MINI-MAX/908-C
Single Board Computer
Technical Manual

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BiPOM Electronics

WARRANTY:

TABLE OF CONTENTS

1. Overview

MINI-MAX/908-C 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.

2. 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

3. Functional Blocks
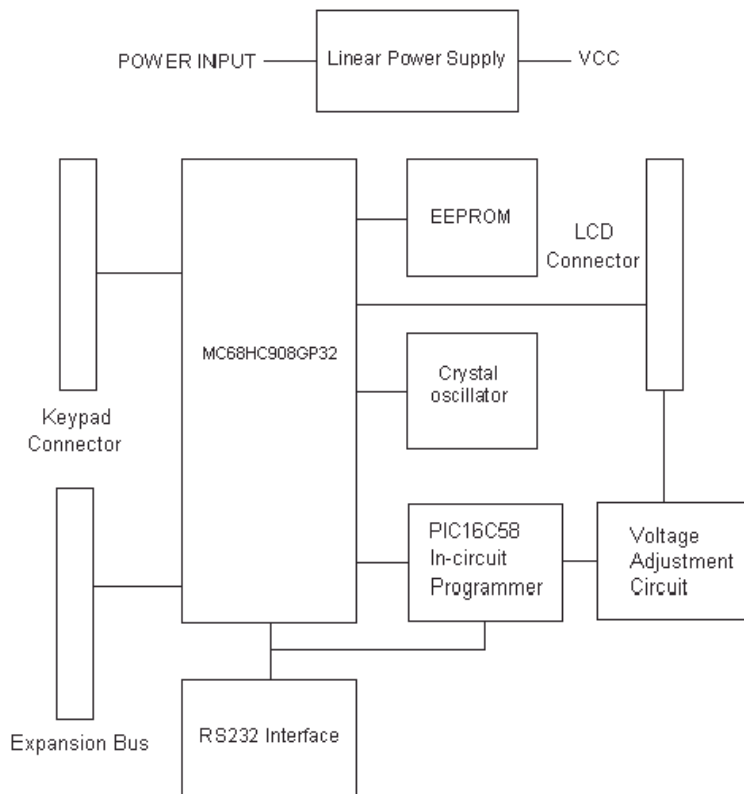
Block diagram of the MINI-MAX/908-C system

Figure 1

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-curcuit 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 a running of 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.

Set Type Request .

  This request allows to check a status of ROM monitor entering.   PC is sending this request to the board at the first time.

< SET_TYPE_COMMAND = 1> <Type = 3><CHECK_SUM = 4>

Set Type Reply .

  The board is sending this reply to the PC after the Set Type Request is received and entering of MC68HC908GP32 to monitor mode is successful.

< SET_TYPE_COMMAND = 1> <STATUS = 0 ><CHECK_SUM = 1>

Note. If STATUS has no zero value it means the board error.

Write Request .

  This request allows to write the buffer of data bytes to the memory. The maximum length of data buffer is 32 bytes.

< WRITE_BUFFER_COMMAND> <TYPE_MEMORY><LENGTH_BUFFER>
<ADDRESS&0x00FF>< (ADDRESS >>8) &0x1F ><… DATA BYTES …><CHECK_SUM>

WRITE_BUFFER_COMMAND(e.g. 2) is the command to write the data buffer to the board.

TYPE_MEMORY defines the type memory on the board.
TYPE_MEMORY = 1 for RAM memory of MC68HC908GP32.
TYPE_MEMORY = 2 for FLASH memory of MC68HC908GP32.
TYPE_MEMORY = 3 for EEPROM memory of AT24CXX chip on the board.

LENGTH_BUFFER defines a length buffer for writing to the memory.

Write Reply .

  The board is sending this reply to the PC after the Write Request is received and

  writing of memory is successful.

< WRITE_BUFFER_COMMAND = 2> <STATUS = 0 ><CHECK_SUM = 2>

Note. If STATUS has no zero value it means the board error.

Read Request .

  This request allows to read the buffer with data bytes from the memory. The maximum length of data buffer is 32 bytes.

< READ_BUFFER_COMMAND> <TYPE_MEMORY><LENGTH_BUFFER>
<ADDRESS&0x00FF>< (ADDRESS >>8) &0x1F ><CHECK_SUM>

READ_BUFFER_COMMAND(e.g. 3) is the command to read the data buffer from the board.

TYPE_MEMORY defines the type memory on the board.
TYPE_MEMORY = 1 for RAM memory of MC68HC908GP32.
TYPE_MEMORY = 2 for FLASH memory of MC68HC908GP32.
TYPE_MEMORY = 3 for EEPROM memory of AT24CXX chip on the board.

LENGTH_BUFFER defines a length buffer for reading from the memory.

Read Reply .

  The board is sending this reply to the PC after the Read Request is received and

  reading of memory is successful.

<READ_BUFFER_COMMAND = 3><STATUS = 0 ><…DATA BYTES …><CHECK_SUM >

Note. If STATUS has no zero value it means the board error.

Erase Chip Request .

This request erases all the flash memory of MC68HC908GP32.

< ERASE_CHIP_COMMAND = 4>

Erase Chip Reply .

The board is sending this reply to the PC after the Erase Chip Request is received and erasing of MC68HC908GP32 is successful.

< ERASE_CHIP_COMMAND = 4> <STATUS = 0 ><CHECK_SUM = 4>

Note. If STATUS has no zero value it means the board error.

<u>**Keypad connector**</u>

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
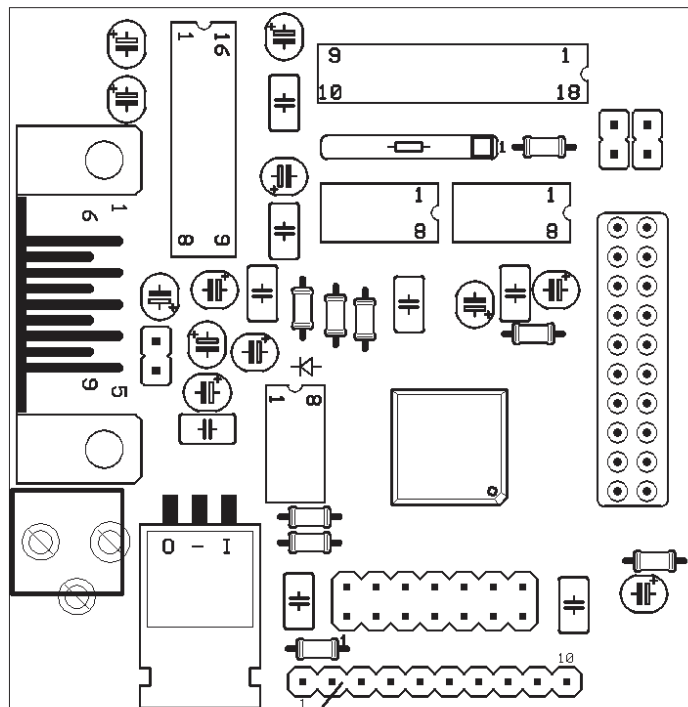
KEYPAD CONNECTOR

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
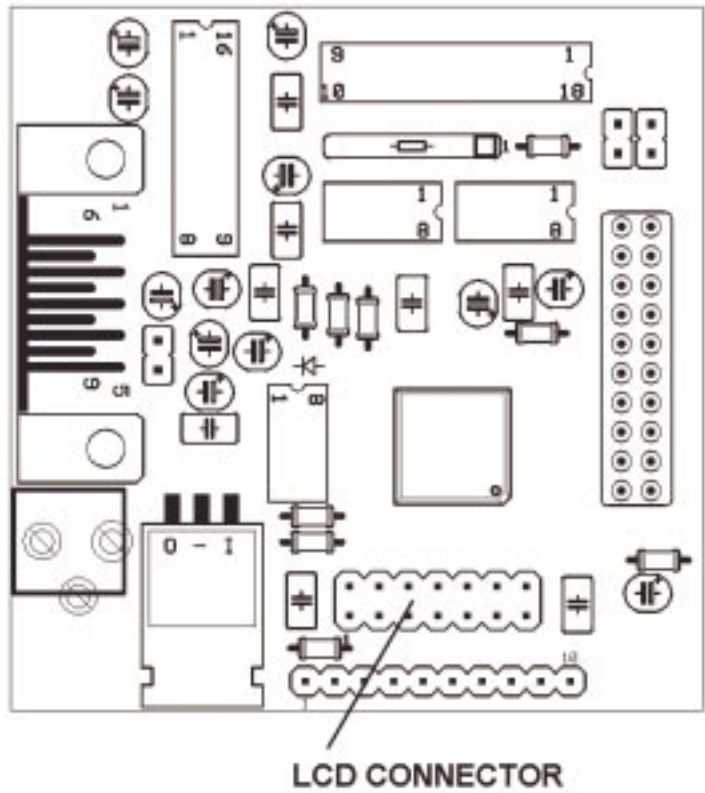
Power Supply Unit

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

RS232 Serial Port (J4)

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.

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

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.

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

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.

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.
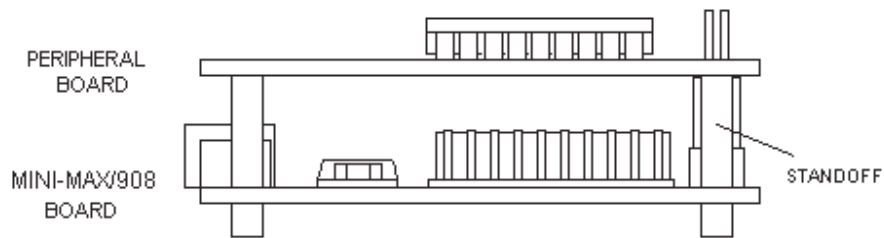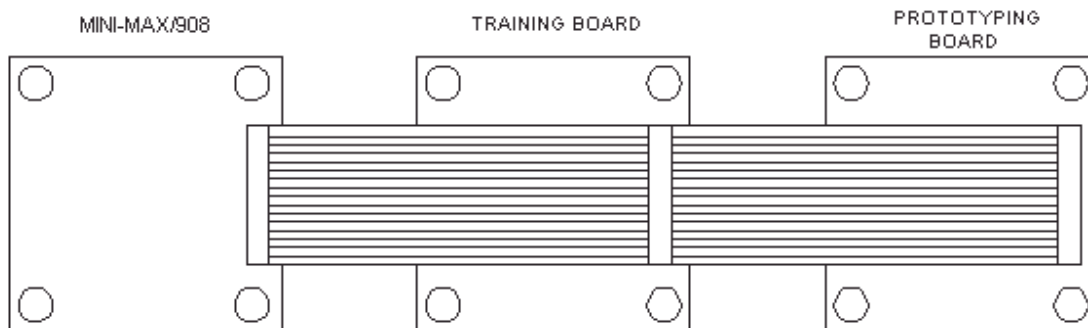
Figure 3

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.
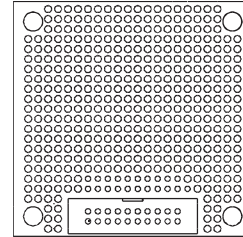
TB-1 Training Board

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.
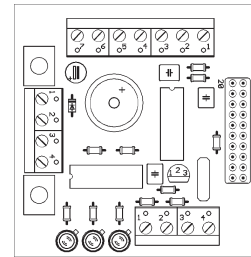
RS232 Devices

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

5. Software

MINI-MAX/908-C comes with sample 68HC908 programs to access on-board peripherals and perform self-diagnostics. MINI-MAX/908-C loader is under **loader** directory and sample 68HC908 programs are under **examples** directory.

Loader

A command-line loader is provided to download programs to the MINI-MAX/908-C, to erase and reset the microcontroller and to read the microcontroller's memory. The syntax of the loader is

Loadmm08 /p=<COM port> /f=<filename> /c=<command> /nomenu

Where

/p=<COM port> selects the serial communications port to use. Allowed values are COM1, COM2, COM3 and COM4

/f=<filename> shows the name of the file to download to the board or the name of the file which will be created with the data that is uploaded from the board. The file should be in binary (raw) form. Hex files are currently not supported.

/c=<command> selects the command to perform. Possible values are READ, WRITE, ERASE, RESET.

READ command reads (uploads) from the board into the specified file. This command reads all the program memory locations of the microcontroller.

WRITE command writes (downloads) the contents of the specified binary file to the board. This command writes as many bytes as there are in the specified file. If there are more bytes in the file than the microcontroller can hold only as many bytes as there are in microcontroller's program memory are written.

ERASE command erases all the program memory locations of the microcontroller.

RESET command resets the board and leaves it in RUN mode.

/nomenu option shows that the loader will execute without a menu. This is useful for calling the program from within another application or batch file.

If /nomenu is not specified, the loader enters the interactive mode and displays a menu to the user. In interactive mode, command-line arguments are ignored and user can enter commands through the menu.

Loadmm08 is a Windows console application that runs under Windows 95/98/NT and 2000. It will run in a DOS environment. Please contact BiPOM Electronics if you need a DOS command-line loader for MINI-MAX/908-C.
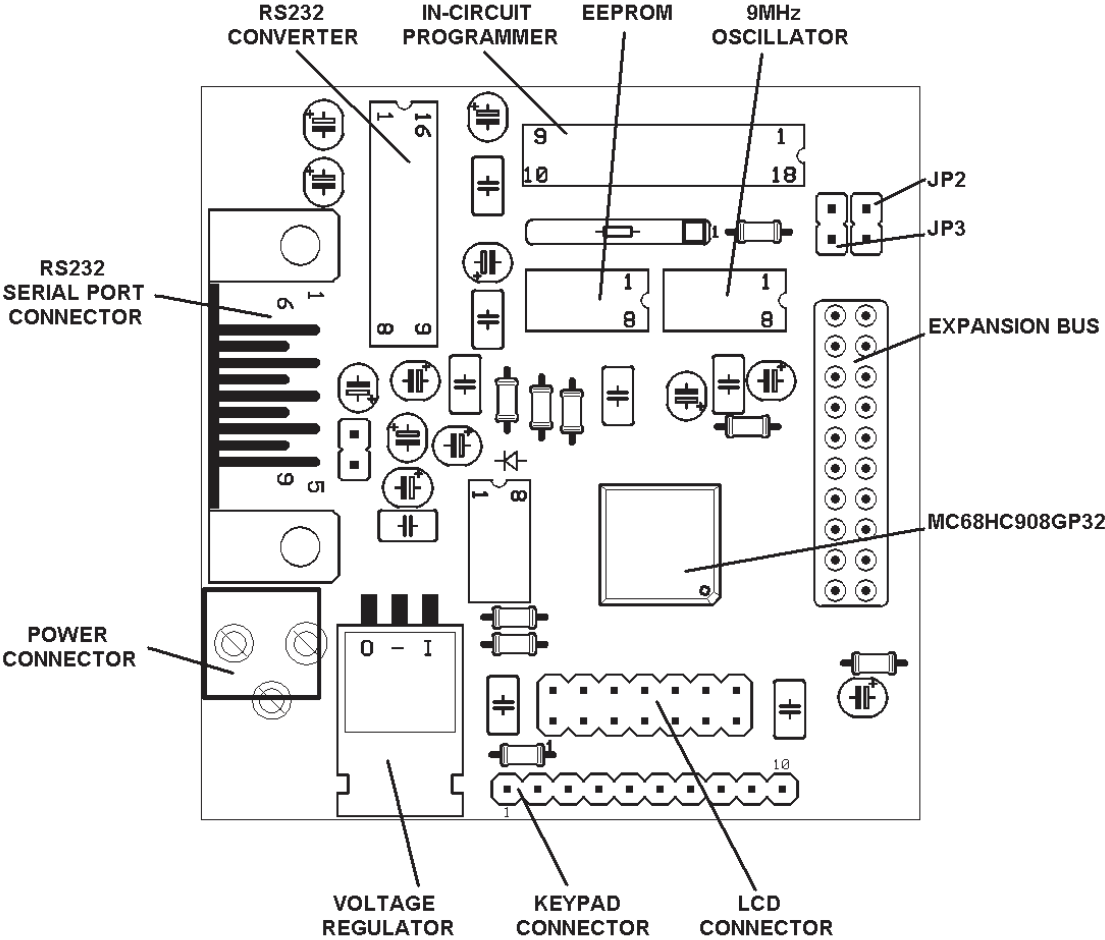
<u>Examples</u>

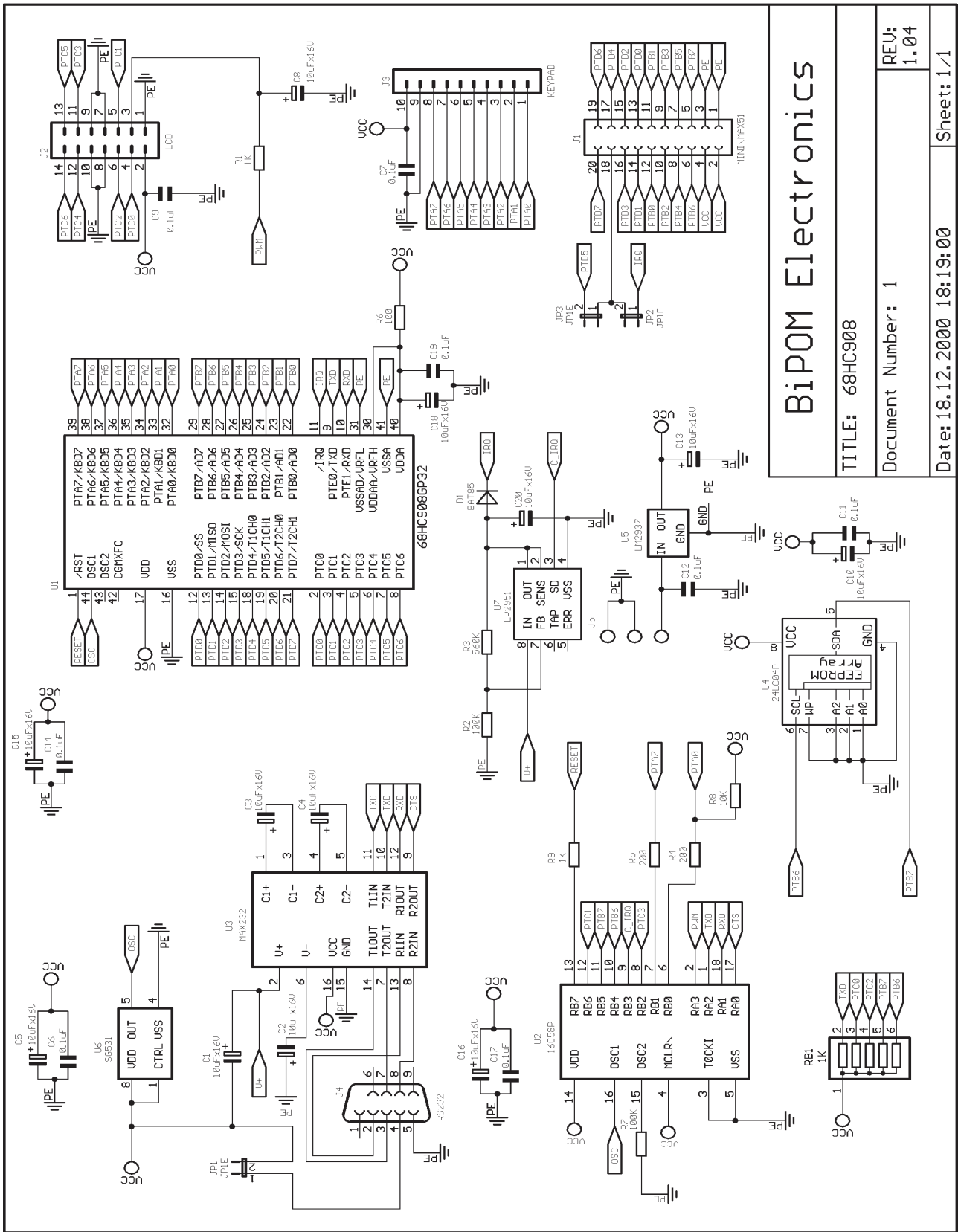Programs are provided on a PC formatted 3.5" diskette in the **examples** directory:

PWM.C   Interface routines for driving an alphanumeric Liquid Crystal

Display module using on-board 68HC908 micro-controller.

KEYPAD.C   Demonstates an example of connecting a keypad to

MINI-MAX/908C board.

IRQC.C   Example of IRQ external interrupts with MINI-MAX/908-C.

PUTCH.C   Example of printing to terminal using putch() function.

IO.C   Toggles all I/O ports of the 68HC908.

6. Board Layout

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

7. Schematics