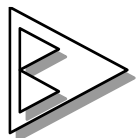


MINI-MAX/51

Micro-controller System

User's Guide



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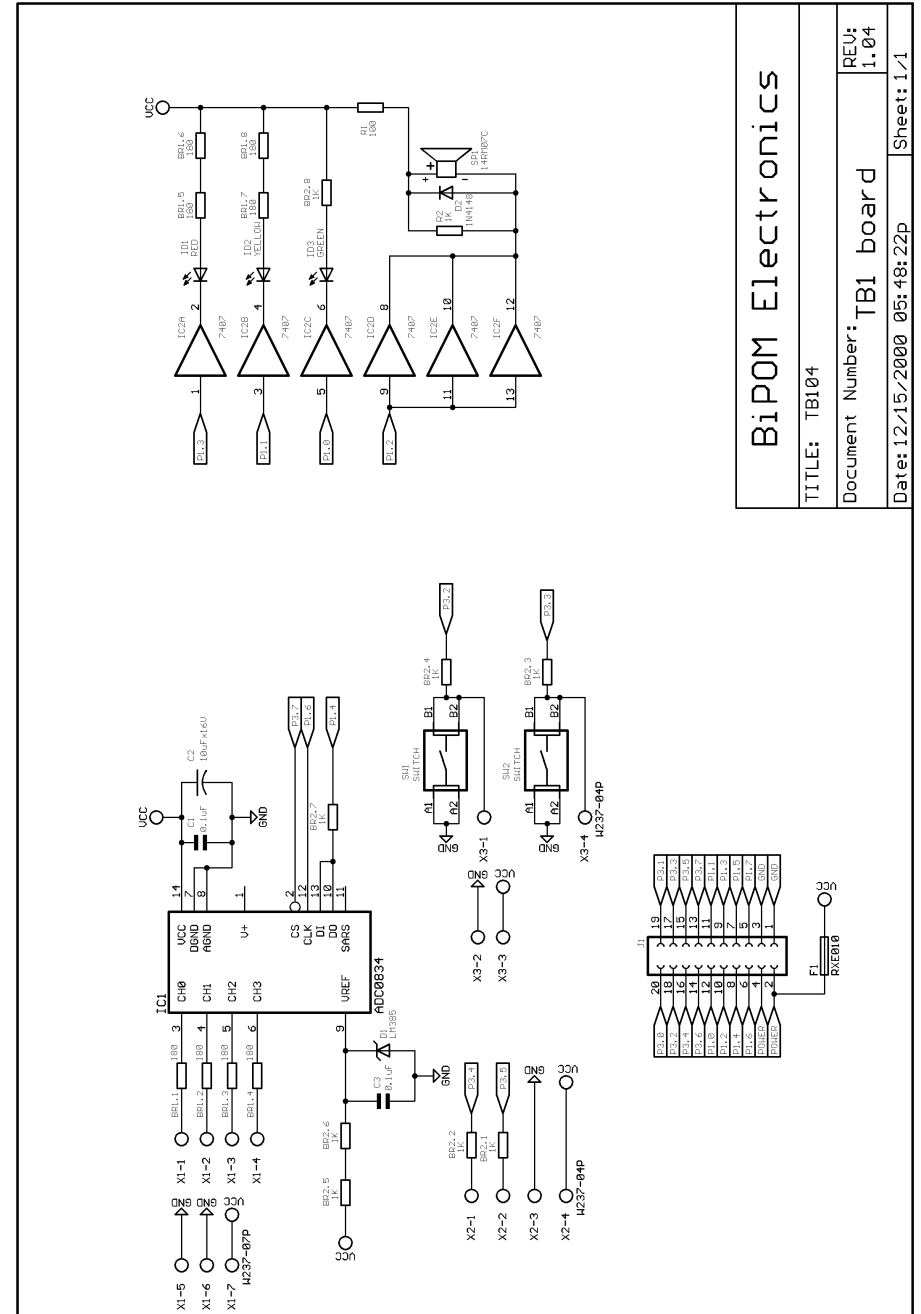
MINI-MAX/51 Microcontroller System User's Guide. No part of this work may be reproduced in any manner without written permission of BiPOM Electronics.

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WARRANTY:

BiPOM Electronics warrants MINI-MAX/51 Microcontroller System for a period of 1 year. If the product becomes defective during this period, BiPOM Electronics will at its option, replace or repair the product. 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 microcontroller system. 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.

TB-1 Schematics



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 an interrupt input (P3.2 and P3.3) on the micro-controller. Pressing a button forces a logic low level on the corresponding micro-controller input.

Interrupt Inputs

AT89S53 has port pins (P3.2 and P3.3) that can be used either as general-purpose inputs/output or as interrupt inputs. A high to low logic transition or a low logic level on those inputs can cause a hardware interrupt to be generated.

Timer/Counter Inputs

AT89S53 has port pins (P3.4 and P3.5) that can be used either as general-purpose inputs/output or as timer/counter inputs. Logic level changes on these inputs can be counted by the timer hardware on the micro-controller eliminating the need for software polling loops.

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).

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INTRODUCTION

The 8051 micro-controller, first Introduced by Intel, is the most popular micro-controller in use today with applications ranging from industrial, medical, home automation to automotive.

MINI-MAX/51 is a powerful, yet easy-to-use microcomputer system based on the latest generation of flash-based 8051 microcontrollers from ATMEL.

The objective of the MINI-MAX/51 Microcontroller System is to give students, hobbyists, engineers, technicians and other users experience with micro-controllers by developing practical applications using Basic, C and 8051 Assembly language.

MINI-MAX/51 is a fully assembled product that is ready to use out of the box. MINI-MAX/51 has 12K of flash memory which holds thousands of lines of BASIC or C programs. Program execution speeds reach over 1 million instructions per second. Programs are downloaded into the MINI-MAX/51 with a personal computer through an available serial (COM) port. Downloads typically take only few seconds.

MINI-MAX/51 comes with Micro-IDE, a Windows-based Integrated Development Environment for microcontrollers and the limited version of BASCOM51 BASIC Compiler that is capable of creating upto 2K of BASIC programs for personal use (for larger programs or commercial use, you should upgrade to the professional version of BASCOM51 that removes the 2K limit).

MINI-MAX/51 users are eligible for free software upgrades through BiPOM Electronics web site at www.bipom.com/boards51.php

An open-source C Compiler for the MINI-MAX/51 is available for download at the same web address.

Functional Blocks

Expansion

TB-1 is connected to MINI-MAX/51-C and other boards through the Expansion Connector (J1).

Table 4 shows the pin assignments for the Expansion Connector.

Expansion (J1)

Signal	Pin	Pin	Signal
P3.0	20	19	P3.1
P3.2	18	17	P3.3
P3.4	16	15	P3.5
P3.6	14	13	P3.7
P1.0	12	11	P1.1
P1.2	10	9	P1.3
P1.4	8	7	P1.5
P1.6	6	5	P1.7
VCC	4	3	GND
VCC	2	1	GND

Table 4

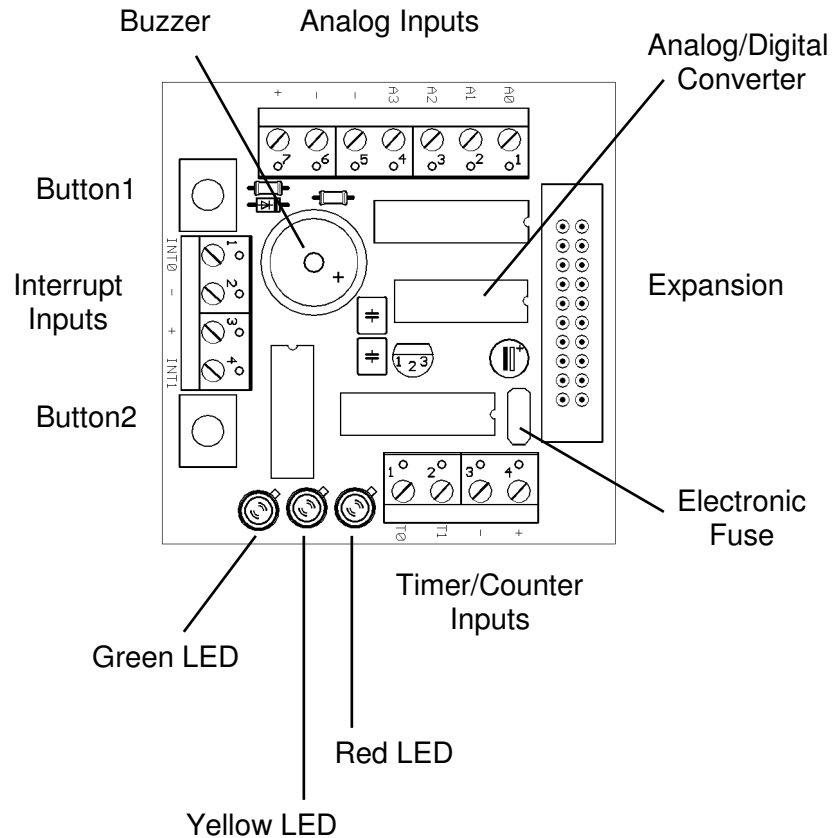
LED's

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.

Board Layout

Layout of TB-1 board is shown below:



The MINI-MAX/51 Microcontroller System is offered as two sets.

Set I contains:

- MINI-MAX/51-C Micro-controller Board
- BASCOM51 Basic Compiler
- Micro-IDE Integrated Development Environment
- Example Projects
- Serial cable, Power Supply, User's Guide

Set II contains:

- MINI-MAX/51-C Micro-controller Board
- TB-1 Training Board with 4-channel, 8-bit Analog/Digital Converter buzzer, traffic lights, counter and interrupt inputs
- 2-row alphanumeric Liquid Crystal Display (LCD)
- Matrix Keypad
- BASCOM51 Basic Compiler
- Micro-IDE Integrated Development Environment
- Example Projects
- Serial cable, Power Supply, User's Guide

The following external items are required:

- IBM Compatible Personal Computer (PC) with
 - Minimum 16MB memory and 10 MB of available hard disk space.
 - One available RS232 Serial (COM) Port.
 - One of the following Operating Systems:

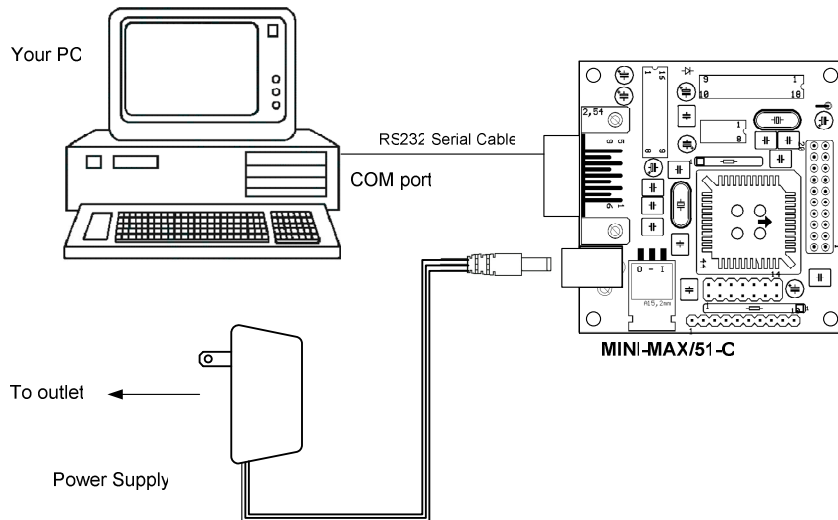
Operating system	Revision
Windows 95	OSR2
Windows 98	All
Windows ME	All
Windows NT	4.0
Windows 2000	All

(MINI-MAX/51 does not work with DOS, Windows 3.1 or lower).

INSTALLATION

Installing the hardware

1. Place the MINI-MAX/51-C Microcontroller board on a clean, **non-conductive** surface.
 2. Connect the provided power supply to the power plug on the . Do not connect the power supply to the outlet yet.
- CAUTION:** Do not use a power supply other than one that is supplied or approved by BiPOM Electronics. Use of another power supply voids the warranty and may permanently **DAMAGE** the board or the computer to which the board is connected !!!
3. Make sure your PC is shutdown and powered off.
 4. Connect the MINI-MAX/51-C to an available serial port on the PC using the supplied serial cable as shown below.
 5. Connect the MINI-MAX/51-C power supply to a suitable wall outlet.
 6. Turn on the PC and start Windows.



TB-1 TRAINING BOARD

Overview

Training Board TB-1 is an experimentation board that illustrates the many capabilities of the 8051 compatible micro-controllers. TB-1 features

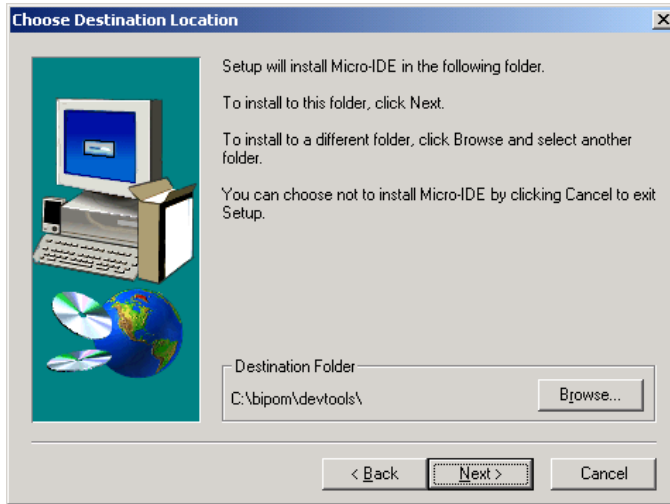
- 3 Traffic light LED's (red, yellow, green)
- 2 interrupt inputs
- 2 switch inputs (in parallel with interrupt inputs)
- 2 timer/counter inputs
- 4 channels of 8-bit analog inputs
- Programmable buzzer
- Expansion bus to other boards

TB-1 is included in the MINI-MAX/51 Set II or can be purchased separately for the MINI-MAX/51 Set I.

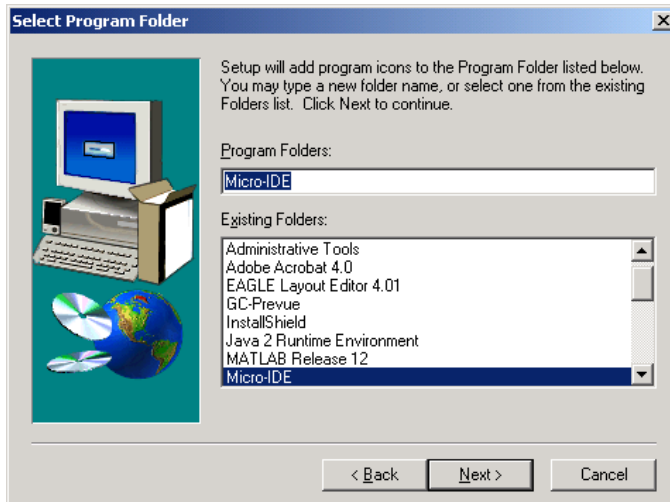
Specifications

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.

- Select the disk location where the software will be installed. Using the default location of c:\bipom\devtools is recommended:



Click Next. Select the Program Folder where the icons for Micro-IDE will be installed. Default selection is **Micro-IDE** folder.



Click Next. Micro-IDE will be installed.

RS232 Devices

Various devices such as keypads, terminals, computers and serial LCD's may be connected to the RS232 port of MINI-MAX/51-C through connector J4. MINI-MAX/51-C can be connected to a host PC through the RS232 port. For example, MINI-MAX/51 can be used as a remote data acquisition or control unit serving a host PC in a client-server configuration.

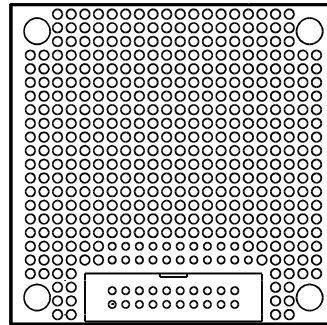
Connection to a host PC is accomplished by using the supplied NULL-Modem cable. MINI-MAX/51-C end of this cable should be a 9-pin Female D connector for connection to J4 on the MINI-MAX/51-C board. Host PC end of this cable can be either 9-pin Female or 25-pin Female D Connector depending on available serial (COM) ports on the host PC.

MINI-MAX/51 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/51 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

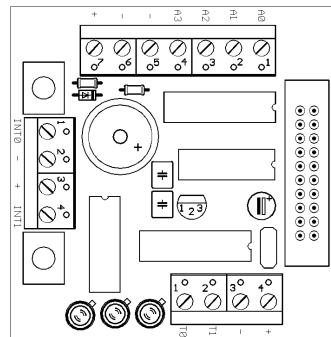
MINI-MAX/51- PROTO-1 Board

PROTO-1 provides prototyping area to add custom circuitry to MINI-MAX/51. PROTO-1 can either be stacked with MINI-MAX/51 using standoffs or connected to MINI-MAX/51 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.

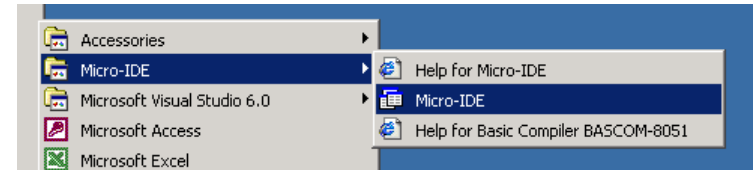


TB-1 Training Board

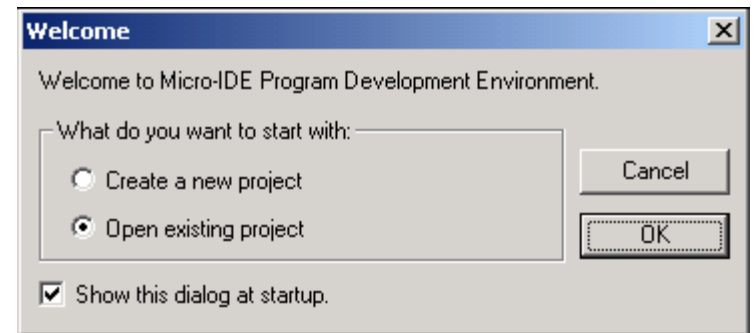
TB-1 Training Board allows performing various experiments with the MINI-MAX/51-C or other 8051 compatible boards. TB-1 has programmable traffic lights, 4-channel, 8-bit analog inputs, buzzer, switch inputs, and counter/timer inputs to test the interrupts.



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.



When Micro-IDE is started, the Project selection window appears:



Click Cancel for this first time because you will first configure communications before opening a project.

Configuring communications

After you have started Micro-IDE, configure the correct COM port and communications parameters:

1. Select 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 MINI-MAX/51-C board. For example, if the board is connected to COM1, select COM1 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

3. Under Loader tab, make sure Com Port is selected as the port that you connected to MINI-MAX/51-C board. For example, if the board is connected to COM1, select COM1 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

4. Open the Terminal window by selecting Terminal under View menu. 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.)

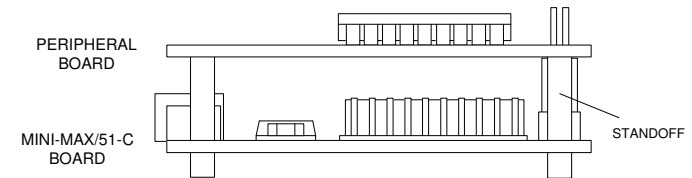
5. Select Tools, Terminal and Connect. This will connect the terminal to the MINI-MAX/51-C board.

Peripherals

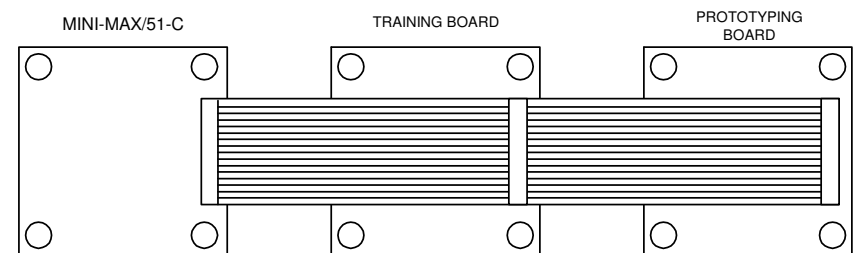
MINI-MAX/51-C can be connected to a wide variety of low-cost peripheral boards to enhance its functionality. Some options are:

- Prototyping board (PROTO-1)
- Training Board (TB-1)
- Digital Input/Output Expander Board (DIO-1)
- 12-bit Analog-To-Digital Converter Board (DAQ-2543)
- Additional MINI-MAX/51 Boards
- Temperature Sensor Interface Board
- Pressure Sensor Interface Board

Peripheral boards can either be stacked on top of MINI-MAX/51-C using stand-offs or connected in a chain configuration using flat ribbon cable. First diagram below shows how MINI-MAX/51-C can be connected to a peripheral board in a stacked fashion. Second diagram shows the chain connection.



STACK CONNECTION



CHAIN CONNECTION

Asynchronous Serial Port

One asynchronous RS232 serial port (U3) is available on MINI-MAX/51-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/51-C in program or run modes. Therefore, user applications must not use CTS.

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

RS232 Serial Port (J4)

Expansion

Most of the micro-controller pins and the power supply are available on the 20-pin MINI-MAX/51 Expansion connector (J3) for interfacing to external circuitry, prototyping boards and peripheral boards. MINI-MAX/51 peripheral boards can be connected either as a piggyback daughter-board on MINI-MAX/51-C using standoffs or can be placed up away from MINI-MAX/51 using a 20-wire ribbon cable. Peripherals section lists the available expansion boards. Table 4 shows the pin assignments for the MINI-MAX/51 Expansion connector.

MINI-MAX/51 Expansion (J3)

Signal	Pin	Pin	Signal
P3.0	20	19	P3.1
P3.2	18	17	P3.3
P3.4	16	15	P3.5
P3.6	14	13	P3.7
P1.0	12	11	P1.1
P1.2	10	9	P1.3
P1.4	8	7	P1.5
P1.6	6	5	P1.7
VCC	4	3	GND
VCC	2	1	GND

Downloading programs

Check if you can build and download programs to the board by following the steps below:

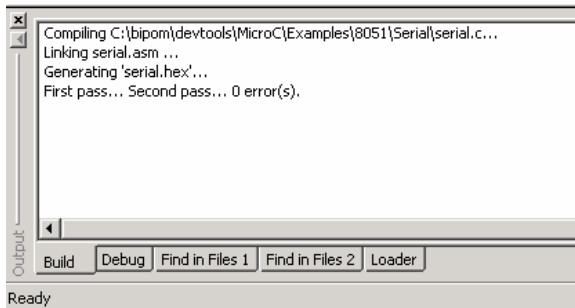
1. Make sure the board is powered and connected to the PC as described in the section **Installing the Hardware**.

2. Micro-IDE is distributed with several example programs that illustrate how to program the 8051 micro-controller. Example projects are located under the Examples folder under the folder where you installed Micro-IDE. Select Project, Open Project and change to Examples folder if you are not already there:

Select the folder **serial** and open the project file **serial.prj** under c:\bipom\devtools\microc\8051\examples. This will open and display the file **serial.c** in edit window. The contents of the project will also be displayed in the Workspace window. Note that the C language keywords, comments, strings and numbers are highlighted in various colors.



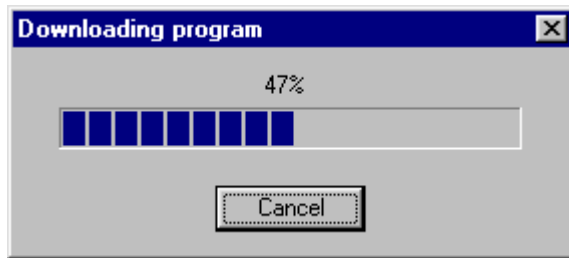
If the project builds successfully, you should see a message indicating no errors on the Output Window:



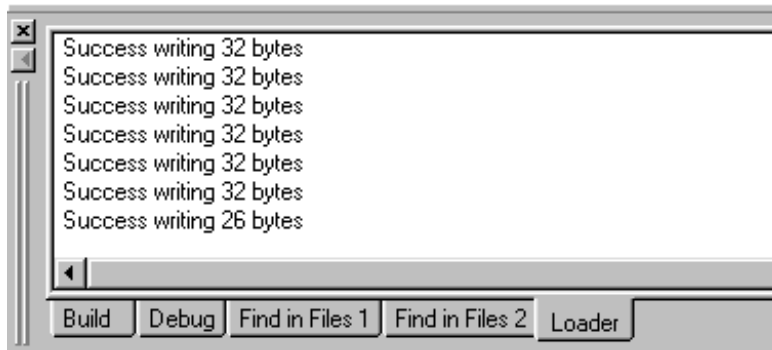
4. Download the file to the board by selecting Download under Build menu:



If the board is powered and connected properly to the PC, a progress dialog will appear:



The progress dialog will disappear following a successful download. Details of the download are shown on the Output Window:



Power Supply Unit

MINI-MAX/51-C series boards come with a 6 Volts unregulated DC power supply. The inner pin of the supply connector is positive and the outer ring is negative. Current consumption of the MINI-MAX/51-C board itself (without any external circuitry) is approximately 50 mA.

MINI-MAX/51-C has an on-board 5 Volt regulator (U5).

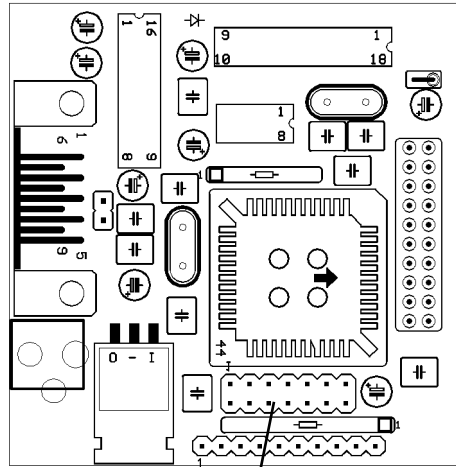
CAUTION: Depending on the current requirements of the any external circuitry such as peripheral boards that are attached to MINI-MAX/51-C and the level of input voltage applied, the power regulator U5 may dissipate enough heat to cause skin injury upon touch. Contact with this regulator should be avoided at all times, even after the power to circuit has been switched off.

LCD Connector

LCD Connector (J3)

Table 2

Signal	Pin	Pin	Signal
Ground	1	2	Vcc
Vee	3	4	P0.0
P0.1	5	6	P0.2
P0.3	7	8	Ground
Ground	9	10	Ground
P0.4	11	12	P0.5
P0.6	13	14	P0.7



LCD connector

1	3	5	7	9	11	13
2	4	6	8	10	12	14

The LCD contrast voltage on the LCD connector can be changed under software control.

When the download is finished, the progress indicator disappears. This means that the board has received the program successfully.

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



Mode button puts the board into **Run** or **Program** mode. In Run mode, the microcontroller is executing the program in its memory. In Program mode, the microcontroller is in Reset state so no programs are running. In Program mode, microcontroller's flash memory can be changed and a new program can be downloaded.

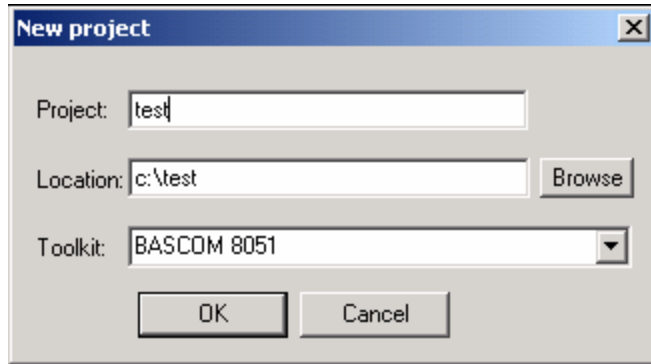
The Mode button is Red in Program mode and Green in Run mode. Following a download, the Mode button will be Red. Click the Mode button to change the mode to Run mode. The program **serial.c** that you just downloaded starts executing. You should now see the message "Press a key to start tests" being displayed on the Terminal window.

Congratulations!!! You have built and executed your first program on the MINI-MAX/51.

Click the Mode button once again so it turns Red. The board is in Program mode now.

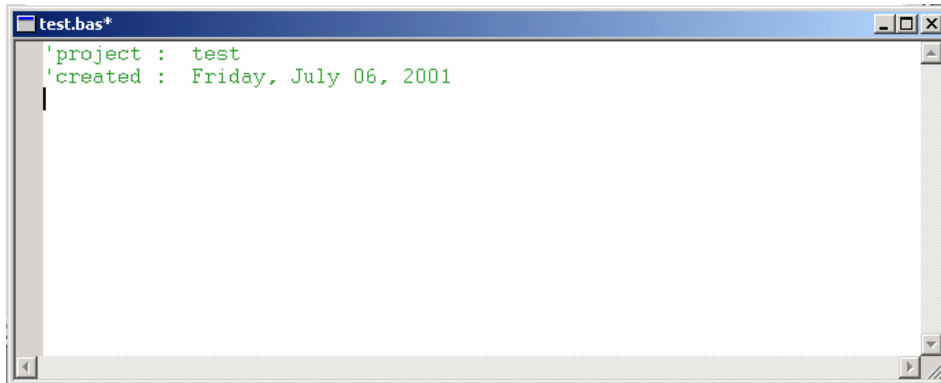
Creating Projects

To create your own 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 examples uses **test** as the project name and **c:\test** as the project location). Toolkit is already pre-selected as BASCOM 8051. Click OK; the new project with the name of test under c:\test will be created.

A blank BASIC file (test.bas) will be automatically created:

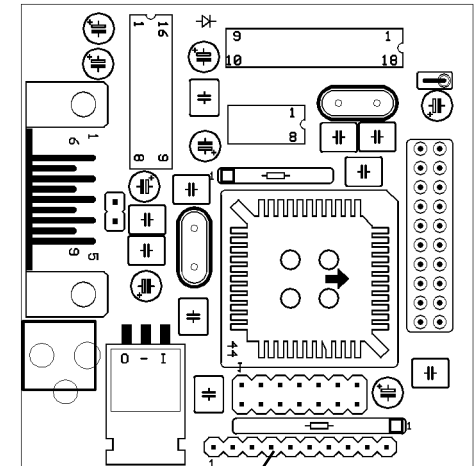


Keypad connector

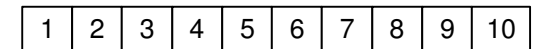
8 pins of Port 2 are connected to the Keypad connector. Many different keypads (for example, 3 by 5 or 4 by 4) can be connected directly to the keypad connector. 5 Volt and Ground power lines are also available on the Keypad connector although they are normally covered with plastic tubing to prevent damage due to incorrect connections. Keypad connector can also be used as a general-purpose port.

Keypad Connector (J2)

Signal	Pin
P2.0	1
P2.1	2
P2.2	3
P2.3	4
P2.4	5
P2.5	6
P2.6	7
P2.7	8
Ground	9
Vcc	10



Keypad connector



CAUTION: Care should be taken not to short circuit connector pins 9 and 10 to any other pin or to each other. Doing so damages the board permanently and invalidates the warranty. Matrix keypads should use pins 1 through 8 only !!!

Micro-controller

MINI-MAX/51-C is based on the ATMEL AT89S53 micro-controller (U1). AT89S53 has all the ports that are available on the 8051 family of micro-controllers: Port 1 (P1), Port 2 (P2), Port 3 (P3) and Port 4 (P4). Micro-controller ports and power lines are provided on a 20-pin expansion bus for interfacing to peripherals and other external circuits.

P0 has open collector outputs that are available on the LCD connector. P1 and P2 are general-purpose bi-directional input/output ports. Port 2 is available on the keypad connector. P1 and P3 are available on the expansion connector. P3 pins can either be used as general-purpose input/output pins or have special purposes such as asynchronous serial port, interrupt inputs and timer inputs.

More information on the AT89S53 micro-controller can be obtained from ATMEL web site at www.atmel.com.

EEPROM

MINI-MAX/51-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. The EEPROM is on a socket and can easily be replaced with higher capacity EEPROM's (up to 64 KiloBytes).

In-System Programming

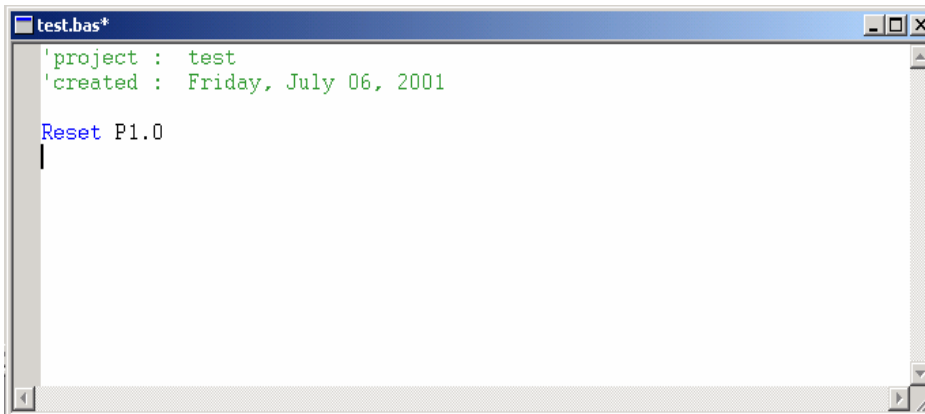
AT89S53 micro-controller is re-programmed through the RS-232 interface using a second micro-controller on the board (PIC16C58). This in-circuit programming feature simplifies program development since downloading programs from a host PC takes only few seconds. User programs can also be debugged over the serial port.

Micro-IDE fully supports In-System Programming and debugging on the MINI-MAX/51-C using the serial port.

Type the following small BASIC program:

Reset P1.0

The BASIC program should now look like this:



```
'project : test
'created : Friday, July 06, 2001

Reset P1.0
```

This program changes port pin P1.0 to logic low level. P1.0 is connected to the Green LED on the Training Board (TB-1) so this program will turn on the Green LED if TB-1 is installed. 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.bas...
Running pre-build or post-build command
```

Download the program to the board by clicking the Download button on the main toolbar. Run the program by clicking the Mode button on the main toolbar.

MINI-MAX/51-C Micro-controller Board

Overview

The core of the 8051 Training Kit is the MINI-MAX/51-C board that is a general purpose, low-cost and highly-expandable micro-controller system. It is based on the ATMEL AT89S53 single-chip Flash micro-controller. This micro-controller features

- 12 Kilobytes of In-System Programmable Flash Memory
- 256 bytes of RAM
- Nine Interrupt Sources
- Three 16 bit Timer/Counters
- Programmable UART Serial Channel
- SPI Serial Interface
- Programmable Watchdog Timer
- 32 general purpose I/O pins

MINI-MAX/51-C board complements these features by providing

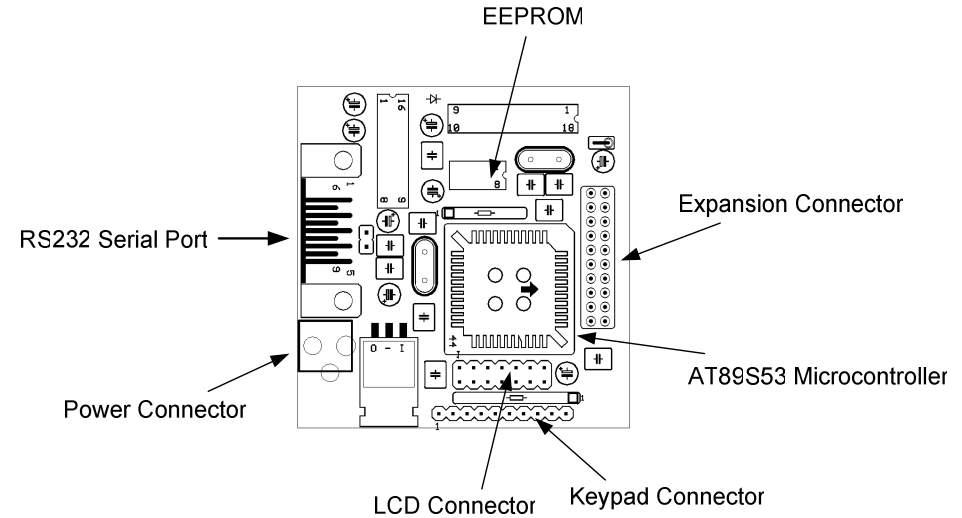
- 512-byte EEPROM (optional 64-Kilobyte EEPROM)
- RS232 Serial Port
- In-circuit Programming of the micro-controller through the serial port
- Keypad connector
- LCD connector (with programmable contrast adjustment for LCD)
- Expansion bus interface to low-cost peripheral boards such as
 - Sensor inputs
 - 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/51-C board is shown below:



Functional Block diagram

