

6808 Training Kit

User's Guide

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WARRANTY:

BiPOM Electronics warrants 6808 Training Kit for a period of 1 year. If the Kit becomes defective during this period, BiPOM Electronics will at its option, replace or repair the Kit. This warranty is voided if the product is subjected to physical abuse or operated outside stated electrical limits. BiPOM Electronics will not be responsible for damage to any external devices connected to the Kit. BiPOM Electronics disclaims all warranties express or implied warranties of merchantability and fitness for a particular purpose. In no event shall BiPOM Electronics be liable for any indirect, special, incidental or consequential damages in connection with or arising from the use of this product. BiPOM's liability is limited to the purchase price of this product.

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INTRODUCTION

The MC68HC08 micro-controller is one of the most popular micro-controllers in use today with applications ranging from industrial, medical, home automation to automotive.

The objective of the 6808 Training Kit is to give students, engineers, technicians, hobbyists and other users experience with micro-controllers by developing practical applications using C and 6808 Assembly language. **The 6808 Training Kit Lab Book** consists of several labs that vary from simple to complicated.

When used in a school environment, it is recommended that the labs accompany a micro-controller course during the semester. Depending on the duration of each lab during the week, each lab in the student manual can be covered during one or two lab weeks. Based on the remaining time during the semester, the instructor may have the students work on one or more advanced projects. Some advanced project ideas are listed in Advanced Project Ideas section of this manual.

This User's Guide is intended for the instructor to get familiar with and setup the 6808 Training Kit for the upcoming labs. The 6808 Training Kit Lab Book should be given to each student group in the lab to perform various exercises during the semester.

INSTALLATION

The 6808 Training Kit consists of the following components:

- MINI-MAX/908-C Micro-controller Board
- Training Board (TB-1)
- Micro C Compiler/Linker/Assembler
- Micro-IDE Integrated Development Environment
- Serial cable
- Power Supply
- Example Lab book and this User's Guide

The following external items are required for each Training Kit station:

- IBM Compatible Personal Computer (PC) with
 - Minimum 16MB memory and 10 MB of available hard disk space.
 - One available RS232 Serial Port.
 - Windows 95 OSR2, Windows 98, Windows NT 4.0, Windows 2000.
(6808 Training Kit will not work with DOS, Windows 3.1 or lower).
- Digital Voltmeter

Installing the hardware

6808 Training Kit hardware consists of a Training Board (TB-1) plugged on top of the MINI-MAX/908-C micro-controller board. This is provided as a set and normally it should not be disassembled (unless access to LCD connector, keypad connector or the EEPROM socket is required).

1. Place the 6808 Training Kit on a clean, **non-conductive** bench top (preferably on an anti-static mat)

Connect the provided power supply to the power plug on the 6808 Training Kit. Do not connect the power supply to the outlet yet.

CAUTION: Do not use a power supply other than the one that is supplied with the 6808 Training Kit. Use of another power supply voids the warranty and may permanently **DAMAGE** the board or the computer to which the board is connected !

2. Make sure the PC is powered off.
3. Connect the 6808 Training Kit to an available serial port on the PC using the supplied serial cable as shown in Figure 1.
4. Connect the 6808 Training Kit power supply to a suitable 110 Volt outlet.
5. Turn on the PC and start Windows.

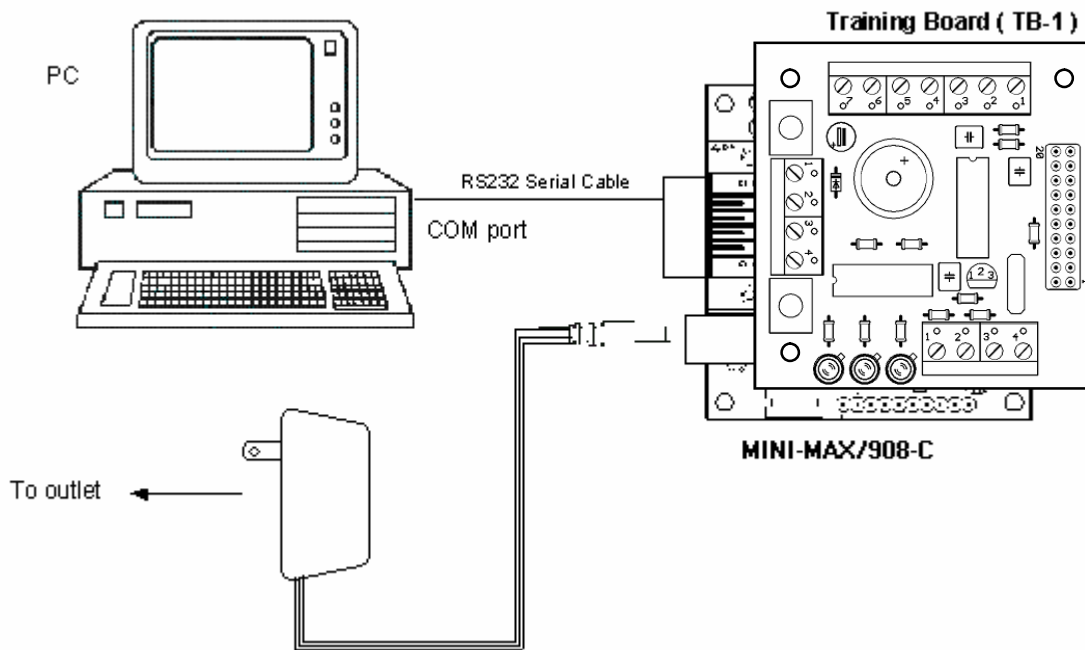


Figure 1

Installing the Software

1. Install the 6808 Training Kit software on the PC by following the printed instructions on the 6808 Training Kit software package. You will be prompted for the Serial number for Micro-IDE during installation; this number is printed on the package for each Training Kit.
2. After installation, start Micro-IDE by selecting Start, Programs and Micro-IDE. Select the Micro-IDE option under Micro-IDE folder. This will start Micro-IDE.

ADVANCED PROJECT IDEAS

- Connecting a printer to the 6808 Training Kit: In this exercise, the student connects a parallel port printer to the MINI-MAX/908-C board using available ports. Student then develops a 6808 program to print characters on the printer using DATA and STROBE lines.
- Using the 6808 Training Kit as a frequency counter: Student develops a 6808 program to measure the frequency and/or period of an incoming signal using 6808's interrupt inputs. The results are then displayed on the terminal window. Input signal is provided from a lab signal generator.
- Using the 6808 Training Kit as a temperature controller: Student develops a 6808 program to connect LM35 or similar temperature sensor to the analog inputs. Depending on the temperature reading one of red, yellow or green LED's are illuminated. If the temperature goes above a preset threshold, the buzzer sounds.
- Using the 6808 Training Kit EEPROM and the Analog-To-Digital Converter as a multi-channel data logger.

MICRO-IDE

Overview

Micro-IDE is an Integrated Development Environment for micro-controller systems application development. Micro-IDE integrates essential components of software development including

- Multi-File Editor
- Project Manager
- C Compiler, Assembler, Linker
- Terminal program, Calculator, ASCII Chart
- Serial Port Loader

Installation

- Micro-IDE works on PC's running Windows 95 OSR2, Windows 98 or Windows NT 4.0 and Windows 2000.
- To install Micro-IDE, insert DISK 1 in your computer's floppy drive. Run **setup.exe** by either double-clicking on this file from Windows Explorer or by pressing **Start** and then selecting run and typing **a:\setup.exe** (or **b:\setup.exe** depending on your floppy drive's letter).
- Insert DISK 2 when prompted for it. Follow the on-screen instructions to complete the installation.
- After the installation is successfully completed, you can start Micro-IDE from the **Start** menu. Press **Start** and select **Programs**. Select Micro-IDE folder (or the name of the folder for Micro-IDE if you changed the default name during installation). Select Micro-IDE.

Configuring communications

1. After you have started Micro-IDE, configure the correct COM port and communications parameters by selecting Tools and Options from the Micro-IDE menu.
2. Under Terminal tab, make sure Com Port is selected as the port that you connected to the 6808 Training Kit. For example, if the board is connected to COM2, select COM2 under Terminal tab. Make sure that the Terminal options are set as follows:

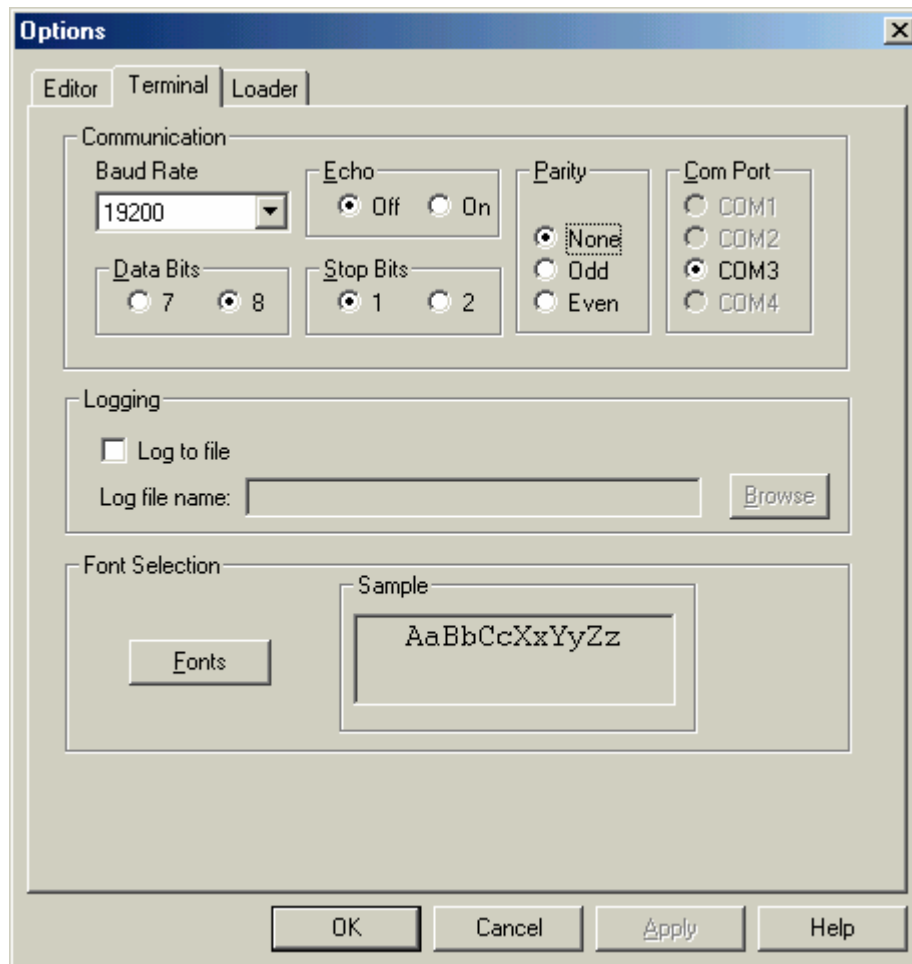
Baud Rate: 19200

Data Bits: 8

Stop Bits: 1

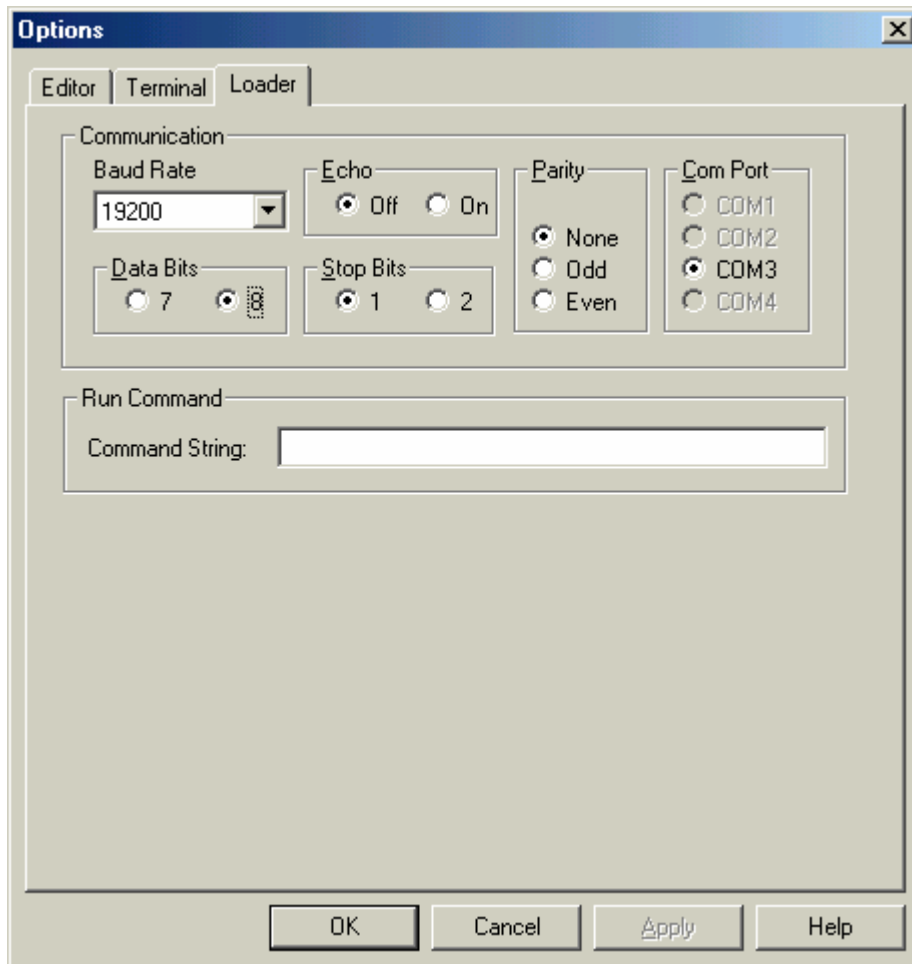
Parity: None

Echo: Off



- Under Loader tab, make sure Com Port is selected as the port that you connected 6808 Training Kit. For example, if the 6808 Training Kit is connected to COM2, select COM2 under Loader tab. Make sure that the Loader options are set as follows:

Baud Rate: 19200
Data Bits: 8
Stop Bits: 1
Parity: None
Echo: Off



Open the Terminal window by selecting Terminal under View menu. Using the Toggle Terminal button on View toolbar you can get the same result. A blank terminal screen will appear on the right side of the Micro-IDE window. (You can resize the terminal screen by selecting the left edge of the terminal window with the left mouse button and dragging to the right.)

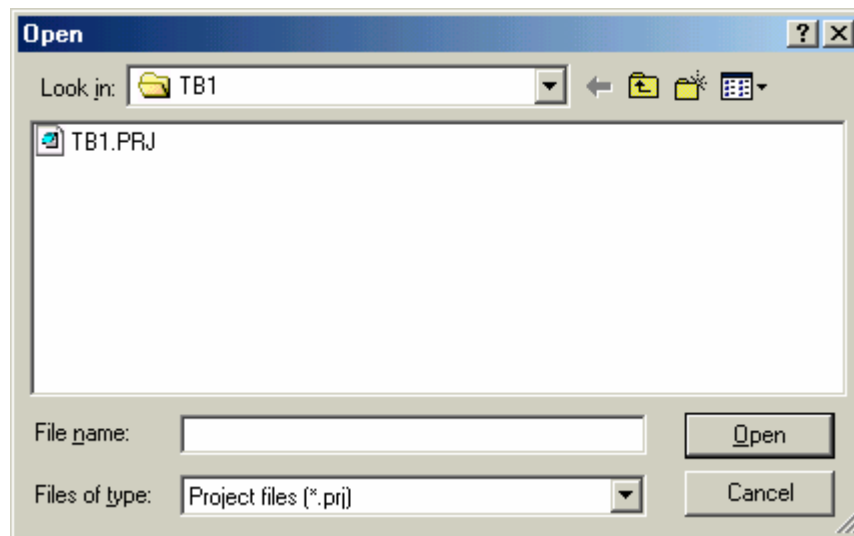


Opening Projects

Micro-IDE is distributed with several example programs that illustrate how to program the 6808 micro-controller.

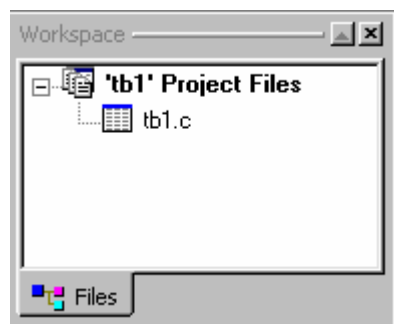
To open the example projects, start Micro-IDE and select Project menu. Start Micro-IDE and open an example project. Example projects are located under Examples folder under the directory where you installed Micro-IDE.

1. From the Micro-IDE menu, select Project, Open Project and open the project file tb1.prj under C:\bipom\devtools\MicroIDE\Examples\6808.

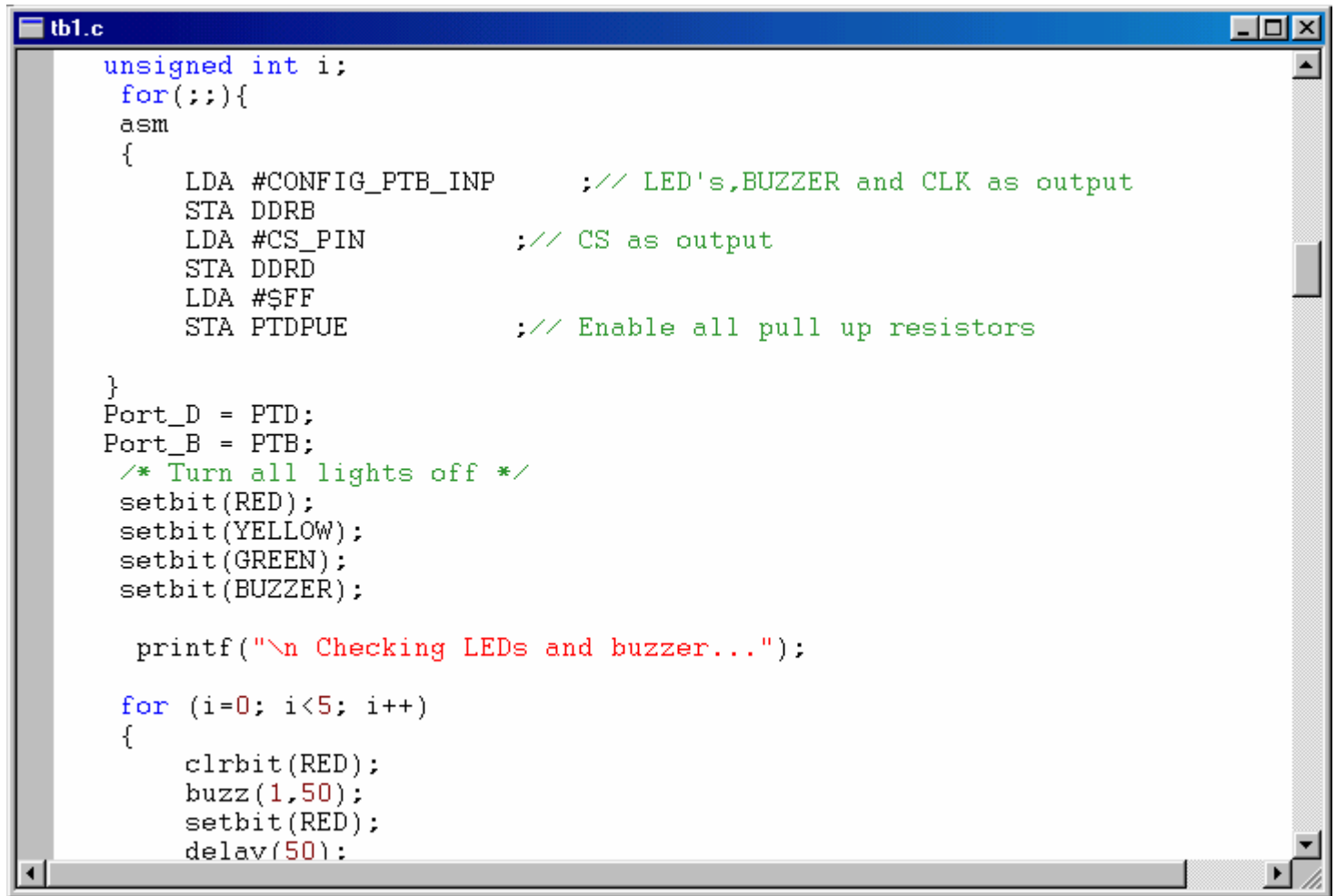


2. To view the file in this project, select View and Project workspace. Using the Toggle Project button on View toolbar you can get the same result.

This will display the Project Workspace with tb1.c as the only file in the project



Double click on tb1.c in the Project Workspace. This will open and display the file tb1.c in edit window. Note that the C language keywords, comments, strings and numbers are highlighted in various colors.



```
tb1.c
unsigned int i;
for(;;){
asm
{
    LDA #CONFIG_PTB_INP      ;// LED's,BUZZER and CLK as output
    STA DDRB
    LDA #CS_PIN             ;// CS as output
    STA DDRD
    LDA #$FF
    STA PTDPUE              ;// Enable all pull up resistors
}
Port_D = PTD;
Port_B = PTB;
/* Turn all lights off */
setbit(RED);
setbit(YELLOW);
setbit(GREEN);
setbit(BUZZER);

printf("\n Checking LEDs and buzzer...");

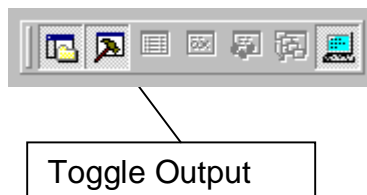
for (i=0; i<5; i++)
{
    clrbit(RED);
    buzz(1,50);
    setbit(RED);
    delay(50);
}
```

3. Select Build and then Build tb1.hex. This will build the tb1 project and generate the tb1.hex file (which is a Motorola hex format file). Using the Build All button on Standard toolbar you can get the same result.

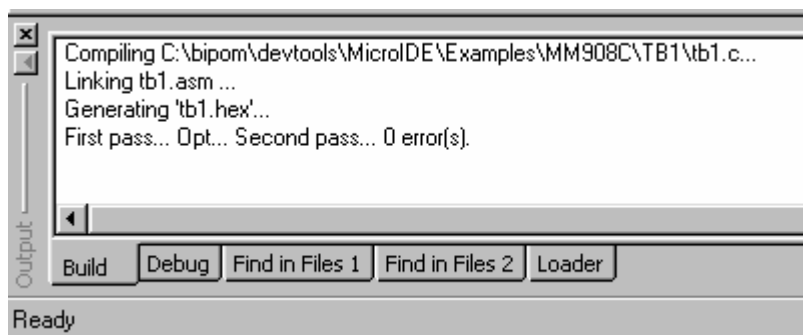


Build All

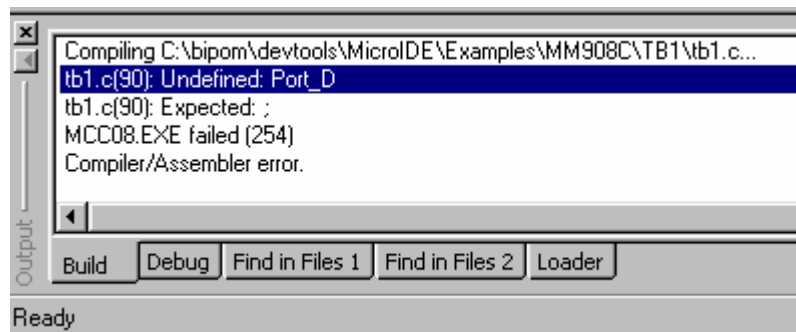
The results of the Build will be displayed on the Output Window. If the Output Window is not visible, open the Output Window by selecting View menu and Output. Alternatively, you can click the Toggle Output button on the View toolbar.



If the project builds successfully, you should see a message indicating 0 errors on the Output Window:



If there are errors building the project (There should not be any errors building the examples that are distributed with Micro-IDE but you can always inject errors to see what effect this has on the build process), the errors are also displayed on the Output Window:



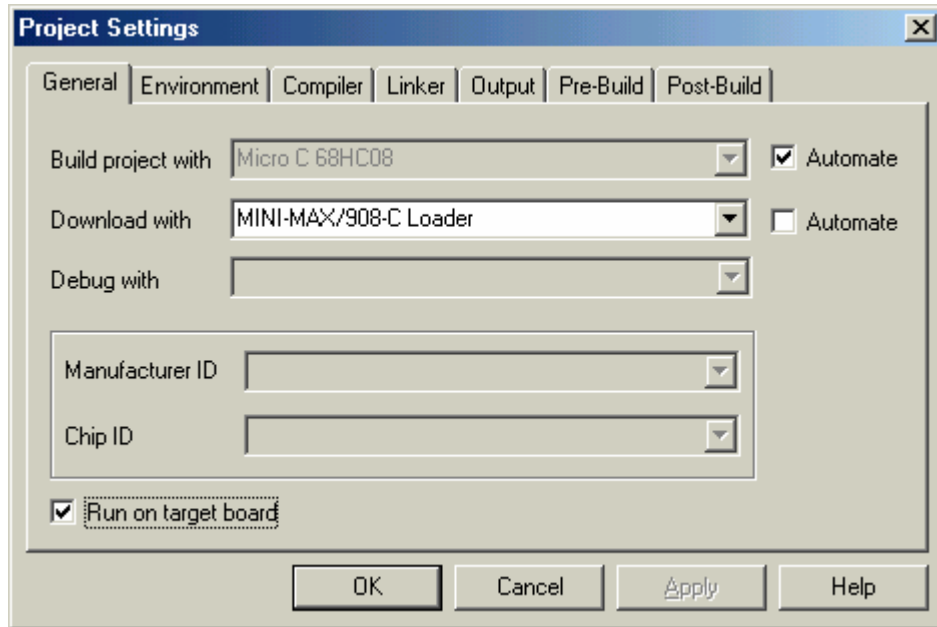
You can double click on the line that shows the error to immediately jump to the source line that contains the error. For example, if you click on the line

tb1.c(90): Expected: ;

your cursor will be positioned on line 90 in tb1.C

Downloading Programs

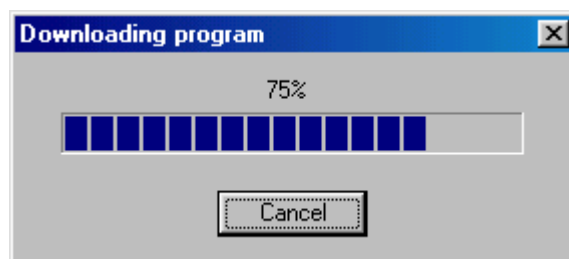
1. Select Mini-Max/908-C Loader under Project / Project Settings / General



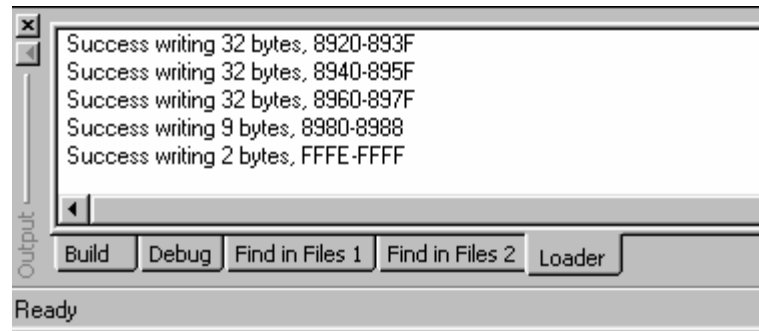
2. Download the file to the board by selecting Download tb1.hex under Build menu. Alternatively, you can click the Download button on the Standard toolbar. Tb1 project should be opened (**Opening project** section describes this).



3. You should see a progress indicator during download. Note that the Set Mode button turns red during download; this indicates that the board is in Program mode. When the download is finished, the progress indicator disappears. This means that the board has received the program successfully.



The results of the Downloading will be displayed on the Output Window.

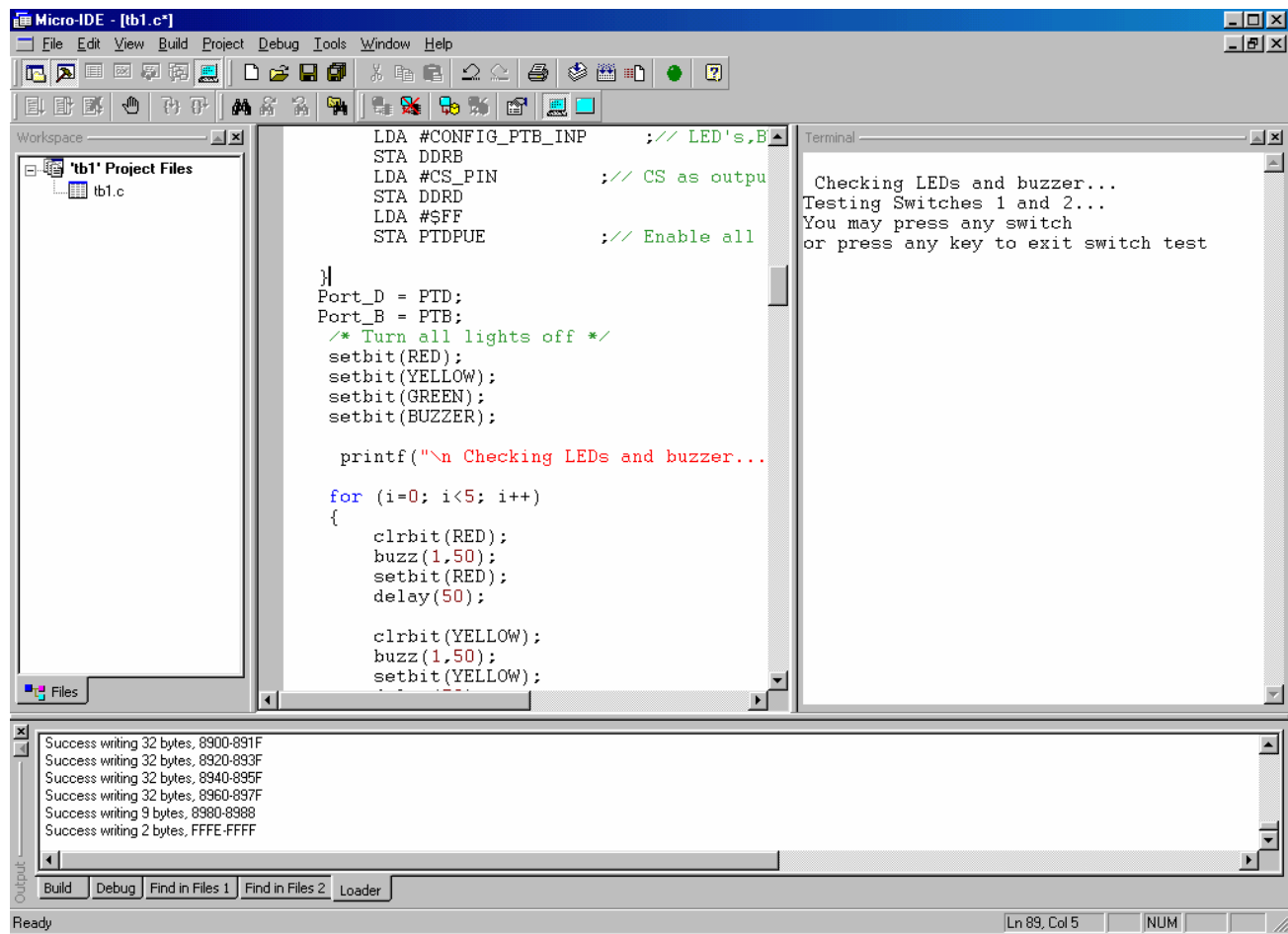


4. Select Tools \ Terminal \ Connect . This will connect the 6808 Training Kit to Terminal window. Alternatively, you can click the Connect button on the Terminal toolbar



5. Click the Mode button to put the board in Run mode. Set Mode button has green color in this mode. In Run mode, the 68HC908 micro-controller on the board will start executing the program (tb1.hex) that you just downloaded.

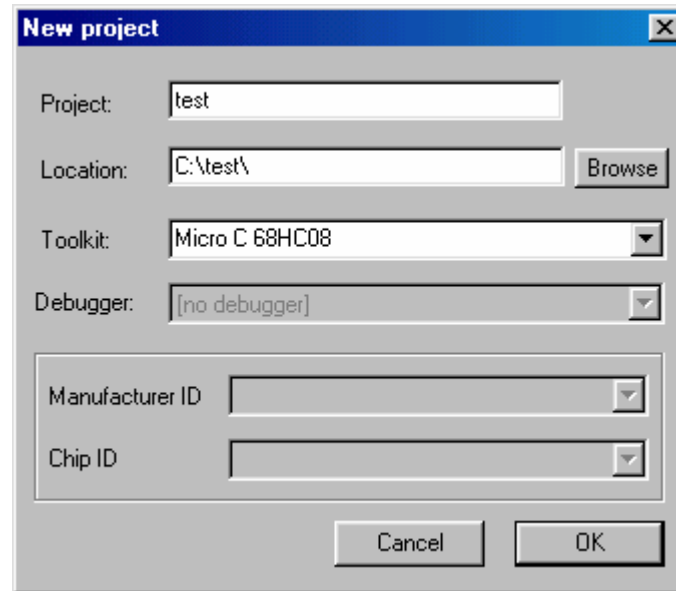
The program will initially flash the LED's on the TB-1 board few times while sounding the buzzer. The program will then display the status of the buttons on TB-1. Press the buttons one at a time and the display should indicate which button is being pressed. Press a key in the terminal window and the program should now display the values from the analog inputs. Finally, pressing a key in the terminal window takes the tests back to the beginning.



This screenshot illustrates the running program from TB1 project on real board.

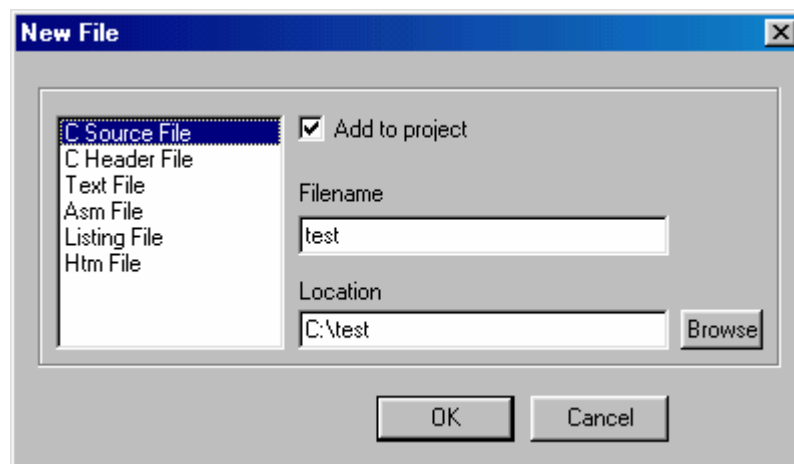
Creating Micro C Projects

To create your own Micro C project, select Project menu and select New Project. This will display the New Project dialog:



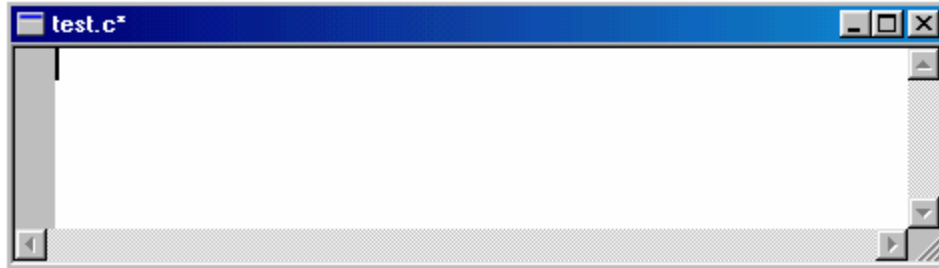
Enter the name of the new project and its location (this example uses **test** as the project name and **c:\test** as the project location). Toolkit is already pre-selected as Micro C 68HC08. Click OK; the new project with the name of test under c:\test will be created.

To add a C source file to the project, first create the C source file. Select File menu and New. New File dialog will appear:



Enter the name of the C source file (for example, **test**) and its location (**c:\test**). The file type is C Source File. Check the Add to project box so **test.c** will be automatically added to test project. Click OK.

A blank C source file (test.c) will be created:



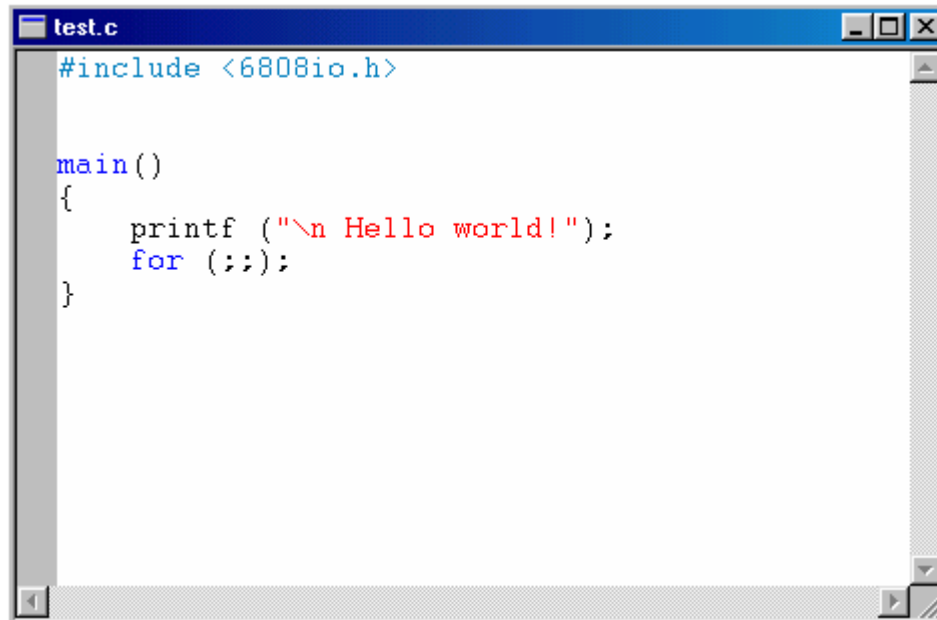
Type the following lines which are the header files required by the Micro C Compiler:

```
#include <6808io.h>
```

Then type the following small C program:

```
main()
{
    printf ("\n Hello world!");
    for (;;)
}
```

The C source file should now look like this:



This program prints **Hello world!** on the Terminal Window. Build the program by clicking the Build button. If the program builds successfully, you will see the following messages on the Output Window:

```
Compiling c:\test\test.c...
Linking test.asm ...
Generating Output...
First pass... Second pass... 0 error(s)
```

You can download the program to the board by clicking the Download button on the Standard toolbar. The **Downloading programs** section describes how to download program code to the board.

After the program has been successful downloaded, it can be started using the Mode button on the Standard toolbar:

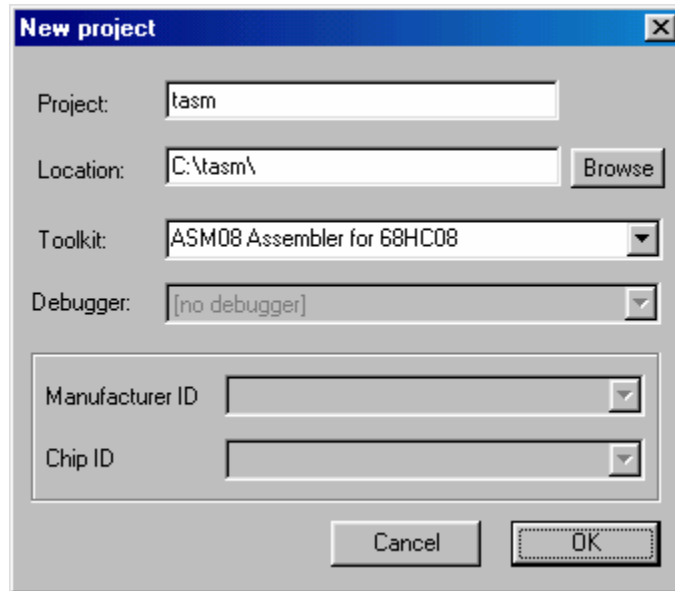


You should see a progress indicator during download. Note that the Set Mode button Mode button puts the board into Run or Program mode. In Run mode, the micro-controller is executing the program in its memory. In Program mode, the micro-controller is in Reset state so no programs are running. In Program mode, micro-controller's flash memory can be changed and a new program can be downloaded.

The Mode button is Red in Program mode and Green in Run mode. Following a download, the Mode button will be Red. Click the Mode button to change the mode to Run mode. The program (test.c) that you just downloaded starts executing and the Green LED turns on. Click the Mode button once again so it turns Red. The board is in Program mode now so the Green LED will turn off.

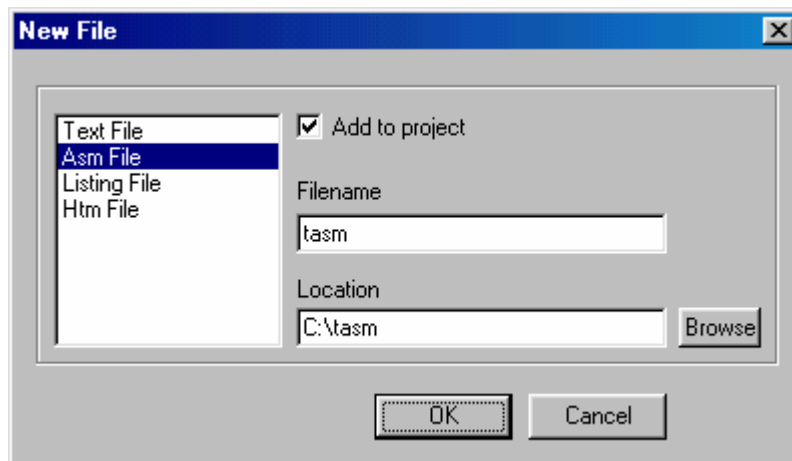
Creating ASM Projects

To create your own ASM project, select Project menu and select New Project. This will display the New Project dialog:



Enter the name of the new project and its location (this example uses **tasm** as the project name and **c:\tasm** as the project location). Toolkit is already pre-selected as ASM08 Assembler for 68HC08. Click OK; the new project with the name of test under c:\tasm will be created.

To add ASM source file to the project, first create the ASM source file. Select File menu and New. New File dialog will appear:



Enter the name of the ASM source file (for example, **tasm**) and its location (**c:\tasm**). The file type is Asm File. Check the Add to project box so **tasm.asm** will be automatically added to test project. Click OK.

Then type the following Assembler program:

```

PTCPUE      EQU  $0000E    ;Port C Input PullUp
SCC1        EQU  $0013    ;SCI Control Register 1
SCC2        EQU  $0014    ;SCI Control Register 2
SCS1        EQU  $0016    ;SCI Status Register 1
SCDR        EQU  $0018    ;SCI Data Register 1
SCBR        EQU  $0019    ;SCI Baud Rate Register 1

STACK      EQU  $0240     ;Stack
          ORG  $0040
REG_TEMP   DS  2          ;Temporary register
;
          ORG  $FFFE     ;Position to reset vector
          FDB  START     ;Set start address
;
          ORG  $8000
START
          BSET 0,$1F     ;Disable COP module
          LDHX #STACK    ;Set initial stack
          TXS           ;Set it up
          BSET 1,PTCPUE  ;Disable PIC communications
; Enable the serial communications
          BSET 6,SCC1    ;Enable the SCI
          BSET 3,SCC2    ;Enable the transmitter
          BSET 2,SCC2    ;Enable the receiver
; Configure Baud Rate Generator
          LDA          # $21    ;PD = 4; BD = 2
          STA          SCBR    ;Baud Rate = 19200
          JSR          NEW_LINE
          JSR          DISP_MSG ;Output message
          FCCZ         'Hello World!'
          BRA          *

; Put character (A) to serial port
PUT_CHR
          BRCLR       7,SCS1,*  ;Transmitting in progress?
          STA          SCDR     ;Send a char to console
          RTS

; Send string(PC) to console
DISP_MSG
          STHX REG_TEMP    ;Store H:X to REG_TEMP
          PULH           ;Get high byte PCH
          PULX           ;Get low byte PCL
          BSR          PUT_STR ;Output string
          PSHX           ;Set new PCL
          PSHH           ;Set new PCH
          LDHX REG_TEMP    ;Restore H:X from REG_TEMP

```

```

        RTS
; Send new line command to console
NEW_LINE
        JSR        DISP_MSG      ;Output message
        FCB        $0A,$0D,0
        RTS
; Send string (X) to console
PUT_STR
        LDA        ,X            ;Get char from string
        AIX        #1           ;Increment pointer
        CBEQA     #0,EXIT_PUT   ;End of string
        BSR        PUT_CHR      ;Output
        BRA        PUT_STR      ;And proceed

EXIT_PUT
        RTS

```

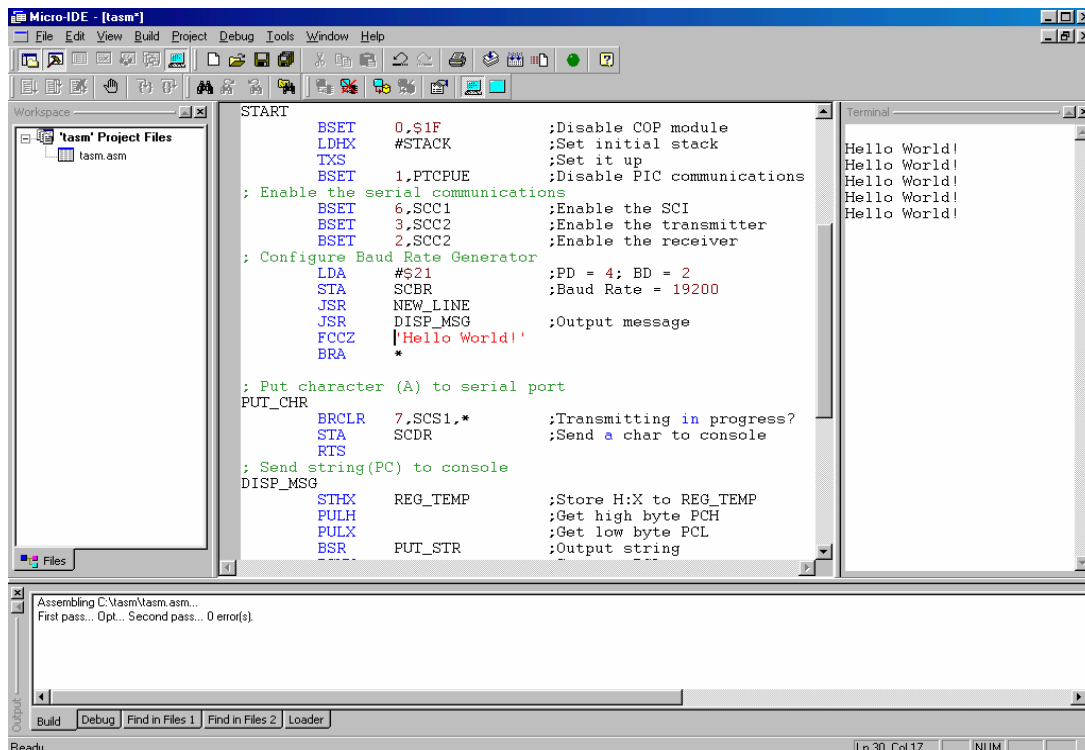
This program prints **Hello world!** on the Terminal Window. Build the program by clicking the Build button. If the program builds successfully, you will see the following messages on the Output Window:

```

Assembling c:\tasm\tasm.asm...
First pass... Second pass... 0 error(s)

```

You can download the program to the board by clicking the Download button on the Standard toolbar. The **Downloading programs** section describes how to download program code to the board. Use Set Mode button to run this program.



MINI-MAX/908-C Micro-controller Board

Overview

The core of the 6808 Training Kit is the MINI-MAX/908-C board that is a general purpose, low-cost and highly-expandable micro-controller system. It is based on the Motorola MC68HC908GP32 single-chip Flash micro-controller. This micro-controller features

- 32 Kilobytes of In-System Re-programmable Downloadable Flash Memory
- 512 bytes of RAM
- Two 16-bit, 2-channel Timer Interface Modules (TIM1,TIM2)
- 8-channel, 8-bit successive approximation Analog-to-Digital Converter (ADC)
- Serial Communications Interface Module (SCI)
- Serial Peripheral Interface Module (SPI)
- Break Module (BRK) to allow single break point setting
- Clock Generator Module (CGMC)
- Computer Operating Properly Module (COP)
- On-chip programming firmware (monitor ROM)
- 33 general purpose I/O pins
- Selectable pullups on inputs on ports A, C and D
- High current 10mA sink/10mA source capability on all port pins
- 8-bit keyboard wakeup port

MINI-MAX/908-C board complements these features by providing

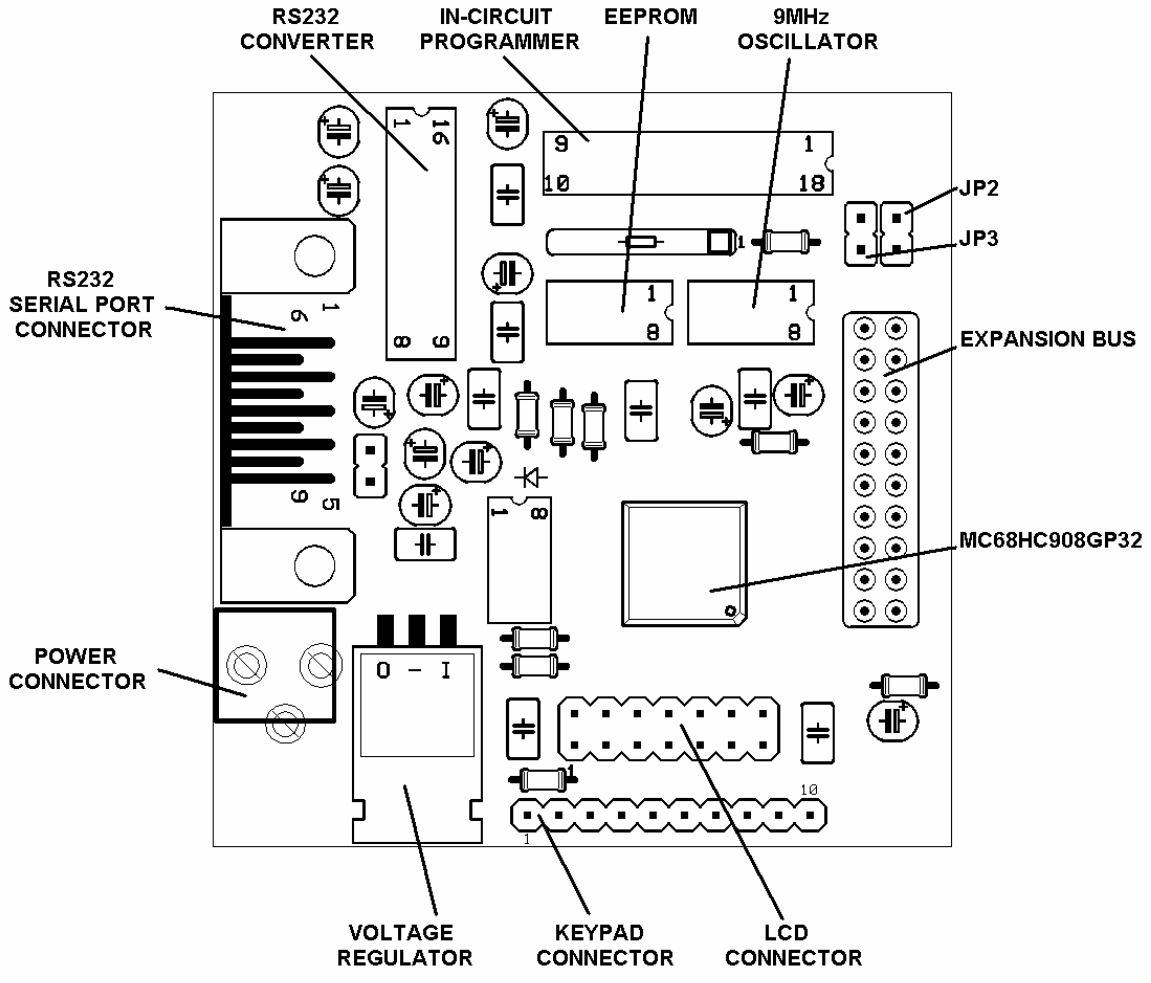
- 512-byte serial EEPROM (can be expanded upto 64-Kilobyte EEPROM)
- RS232 Serial Port
- In-circuit Programming of the micro-controller through the serial port
- Keypad connector
- LCD connector (with programmable contrast adjustment for LCD)
- Expansion bus interface to low-cost peripheral boards such as
 - Instrumentation amplifiers
 - Pressure inputs
 - Strain-gage inputs
 - 12 and 16-bit Analog-to-Digital Converters
 - Digital Input/Output cards
 - LED and LCD displays.

Specifications

Dimensions are 2.35 X 2.40 inches (5.97 X 6.10 centimeters).
Mounting holes of 0.125 inches (3 millimeters) on four corners.
0° - 70° C operating, -40° - +85° C storage temperature range

Board Layout

Layout of MINI-MAX/908-C board is shown below:



Functional Blocks

Block diagram of the MINI-MAX/908-C system

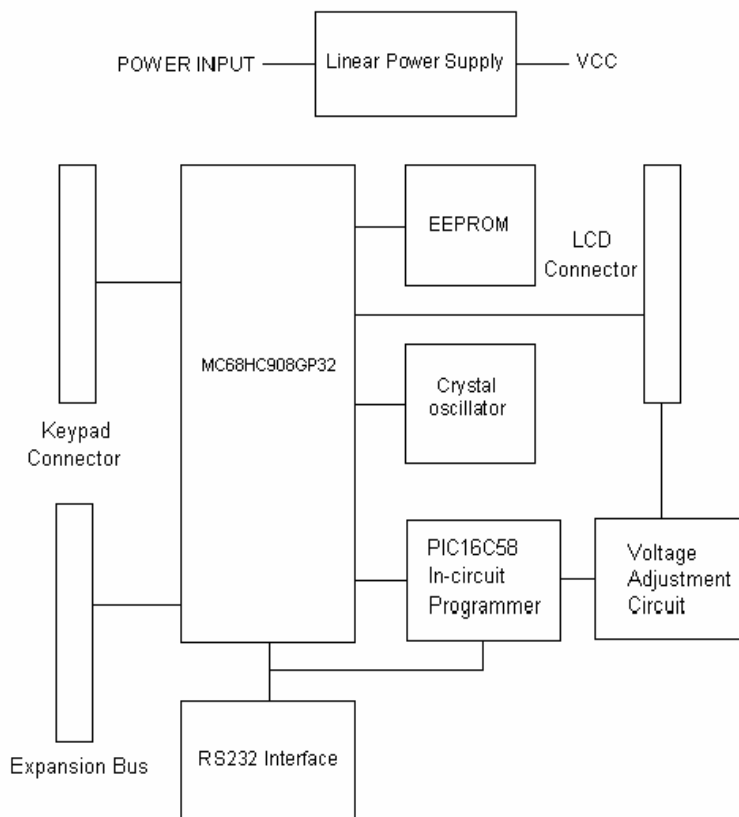


Figure 2

Micro-controller

MINI-MAX/908-C has a Motorola MC68HC908GP32 micro-controller (U1). Micro-controller ports and power lines are provided on a 20-pin expansion bus for interfacing to peripherals and other external circuits. MC68HC908GP32 has the A (PTA), B (PTB), C (PTC), D (PTD) and E (PTE) ports.

PTC pins are available on the LCD connector. PTA pins are available on the Keypad connector and can either be used as general-purpose bi-directional input/output ports or special-purpose keyboard wakeup port. PTB and PTD are available on the expansion connector. PTD pins can either be used as general-purpose input/output pins or for special purposes such as serial peripheral interface and timer inputs/outputs. PTB pins can either be used as general-purpose input/output pins or as Analog-to-Digital Converter inputs. PTE pins are available as input/output of serial communications interface module. IRQ pin (external interrupt) is also available on the expansion connector.

More information on the MC68HC908GP32 micro-controller can be obtained from Motorola web site at www.motorola.com.

EEPROM

MINI-MAX/908-C uses a 24C04 (U2) 512-byte Electrically Erasable Programmable Read-Only-Memory (EEPROM). Typically this EEPROM is used for storing calibration values for sensors, customer identification, serial number and other parameters depending on the application. This EEPROM is on a socket and can easily be replaced with higher capacity EEPROM's (up to 64 KiloBytes).

In-System Programming

MC68HC908GP32 micro-controller can be re-programmed remotely over the RS-232 interface using the PIC16C58 micro-controller on the board. The in-circuit programming feature simplifies program development since downloading programs from a host PC takes only few seconds.

Micro-IDE Integrated Development Environment from BiPOM Electronics fully supports In-System Programming the MINI-MAX/908-C using the serial port. MINI-MAX/908-C loader of Micro-IDE is very fast. First it downloads RAM resident loader into MC68HC908GP32 using the in-circuit programmer PIC16C58. When RAM resident loader is running the MINI-MAX/908-C loader can write/read/erase the board directly without PIC16C58. For example, MINI-MAX/908-C loader takes only 25 seconds for writing/reading of 32 KiloBytes Flash memory (a downloading of RAM resident loader takes 10 seconds additionally).

The on-chip Downloadable Flash memory of MC68HC908GP32 allows the program memory to be reprogrammed in-system through special pin (PTA0) dedicated to serial communication between ROM monitor and PIC16C58 . PIC16C58 is a bridge between RS232 of PC host and serial interface of ROM monitor. PC sends requests (such as Write, Read or Erase Chip) through the RS232 interface, PIC decodes this request and sends the necessary request to MC68HC908GP32 or I2C request to the EEPROM .

The board can work in the two modes :

- Run Mode;
- Monitor Mode.

Run mode is a standard mode when MC68HC908GP32 is running its own program. Monitor mode is a special mode when the MC68HC908GP32 is running the ROM monitor. For In-System Programming, first the PC should switch the board to Monitor mode. For this operation PC should make the RTS line of communication port as logical "0" (+12V should appear on the RTS pin of COM port). PIC16C58 is checking the state of this signal all the time. When RTS is low the PIC will turn on Monitor mode for Motorola chip. When RTS is high, the PIC will turn off Monitor mode and MC68HC908GP32 will start running the program. The user can use this opportunity for resetting of the board. Then the PC should send the Set Type Request. After this operation the PC can send any request (such as Write, Read, Erase) to the board.

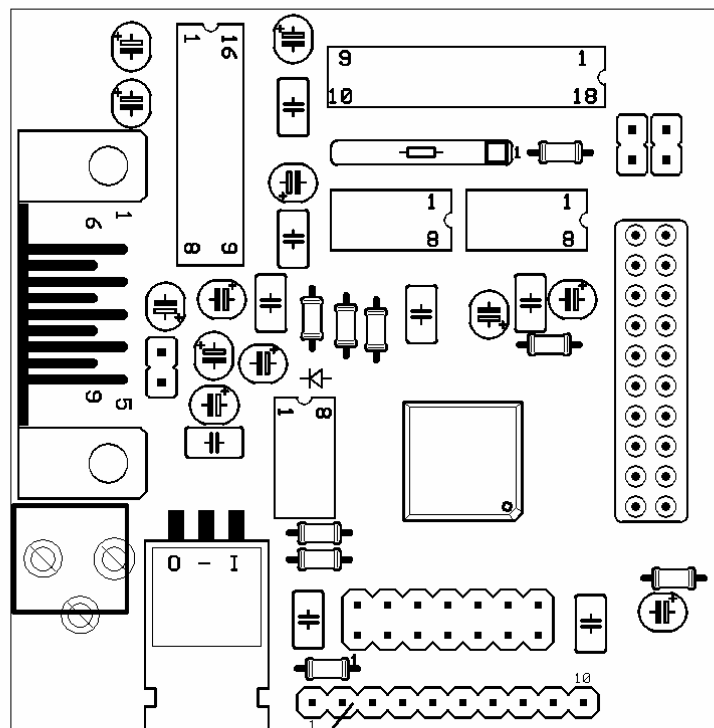
Keypad connector

PTA pins are connected to the Keypad connector. Many different keypads (for example, 3 X 5 or 4 X 4) can be connected directly to the keypad connector. 5 Volt and Ground power lines are available on the Keypad connector. This connector can also be used as a general-purpose port.

Keypad Connector (J3)

Signal	Pin
PTA0	1
PTA1	2
PTA2	3
PTA3	4
PTA4	5
PTA5	6
PTA6	7
PTA7	8
Ground	9
Vcc	10

Table 1



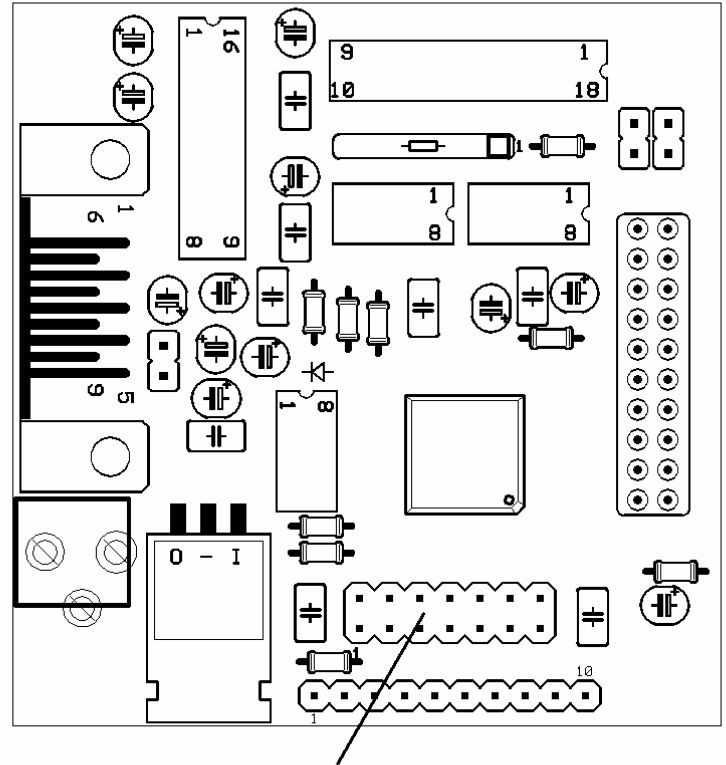
KEYPAD CONNECTOR

LCD Connector

LCD Connector (J2)

Signal	Pin	Pin	Signal
Ground	1	2	Vcc
Vee	3	4	PTC0
PTC1	5	6	PTC2
Ground	7	8	Ground
Ground	9	10	Ground
PTC3	11	12	PTC4
PTC5	13	14	PTC6

Table 2



LCD CONNECTOR

LCD connector

Power Supply Unit

MINI-MAX/908-C comes with a 6 Volts unregulated DC power supply. Other power supplies can also be used although this invalidates the warranty. External power supply should be able to supply 6 to 12 Volts DC with minimum 100mA current. The inner pin of the supply connector is positive and the outer ring is negative.

WARNING: Correct polarity should be observed when applying external DC supply to Power terminal; otherwise MINI-MAX/908-C will be permanently damaged.

MINI-MAX/908-C converts the incoming unregulated voltage to regulated 5 Volts using the on-board 5 Volt regulator (U5).

CAUTION: Depending on the current requirements of the any external circuitry such as peripheral boards that are attached to MINI-MAX/908-C and the level of input voltage applied, the power regulator U5 may dissipate enough heat to cause skin injury upon touch. Contact with this regulator should be avoided at all times, even after the power to circuit has been switched off.

Asynchronous Serial Port

One asynchronous RS232 serial port (U3) is available on MINI-MAX/908-C. U3 converts micro-controller's RXD and TXD pins to/from RS232 levels. U3 has built-in voltage-doubler and inverter that generates +/- 10 Volts for RS232 logic levels. RS232 port is made available on a 9-pin male D connector J4. Hand-held terminals, computers, modems and other serial devices may be connected to the RS232 port. CTS/RTS Modem control lines are provided on the RS232 port. CTS is used by external host such as a PC to put MINI-MAX/908-C in monitor or run modes. Therefore, user applications must not use CTS.

Expansion

Most of the micro-controller pins and the power supply are available on the 20-pin MINI-MAX/908 Expansion connector (J1) for interfacing to external circuitry, prototyping boards and peripheral boards. MINI-MAX/908 peripheral boards can be connected either as a piggyback daughter-board on MINI-MAX/908-C using standoffs or can be placed up away from MINI-MAX/908 using a 20-wire ribbon cable. Peripherals section lists the available expansion boards. Table 4 shows the pin assignments for the MINI-MAX/908 Expansion connector.

Pin 18 of Expansion connector can be connected to IRQ pin of MC68HC908GP32 by connecting JP2 jumper. JP3 jumper should be removed in this case.

WARNING: IRQ pin is forced to high voltage (8 Volts) in Monitor Mode. This voltage can permanently damage the electronic parts connected to this pin. Only external circuitry that is compatible with such high voltage should be connected to the Expansion connector if IRQ pin is connected to pin 18 of Expansion connector through JP2.

Pin 18 of Expansion connector is connected to PTD5 pin if jumper JP3 is installed. JP2 jumper be removed in this case.

WARNING: Jumpers JP2 and JP3 should not be connected at the same time.

RS232 Serial Port (J4)

Signal	Pin
Not Connected	1
Receive (RXD)	2
Transmit (TXD)	3
Vcc (Optional with JP1)	4
Ground	5
Not Connected	6
RTS	7
CTS	8
Not Connected	9

Table 3

MINI-MAX/908 Expansion (J1)

Signal	Pin	Pin	Signal
PTD7	20	19	PTD6
PTD5 or IRQ	18	17	PTD4
PTD3	16	15	PTD2
PTD1	14	13	PTD0
PTB0	12	11	PTB1
PTB2	10	9	PTB3
PTB4	8	7	PTB5
PTB6	6	5	PTB7
VCC	4	3	GND
VCC	2	1	GND

Table 4

Peripherals

MINI-MAX/908 can be connected to a wide variety of low-cost peripheral boards to enhance its functionality. Some possibilities are:

- Prototyping board (PROTO-1)
- Training Board (TB-1)
- Digital Input/Output Expander Board
- 12-bit Analog-To-Digital Converter Board
- Additional MINI-MAX Boards
- Temperature Sensor Interface Board
- Pressure Sensor Interface Board

Peripheral boards can either be stacked on top of MINI-MAX/908 using stand-offs or connected in a chain configuration using flat ribbon cable. Figure 3 shows how MINI-MAX/908-C can be connected to a peripheral board in a stacked fashion. Figure 4 shows chain connection.

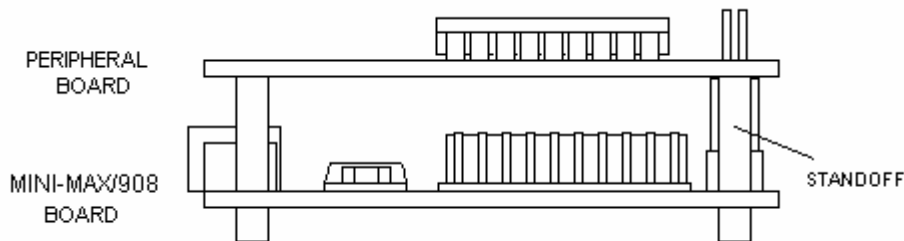


Figure 3

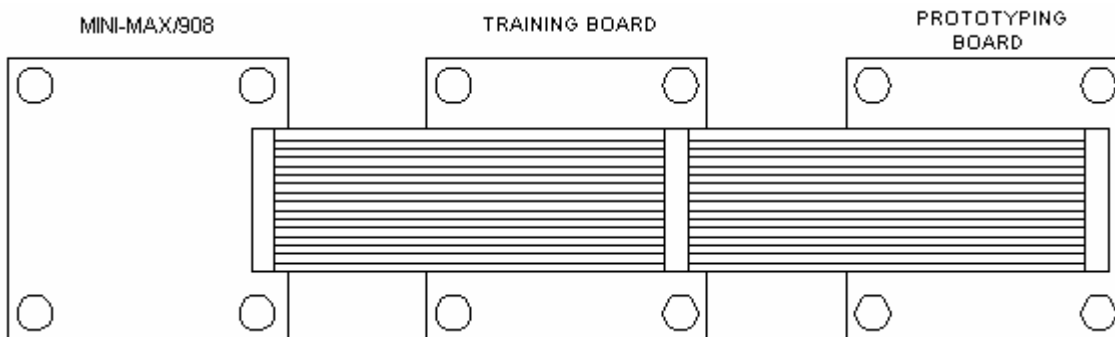
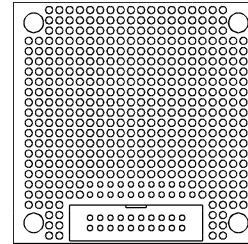


Figure 4

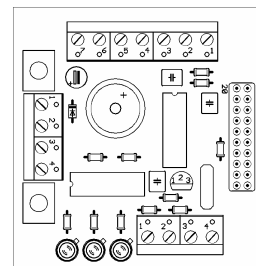
PROTO-1 Board

PROTO-1 provides prototyping area to add custom circuitry to MINI-MAX/908. PROTO-1 can either be stacked with MINI-MAX/908 using standoffs or connected to MINI-MAX/908 as a separate board using ribbon cable (EXPCABLE-6 or EXPCABLE-18). The latter method is useful for mounting behind the panel of an instrument enclosure, for example, as a detachable display board.



TB-1 Training Board

TB-1 Training Board allows performing various experiments with the MINI-MAX/908-C or other compatible boards. TB-1 has programmable traffic lights, 4-channel, 8-bit analog inputs, buzzer, switch inputs, and counter/timer inputs to test the interrupts.



RS232 Devices

Various keypads and terminals may be connected to the RS232 port of MINI-MAX/908-C through connector J4. MINI-MAX/908-C can be connected to a host PC through the RS232 port. For example, MINI-MAX/908 can be used as a remote data acquisition or control unit serving a host PC in a client-server configuration.

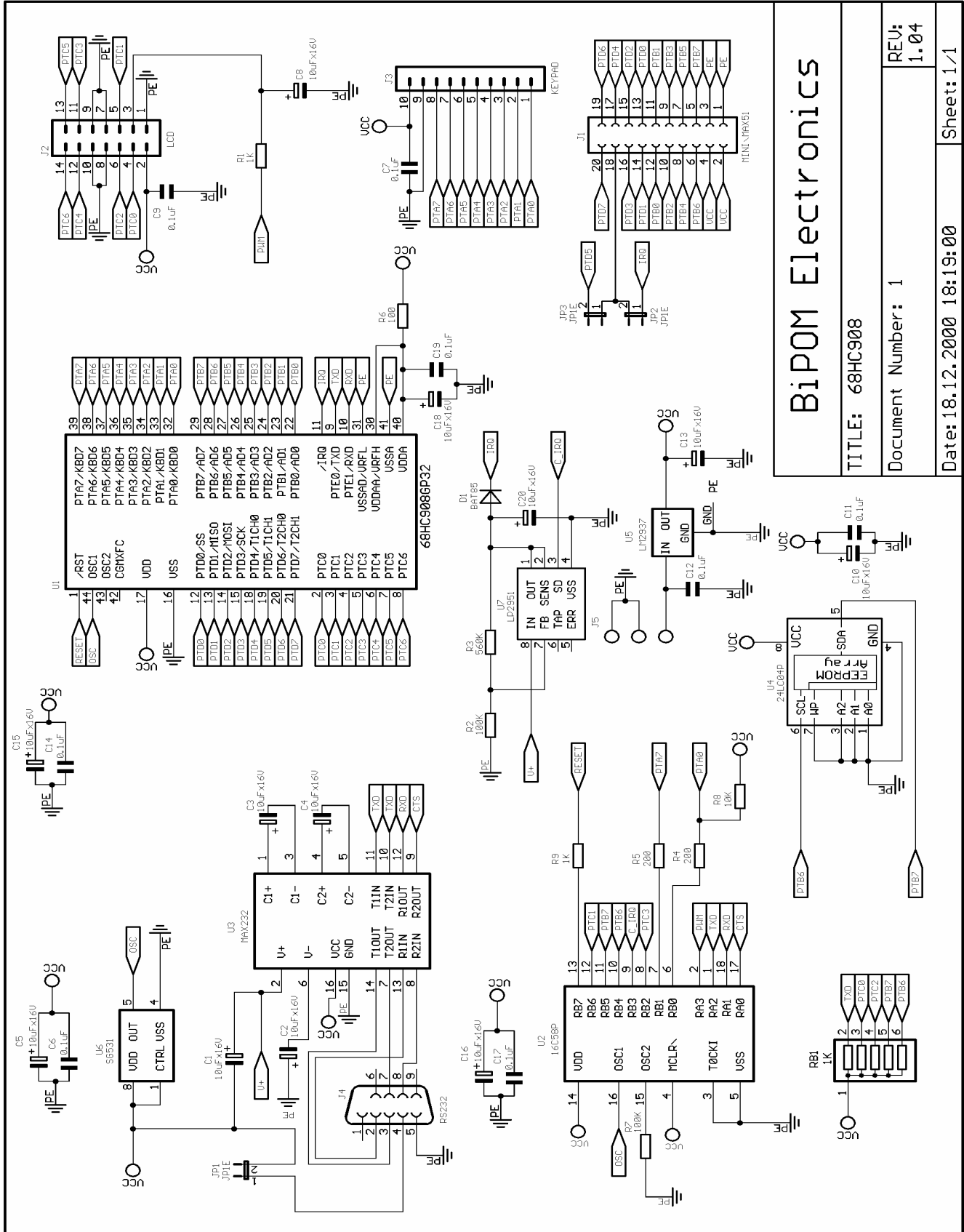
Connection to a host PC is accomplished by using the supplied NULL-Modem cable. MINI-MAX/908-C end of this cable should be a 9-pin Female D connector for connection to J4 on the MINI-MAX/908-C board. Host PC end of this cable can be either 9-pin Female or 25-pin Female D Connector depending on available serial (COM) ports on the host PC.

MINI-MAX/908 9-pin Female			Host PC 9-pin Female
RECEIVE DATA (RXD)	2	3	TRANSMIT DATA (TXD)
TRANSMIT DATA (TXD)	3	2	RECEIVE DATA (RXD)
GROUND	5	5	GROUND
RTS	7	8	CTS
CTS	8	7	RTS

MINI-MAX/908 9-pin Female			Host PC 25-pin Female
RECEIVE DATA (RXD)	2	2	TRANSMIT DATA (TXD)
TRANSMIT DATA (TXD)	3	3	RECEIVE DATA (RXD)
GROUND	5	7	GROUND
RTS	7	5	CTS
CTS	8	4	RTS

Table 5

Schematic



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TB-1 TRAINING BOARD

Overview

Training Board TB-1 is an experimentation board that illustrates the many capabilities of the 6808 compatible micro-controllers. TB-1 features

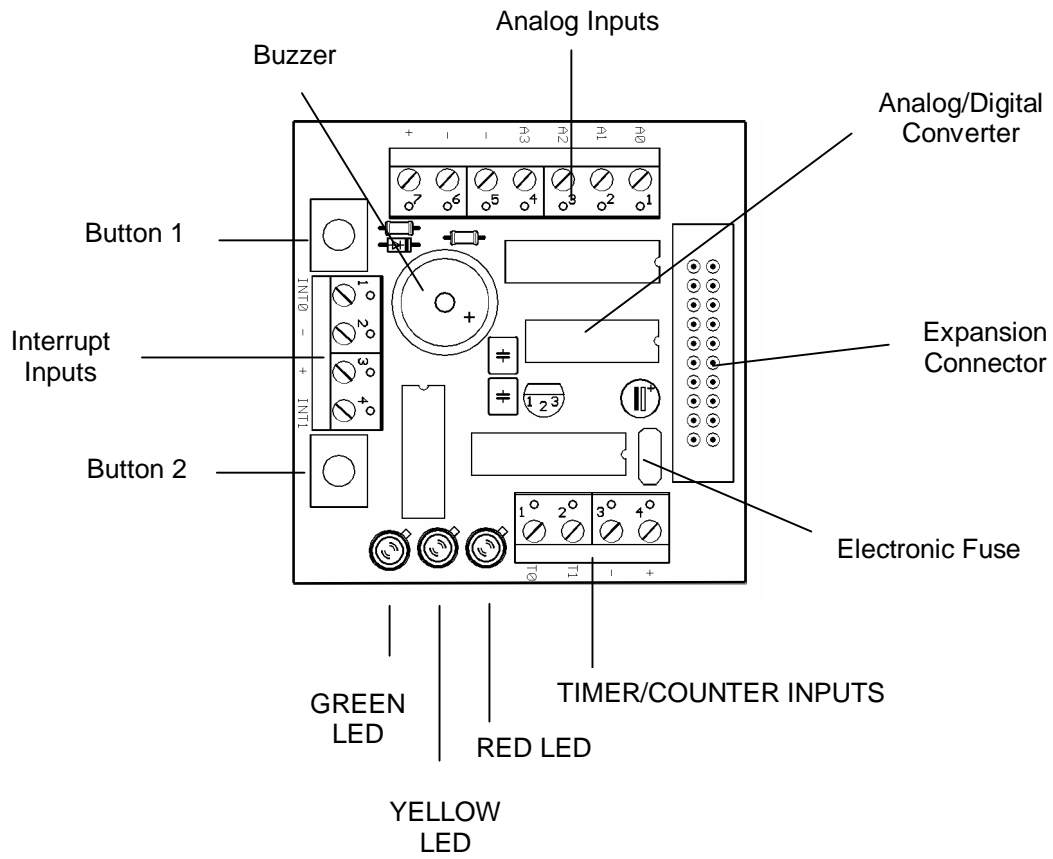
- 3 Traffic light LED's (red, yellow, green)
- 2 inputs
- 2 switch inputs (in parallel with inputs)
- 4 channels of 8-bit analog inputs
- Programmable buzzer
- Expansion bus to other boards

Specifications

Dimensions are 2.35 X 2.40 inches (5.97 X 6.10 centimeters).
Mounting holes of 0.125 inches (3 millimeters) on four corners.
0° - 70° C operating, -40° - +85° C storage temperature range

Board Layout

Layout of TB-1 board is shown below:



Functional Blocks

Expansion

TB-1 is connected to MINI-MAX/908-C and other boards through the Expansion Connector (J1).

Table 6 shows the pin assignments for the Expansion Connector.

Expansion (J1)

Signal	Pin	Pin	Signal
PTD7	20	19	PTD6
PTD5 or IRQ	18	17	PTD4
PTD3	16	15	PTD2
PTD1	14	13	PTD0
PTB0	12	11	PTB1
PTB2	10	9	PTB3
PTB4	8	7	PTB5
PTB6	6	5	PTB7
VCC	4	3	GND
VCC	2	1	GND

Table 6

LED's

TB-1 has 3 Light Emitting Diodes (LED's) that are connected in a traffic light pattern. Red and green LED's are on each side and the yellow LED is in the middle.

LED's are driven by a 7407 buffer (IC2). Each LED has two pins; cathode (negative terminal) and anode (positive terminal). The current through the LED's are limited through current limiting resistors that tie the anode pins to Vcc. To turn an LED on, the cathode is pulled to ground through the corresponding gate of the 7407 buffer. To turn an LED off, the corresponding gate of the 7407 buffer is deactivated by setting the input of the gate to a logic high level.

Buzzer

Because the buzzer requires higher current than the LED's, buzzer is driven by three 7407 buffer gates that are connected in parallel. Due of the inductive nature of the buzzer, a freewheeling diode (D4) is used to clamp reverse voltages that may be induced on the buzzer when the buzzer is being turned on or off.

Buttons

There are 2 push buttons on the TB-1. Each button is connected through a protection resistor to PTD pin on the micro-controller. Pressing a button forces a logic low level on the corresponding micro-controller input. Push Button #1 is connected to PTD5. Push Button #1 is connected to PTD4.

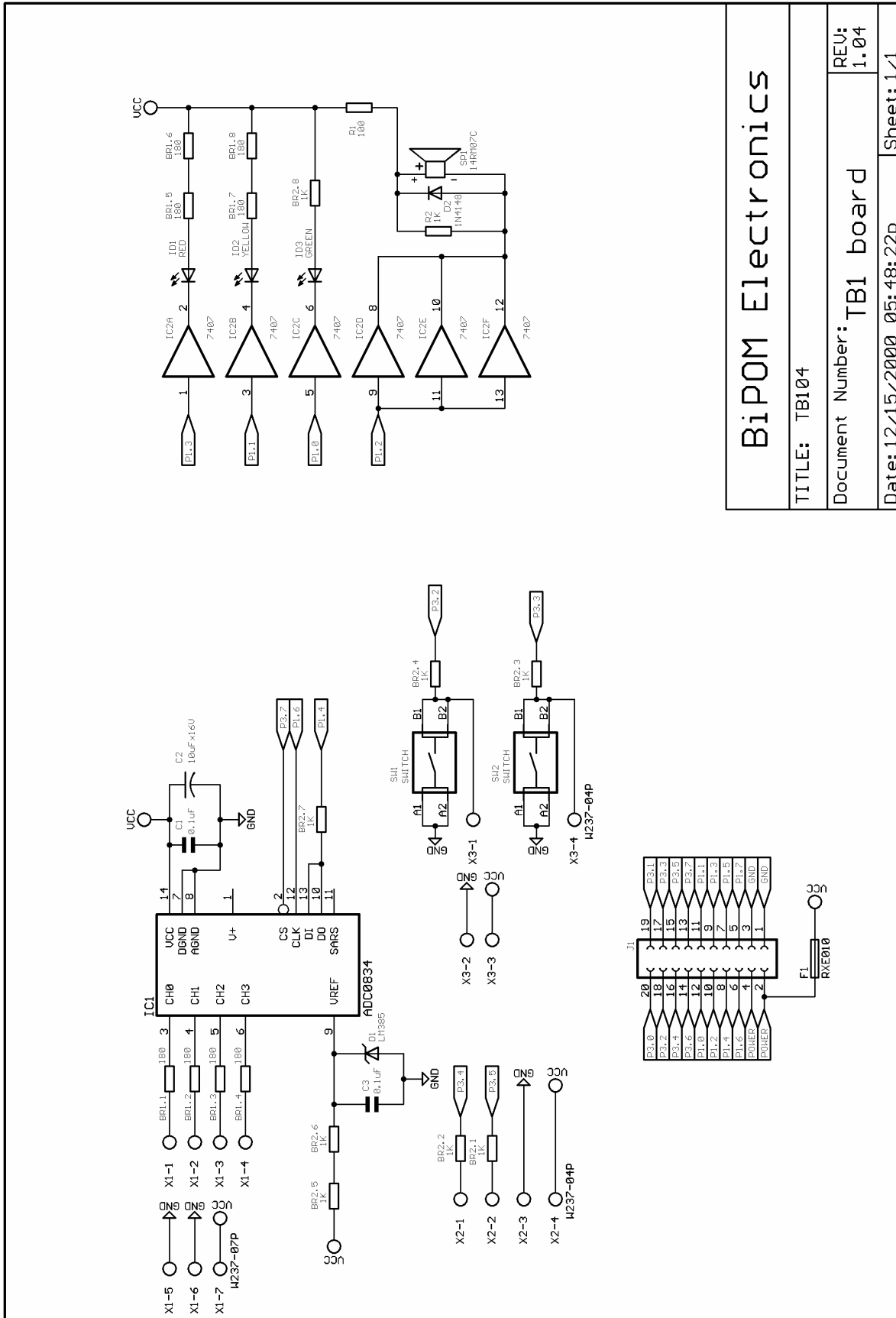
Inputs

There are 2 inputs which are available on terminal block. The inputs are connected to MC68HC908GP32 port pins (PTD3 and PTD4).

Analog/Digital Converter (ADC)

TB-1 has a type ADC0834, 4-channel, 8-bit Analog/Digital converter. Analog inputs are available on X1 terminal block. Analog/Digital Converter is controlled by the micro-controller through 4 port lines. Chip Select (CS) is an input to the ADC. Chip Select enables data conversion when it is logic low and disables data conversion when it is logic high. Clock is an input to the ADC. Mode of operation (single-ended versus differential) and channel number is entered through the DI pin one bit at a time (on every transition of the Clock input). The 8-bit data that corresponds to the voltage on the selected channel is output on DO one bit at a time (on every transition of the Clock input).

Schematic



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