELLONEW.HEX
HELLONEW LST         3,098  10-11-98  3:39p HELLONEW.LST
```

HELLONEW.ASM is the source file we created.
HELLONEW.HEX is the assembled ASCII hex object file we will load in the SDK.
And HELLONEW.LST is assembler list file that contains error and status messages from the assembler.

Now make sure that the SDK power is off (green LED is off). Then run the terminal emulation program (we'll use Procomm for this example):

```
C:/51TOOLS/PROCOMM
```

After the startup screen is displayed, push the Enter key until a blue screen appears. If this is the first time you've used Procomm, then type Alt-P and select 9600-N-8-1 (selection #11). Then select the COM port you are using on your PC (COM1-4 are selections #20-23, and press enter). Save your settings by selecting #24 and press enter, so you won't need to set them again next time you run Procomm.

Then connect power to the SDK, and press the return key while running Procomm, and you should see the following sign on message and # prompt:

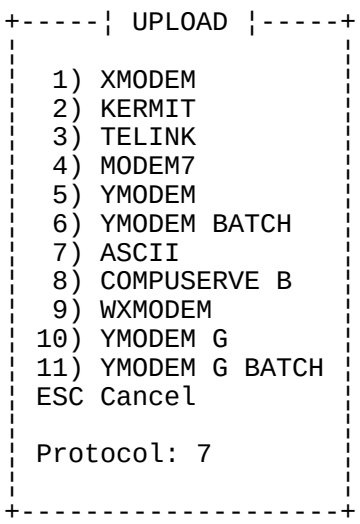
```
=====================================================
HTE 8031/32 DryICE Monitor       Version 2.6  10/10/90
Copyright (c) 1988,89,90  HiTech Equipment Corporation
=====================================================
User Internal RAM from 00h to FFh.
User RAM from 4000h to BE00h.
Single Step Interrupt #5 - Timer 2.

ACC B SP DPTR R0 R1 @R0 @R1 CAFRsOxP Opcode PC   Mnemonic
00 00 07 0000 FF FF FF  FF  00000000 FF     4000 MOV   R7,A
#
```

The # is the command prompt. In this case we want to load the HELLO program hex file, so we have to tell the monitor we want to load a file, so we use the L command:

```
#L
```

After you press the return key, the monitor program waits to receive an Intel ASCII HEX formatted file, so you must select the file upload function in your terminal emulator to

send the ASCII file HELLONEW.HEX to the board. In Procomm, you press the PageUp key, which opens a menu with several file transfer options, as shown below.



Select option #7 (ASCII), and when you press Enter, Procomm asks for the name of the file to upload.

If the HEX file is not in the same directory as PROCOMM, you must include the complete directory path.

Procomm then loads the file into memory, at the default location 4000h, which is where your program will generally start when running on the development board under the monitor. When the download operation is complete there is a beeping noise (this is usually a second or two at most), and you will need to press the Escape key until the monitor displays the Next Address: XXXX message and the # prompt as shown:

```
Next Address: 401F
#
```

The “Next Address” prompt indicates the next available program memory location, which is the byte following the program we just loaded into program memory. At this point our program is in memory and ready to run, but just to be sure, we can take a look at the beginning of the program by using the disassemble command DASM:

```
#DASM 4000 400B
Opcode PC   Mnemonic
0102   4000 AJMP  4002
90400E 4002 MOV   DPTR,#400E
123F09 4005 LCALL 3F09
123F00 4008 LCALL 3F00
```

```
020000 400B LJMP  0000
```

Now let's try running the program to see if it works:

```
#G 4000
```

```
Hello World!
```
← If everything is correct, you should this message.

Congratulations, your program works! If you don't see this message, check your program for errors and try again.

After completion, the program re-enters the monitor, which waits for you to press the Enter key and displays the sign-on message again.

You can also run the program at full speed by using the Execute command:

```
#E 4000
```

```
Hello World!
ACC B SP DPTR R0 R1 @R0 @R1 CAFRsOxP Opcode PC   Mnemonic
24 00 07 401E FF FF FF  FF  00000000 020000 400B LJMP  0000
```

Note there are two differences between the Go and Execute commands:

- The hello message is printed out faster, because the Execute command runs at full speed but does not allow you to stop the program, unlike the Go command, which allows the user to stop the program with the Control-C key.
- Upon exiting the Go command, the monitor displays the registers.

The differences are covered in the sections on the commands and in the section following the command descriptions.

Using the Monitor

Line Editing

The Development Board recognizes the use of the Backspace key (<BS>) or the Delete key (<DEL>) for the correction of errors made during entry of commands. This echoes as <BS> <space> <BS> to the terminal. The command line will not be read by the Development Board until it is either terminated by a Carriage Return (<CR>) or exceeds 32 characters. A Control-X will erase the entire input line and restart the input routine.

Start/Stop/Restart

For commands producing a large amount of output display, you can type a Control-S, to stop the scrolling of information on the terminal. Typing any character (including Control-S), will restart the flow of information. Typing a Control-C will return the Development Board to the command mode.

Command Syntax Notation

The syntax of each command is described with a simple notation system. The command notation shows what command keywords to use, indicates the parts of the command that can be omitted or included at the user's option, and shows the places in the command where the user has a choice of several kinds of entries. The following is used in command syntax notation:

- Keywords are shown in ALL CAPS.
- Parameters are numeric entries and are shown in lower case and entered as hexadecimal values. Leading zeros are not required.
- Required entries are shown without square brackets .
- Optional entries are shown in square brackets.
- Command and first parameter must be separated by an space.
- Parameters must be separated by commas or spaces.
- The command is acted on only after you enter a Carriage Return (<CR>) or exceed 32 characters.
- If the starting address is omitted from commands which require a starting address, it may default to the address immediately past the end of the last command.
- If an ending address is not supplied for display commands requiring an ending address, the the command will output either 8 or 16 lines of information.
- Only enough characters to uniquely identify the command need be typed.
- Commands can be entered in uppercase, lowercase, or a combination of both.

Special Characters

<BS> - Backspace key is used for line editing to correct errors.

<CR> - Carriage Return is used to terminated the command string.

<DEL> - Delete key is used for line editing to correct errors.

<ESC> - Escape key is used to abort command executing and return to the command mode.

^C - (Control-C) Abort command executing and return to the command mode.

^S - (Control-S) Stops scrolling of screen display at any time.

^Q - (Control-Q) Restarts scrolling of screen display.

^X - (Control-X) Will erase the entire input line and restart the input routine.

Monitor Commands

?

Purpose: Gives list of available commands.

Format: ?

Remarks: List all available commands to terminal (same as the Help command).

ASM

Purpose: Assembles mnemonics (instructions) one line at a time into machine language.

Format: ASM [start_address]

Remarks: If start_address is specified, ASM will start from the specified address. If start_address is not specified, it will start from where the last ASM command left off. After each line of code is entered, the machine code, the hexadecimal address, and the code mnemonics will be displayed. ASM will now prompt for the next line of code. [CR] at the prompt will exit ASM. If the first character of the line is an '@', it will toggle the disassembly feature. If the first character of the line is a semicolon (';'), it ignores the rest of the line.

DASM

Purpose: Disassembles (translates) program memory into Intel 8051 mnemonics, their hexadecimal addresses and hexadecimal data. This is not a symbolic disassembler.

Format: DASM [start_address] [, end_address]

Remarks: If start_address is specified, it will start from the specified start address. If start_address is not specified, it will start from the last disassemble pointer. If end_address is specified, it will end with the specified end address. If end_address is not specified, it will disassemble the next 16 instructions. After the DASM executed, a new disassemble pointer will be saved for the next DASM.

DC

Purpose: Dump the contents in bytes of code program memory.

Format: DC [start_address] [, end_address]

Remarks: If start_address is specified, it will start display from the specified start address. If start_address is not specified, it will start from the last display pointer. If end_address is specified, it will end with the specified end address. If end_address is not specified, it will display 8 lines.

DI

Purpose: Dump the contents in bytes of internal data memory.

Format: DI [start_address] [, end_address]

Remarks: If start_address is specified, it will start display from the specified start address. If start_address is not specified, it will start from zero. If end_address is specified, it will end with the specified end address. If end_address is not specified, it will end at 07Fh.

DR

Purpose: Dump the contents of all the main registers, and some of the Special Function Registers (SFR).

Format: DR

Remarks: (none).

DX

Purpose: Dump the contents in bytes of external data memory.

Format: DX [start_address] [, end_address]

Remarks: If start_address is specified, it will start display from the specified start address. If start_address is not specified, it will start from the last display pointer. If end_address is specified, it will end with the specified end address. If end_address is not specified, it will display 8 lines.

EXEC

Purpose: Transfers complete control to the user program. This bypasses the monitor so the Devlopment Board will not respond to a ^C. Since the Monitor is disabled, the program will run in real-time.

Format: EXEC [start_address]

Remarks: If start_address is specified, it will start execute from the specified start address. If start_address is not specified, it will start from the present Program Counter (PC). The monitor must be restarted with a hardware reset after this command.

FC

Purpose: Fill the code program memory locations with a constant hex value.

Format: FC start_address , end_address , value

Remarks: none.

FI

Purpose: Fill the internal data memory locations with a constant hex value.

Format: FI start_address , end_address , value

Remarks: An attempt to fill the upper half of internal data RAM (80h to 0FFh) with a constant will overwrite the Development Board monitor work space, and may require a hardware reset to recover.

FX

Purpose: Fill the external data memory locations with a constant hex value.

Format: FX start_address , end_address , value

Remarks: Do not attempt to fill locations FFE0 to FFFF (UART).

GO

Purpose: Begin program execution and continue until the breakpoint is reached. No trace history is given.

Format: GO [start_address] [, breakpoint]

Remarks: If start_address is specified, it will start execute from the specified start address. If start_address is not specified, it will start from the present Program Counter (PC). Breakpoint address must correspond to the locations of opcodes. If a breakpoint address lies between opcodes, the monitor will not stop as it passes over the breakpoint location.

Note: This form of breakpoint will not be recognized inside of an interrupt routine.

HELP

Purpose: Gives brief list of available commands and their syntax.

Format: HELP

Remarks: List all commands to terminal.

HEX

Purpose: This command allows the operator to do quick hex calculations such as finding offsets for branch instructions.

Format: HEX address,offset

Remarks: The HEX command adds the offset to the address and displays the hex output. It also subtracts the offset from the address and displays its hex output.

Display Format: The HEX function displays 4 hex values: the specified address, the offset, the forward jump address, and the backward jump address.

Example:
#HEX 4AF0,3F
4AF0 003F 4B2F 4AB1

INTR

Purpose: The monitor requires an interrupt in order to implement single step and trace debugging functions. By default, the monitor uses one of the interrupts for single step and break points. The default is shown in the sign on message, and can be changed using the INTR command. As a result, the selected interrupt is not available for your use. This command allows you to change the interrupt used by the monitor. If you need to use that interrupt, use this command to specify a different interrupt for the monitor to use.

Format: INTR [interrupt_number]

Remarks: The default interrupt varies, depending upon the specific software and board configuration, and is printed as part of the sign-on message. If you do not want to use the default, execute the INTR command after each system reset.

- Name of Interrupt
0 - External 0
1 - Timer 0
2 - External 1
3 - Timer 1
4 - Serial Port
5 - Timer 2

LOAD

Purpose: Load an absolute Intel Hex file format from the terminal into user program RAM area.

Format: Load [offset_address]

Remarks: Normally the optional address is left out, and the starting address inside the .HEX file to be loaded specifies the beginning of the program. The device sending the hex file must be operating at the same baud rate as the terminal. This is usually done with an upload command to the terminal emulator of the PC. After the hex file is received, an escape (<ESC>) will terminate the command and the monitor will report the present location of the load pointer to the terminal. If 'offset_address' is not specified, offset will default to zero. If the positional 'offset_address' is specified, it will be added to the load pointer causing the program to be loaded higher in memory than was originally intended. The offset 'wraps around' the top of memory, so it is possible to load a file into a lower location if desired. For example, an offset of 0FFFE (hex) will cause the file to load 2 locations lower than origin location. The load command will report an check sum error, but will not abort the command. NOTE: Data cannot be loaded between 0000 and 4000h, as that is where the monitor ROM resides.

MC

Purpose: Moves the contents in a block of the code program memory to a new location.

Format: MC start_addr, end_addr, new_addr

Remarks: Do not try to move a block to a higher memory location within the original block (overlapping blocks).

MEM

Purpose: Switch on board RAM between Separate code and external memory with Overlap code and external memory. Normally, the 8051 is a Harvard architecture CPU, with separate program and data memory address spaces. Using this command, you can overlap the program and data memory spaces, so that the SRAM will respond to either program or data fetch cycles from the CPU. See Memory Map for details.

Format: MEM

Remarks: Toggle memory chip U4 between separate and overlapped program and external data memory. When overlapped, code and data addresses both access U4. When separated, the memories must be accessed with MOVC instructions for getting information from code memory and MOVX instructions for external data memory.

MX

Purpose: Moves the contents in a block of the external data memory to a new location.

Format: MX start_addr, end_addr, new_addr

Remarks: Do not try to move a block to a higher memory location located within the original block (overlapping blocks).

PC

Purpose: Display and alter the contents of the user Program Counter.

Format: PC [new_value]

Remarks: If new_value is specified on the command line, it will alter the data in the user program counter to the new_value. If a new value is not specified on the command line, it will display the current data in user program counter and prompt the user with '-'. If new data is typed before the terminating <CR> then that new data will replace the data currently in user program counter. If the <CR> is typed with no preceding data then the user program counter will remain unchanged. On power-up or reset, the program counter is set to 4000h.

PS

Purpose: When Program Step is ON, the step command will not display any instruction code in a CALL routine. This is useful when you don't want to see the internal step-by-step operation of a subroutine, and would rather let the subroutine execute to completion before returning to the monitor.

Format: PS

Remarks: The default is off. Typing PS will toggle this option.

RESET

Purpose: This command clears out all regisisters to the state they would be after a reset power-up. Refer to the Intel 8051 user manual for details.

Format: Reset

Remarks: Reset the registers.

S

Purpose: Single step through the program execution beginning at the present program counter and continue to step until the number of steps has expired until the breakpoint is reached.

Format: S [number_of_steps]

Remarks: Dumps main register contents and disassembles code memory as it progresses. If 'number_of_steps' is not specified, it will step only once.

Display: This command displays register values, then executes the instruction. For example, after execution of the Step command, the display shows the accumulator to contain 00h before the instruction is executed. Execution of a DR command will then show current contents of the registers without executing an instruction.

```
#S
ACC  B   SP  DPTR  R0  R1 @R0  @R1   CAFRs0xP   Opcode   PC  Mnemonic
00   00  07  0000  35  7A 00   00    00000001   04       4000  INC   A
#DR
ACC  B   SP  DPTR  R0  R1 @R0  @R1   CAFRs0xP   Opcode   PC  Mnemonic
01   00  07  0000  35  7A 00   00    00000001   04       4001  INC   A
. . .etc.
```

SB

Purpose: Show the current value of a bit and allows a new value to be substituted if desired.

Format: SB bit_address

Remarks: Only the least significant bit of the data entered will be transferred to the address bit location.

SC

Purpose: Show the current value in a byte of code program memory and allows a new value to be substituted if desired.

Format: SC address

Remarks: Pressing <CR> without entering new data will advance the monitor to the next location without changing memory contents. The entered value will be written to the address location specified, and will advance the monitor to the next location. A period must be entered to exit this command.

SI

Purpose: Show the current value in a byte of internal data memory and allows a new value to be substituted if desired.

Format: SI address

Remarks: Pressing <CR> without entering new data will advance the monitor to the next location without changing memory contents. The entered value will be written to the address location specified and will advance the monitor to the next location. A period must be entered to exit this command.

SX

Purpose: Show the current value in a byte of external data memory and allow a new value to be substituted if desired.

Format: SX address

Remarks: Pressing <CR> without entering new data will advance the monitor to the next location without changing memory contents. The entered value will be written to the address location specified, and will advance the monitor to the next location. A period must be entered to exit this command.

TRACE

Purpose: Begin program execution and continue until the breakpoint is reached. Dumps main register contents and disassembly of code memory as it progresses.

Format: TRACE [start_address] [, breakpoint]

Remarks: If start_address is specified, it will start to execute from the specified start address. If start_address is not specified, it will start from the present Program Counter (PC). Breakpoint address must correspond to the locations of opcodes. If a breakpoint address lies between opcodes, the monitor will not stop as it passes over the breakpoint location.

Note: This form of breakpoint will not be recognized inside of an interrupt routine.

Display: See 'S' command for detail.

VIEW

Purpose: This command allows you to see when your interrupts are occuring during the execution of your code in the Trace mode. The interrupts are also shown during the **GO** and **STEP** commands. Typing "View" will toggle the view option on and off.

Format: View

Remarks: The default for view is off

Special Function Register Names

There are command keyword registers. If new_value is specified on the command line, it will alter the data in the user keyword register to the new_value. If a new value is not specified on the command line, it will display the current data in user keyword register and prompt the user with a # sign. If new data is typed before the terminating Enter key then the new data will replace the data currently in user keyword register. If the Enter key is typed with no preceding data then the user keyword register will be unchanged. The keyword registers are as follows:

ACC	**IP**	**PSW**	**R5**	**SCON**	**TH1**
B	**P0**	**R0**	**R6**	**SP**	**TL1**
DPH	**P1**	**R1**	**R7**	**T2CON**	**TH2**
DPL	**P2**	**R2**	**RCAP2H**	**TCON**	**TL2**
DPTR	**P3**	**R3**	**RCAP2L**	**TH0**	**TMOD**
IE	**PCON**	**R4**	**SBUF**	**TL0**	

Register	**Name**	**Address**
ACC*	Accumulator	0E0h
B*	B register	0F0h
DPTR*	Data Pointer	<n/a>
DPL*	Data Pointer low byte	081h
DPH*	Data Pointer high byte	082h
IE*	Interrupt Enable Control	0A8h
IP	Interrupt Priority Control	0B8h
P0	Port 0	080h
P1	Port 1	090h
P2	Port 2	0A0h
P3	Port 3	0B0h
PCON	Power Control	087h
PSW*	Program Status Word	0D0h
RCAP2H+	T/C 2 Capture high byte	0CBh
RCAP2L+	T/C 2 Capture low byte	0CAh
SBUF	Serial Data Buffer	099h
SCON	Serial Control	098h
SP*	Stack Pointer	080h
T2CON+	Timer/Counter 2 Control	0C8h
TCON	Timer/Counter Control	088h
TH0	Timer/Counter 0 high byte	08Ch
TL0	Timer/Counter 0 low byte	08Ah
TH1	Timer/Counter 1 high byte	08Dh
TL1	Timer/Counter 1 low byte	08Bh
TH2+	Timer/Counter 2 high byte	0CDh
TL2+	Timer/Counter 2 low byte	0CCh
TMOD	Timer/Counter Mode Control	089h

* These registers are stored in memory as "user image" during monitor operation.
+These registers are only for the 8032/8052.

Description of Monitor Operation

Debugging an interrupt routine

The Development Board's trace and breakpoint functions are interrupt driven. That is, an interrupt is generated between each instruction causing the monitor to temporarily take control of the program. The trace information is sent to the console and/or the breakpoint comparison is made. For this reason, the trace and breakpoint features are normally disabled inside of interrupt routines. Usually the results of interrupts can be seen from within the main body of the program, through altered registers, memory locations, etc. This can be observed by running the sample interrupt program provided in the appendix. When debugging an interrupt routine, the best approach is to trace the operation of the routine as a stand-alone module by transferring program control directly to it from the monitor.

Interrupt Service Vectors

All but two of the interrupts have been mapped up to begin at location 4000h (user RAM space). This is the beginning of user RAM space, and programs should be ORG'd to begin here. Only the power-up reset and timer 2 interrupt vectors have not been mapped into user RAM space. A typical source program might begin as follows:

```
USERRAM  EQU  4000h

    ORG   USERRAM+00h

    JMP   start_program       ;jump to the beginning of program


    ORG   USERRAM+03h

    JMP   int_0_routine       ;jump to external 0 interrupt service routine


    ORG   USERRAM+0Bh

    JMP   timer_0_routine     ;jump to timer 0 interrupt service routine

    etc . . .
```

With this type of organization, once a program has been debugged it may be ROM'd by simply changing the EQU of 'USERRAM' to 0 and reassembling.

Use of the Enhanced Monitor Breakpointing Feature

The following is a description of how the breakpoint feature has been implemented in the monitor firmware. This allows the user of the Development boards to take full advantage of this feature.

When a breakpoint address is specified, that address location as well as the next two addresses are filled with a LJMP monitor instruction (a 3 byte instruction). When the

program executes that jump instruction, control is returned to the monitor, which restores the user's code to the breakpoint address, and adjusts the program counter to point to it.

Implementing a breakpoint function in firmware this way allows the creation of very inexpensive development tools like this SDK, but the user must be aware of a few anomalies that can occur when he is debugging his code. These anomalies involve the careful selection of breakpoint addresses, and manifest themselves as improper user program executions or crashes.

1. As mentioned above, the code at the breakpoint address is replaced with a 3 byte jump instruction. If you set a breakpoint within 2 instructions of the end of a subroutine, or where some other program entry point occurs, the program will likely crash. See example below:

```
          ....
          MOV     A,R5    ;SETTING A BREAKPOINT HERE OR THE
          RET             ;NEXT INSTRUCTION WILL CORRUPT THE
TIMER0:   PUSH    PSW     ;FIRST INSTRUCTION OF THE TIMER
          PUSH    A       ;INTERRUPT ROUTINE.
          ....
```

A breakpoint set at the first or second instruction shown will corrupt the first instruction of the timer interrupt, causing an extra POP of the PSW (which never got pushed), eventually causing the stack to go below it's limits, and crashing the program.

2. If the background routine is very short, and the major processing is done in interrupt foreground routines, there is a problem which could result from setting a breakpoint in the interrupt routine, followed by a breakpoint in the background routine. The shorter the background routine is, the better the chance is that the interrupt return address is in the middle of the breakpoint you set. The following is a repeat of the sequence for clarity:

a.) Start the program and set a breakpoint at the end of an interrupt routine:

```
#E ,YYYY
```

Main program:

```
Main:   ....
        ....
ZZZ:    MOV ...
        MOV ...
        ADD ...
        ....
```

Interrupt Service Routine

```
INT0:   ....
        MOV ....
YYYY:   DJNZ ...
        ....
```

b.) After reaching breakpoint YYYY, execute to a breakpoint within the Main module:

```
#E ,ZZZZ
```

c.) If the interrupt return address on the stack is ZZZZ+1 or ZZZZ+2, the program will crash.

d.) The probability of this occurring goes up as the size of the Main program loop goes down. Consider the case of:

```
Main:     MOV     A,#5    ;2 bytes
          SJMP    Main    ;2 bytes
```

A breakpoint set at Main will mess up the next instruction as well. If the next instruction is at the interrupt return address, the program crashes. This will happen 50% of the time.

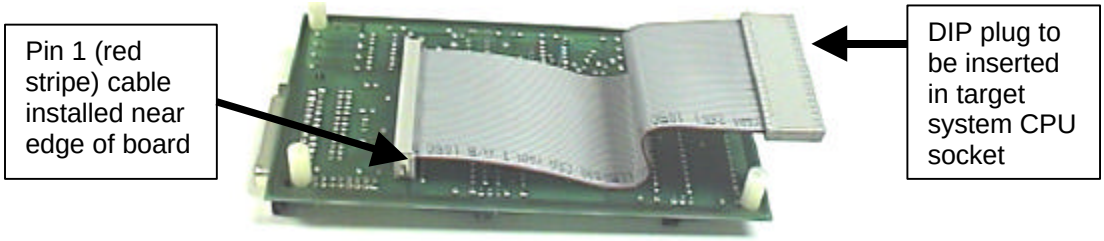
By carefully selecting your breakpoints to avoid these pitfalls, you can make full and proper use of the features of the monitor.

Using the SDK as an ICE

The SDK may be used as an ICE (In-Circuit Emulator) for 8051 compatible CPUs, running in the external program access (external bus) mode. The "host" system is your PC, which is used to communicate with and control the SDK. The "target" system is an 8051 system of your own design, which will incorporate an 8051 style CPU and operate independently of the SDK once you have it running properly. One end of the ICE cable plugs into the P2 connector underneath the SDK, and the other end has a 40 pin DIP plug, which can be plugged into the target system in place of the CPU chip. Then the SDK can be used to develop and debug your programs in the target system, by loading your program into the SDK's program RAM.

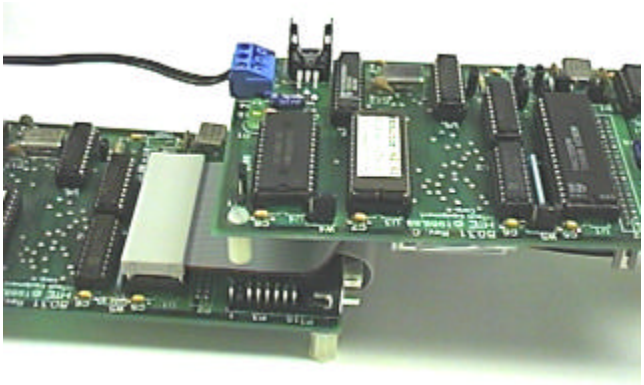
Operation of the SDK as an ICE

The SDK can be operated as an ICE, by plugging the ICE cable into P2 on the bottom of the SDK board, and the DIP plug into your target system where the 8051 would have been installed. The ICE cable is shown below, installed on the P2 connector that is on the bottom of the SDK board. Be sure to check the orientation and alignment of the cable, to prevent damage to the SDK or your target system.



ICE Cable attached to underside of SDK

There are also jumpers which should generally be moved for ICE operation. They are W1 and W2, which select the crystal on the SDK or the target system's crystal for clocking the CPU chip. The photo below shows how the ICE cable is plugged into a target system's CPU socket. In the photo, the ICE cable is plugged into another SDK board's CPU socket. It almost looks like a case of recursion in hardware, but you can't plug an SDK's cable into itself!



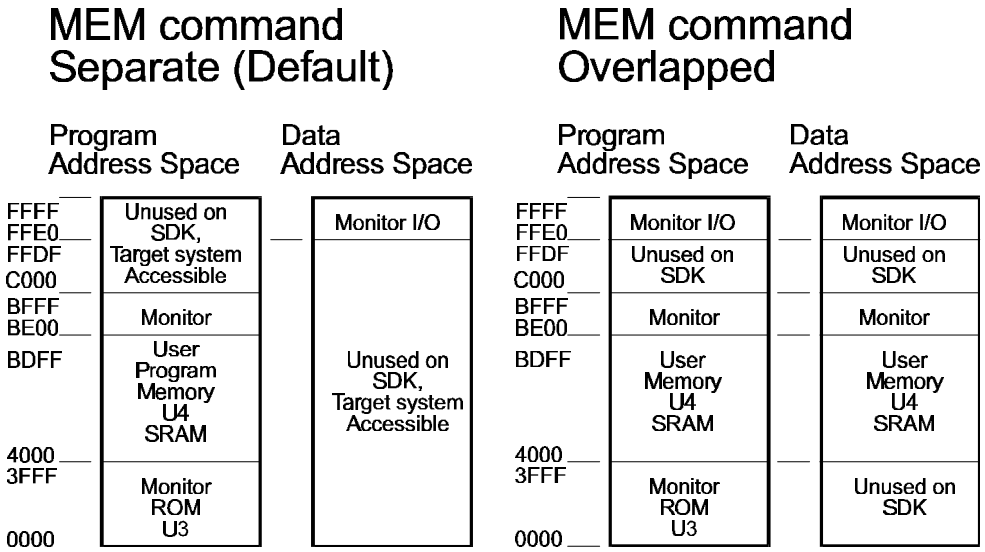
SDK ICE cable plugged into target CPU socket

SDK Memory Map Implications for ICE Operation

When the SDK is plugged into the target system, the memory and I/O devices on the SDK will take precedence to those on the target system and overlay them. In other words, the monitor ROM will occupy the program memory space from 0000 to 4000h, and any memory in that range that exists in your target system will be ignored by the SDK. Likewise the RAM at locations 4000h – BDFFh and I/O in the external data memory address space at locations FFE0h to FFFFh on the SDK will preempt use of these locations in your target system. (These addresses assume the standard 32Kx8 SRAM is installed in U4. See memory maps appendix J for details.)

Memory cycles which access resources on the SDK will not access memory location in the target system via the ICE cable. Only accesses to memory addresses which are not implemented on the SDK will access the target system addresses. When a user program is executed in the default memory configuration (MEM command, separate mode), it will access program memory on the SDK from 0000h to BDFFh and on the target CPU in the range C000h to FFDFh. When the program accesses external data memory, it will access data memory on the target system in the range 0000h to FFDFh, and the reserved monitor memory mapped I/O on the SDK in the range FFE0h to FFFFh.

When the user program is executed in overlapped memory mode (MEM command, overlap mode), the user program memory (SRAM U4) will also appear in external data memory in the range 4000h to C000h.



Circuit Description

The processor is the 8032, the ROMless version of the 8052 family. It has four, 8 bit I/O ports, P0 thru P3. P0 is used as the data port and also carries the low order eight address bits. These bits are latched by the octal latch on the falling edge of the ALE line. These are then combined with the high order address bits from P2 to form the full 16 bit address. The address decoders are PLD's, which decode the three most significant address lines to deliver the chip select and read signals to the external RAM and ROM. This decoder provides several different combinations of mapping which are discussed in the section on jumpering. The PLD's multiplex other I/O port lines as well.

Memory Map PALs

Two 16V8 PLDs are programmed to provide address mapping for Static RAM types of 8k and 32k on board and off board. Other mapping may be incorporated by contacting HiTech Equipment for your custom programming needs.

Configuration Jumpers

The Development Board is shipped with the default jumpers installed as shown in Appendix D.

The jumpers on the Development Board are classified into three groups. Serial I/O, Memory device selection, and Memory mapping. The memory mapping group is further broken down into two sub-groups; device address, and address field. Address field refers to program memory space versus Data memory space.

Serial I/O Jumpering

The default jumper installation for the serial I/O port is with all modem control lines disabled. Incoming DTR and RTS are ignored and the outgoing CTS and DSR are tied high (+12v.). This will allow the Development Board to send to and receive from most standard RS-232 "terminal" devices. Note that the Development Board is configured as an RS-232 DCE (like a "modem"), and that a null modem is not required to communicate with a standard PC COM port.

The monitor does not utilize any of the modem control lines.

Memory Mapping

The 8051 family of processors are capable of addressing a maximum of 128k of external program and data memory. This memory is broken down into two types, with the processor being able to address maximum of 64k of program memory (read only), and a maximum of 64k of data or read/write memory. (Peripheral devices are also usually located in the latter space). Both memory fields are addressed using the same 16 address lines. During a read, the desired field is selected by the use of the RD (for data memory) or the PSEN (for program memory)lines.

The Development Board has a jumper field associated with each memory socket to allow the location of that device in either external RAM space, program memory space, or both. In the last option, the device will appear at the same address in both spaces. This option is required for operation of the monitor during program development or in any operation which requires having the CPU write into it's own program memory space. This limits the system to a total of 64k of memory but once program development is done, the Development Board can be jumpered for its full 128k range.

Device Address

The Development Board is set up to support the development monitor EPROM in U3 and 32k Static RAM devices in location U4. These may be changed by alteration of the jumpers as shown in the schematic. See Appendix D for more details.

Memory Speeds

Two important memory timing specifications must be met when adding memory devices to the Development Board. The most common timing consideration when selecting memory devices in their response time from receiving a chip select and valid address to their placing data on the bus. (Note that the times required by the 8051 differ depending on whether the read is from data or program memory, see the 8051 Data Sheet). The other timing specification which must be considered, is the time required by the device before it releases the bus after it is deselected. For the program memory, this must be less than 75 ns. at 11.059 Mhz. These times depend on the specific 8051 CPU variant used, and the memory and logic devices.

More information and application note references are available on the subject of timing, and can be found on the HTE web site, and in the text "Embedded Controller Design" by Ken Arnold.

Appendix A. Monitor Command Summary

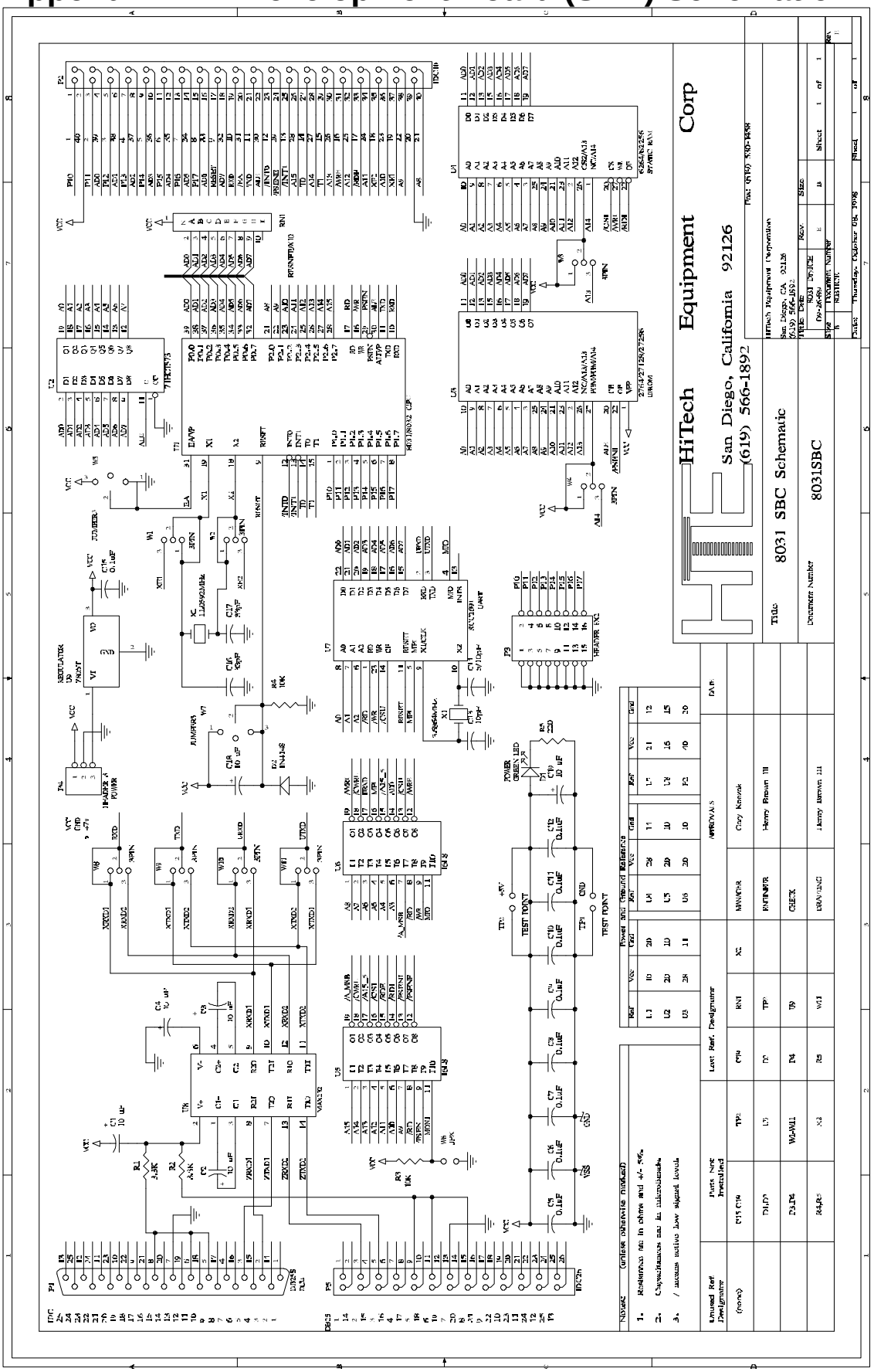
<BS>	Backspace key used for line editing to correct errors.
<CR>	Carriage Return is used to terminated the command string.
<DEL>	Delete key used for line editing to correct errors.
^C	(Control-C) Abort the command and return to the command mode.
^S	(Control-S) Stops scrolling of screen display at any time.
^Q	(Control-Q) Restarts scrolling of screen display.
^X	(Control-X) Will erase the entire input line and restart the input routine.

?	Displays list of commands.
ASM	Assembles 8051 mnemonics and hexadecimal into memory from address
DASM	Disassembles memory from address to address into 8051 mnemonics and hexadecimal addresses and data.
EXEC	Transfers complete control to the user program.
GO	Begin program execution at start address and continue until the breakpoint is reached.
HELP	Gives list of commands.
HEX	Hex calculator, gives sum & difference of two hex numbers.
INTR	Changes the debug interrupt used by the monitor to the specified interrupt.
LOAD	Load an Intel Hex file format from the serial port into external RAM area.
MEM	Switches U4 between separate and overlapped code and external access.
PC	Display and permits modify of the user Program Counter.
PS	Switches between tracing subroutine calls and skipping over them in Step mode.
RESET	Restores the processor to the same state as activating the CPU RESET pin.
S	Single step number of steps.
TRACE	Traces program execution beginning at start address. Dumps main register contents and disassembly of code memory as it progresses.
VIEW	View interrupts during executing. Turn view off and on.
DC	Dumps the code data memory.
DI	Dumps the internal data memory.
DR	Dumps the on-chip register memory.
DX	Dumps the external data memory.
FC	Fill the code data memory with user specific constant.
FI	Fill the internal data memory with user specific constant.
FX	Fill the external data memory with user specific constant.
MC	Move bytes within the code data memory.
MX	Move bytes within the external data memory.
SB	Display and permits modify of a series of bit addressable memory.
SC	Display and permits modify of a series of byte from code data memory.
SI	Display and permits modify of a series of byte from internal data memory.
SX	Display and permits modify of a series of byte from external data memory.

Keyword Registers:

ACC	IP	PSW	R5	SCON	TH1
B	P0	R0	R6	SP	TL1
DPH	P1	R1	R7	T2CON	TH2
DPL	P2	R2	RCAP2H	TCON	TL2
DPTR	P3	R3	RCAP2L	TH0	TMOD
IE	PCON	R4	SBUF	TL0	

Appendix B. Development Board (SDK) Schematic



Appendix C. OEM SBC Schematic

Appendix D. Development Board Jumpers

Jumper Name	Pins Shorted		Function
W1	1 - 2	*	External crystal - X1
W2	1 - 2	*	External crystal - X2
W1	2 - 3		On Board crystal - X1
W2	2 - 3		On Board crystal - X2
W3	1 - 2	*	U4 - 8k Static RAM
W3	2 - 3		U4 - 32k Static RAM
W4	1 - 2	*	U3 - 2764/27128 EPROM
W4	2 - 3		U3 - 27256 EPROM
W5	1 - 2	*	U1 /EA to ground – CPU external program access mode
W5	2 - 3		U1 /EA to +5v- CPU internal program access mode
W6	out		8 k Static RAM installed
W6	in		32 k Static RAM installed
W7	out		Normal
W7	in		U1 - Reset
W8	1 - 2	*	DCE configuration
W8	3 - 4	*	
W8	5 - 6	*	
W8	7 - 8	*	
W8	1 - 4		DTE configuration
W8	2 - 3		
W8	5 - 8		
W8	6 - 7		

* Note: Asterisk (*) means the default jumper has been cut (a trace) on the bottom side of the board. Normally, the traces are cut prior to being shipped, and jumper plugs are installed.

Appendix E. Intel Hex Format

Intel hex data file formats begin with a 9-character prefix and end with a 2-character suffix. The byte count must be equal to the number of data bytes in the record. Data record and end-of-file record are the two types of records. The number of bytes per record is variable. Each record begins with a colon, which is followed by a 2-character byte count. The 4 characters following the byte count is the address of the first data byte. Each byte is represented by 2 hex digits that equals to the number of bytes in each record. It ends with the checksum.

:BCAAAATTHH . . . HHCC

:	Start character (colon)
BC	The hexadecimal number of bytes in the record. If BC = 0 the it is the end-of-file record.
AAAA	Address in hexadecimal of first data byte in the record.
TT	Record type. If TT = 00 then data record. If TT = 01 then end-of-file record
HH	One data byte in hexadecimal notation.
CC	Checksum is the two's complement of binary summation of preceding bytes in record including the byte count, address and record type.

Appendix F. Error Messages

Unknown HEX number

Explanation: This error is caused by an invalid hex number. All parameters are entered in hexadecimal.

Action: Enter a valid hexadecimal number.

Illegal # of parameters

Explanation: This error occurs when the command needs more parameters.

Action: Check the command description for the command.

No RAM at address : xxxx

Explanation: This error occurs at address 'xxxx' when a command failed to verify after it has written a byte to RAM.

Action: Check the hardware for RAM at .'xxxx'.

Invalid command

Explanation: An invalid command was detected.

Action: Correct the invalid command.

Unknown error

Explanation: An unknown error was detected. This was probably caused by writing to the monitor internal RAM area.

Action: Reset the system.

Appendix G. Useful Monitor Routines

You can use the development board for purposes other than code development. Below are the entry points to the subroutines in our firmware which might be useful. These routines for ASCII characters from the host via the external RS-232 port (P5).

Routine	Entry point	Description

```
Getchar   3F03H     ;Returns character in acc
                    ;Will not return until character
                    ;has been received.  May or may
                    ;not echo character.
                    ;No other registers are affected.

Sendchar  3F06H     ;Sends character in acc.
                    ;No other registers are affected.

Sendstr   3F09H     ; Sends a string to the display.
                    ; String is in External memory
                    ; DP points to string
                    ; Terminate string with $ character
```

Appendix H. Using the OEM version of the SBC

Essentially, the OEM (Original Equipment Manufacturer) version of the SBC is a minimum configuration version of the Development Board. This version is a much lower cost unit (<$50.00US), as it does not have the components which are only needed for development of programs. It does not have the following items:

1. A monitor EPROM. On the SBC, the user's final program is burned into an EPROM and put in the same socket where the monitor EPROM is on the Development Board (U3).

2. An external serial port. On the SBC, only one DB-25 connector is present. The 8032's serial port is available at RS-232 levels at the DB-25 connector on the short side of the board. The extra serial port present on the Development Board is not needed since code is not developed on the SBC. The extra serial port is available as an option, however.

3. The decoding PALs. These are used in the Development Board to decode the addresses used by the UART and to map RAM and EPROM in the 8032's address space. The SBC does not need memory decoding so these connections must be jumpered as follows:

For U5, Connect:	**For U6, Connect:**
a. pins 5 and 16	a. pins 9 and 19
b. pins 8 and 14	b. pins 13 and 20
c. pins 9 and 13	

Once code development has been completed on the Development Board, it is ready to be programmed into an EPROM and installed in SBCs. In order to do this, though, the program must first be assembled with its origin starting at 0000h. If the program has been written as shown in the section on Interrupt Service Vectors, then this is simply a matter of changing the USERRAM equate to 0000h. After the program has been reassembled, it is ready to be programmed into an EPROM and run in the SBC.

In addition, the code can be contained in an 8051 variant that has internal memory, such as the 8051 BASIC chip. In this case, the processor must be told to execute code internally. This is done by cutting the trace shorting pins 1 and 2 of jumper 3 and installing a jumper connector on pins 2 and 3.

The following is the pinout for the power connector:

Pin Description

1. +5v in. This pin is used instead of pin 1 if you already have a regulated +5v supply available. However, if there is no on-board regulator, this pin must be used to deliver power to the board.
2. Ground
3. If a voltage regulator is installed in U9, +6v to +12v may be applied to this pin. This voltage is regulated down to +5v by U9.

Appendix I. Useful Web sites

Below is a list of useful web sites, related to the 8051 family of devices.

http://www.hte.com
The HTE web site has lots of useful information, updates, free/shareware, the current version of this manual, and links to all the sites listed below, plus new and updated information.

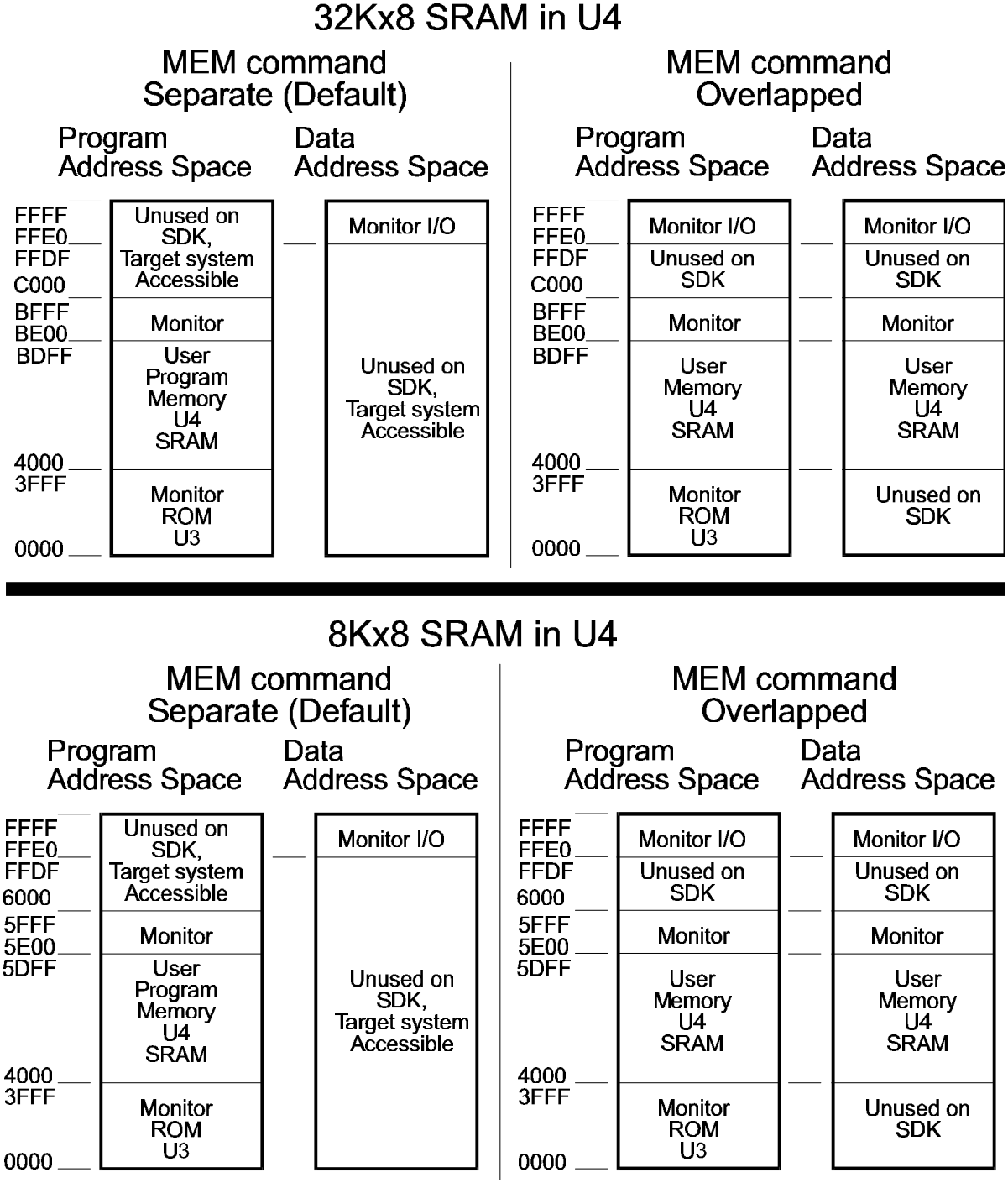
http://developer.intel.com
Intel is the originator of the 8051 architecture, and has free software utilities that allow automatic configuration of the various 8051 on-chip resources.

http://mcu.philips.com
Philips Semiconductors has an extensive line of 8051 derivatives and a large collection of application notes on their web page.

http://www.atmel.com
Atmel has 8051 derivatives that incorporate flash program memory and are available in packages as small as 20 pins.

Appendix J. Memory Maps

The memory maps below show the program and data memory address spaces for both normal and overlapped program and data memory.



Appendix K. Problem Report and Comment Form

Please complete this form if you discover any software or hardware problems, documentation problems, or would like to suggest product enhancements. Duplicate this form if you need additional copies and/or attach extra pages if necessary.

___ Hardware Problem ___ Documentation Problem
___ Software Problem ___ Product Enhancement

Date: _____ Serial #: _____
Product: _____ Version #: _____
Name: _____ Title: _____
Company: _____
City: _____ State: _____ Zip: _____
Country: _____

Phone: (_____) _____ Ext: _____

Please describe the problem, how to reproduce it and your suggested correction. Or, decscribe documention problems or suggest enhancements that you would like to see added to this product.

Send or fax form to:

HiTech Equipment Corporation Attn: Technical Support
9672 Via Excelencia (619) 566-1892
San Diego, CA 92126 Fax: (619) 530-1458

http://www.hte.com

Or e-mail techsupport@hte.com