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PC/104 Embeddable Computer Board

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❑ Introduction

The Micro/sys SBC1190 offers a high integration CPU board at low cost. On the PC/104 form factor (3.55" x 3.775") card, a variety of features are available. Two serial ports, a watchdog timer, a real-time clock, and 24 lines of digital I/O are some of the standard features. The powerful 80C188EB CPU is compatible with the Intel 80x86 family of processors and contains an interrupt controller, three timer/counters, and both serial ports.

Additionally, the SBC1190 has the available options of an eight-channel 12-bit A/D converter, a four-channel 12-bit D/A converter, and a 10Base-T ethernet adapter.

If, however, your application has I/O demands that exceed the on-board resources, simply plug PC/104 I/O modules onto the SBC1190.

The RUN.EXE™ firmware offers reliability and ease of development. This innovative firmware allows the SBC1190 to execute application programs written in any popular PC language. No DOS licenses, special startup code, locators, or special libraries are needed.

The SBC1190 includes flash EPROM program memory, allowing applications to be downloaded to the computer through a serial port. An on-board flash programmer then places the application program in non-volatile flash memory. Upon powerup or reset, the computer henceforth executes this program. With over 100,000 download cycles possible, the SBC1190 will virtually never need any memory device changing due to program changes.

❑ How to Work with the SBC1190

Factory Configuration

The SBC1190 is a very capable embeddable computer, and there are many possible operating modes. To optimize the SBC1190 for a particular application may take some time familiarizing yourself with the various CPU and on-board peripherals. The other sections of this Reference Manual provide in-depth documentation on all hardware and software aspects of the SBC1190.

However, if you are like most people, you probably want to "kick the tires" of the SBC1190 immediately upon receipt. For this reason, the SBC1190 is shipped complete with installed memory, firmware, and a configuration that allows it to be run directly out of the box.

Here is how the SBC1190 is configured:

Static RAM memory is installed, and all configuration jumpers are set to default settings for the devices installed.

The flash memory is loaded with the Micro/sys RUN.EXE firmware. This firmware includes an industrial BIOS, a DOS emulator, and an XMODEM program download system. This firmware is in an area of the flash memory that never needs to be modified. This leaves 128K for user programs on SBC1190s with 256K flash memory, 384K for SBC1190s with 512K flash.

As shipped, the user program area is loaded with a program that manages serial communications with a host computer running Borland's Turbo Debugger. Therefore, upon first receiving the SBC1190, you can download programs to RAM for debugging.

Until the first time you download an application program into the flash memory, this debug capability will remain. When you use the XMODEM download, the program you download overwrites the resident debug manager. To use Turbo Debugger again, you will have to download a supplied debug manager .EXE file into the flash program area, overwriting the last application program you downloaded. You can then download to RAM once again.

LOAD and RUN Mode Serial Port Connections

The SBC1190 communicates through serial ports COM A (J4) and COM B (J3). COM A is used as if it were the video monitor on a PC. For example, print statements are sent out COM A. COM B can be used for download and debug. Alternatively, the COM 4 port of a Micro/sys MPC302 Dual Serial card can be used for debug.

The innovative SBC1190 development method uses a special LOAD/RUN cable set that is supplied as part of the DK1190 Kit. **The first cable, CA4020, is plugged into the SBC1190 serial port. The second cable, CA4035, connects between the CA4020 cable and a COM port on your host PC.**

The CA4035 cable is delivered in two different physical configurations which are electrically equivalent. One version has a single DB9 connector on one end, and two DB9 connectors, labeled "RUN" and "LOAD" on the other end. The other version has a single DB9 connector on both ends, with one DB9 having a switch with "RUN" and "LOAD" positions.

Depending upon the connections you make with these cables, the system enters either the BIOS Boss or RUN mode at power-up. The BIOS Boss is for downloading a programs and changing the system settings. RUN mode is used for installed systems executing an application program, and also for debug using Turbo Debugger.

The BIOS Boss is entered only when the CA4035 LOAD connector or switch position is used on the SBC1190 COMB port. The RUN mode is <u>any other</u> serial cabling configuration.

The following sections indicate when to use LOAD and RUN serial connections, depending upon the desired activity.

Reset Switch Connection

If you want a reset switch, connect any contact closure between the two pins of J6.

Power Connections

Power is supplied to the SBC1190 through a 5 position removable terminal block, TB1. Legends describing the voltages on each pin are printed on the board.

For most applications, all you need is 5V on TB1-1 and GROUND on TB1-5. TB1-3 can accept +12V and TB1-4 can accept -12V to supply PC/104 add-on modules with those voltages, if needed.

Running Turbo Debugger

When you power up with the LOAD/RUN cable attached to COM B, SBC1190 firmware determines whether you want to run the BIOS Boss, or the currently downloaded .EXE file. This is determined by the configuration of the CA4035 LOAD/RUN cable plugged into the open 9-pin connector of the CA4020 cable. If there are two 9-pin connectors on one end, use the one labeled 'RUN'. If there is a switch, place it in the 'RUN' position.

Note that if you previously used the BIOS Boss to download an application program, the remote debug manager has been overwritten, and must first be reloaded before Turbo Debugger can be used again. A compatible remote debug manager may be found on the support diskette.

The debug manager sends sign-on and program load status messages to its "console", COM A. While it is not necessary to connect a terminal to display these messages, some designers like to see what's going on. To display these messages, connect a dumb terminal, or a PC running a terminal program, through a null modem cable, to COM A (J3). Set the terminal to 19,200 baud, n, 8, 1.

Apply power to the SBC1190. The green LED (D2) should light. If you attached a terminal to COM A, you will see a sign-on message.

Now start Turbo Debugger on your development PC. To start Turbo Debugger in remote mode at the 115K baud rate that the SBC1190 supports, type:

C:>td -rp1 if the CA4035 is connected to COM 1 on your PC, or

C:>td -rp2 if the CA4035 is connected to COM 2 on your PC

The standard Turbo Debugger screen will be displayed on your development PC, allowing you to examine and modify registers, memory, and I/O ports. But more importantly, you can download a program into RAM for test.

A simple demonstration program, BLINK.EXE is supplied, and can be used as a first program to download to RAM. Alternatively, if you have a terminal attached to COM A, you can run a version of the classic HELLO.C, or any other operator interface program. Make sure that BLINK.EXE and BLINK.C are in your current directory, or you may have to search through directory trees to find them. To download BLINK, use Turbo Debugger's menu system:
File / Open / BLINK.EXE.

Now you can single step, or run full speed.
Alt-X will exit Turbo Debugger.

The set of Turbo Debugger features available depends on the compiler used. Borland C, Pascal, or TASM (assembly language) programs can be debugged using the full feature set. Microsoft C and QuickBASIC programs, and executable files from other compilers, can be downloaded to RAM through Turbo Debugger and run with limited debug features. To set breakpoints or examine variables, you will need to have a listing of the .MAP file generated by your linker, and use the addresses listed instead of the names for routines and variables. (This is because Microsoft does not use standard debug records in their .OBJ files.)

Placing diagnostic print statements at critical points in your non-Borland code can be quite useful for tracing program execution with a terminal attached to COM A. Many designers create a small debug menu and prompt at COM A to allow program internal tables and variables to be dumped to the COM A terminal for debug.

The Turbo Debugger remote debug manager can be used indefinitely until the first time you use the BIOS Boss to download a program, which overwrites the remote debug manager. If you want to return to using Turbo Debugger after the remote debug manager has been overwritten, or to download a different remote debugger version, first locate the desired remote debugger file supplied with the SBC1190. The SBC1190 COM B port, or the COM 4 port of a serial card installed onto the SBC1190 can be used for debug. There are also several different Turbo Debugger version ranges. See the README file on the diskette for information on choosing the proper remote debug manager. Then use the BIOS Boss to download the proper file into flash.

❑ BIOS Boss™

When you power up the SBC1190, firmware checks for the 'LOAD' configuration of the CA4035 cable connected to COM2 (through the CA4020 cable plugged into J2). When the 'LOAD' end of the cable is used on COM2, powering up the system should result in a sign-on message similar to the following:

```
BIOS Boss, SBC1190 v1.00 (c)Micro/sys, Inc. 1993-98

Do you wish to start the BIOS Boss?
  <Y>es
  <N>o
  <S>afe mode, no ANSI color
```

Answering 'y' to this will invoke the BIOS Boss, a utility for altering system information and programming. Answering 'S' to this will invoke the BIOS Boss as well but without ANSI display features. Even in safe mode, a minimum VT-100 emulation is still required.

When using the SBC1190 under its standard configuration, the BIOS Boss menu will look something like this:

```
Main menu:          Micro/sys, Inc.      System mode:RUN.EXE
<E>rase flash and download EXE file
E<X>it BIOS Boss
Flash <S>etup                                  <C>omm speed

       Last error = No error

No EXE file found:

Max size of EXE file that can be downloaded = 393216
bytes
```


<E>rase flash and load stand-alone EXE file

This menu selection allows you to transfer a single stand-alone EXE file from your desktop PC to the SBC1190 using the XMODEM protocol.

Type 'E' to begin this file download procedure. Because this function will erase any application previously loaded on the SBC1190, the BIOS Boss will require that you confirm this choice by typing 'c' to continue.

Erasing of the flash may take a few seconds, once this is complete, you will be directed to start an XMODEM transfer of your file. Since you are sending a file to the SBC1190, most terminal programs actually call this an upload.

At this point, use whatever keystrokes are necessary to enter the file **upload** function of your terminal program. If presented with a series of protocols from which to choose, select XMODEM. Satisfy any other needs your terminal program has, among them entering the name of the file you want to download.

Once the download has started, most terminal programs will give a live display of the current download status, for instance the total file size, the number of bytes sent so far, and estimated download time (which is, in some cases, quite inaccurate). The program is programmed into the flash memory as it is received by the SBC1190. Once the file has been downloaded and programmed into the flash memory, the BIOS Boss displays a message that the download is complete.

E<X>it BIOS Boss

This menu selection will exit the BIOS Boss and attempt to start the system and (already loaded) EXE file as defined in *Flash <S>etup.*

Flash <S>etup™

This menu selection allows you to view and alter system startup parameters and information. The Flash Setup menu will look something like this:

```
     Flash setup menu        Micro/sys,Inc.
<ESC> Return to main menu
<T>ime/date settings
<S>afe/ansi mode:   ANSI mode (with color)
<C>ommand Tail:


N<e>twork Setup
```

<T>ime/date settings

Use this option to view and make changes to the time and date.

<S>afe/ansi mode

Most terminals and terminal programs will support ANSI and extended ASCII which are used by the BIOS Boss to display its user interface. If the BIOS Boss menus do not appear to be displayed properly then your terminal may not support ANSI and/or extended ASCII. To get around this problem you can set the BIOS Boss to operate in Safe mode which does not use these features.

Note: The BIOS Boss does require a VT100 or better terminal, even in safe mode.

<C>ommand Tail

The BIOS Boss allows the use of EXE files that can accept command tails that would normally be typed after the application name on the command line of a DOS prompt. If your application can accept command line information, you may enter that command tail here.

Example:
You may have one program which you may want to run differently on different SBC1190s or you may just want to be able to periodically alter startup parameters without recompiling and redownloading your code each time. For example, lets say that your program (USERPROG.EXE) has the ability to communicate out either COM port at various baud rates. In a DOS environment you might have the following line in your AUTOEXEC.BAT file:

USERPROG 2 9600

After loading USERPROG.EXE into the SBC1190 flash, you can then enter the following information in the Command Tail setting for a similar effect:

<C>ommand Tail: **2 9600**

<E>thernet setup

If an Micro/sys MPC356 PC/104 Ethernet Adapter is installed, then you will also have an ethernet setup option available. This selection will allow you to view the system's ethernet settings and system resources. It also allows you to change IP address values.

```
 Network setup menu: Micro/sys,Inc.
IP address <S>ource: Specify an IP address
<I>P address:          0.  0.  0.  0
S<u>bnet mask:         0.  0.  0.  0
Default <G>ateway:     0.  0.  0.  0

<L>ocal name:

Ethernet Address:      00-60-92-00-10-00
Ethernet base address: 300h
Ethernet IR<Q>:        IRQ4

<A>dvanced network menu
```

<C>omm Speed

This menu selection allows you to change the speed of the COM ports to baud rates faster than 19200bps. This is particularly useful when you are downloading large files to the flash. Changes made with this option are for this BIOS Boss session only and are not permanently saved.

❑ Theory of Operation

80C188EB Processor

At the heart of the SBC1190 is the Intel 80C188EB processor. This chip is a 16-bit, CMOS CPU that can execute the 8086 instruction set. It has an 8-bit external data bus in order to reduce the number of external chips necessary. It also integrates a number of common PC peripherals in order to further reduce the chip count. The 80C188EB includes an interrupt controller, three 16-bit timer/counters, and a wait-state generator. It also includes two UARTs.

On-board Memory

The on-board memory consists of a 32-pin JEDEC memory socket, one surface mounted flash memory, and a surface mounted RAM. The surface mounted RAM, U10, is configured for static or pseudo-static RAM. A 128k x 8 or 512k x 8 static or pseudo-static RAM can be installed.

A 5V flash EPROM is surface mounted on the board. RUN.EXE firmware resides in this flash EPROM. However, due to the efficiency of RUN.EXE, there is still a large memory space available for the application program. 256k x 8 is the standard flash size, with 512k available as an option.

Socket U13 can accept 32k or 128k static RAM, and the RAM can be battery-backed. In addition, U13 can accept an EPROM: 27C128 (16k), 27C256 (32k), 27C512 (64k), or 27C010 (128k).

Off-board Memory

Any memory that is not allocated to on-board memory defaults to off-board memory. The memory mapping PAL equations in U7, and software initialization of the 80C188EB chip selects perform this function.

Serial Ports

The SBC1190 has two asynchronous serial ports on-board. The UARTs for COM A and COM B are integrated into the 80C188EB. Note that these ports are not PC-compatible, but offer additional capabilities such as 9-bit modes of operation.

The COM ports support the RXD and TXD lines, and modem controls RTS and CTS. The COM ports have internal baud rate generators, and support baud rates over 200K bits per second.

The 80C188EB serial port 0 is routed to the COM B connector, and serial port 1 is routed to the COM A connector. Serial port 0 has integral interrupt capabilities that make it preferable for COM B connections during debug.

COM A signals are available on the J5 connector as full-duplex RS485 signals.

Parallel I/O Lines

The SBC1190 includes an 82C55 device for general-purpose digital I/O. The 24 I/O lines are CMOS/TTL compatible, and are programmable as input or output in two groups of 8 bits and two groups of 4 bits. Eight of the lines have bit set/reset capabilities. All 24 lines are presented, unbuffered, at connector J2.

Interrupt Controller

An interrupt controller is integrated into the 80C188EB, and it provides 7 maskable and 1 non-maskable interrupts. Two internal interrupt sources are the timers and the COM A serial port.

External interrupt inputs 0, 1, 2, and 3 are routed to the PC/104 interface for use by add-on I/O modules as IRQ4, IRQ5, IRQ6, and IRQ7, respectively. Configuration jumper W9 allows CPU external interrupt input 4 to be selected from the COM A serial port, or from PC/104 IRQ2 or IRQ3.

Configuration jumper W7 selects either the PC/104 IOCHCK signal or the on-board power fail signal for the NMI non-maskable interrupt input. W8 can be jumpered to cause an interrupt when an A/D conversion is complete.

Watchdog Timer

In many applications it is important that if the program gets "lost," a hardware reset will occur in order to restart the system. The SBC1190 has an on-board watchdog timer to effect such a reset.

The on-board watchdog timer is designed so that if it doesn't get strobed within 1.6 seconds, it will reset the system. It may be strobed by writing to port FE4CH. If the program continues to strobe the watchdog timer, it is assumed that the program is operating correctly and no reset will result.

Timer/Counters

The 80C188EB contains three timer/counters (T0, T1, & T2). Two of these are connected to external pins available at connector J5. The third timer (T2) is not connected to any external pins, and can only be clocked by the internal CPU clock. It can be used as a prescaler to the other two timers, or it can generate interrupts. Under RUN.EXE, the third timer is used as a prescaler for T0 which serves as the DOS timer tick for the system.

Real-time Clock

The real-time clock allows the SBC1190 to keep track of the date and time. The Dallas DS1302 clock chip is attached to 3 internal I/O port pins of the 80C188EB CPU. The DS1302 internal registers contain year, month, date, day-of-week, hours, minutes, seconds, and an AM/PM indicator.

Analog Input

This option provides 8 channels of analog input to the SBC1190. The A/D chip used is the Maxim MAX197. This chip allows for independent software configuration of the input ranges for each channel. The ranges allowed are: ±10V, ±5V, +10V, +5V and provide 12-bits of accuracy.

Analog Output

The analog output option uses a Maxim MAX525 chip to provide 4 channels of analog output. This 12-bit DAC has an output range of 0 to 5V.

Ethernet

The optional ethernet interface is designed to connect to a 10BASE-T, twisted-pair network. The ethernet controller chip used is the SMC LAN91C94. When installed, this option includes the Embedded Netsock system which provides a built-in network stack that allows easy connection to a network with minimal coding.

On-board Flash Programming

The SBC1190 has the capability of programming flash memory on-board. This option uses one bit (D5) of the 80C188EB port 1 to enable writes to the flash memory.

Add-on PC/104 I/O Resources

The J1 connector is a standard PC/104 connector for adding more I/O to a system based on the SBC1190. A wide range of PC/104 modules are available, including digital I/O, analog I/O, communication, network, video, GPIB, and motor control.

The PC/104 implemented on the SBC1190 is for 8-bit transfers to add-on cards.

RUN.EXE firmware

RUN.EXE firmware installed in flash memory at U22 occupies the top of the memory map, including the power-up vector. When applying power or resetting the system, the firmware initializes the registers in the 80C188EB and then sets up the environment so that, to an application program, it looks like an IBM PC running DOS. It can then: run an .EXE file stored in the lower part of the same flash EPROM device, or load a file from the COM B port into flash memory using the XMODEM protocol.

❑ SBC1190 Card Configuration

The SBC1190 is a highly integrated CPU, with on-board memory and firmware. This means that there is very little to configure according to any application. Most system configuration will be on add-on PC/104 cards. However, there are a few configuration jumpers on the SBC1190 that may need to be set. This section details all SBC1190 configuration jumpers.

Memory Mapping

Upon power-up or reset, the SBC1190 firmware automatically sizes flash EPROM and RAM. Memory mapping is then programmed through the use of the 80C188EB chip select unit. Chip selects will be initialized properly for the RAM device in U10, and the flash code storage device in U22.

Flash EPROM at U22 is mapped at the top of the 1MB address space, and RAM in U10 is mapped at the bottom of the 1MB address space. Refer to the Memory Map and I/O Map heading in the *Programming the SBC1190* section.

Memory Socket U13 Configuration

The U13 socket can be configured for RAM or EPROM devices, depending on the jumpering of W10.

To configure U13 for 32k or 128k RAM:
jumper W10 pins 1-3, 2-4, and 5-6.

To configure U13 for 16k, 32k, 64k, or 128k EPROM
or 128k 5V flash EPROM:
jumper W10 pins 1-2, 3-5, and 4-6.

The onboard 3V battery can be configured to back up low-power CMOS RAM installed in U13. Jumper W6 selects the power source for the device in U13. Jumper 1-2 for 3V battery backup power to be applied to U13 whenever system power is removed; jumper 2-3 for normal Vcc powering of U13. Do not select battery backup for an EPROM device installed in socket U13.

Interrupt Sources

In systems with many interrupts, some choices may have to be made in routing interrupt inputs to various 80C188EB interrupt pins. Jumpers W7, W8, & W9 accomplish this.

W9 selects the input for 80C188EB pin INT4. Jumper 1-3 to connect PC/104 IRQ3 to INT4; jumper 2-3 to connect PC/104 IRQ2 to INT4 this requires a wire rather than a plug-on jumper 3-4 to connect COM A interrupt to INT4.

W7 selects the input for 80C188EB non-maskable interrupt. Jumper 1-2 to connect the on-board power fail signal to NMI; leave unjumpered to connect PC/104 IOCHCK signal to NMI.

Watchdog Timer

Jumper block W4 enables the watchdog timer strobe. If the watchdog timer is enabled by W4 1-2 shorted, make sure that your application program reads or writes to the appropriate port before the timeout period of about 1.6 seconds elapses.

COM A - RS485

The COM A serial port can be configured for either RS232 or RS485. Jumper W2 is used to select RS232 or RS485 for COM A. Jumper W2 1-2 for RS485 operation.

Ethernet

W5 controls the powerup settings of the ethernet controller. When W5 is jumpered, the ethernet will powerup at its default settings of 300h. W5 also disables the EEPROM where the ethernet configuration data is stored. Therefore, to program the configuration settings for the ethernet controller or to load preprogrammed settings at powerup, remove any jumper from W5.

Summary of SBC1190 Jumper Settings

W1	---	Factory use only
W2	1-2	COM A - RS485
	2-3	COM A - RS232
W3	---	Factory use only
W4	1-2	Enable watchdog timer
	N/C	Disable watchdog timer
W5	1-2	EEPROM disable - Ethernet uses default settings
	2-3	EEPROM enable - Ethernet loads settings from EEPROM
W6	1-2	U13 battery-backed
	2-3	U13 on system Vcc
W7	1-2	PFAIL to NMI
	N/C	PC/104 IOCHCK to NMI
W8	1-2	A/D conversion interrupt on IRQ7 (INT3)
	N/C	A/D polled for end of conversion
W9	1-3	IRQ3 to INT4
	2-3	IRQ2 to INT4
	3-4	COMA to INT4
W10	1-3, 2-4, 4-6	U14 configured for RAM
	1-2, 3-5, 4-6	U14 configured for EPROM

❑ Installation and External Connections

Installation

The SBC1190 can be installed using the four mounting holes supplied in the corners. These holes are placed according to the PC/104 standard.

Connecting Power and Reset

Power is applied to the SBC1190 through terminal strip TB1. +5V, +12V, -12V, external battery, and ground terminals are provided. A reset switch can be attached to two-pin connector J6.

Serial Ports COM A and COM B

Connections to serial ports COM A and COM B are made at connectors J4 and J3, respectively. Both are 10-pin headers. A simple ribbon cable can be used to adapt J3 and J4 signals to a 9-pin male connector, which is standard on IBM AT computers. The following table shows the pinout for J3 and J4, as well as the wiring of the ribbon cable assembly that adapts to a DB9 connector.

J4 COM-A and J3 COM-B Serial Port Connector/Cable		
J4/J3 Pin	RS232	DB9 Pin
1		1
2		6
3	RX Data In	2
4	RTS Out	7
5	TX Data Out	3
6	CTS In	8
7		4
8		9
9	GND	5
10		

The Micro/sys cable CA4020 adapts the J3 or J4 10-pin header to a standard DB9 connector.

I/O Lines

Connections to the parallel I/O lines from the 82C55 are made at connector J2, at the first 26 pins. Additionally, if the A/D or D/A options are installed, the analog signals will be available on the same connector. The following table shows the pinout for J2.

J2 I/O Connector			
J2 Pin	Signal	Signal	J2 Pin
1	PA0	PA1	2
3	PA2	PA3	4
5	PA4	PA5	6
7	PA6	PA7	8
9	PB0	PB1	10
11	PB2	PB3	12
13	PB4	PB5	14
15	PB6	PB7	16
17	PC0	PC1	18
19	PC2	PB3	20
21	PC4	PC5	22
23	PC6	PC7	24
25	GND	GND	26
27	AOUT0	GND	28
29	AOUT1	GND	30
31	AOUT2	GND	32
33	AOUT3	GND	34
35	AIN7	GND	36
37	AIN6	GND	38
39	AIN5	GND	40
41	AIN4	GND	42
43	AIN3	GND	44
45	AIN2	GND	46
47	AIN1	GND	48
49	AIN0	GND	50

RS485 and Miscellaneous Lines

A 14-pin header, J5, provides inputs and outputs for timers 0 and 1. COM A RS485 signals are also available at this connector. Additionally, there is a single digital input, signal from the 188EB processor that has been made available at J5. The following table shows the pinout for J5.

J5 Timer/Misc Connector	
Pin	Signal
1	GND
2	485TX+
3	485 TX-
4	485RX+
5	485RX-
6	P2.5 (from CPU)
7	GND
8	VCC
9	T0 In
10	T0 Out
11	T1 In
12	T1 Out
13	GND
14	-Bootswap

PC/104 Bus

J1 of the SBC1190 provides a standard PC/104 connection for easy integration of 8-bit PC/104 plug-on modules. The following table shows the pinout for J1.

1A	1B
IOCHK*	GND
SD7	RESET
SD6	+5V
SD5	IRQ9
SD4	--
SD3	--
SD2	-12V
SD1	--
SD0	+12V
IOCHRDY	(KEY)
AEN	SMEMW*
SA19	SMEMR*
SA18	IOW*
SA17	IOR*
SA16	--
SA15	--
SA14	--
SA13	--
SA12	REFRESH*
SA11	SYSCLK
SA10	IRQ7
SA9	IRQ6
SA8	IRQ5
SA7	IRQ4
SA6	IRQ3
SA5	--
SA4	GND
SA3	BALE
SA2	+5V
SA1	OSC (14MHz)
SA0	GND
GND	GND

❑ Programming the SBC1190

RUN.EXE

When developing applications for the SBC1190, the RUN.EXE firmware offers quick, easy development. RUN.EXE executes .EXE files created by popular PC languages without the royalty cost or memory cost of having DOS in the target system. Also, debugging is facilitated by using the powerful Borland Turbo Debugger to download and step through your program.

Using RUN.EXE, you can ignore many of the low-level, detailed programming issues involved with the SBC1190. RUN.EXE performs all device and memory initialization, starts the system timer ticks, and presents a warm, running environment to the program immediately upon power-up. For the most part, you can write a program as though you were writing it for an IBM PC.

RUN.EXE also redirects all console I/O through the COM A port so that if programming in C, printf() will print characters out COM A and scanf() will receive characters from COM A. Likewise with Writeln() and Readln() in Pascal.

System Initialization Without RUN.EXE

When RUN.EXE is not installed, you will need to handle all of the initialization of the devices on-board. The 80C188EB is highly configurable for many modes of operation and it will not operate properly until the configuration registers have been initialized.

The details of SBC1190 initialization must be selected according to application needs. The Appendices include full programming details for the major SBC1190 devices.

Serial I/O Ports

The SBC1190 BIOS supports INT 14h, RS232 I/O. An application program can use INT 14h BIOS calls to manage one or both serial ports. However, the debug manager uses INT 14h, so **INT 14h is not available when running under Turbo Debugger**.

To configure COM A and COM B, you can use BIOS INT 14h. Most C compilers offer library support (i.e. _biosserialcom()) for setting baud rate, stop bits, data bits, and parity. Use COM A indicators for SBC1190 COM A, and COM B indicators for SBC1190 COM B.

Note that the SBC1190 COM A and COM B ports are not PC-compatible at the register and bit level. This means that existing code that directly accesses COM 1, COM 2, COM 3, or COM 4 of a PC will not operate properly on the SBC1190. Micro/sys offers the CommBLOK software library with interrupt-driven, buffered serial drivers through the SBC1190 COM A and COM B ports.

RUN.EXE firmware initializes both COM ports for 19,200 baud, 8 data bits, 1 stop bit, no parity. Since it is not operating the COM ports in interrupt-driven mode, it does not enable COM interrupts. Also, the console I/O (BIOS INT 10h and INT 16h) is redirected through the COM A port. Hence, COM A is best for serial operator I/O.

When programming the SBC1190 serial ports, use the following cross reference table:

SBC1190 Port	BIOS Port	80C188EB Port
COM A	0	1
COM B	1	0

The RTS control outputs are implemented as two pins of the CPU parallel port P1. RTS for COM A is bit P1.4; RTS for COM B is bit P1.3. These output bits can be set and cleared through reading and writing to Port 1 at I/O ports FF52h and FF56h. The CTS inputs are readable in the Serial Status registers. Note that bit 6 in each Serial Control register affects operation of the CTS input.

COM A has a full-duplex RS485 connection available. You can use it to link over 30 units on a single twisted-pair cable. You must manage the transmit enable of the RS485 driver with your software such that only one transmitter on one unit is enabled at any point in time. To enable the RS485 transmitter on the SBC1190, set the RTS for COM A. Clear RTS to receive. (See previous page for controlling RTS)

Parallel I/O Lines

Programming the parallel I/O lines is accomplished by merely accessing the 82C55 device at I/O ports FE40h - FE43h. Port A is at FE40, Port B is at FE41, Port C is at FE42, and the Configuration Register is at FE43. (See the data sheet on the 82C55 device in the Appendix.)

A single write to the digital I/O configuration register will set the operation of all the digital I/O ports. For simple *mode 0* operation, the following table may be used to select a suitable configuration byte.

Digital I/O Control Byte				
Port A	**Port B**	**Port C 7-4**	**Port C 3-0**	**Control Byte**
Out	Out	Out	Out	80h
Out	Out	Out	In	81h
Out	Out	In	Out	88h
Out	Out	In	In	89h
Out	In	Out	Out	82h
Out	In	Out	In	83h
Out	In	In	Out	8Ah
Out	In	In	In	8Bh
In	Out	Out	Out	90h
In	Out	Out	In	91h
In	Out	In	Out	98h
In	Out	In	In	99h
In	In	Out	Out	92h
In	In	Out	In	93h
In	In	In	Out	9Ah
In	In	In	In	9Bh

Watchdog Timer

The watchdog timer is designed to restart the system in the event of a program crash. The watchdog timer is strobed by writing to port FE4Ch. If the watchdog timer is enabled, your program will need to strobe the watchdog at least once every 1.6 seconds or a system reset will occur.

Under RUN.EXE firmware, the interrupt service routine for interrupt 1Ch strobes the watchdog timer by doing a write to port FE4Ch. Interrupt 1Ch is the DOS user timer tick routine which is called 18.2 times per second. This ensures that the system comes up properly and continues to run until the application program takes over. Your program can then revector interrupt 1Ch to a null interrupt handler or to a custom interrupt handler.

Once interrupt 1Ch is revectored, it becomes the responsibility of the application program to strobe the watchdog. It is usually desirable to strobe the watchdog from mainline code rather than from an interrupt service routine because it is possible that an ISR may continue to run after a program has crashed.

Red LED

Data bit D6 of 80C188EB port 1 is connected to LED2. Setting P1.6 low turns on the LED; setting P1.6 high turns off the LED. This can be used by a program for various signalling purposes.

Interrupts

The 80C188EB interrupt controller is programmed through ports FF02h to FF1Fh.

Note that there are two phases to interrupt programming: initialization and service routines.

Initialization of the interrupt controller must take place before any interrupts occur. Additionally, interrupt vectors must be set up in the first page of RAM to point to the appropriate interrupt handler for each type of hardware interrupt.

Interrupt service routines must perform End Of Interrupt (EOI) acknowledgements to the hardware. First the interrupting device must be serviced (e.g. a received character read from the COM port that caused a receive interrupt). Next, the interrupt controller must be given an EOI command to unlock it for the next interrupt.

Failure to properly sequence EOI commands can result in missing all interrupts after the first.

Refer to the Appendix for details on the 80C188EB interrupt controller.

Timers

The three timer/counters in the 80C188EB are programmed through ports FF30h to FF47h. Note, however, that on the IBM PC, the clock source for all three timers is a 1.19318 MHz oscillator. On the SBC1190, the clock source for two of the timers can be set to be either internal or external. The internal clock is the CPU clock (12 MHz, 20 MHz, or 25 MHz) divided by 2, 4, 8, or 16. The external clock is from connector J5. Thus, when programming the timers directly, the count should be changed to reflect the differences in input frequency from a standard PC.

The RUN.EXE firmware initializes the 80C188EB timer registers so that the output of timer 0 is 18.2Hz, implementing the standard PC BIOS timer tick.

Real-time Clock

The real-time clock allows the SBC1190 to constantly keep track of the time and date when the system is powered down. It also allows data to be stored in RAM and retrieved after power is restored. The clock is based on the Dallas DS1302 clock chip. It is accessed through 3 I/O port lines of the 80C188EB.

With the RUN.EXE firmware, you can call Interrupt 1Ah Function 02h through Function 05h to set or read the clock. Details on using this interrupt are available in a number of books such as the DOS Programmer's Reference (1992, Dettmann and Johnson, Que Corporation).

Accessing Memory in Socket U13

If RAM or EPROM devices are installed in socket U13, the size and starting address must be programmed into the 80C188EB chip select unit. Socket U13 is accessed through the GCS0 chip select line. You must configure the GCS0 signal through the chip select configurations registers, according to programming information in Appendix A.

Note that you must not let U13 overlap memory areas reserved for RAM in U10, or flash addresses F0000h - FFFFFh.

During initialization, RUN.EXE firmware opens chip select UCS to "see" the entire flash device. After initialization and loading, UCS is reduced to the 64K address range F0000h - FFFFFh for BIOS code. Therefore, your program can configure GCS0 upon startup for a desired address range for the memory in U13. By enabling and disabling GCS0, you can "unlock" and "lock" the memory contents in U13 (i.e. for battery-backed RAM integrity).

❑ SBC1190 Options

8 Channel A/D

4 Channel D/A

Ethernet

♦ A/D Converter - 8 Channel

When ordered with 1190OPT11, the SBC1190 comes installed with the Maxim MAX197 multi-range, 12-bit data acquisition system (DAS). This system provides 8 analog input channels that are independently software programmable for a variety of ranges. Connections to the A/D can be made at connector J2. A pinout for connector J2 follows the A/D & D/A sections. Programming of the A/D converter may be accomplished in one of two ways. The device may be accessed directly, or through a special Micro/sys system function.

Direct Method:

To access the A/D converter directly requires three steps.

1. First, the **Control Byte** must be written to the Base Address of the A/D converter which is located at port address FE44h. The Control Byte carries your configuration choices for the analog read. See the tables on the following page for setting the individual bits of the Control Byte. The A/D conversion is initiated by the writing of the Control Byte.

2. Once the conversion is compete the A/D converter will raise the ADCRDY signal. This signal is available at digital I/O Port 2.2 of the the 188EB. The port 2 pin register is loaded at address 0xFF5A by continuously polling the ADCRDY bit you will know when the converted data is ready to read. This signal can also be connected to INT3 so that the A/D converter may be controlled through the use of interrupts.

3. To read the converted data, simply **read the A/D converter** at its Base Address to get the low byte and then read the A/D converter again at its Base Address + 1 for the high byte.

   Read the converted data as a signed integer. For unipolar conversions, the value will be an integer in the range 0 to +4095. For bipolar conversions, the value will be an integer in the range -2048 to +2047.

A/D System Function:

The A/D converter may also be accessed by use of the BIOS interrupt 1Ah function DDh. Subfunctions 20h and 21h may be called to start and check the A/D conversion.

Subfunction 20h: Start ADC Conversion

Inputs:

AL	20h	
AH	DDh	
BL	Analog channel (0 - 7)	
BH	0	0 to +5V range
	1	-5 to +5V range
	2	0 to +10V range
	3	-10 to +10V range

Outputs:

None

Subfunction 21h: Check A/D Conversion

Inputs:

AL	21h
AH	DDh

Outputs:

BL	0	conversion not complete
	1	conversion complete
AX	ADC reading if conversion is complete	

(Look for A/D examples on the support diskette)

CONTROL Byte
Address= FE44h

Bit 7-6 - Set as indicated:

Bit 5 - ACQMOD:
0 = internally controlled acquisition
1 = externally controlled acquisition

Bit 4 - RNG:
(See Table)

Bit 3 - BIP:
(See Table)

Bit 2-0 - Channel:

Range & Polarity Selection		
BIP	RNG	Input Range (V)
0	0	0 to 5
0	1	0 to 10
1	0	±5
1	1	±10

♦ D/A Converter - 4 Channel

When ordered with 1190OPT2, the SBC1190 comes installed with the Maxim, 12-bit Voltage-Output DAC with Serial Interface. This system provides four 12-bit, voltage-output digital-to-analog converters (DAC) and four precision output amplifiers. Connections to the D/A can be made at connector J2. A pinout for connector J2 follows the A/D & D/A sections. Programming of the A/D converter may be accomplished in one of two ways. The device may be accessed directly, or through a special Micro/sys system function.

Direct Method:

1. Before starting a D/A conversion, make sure the DACCS# and the RTCDACCLK signals are set high. These signals are available at 188EB DIO port 2, bits 5 and 6 respectively. Then, to enable the converter, **drop the DACCS# signal**. This signal must remain low while the DAC is being written to.

2. Next, **write the 16-bit Input Data Word** to the Converter. The serial data is composed of two DAC address bits, two control bits, and the 12 data bits. The 4-bit address/control code determines the register or registers to be updated and the mode in which they are written to. Use the table on the following page to construct the input data word.

   To clock data into the DAC, use the RTCDACCLK and RTCDACIO signals. RTCDACIO is available at 188EB DIO port 2, bit 7, and defines the data bit being sent. RTCDACCLK is available at 188EB DIO port 2, bit 6, and provides the clock pulse. Data bits are clocked in on the rising edge of RTCDACCLK.

3. Once the input data word has been clocked into the DAC's input registers, the data must be latched into the appropriate registers. To do this, **set the DACCS# signal**. The proper output voltages should then appear at J2.

D/A System Function:

The D/A converter may also be accessed by use of the BIOS interrupt 1Ah. Subfunction 30h may be called to initiate a D/A conversion.

Subfunction 30h: Output to D/A converter

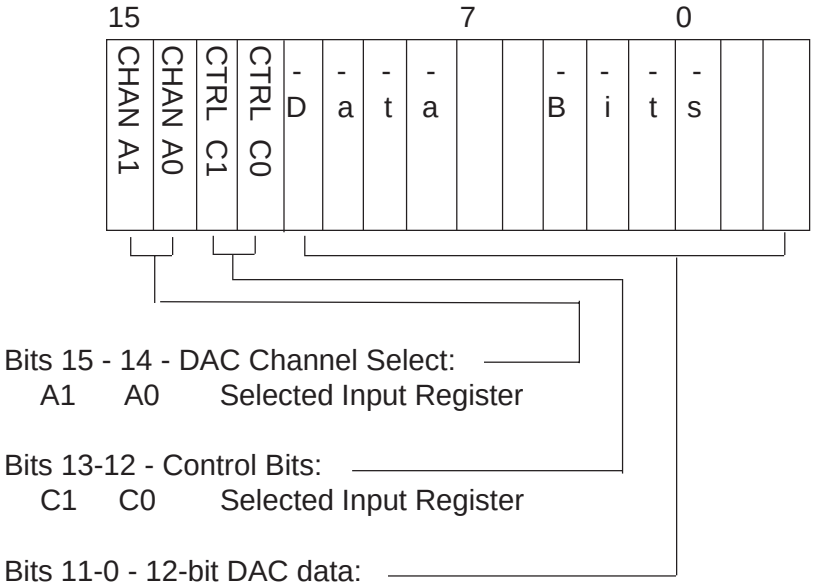
Inputs:

AL	30h
AH	DDh
BL	Analog channel (0 - 3)
CX	0 to FFFh (FFFh is +5V full-scale)

Outputs:

None

DAC Input Data Word



DAC Input Data Word					
16-bit Input Data Word					Function
A1	A0	C1	C0	D11..D0	
0	0	0	1	12-bit DAC data	Load DAC A input register; DAC output unchanged
0	1	0	1	12-bit DAC data	Load DAC B input register; DAC output unchanged
1	0	0	1	12-bit DAC data	Load DAC C input register; DAC output unchanged
1	1	0	1	12-bit DAC data	Load DAC D input register; DAC output unchanged
0	0	1	1	12-bit DAC data	Load input register A; all DAC registers updated
0	1	1	1	12-bit DAC data	Load input register B; all DAC registers updated
1	0	1	1	12-bit DAC data	Load input register C; all DAC registers updated
1	1	1	1	12-bit DAC data	Load input register D; all DAC registers updated
X	0	0	0	12-bit DAC data	Load all DACs from shift register
X	1	0	0	XXXXXXXXXXX	No Operation (NOP)
0	X	1	0	XXXXXXXXXXX	Update all DACs from their respective input registers

"X" = Don't Care

♦ Ethernet

The 1190OPT20 option adds IEEE 802 Ethernet capabilities to the Micro/sys SBC1190 Computer Board. As always, Micro/sys products provide ease of use, with particular attention to flexibility for use in embedded systems. For information on configuration and programming of the SBC1190 ethernet option and the Embedded Netsock system, please refer to the separate documentation that accompanies 1190OPT20.

❑ Troubleshooting

Red LED blinks twice then repeats

Problem: The SBC1190 has attempted to start but has not found a valid EXE in flash.

Solution: Use the BIOS Boss to load an EXE file to the SBC1190.

Green LED is blinking

Problem: The SBC1190 is continually resetting. Probable cause of this is poor power supply of +5V to the SBC1190.

Solution: Check that Vcc on the SBC1190is a strong +5V and that ground also is properly connected.

Problem: If your application is loaded on the board and makes use of the watchdog timer, then your application may be causing the reset.

Solution: Try using a version of your application that does not make use of the watchdog timer or make sure that your application, after enabling the watchdog timer, strobes the watchdog frequently.

The BIOS Boss will not start

Problem: The SBC1190 is not recognizing the download cable connected to COM B.

Solution: Verify that the 'LOAD' end of the CA4035 cable is connected to COM B of the SBC1190 via the CA4020 ribbon cable.
Also verify that the unlabeled end of the CA4035 cable is connected to a terminal running at 19200 BAUD, 'N', 8, 1.

Problem: The terminal is not receiving or displaying received characters properly to the screen.

Solution: Verify that your terminal (or terminal program) is working properly and will display characters received at 19200 BAUD, 'N', 8, 1.

Turbo Debugger does not connect with the SBC3386EX in RUN.EXE mode.

Problem: Possible version conflict. There are several versions of Turbo Debugger for which a matching version of the remote debug manager must be used.

Solution: See the README.DOC on the support diskette for Turbo Debugger version information then use the BIOS Boss to load the remote debug manager that is compatible with your version of Turbo Debugger.

When attempting to load files to the SBC1190, the file transfer is aborted immediately.

Problem: If using Procomm Plus the transfer is being cancelled by the terminal program.

Solution: Change *Setup/Protocol Options/General Options/ Abort Xfer if CD lost* to "No".

Problems loading a file or files to the SBC1190

Problem: Possible Protocol conflict.

Solution: When loading an EXE in RUN.EXE mode, you must upload using the XMODEM protocol.

Appendices

Appendix A: ***Mapping***

Appendix B: ***References***

Appendix A - Mapping

SBC1190 Memory Map

There are a number of memory options available on the SBC1190. The following table indicates the memory maps that are automatically implemented by RUN.EXE firmware upon power-up.
Note: The location of a device installed in the U6 socket is user programmable by writing to chip select GCS0.

SBC1190 Memory Maps

Address Range	128K RAM in U10	512K RAM in U10	256K Flash in U22	512K Flash in U22
00000-1FFFF				
20000-3FFFF				
40000-5FFFF				
60000-7FFFF				
80000-9FFFF				HIDDEN FLASH
A0000-BFFFF				
C0000-DFFFF			HIDDEN FLASH	
E0000-EFFFF				
F0000-FFFFF				

SBC1190 I/O Map

The I/O map of the SBC1190 consists of the internal Peripheral Control Block (PCB) of the 80C188EB processor, as shown in the appendix. The PCB starts at port FF00h, so all port addresses shown have FF as a prefix (i.e. Port 1 Direction Register is at port FF50h). The 82C55 parallel I/O device is addressed by GCS1, which is programmed to include ports FE40h through FE43h. The Analog-to-Digital Converter is located at FE44h and FE45h. The watchdog timer is strobed by a write to port FE4Ch. See the following table for a complete list of I/O addresses for the SBC1190.

SBC1190 I/O MAP

Port Address	Function
0000 - 7FFF	Offboard I/O
82C55	
FE40	DATA A
FE41	DATA B
FE42	DATA C
FE43	CONTROL
Analog	
FE44 (write)	ADC Control
FE44 (read)	ADC Data D0 - D7
FE45 (read)	ADC Data D8 - D11
Miscellaneous	
FE48	Altmap
FE4C	Watchdog
80C188EB	
FF02	EOI
FF04	POLL
FF06	POLLSTS
FF08	IMASK
FF0A	PRIMSK
FF0C	INSERV
FF0E	REQST
FF10	INSTS
FF12	TCUCON

Port Address	Function
FF14	SCUCON
FF16	I4CON
FF18	I0CON
FF1A	I1CON
FF1C	I2CON
FF1E	I3CON
FF30	T0CNT
FF32	T0CMPA
FF34	T0CMPB
FF36	T0CON
FF38	T1CNT
FF3A	T1CMPA
FF3C	T1CMPB
FF3E	T1CON
FF40	T2CNT
FF42	T2CMPA
FF46	T2CON
FF50	P1DIR
FF52	P1PIN
FF54	P1CTRL
FF56	P1LTCH
FF58	P2DIR
FF5A	P2PIN
FF5C	P2CTRL
FF5E	P2LTCH
FF60	B0CMP
FF62	B0CNT
FF64	S0CON
FF66	S0STS
FF68	S0RBUF
FF6A	S0TBUF
FF70	B1CMP

Port Address	Function
FF72	B1CNT
FF74	S1CON
FF76	S1STS
FF78	S1RBUF
FF7A	S1TBUF
FF80	GCS0ST
FF82	GCS0SP
FF84	GCS1ST
FF86	GCS1SP
FF88	GCS2ST
FF8A	GCS2SP
FF8C	GCS3ST
FF8E	GCS3SP
FF90	GCS4ST
FF92	GCS4SP
FF94	GCS5ST
FF96	GCS5SP
FF98	GCS6ST
FF9A	GCS6SP
FF9C	GCS7ST
FF9E	GCS7SP
FFA0	LCSST
FFA2	LCSSP
FFA4	UCSST
FFA6	UCSSP
FFA8	RELREG
FFB0	RFBASE
FFB2	RFTIME
FFB4	RFCON
FFB6	RFADDR
FFB8	PWRCON
FFBC	STEPID

Micro/sys SBC1190 PC/104 Computer Reference Manual

Appendix B - References

Intel Corp., Intel 80C186EB/80C188EB Microprocessor User's Manual, Order No. 270830-003 (or latest revision), Mt. Prospect, IL

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