EV System Component List

QTY	DESCRIPTION
1	MAX191 evaluation kit (MAX191EVKIT-DIP)
1	Maxim 80C32 µC module (80C32MODULE-DIP)

EV Kit Component List

DESIGNATION	QTY	DESCRIPTION
C1	1	200pF ceramic capacitor
C2, C3, C4, C5, C6, C13	6	10µF 16V electrolytic capacitors
C7	1	22µF ceramic capacitor
C8, C9, C11, C12, C14	5	0.1µF ceramic capacitors
C10	1	0.01µF ceramic capacitor
R1, R2	2	1kΩ 5% resistors
RS1	1	10kΩ 9-resistor SIP
U1	1	74HCT157A
U2	1	Maxim DG413DJ
U3	1	Maxim ICL7660CPA
U4	1	Maxim MAX191BCNG
H1	1	10-pin header
J1	1	Female data connector
None	1	Software on 5 1/4" floppy disk
None	1	3.00" x 3.00" PC board
None	1	MAX191 data sheet

EV System Quick Start

The MAX191 EV system includes a Maxim 80C32 µC module and a MAX191 EV kit. The two connect through a 40-pin data connector on adjoining edges of the boards. The EV system then connects to an IBM-compatible computer running software provided with the MAX191 EV kit.

The following steps outline the procedure for using the MAX191 EV system:

1) Copy the MAX191 software disk to another disk or to a hard-disk directory in the personal computer. Store the original disk in a safe location.
2) Read the README text file found on the floppy disk. It contains information on any hardware or software changes made after this manual was written.
3) Connect the MAX191 evaluation board to the 40-pin data connector on the Maxim 80C32 module.
4) Connect an 8V to 16V source to the 2-pin power connector on the 80C32 module. The positive lead connects to the terminal marked VIN. The Maxim 80C32 module requires approximately 100mA. The MAX191 evaluation board draws less than 10mA.
5) Connect a cable from the personal computer to the 9-pin connector on the 80C32 module. If the serial port on the personal computer has a standard 9-pin connector, a straight-through cable is used to attach the board. Computers with a 25-pin serial port connector need an adapter or adapter cable (D25 female to D9 male); both are available at most computer stores.
6) Turn on the power to the 80C32 module. The switch is located near the 2-pin power connector. The LED indicates power from the on-board regulator.
7) To start the Maxim EV system software on the personal computer, set the default drive or directory to match the storage location of the Maxim programs, then enter the program name “191EVKIT”.
8) Set the active serial port, shown on the bottom line, to indicate the port connected to the Maxim 80C32 module. The Ctrl-T command toggles the active port between COM1 and COM2. A list of commands affecting the communications link appears at the bottom of the screen.
9) The 80C32 module will transmit a logon message and RAM test results when communications are initialized. The MAX191 RAM resident program will then be downloaded automatically. The system is ready for use when the MAX191 revision banner appears and the status indication on the bottom display line changes to “*** READY ***”.
10) Enter a “?” to display a menu of available MAX191 conversion commands. This help list is available whenever the MAX191 system is ready for use.
11) Connect an analog input across the MAX191 inputs (AIN+ and AIN-). The input range is 0V to +4.096V for unipolar and -2.048V to +2.047V for bipolar operation.
12) Single conversions are displayed whenever the Enter key is pressed. Continuous conversions are initialized with a “C” and continue until any key is pressed.

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EV Kit Quick Start

Without the 80C32 module, the MAX191 evaluation board can perform a limited evaluation of the MAX191 using external signals. To evaluate the device in the serial-interface mode, refer to the timing diagram in Figure 10b of the MAX191 data sheet and connect the board as follows:

1) Connect a +5V power supply to the marked pads (GND and +5V) on the board.
2) Ground the PAR pin on the 10-pin header to set the MAX191 in the serial-interface mode.
3) Connect the clock signal (0.1MHz to 1.6MHz) to the SCK pin on the 10-pin header.
4) Connect the chip-select signal ($\overline{CS}$) to the serial chip-select pin (SCS) on the 10-pin header.
5) Connect an oscilloscope to the serial data pin (SDAT) on the 10-pin header.
6) The MAX191 V_{SS} voltage can be changed to -5V by grounding the V_{SS} select pin (VSEL) on the 10-pin header. The V_{SS} voltage is 0V when this pin is left open.
7) Leaving the BIP pin of the 10-pin header open will operate the MAX191 in bipolar mode. Grounding the pin will change the mode to unipolar.

Detailed Description

V_{SS} Circuit

An ICL7660 +5V to -5V converter and a DG413 analog switch are the means for switching the MAX191's V_{SS} voltage between ground and -5V. The analog switch is not required for most application circuits because the V_{SS} voltage will be fixed at either -5V or ground. The MAX191 requires a negative supply only if the input voltage is expected to go below ground.

The ICL7660 provides a -5V source with minimal additional circuitry. The ICL7660 converter circuit on the MAX191 EV kit is the standard application circuit for +5V to -5V conversions. Its 10mA output capacity is much more than the 100µA needed for the MAX191 EV kit. The additional current is available for user circuits in the prototyping area. For applications where the MAX191 is the only load, the 10µF capacitors may be reduced to 0.1µF.

Table 1. Port 1 Bit Functions

BIT	NAME	FUNCTION
P1.0	SCK	Clock signal for serial mode
P1.1	VSEL	Selects 0V or -5V for MAX191's V_{SS} pin: Low = 0V, High = -5
P1.2	BSY	The MAX191 BUSY output
P1.3	PAR	The MAX191 PARallel mode select pin. Also controls the 74HCT157 multiplexer.
P1.4	BIP	The MAX191 BIPolar pin
P1.5	HBE	The MAX191 HBEN (high-byte enable) pin
P1.6	SRD	The MAX191 D7/SDATA (serial data) pin
P1.7	SCS	Serial mode chip-select signal

Interface Modes

Communications between the 80C32 module and the MAX191 can be in serial or parallel mode. A 74HC157 multiplexer is used to toggle the MAX191 chip-select signal ($\overline{CS}$) between the serial chip select ($\overline{SCS}$, P1.7) and a decoded address signal ($\overline{CS0}$). In either mode, the MAX191 BIP, PAR, and HBEN pins are controlled by the 80C32 port 1 programmable bits. In serial mode, port 1 also toggles the clock pin and receives the serial data. Table 1 lists the functions of the port 1 bits.

Reference Circuit

The MAX191 EV kit is configured to operate with the MAX191's internal 4.096V reference, using external reference compensation mode ($\overline{PD}$ pin floating—see MAX191 data sheet). Access to the $\overline{PD}$ pin is provided via connector location JJ1.

To evaluate the MAX191 in internal reference compensation mode, remove the reference compensation capacitors C7 and C11, and force the $\overline{PD}$ pin high at location JJ1.

To place the MAX191 in its low-current power-down mode, connect $\overline{PD}$ to ground using JJ1.

Monitoring the MAX191 Supply Current

A jumper position (JJ2) included on the MAX191 EV kit printed circuit board provides a convenient place to monitor the MAX191's V_{DD} supply current. To insert a current meter, cut the trace across the position marked

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JJ2 and connect the meter using the two holes present. The circuit can be returned to normal by soldering a short piece of wire between the two holes. To evaluate the MAX191 in its low-current shutdown mode, connect $\overline{PD}$ to ground using jumper location JJ1.

Analog Inputs

The MAX191's analog inputs are brought to pads marked AIN+ and AIN-. An optional input filter consisting of 1kΩ resistors (R1 and R2) is in series with the input and a 0.01µF capacitor (C10) across the input pins. A wire may be inserted across jumper JJ3 to connect AIN- to ground if the MAX191 is limited to single-ended input operation.

Software

191EVKIT Program

The 191EVKIT program is one of two separate programs supplied with the MAX191 EV kit. The program, which runs on a personal computer, handles the user interface, controls communications with the 80C32 module, and displays conversion results. It was written in the C language using Microsoft's QuickC software package. The *EV System Quick Start* section gives instructions for starting the program as well as for making connections to the boards.

The following commands are available whenever the 191EVKIT program is running. A list of these commands is displayed at the bottom of the screen.

Esc.....Clears the data field and redraws the screen.

Ctrl-T... ...Toggles the active serial communications port between COM1 and COM2. The active port is identified on the bottom status line.

Ctrl-R... ...Changes the baud rate of the active serial port. The board and program initialize at 1200. If the program is exited with another rate active, the board must be manually reset. Higher baud rates are usable for data uploading and on personal computers with faster video operations. Data will be lost if the rate is set too high.

Ctrl-U... ...Downloads the RAM resident program. Can be used to force reloading of the RAM resident program.

Ctrl-X... ...Exits the 191EVKIT program and returns to DOS.

MAX191 RAM Resident Program

The second program supplied with the kit is an 80C32 assembly language program that is transferred to the 80C32 module and controls the MAX191 converter. Both the source code (191RAM.ASM) and hex (191RAM.MAX) files are on the floppy disk supplied with the EV kit. The hex file is downloaded automatically when communications with the module are initiated. It transmits a logon banner, displays a command prompt, and changes the lower right-hand corner of the display to indicate "**** READY ****" when program loading has been completed.

The command prompt gives the present operating mode of the MAX191. It indicates the output format (DECimal or HEXadecimal), the input mode (UNIpolar or BIPolar), the interface mode (PARallel or SERial), and the MAX191 V_{SS} voltage (0V or -5V). For example, the following command prompt indicates decimal output format, unipolar input mode, parallel interface mode, and V_{SS} = 0V.

MAX191:DEC:UNI:PAR:V_{SS} = 0V: >

Any of the following commands may be entered whenever the prompt is displayed. A command help list will appear when a question mark "?" is entered.

Software Commands

The following commands are available whenever the MAX191 RAM resident program has been downloaded to the 80C32 module. Entering a question mark "?" produces a help list.

MAX191 Conversion-Mode Selection Commands

U .....The MAX191 interprets the input as a unipolar (0V to +4.096V) voltage.

B .....The MAX191 interprets the input as a bipolar (-2.048V to +2.047V) voltage.

P.....Changes the interface mode between the 80C32 and the MAX191 to parallel.

S.....Changes the interface mode between the 80C32 and the MAX191 to serial.

V .....Sets the MAX191 V_{SS} voltage to -5V. The -5V supply must be used when the MAX191 input is expected to go negative.

Z .....Sets the MAX191 V_{SS} voltage to 0V.

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H .....Changes the format of the displayed results. For hexadecimal format, the range is 0 to FFFF (0 to full scale) for unipolar mode, and 8000 to 7FFF (negative full scale to positive full scale) for bipolar.

D .....Changes the format of the displayed results. For decimal format, the range is 0V to +4.096V for unipolar and -2.048V to +2.047V for bipolar.

MAX191 Conversion Commands

CR .....Striking the carriage return (the “Enter” key on the PC keyboard) or the space bar performs a single conversion and displays the results.

C.....Performs continuous conversions and displays the results until any key on the keyboard is pressed.

L .....Performs continuous conversions and ignores the results. This allows the user to observe the timing relationships with an oscilloscope. The function terminates when a key is pressed.

R .....Collects conversion results in the RAM located on the 80C32 module. See the following commands for details.

O.....Retrieves previously stored values in the 80C32 module RAM and displays the results. Changing the MAX191 conversion mode (unipolar/bipolar) after conversions are collected will cause an erroneous display.

N .....Sets the number of readings collected with the “R” command and displayed with the “O” command between 1 and 4100.

W .....Sets the period between conversions as they are collected and stored in the RAM. Each count increases the delay by approximately 2µs. The delay period also occurs between conversions following the “L” command.

F.....Retrieves the contents of the 80C32 RAM and stores the readings in a file. The readings are stored in text (ASCII) format with a single reading per line. The output file may be viewed with a wordprocessing program or imported by a spreadsheet program.

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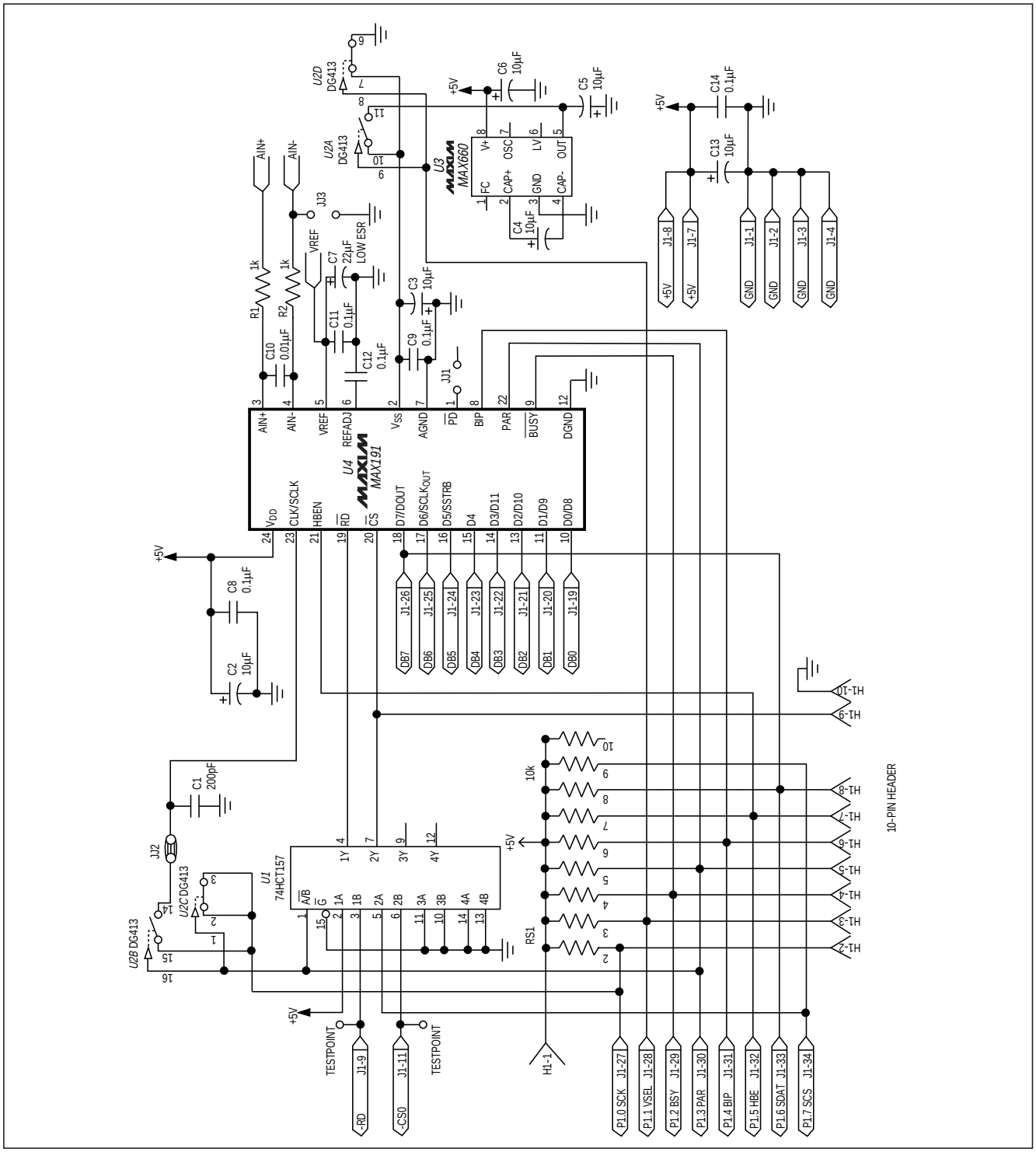

Figure 1. MAX191 EV Kit Schematic

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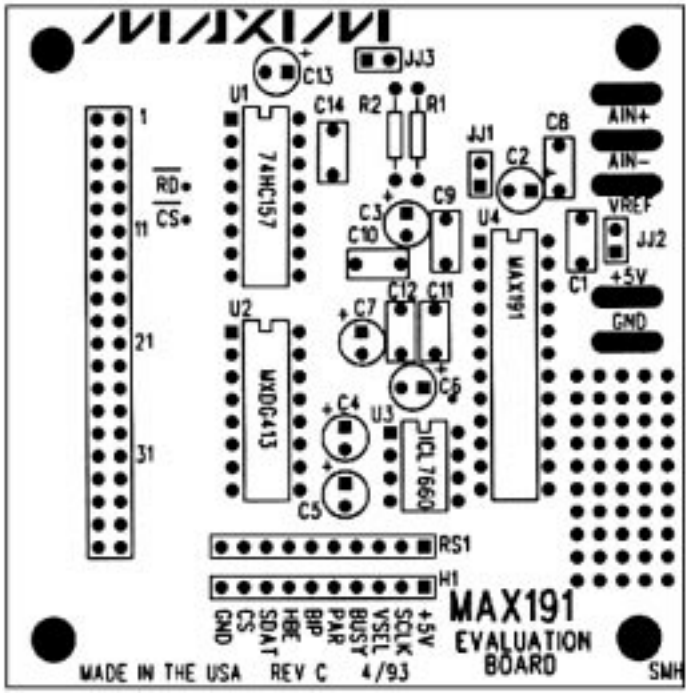

Figure 2. MAX191 EV Kit Component Placement Guide

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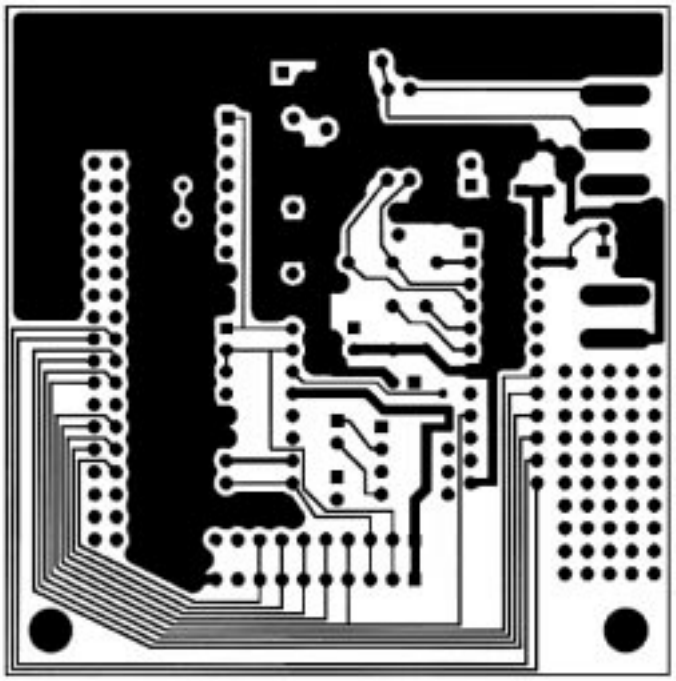

Figure 3. MAX191 EV Kit Component-Side Layout

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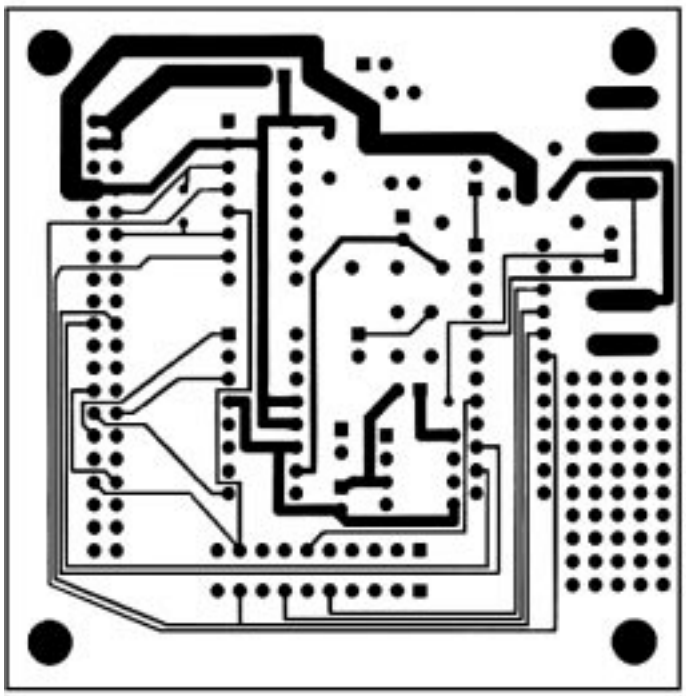

Figure 4. MAX191 EV Kit Solder-Side Layout

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80C32 Module Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2	2	15pF ceramic capacitors
C4, C5, C6, C7, C8, C9, C10, C11, C12	9	0.1µF, 50V ceramic capacitors
C3, C13, C14	3	22µF, 16V radial electrolytic capacitors
D1	1	1N4001 diode
J1	1	40-pin right-angle male connector
J2	1	DB9 right-angle socket
R1	1	620Ω resistor
RS1	1	Reset switch
SW1	1	Reset switch
SW2	1	80C32
IC1	1	MAX233CPP
IC2	1	MAX233CPP
IC3	1	27C64
IC4	1	74HCT573
IC5	1	74HCT139
IC6	1	74HCT08
IC7	1	74HCT245
IC8	1	62256
IC9	1	78M05
IC10	1	MAX707CPA
Y1	1	11.059MHz crystal
None	1	2-pin power connector
None	1	28-pin 600-mil socket for IC3 (the EPROM)
None	1	Rubber feet
None	1	3.00" x 5.50" PC board

80C32 Module

80C32 Module General Description

The Maxim 80C32 microcontroller (µC) module is intended for use with this and other Maxim evaluation kits (EV kits). It contains the 80C32 µC, RS-232 interface, 8kbytes of EPROM, 32kbytes of static RAM, and address decoding logic. A 40-pin connector mates with a connector found on Maxim EV kits designed to interface with the 80C32 module.

The module is connected to an IBM-compatible personal computer over a serial communications port. Software provided with each EV kit runs on the computer and controls the unit consisting of the 80C32 module and EV kit. The program uses a routine stored in the 27C64 EPROM to download special 80C32 code for each kit. The downloaded code controls the EV kit and, together with the program running on the personal computer, displays the output data.

The board operates from a single 8V to 22V supply. Both the pre-regulated and regulated +5V levels are available to the EV kit through the 40-pin connector.

80C32 Module Power Supply

The Maxim 80C32 module requires an input of 8V to 22V for normal operation. An on-board 78M05 power regulator supplies the 5V required for the logic on the module, and any 5V requirements for the EV kit attached to the 40-pin connector. The pre-regulated voltage is also available on the data connector. The source must be capable of supplying 100mA for the module and meeting the load requirements of the EV kit.

Microprocessor Supervisor

A MAX707 on the module monitors the 5V logic supply, generates the power-on reset, and produces a reset pulse whenever the reset button is pressed. A watchdog function was not included because they frequently interfere while debugging programs, and debugging is a prime function of this board.

80C32 Microcontroller

The 80C32 is a member of the popular Intel 8051 family of µCs. It is a low-power CMOS version that requires external ROM for program storage, 256 bytes of internal RAM, and four 8-bit I/O ports. Three of the ports are required by the system for serial communications and memory control. The fourth port (P1) is available through the data connector.

The 80C32 communicates with the PC over a serial RS-232 link. A MAX233 acts as a level shifter between the ±15V RS-232 signals and the TTL levels of the 80C32. The MAX233 also generates the output voltages necessary to drive RS-232 lines.

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Port 0 (pins 32–39) of the 80C32 multiplexes the lower eight bits of memory address and the eight bits of read/write data. The lower eight bits of address data are latched during each I/O cycle by the 74HCT573 octal latch. The latch is controlled by the address latch enable (ALE) signal of the 80C32. Port 2 (pins 21–28) of the 80C32 supplies the upper eight bits of address information.

The port 3 pins (10-17) provide several unrelated functions. Pins 10 and 11 are used as the receive data (RxD) and transmit data (TxD) pins of the RS-232 link. Pins 16 and 17 act as the write ($\overline{WR}$) and read ($\overline{RD}$) control signals for the data I/O cycles. Four other pins are configured as interrupt and timer controls, but are not used on this board.

Memory

The board has a 27C64 EPROM containing code for initializing the 80C32 and downloading additional program code to the 62256 RAM. After a reset, the EPROM resident code initializes the 80C32, determines the address range of the RAM, sets the RS-232 baud rate to 1200, and waits for communications from the PC. Receiving any character will prompt the program to send an initial banner that includes the program name, revision level, and boundaries of the on-board RAM.

The 62256 CMOS (32kbyte) static RAM is used to hold program code for the various Maxim EV kits that use the 80C32 module as the controller. Programs are transferred from disk to the RAM using software running on a personal computer, such as MAXLOAD or other programs provided with Maxim EV kits. Programs written to execute from this RAM start at 4000 (HEX) and are typically less than 4kbytes long. The remaining RAM is available for data storage.

Address Ranges

Logic on the module board generates various enable signals for different address ranges. The ROM and RAM enable signals are fed directly to the respective chips. Several additional signals (CS0–CS3) are available on the data connector to be used by Maxim EV kits. Table 2 outlines the address range for each of the elements found on the 80C32 module.

Table 2. Address Ranges in Hexadecimal

ADDRESS RANGE (HEX)			ENABLE SIGNAL
0000	→	3FFF	ROM
4000	→	BFFF	RAM
C000	→	CFFF	CS0
D000	→	DFFF	CS1
E000	→	EFFF	CS2
F000	→	FFFF	CS3

Data I/O Connector

A 40-pin connector mounted on the edge of the printed circuit board provides connection between the µC module and other Maxim EV kits. Both power and digital signals are transferred via the connector. To join the module board with an EV kit, carefully align and insert the pins on the connector with the mating 40-pin female connector of the kit. The pin functions are listed in Table 3.

Table 3. I/O Connector Pin Functions

PIN	FUNCTION	DESCRIPTION
1-4	Ground	
5, 6	Pre-regulator input	
7, 8	Regulated +5V	
9	$\overline{RD}$	Read strobe
10	$\overline{WR}$	Write strobe
11	$\overline{CS0}$	Address C000-CFFF
12	$\overline{CS1}$	Address D000-DFFF
13	$\overline{CS2}$	Address E000-EFFF
14	$\overline{CS3}$	Address F000-FFFF
15-18	ADDR0-ADDR3	Lowest 4 bits of address
19-26	DB0-DB7	8-bit data bus
27-34	P1.0-P1.7	8 bits of port 1
35-40	Reserved	

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Software Architecture

Software for EV kits using the Maxim 80C32 module is divided into three elements: the interface program running on an IBM-compatible PC, a module program located in EPROM, and a program supplied on disk that is transferred to the RAM located on the module.

EPROM Resident Program

The EPROM resident program initializes the 80C32, establishes communications over the RS-232 link, verifies the static RAM, and downloads other programs. Its operation starts on power-up and whenever the reset button is pressed. After reset, the program waits indefinitely to receive a character over the RS-232 port. When the first character is received, a logon banner identifying the module and firmware revision is transmitted.

Immediately following transmission of the logon banner, the program runs a checker routine for the on-board 256kbit static RAM. The RAM is filled with several patterns and then read to verify that each pattern has been retained. A pass or fail indication is displayed on the personal computer after each pass. EV kit software requires proper operation of the RAM. Do not attempt to use the board if any of the RAM checks fail.

Two other programs for the EV kits are provided on a floppy disk shipped with each kit. One program acts as the user interface and transmits commands to the 80C32 module. The other is an 80C32 application program that executes from the RAM located on the module. The procedure for loading the programs varies with each kit, so follow the instructions provided.

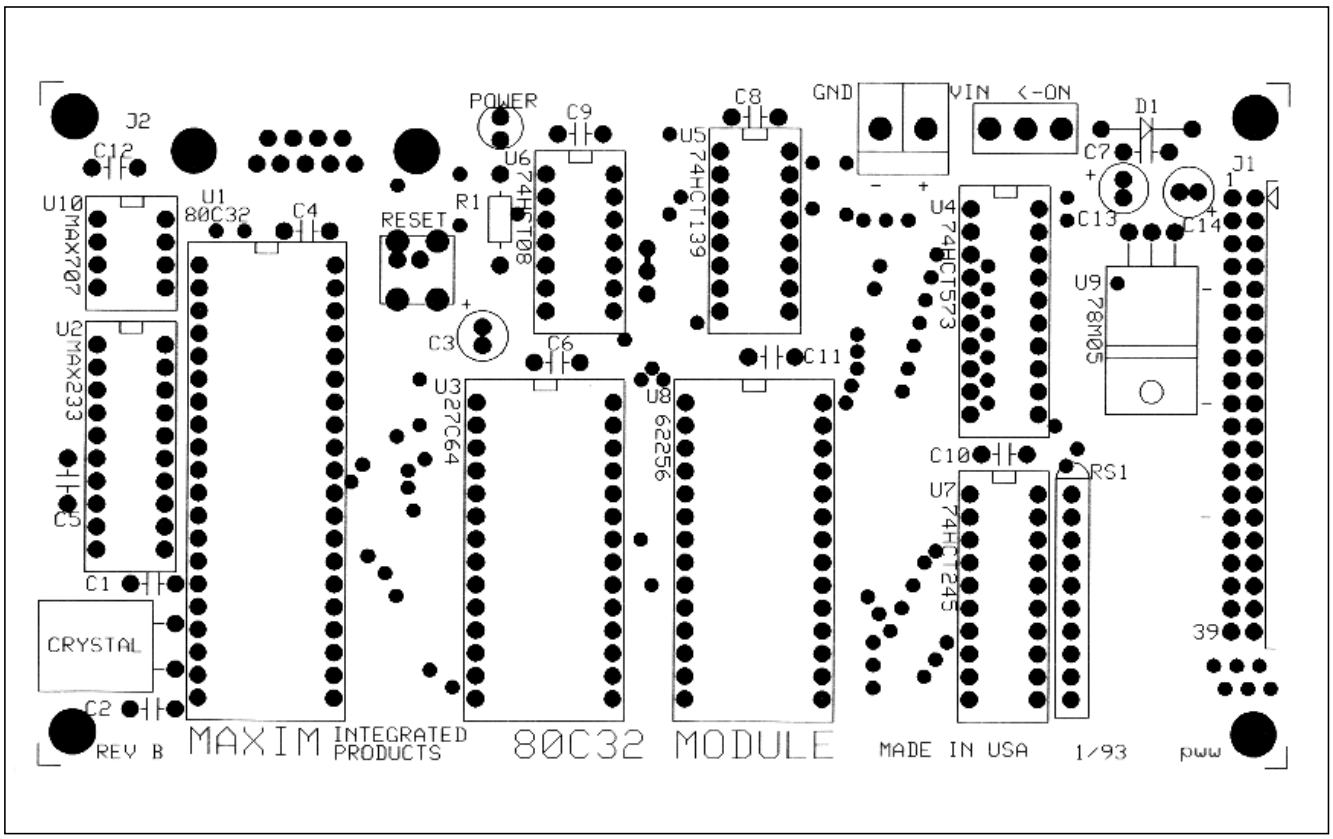

Figure 5. 80C32 Module Component Placement Guide (x2)

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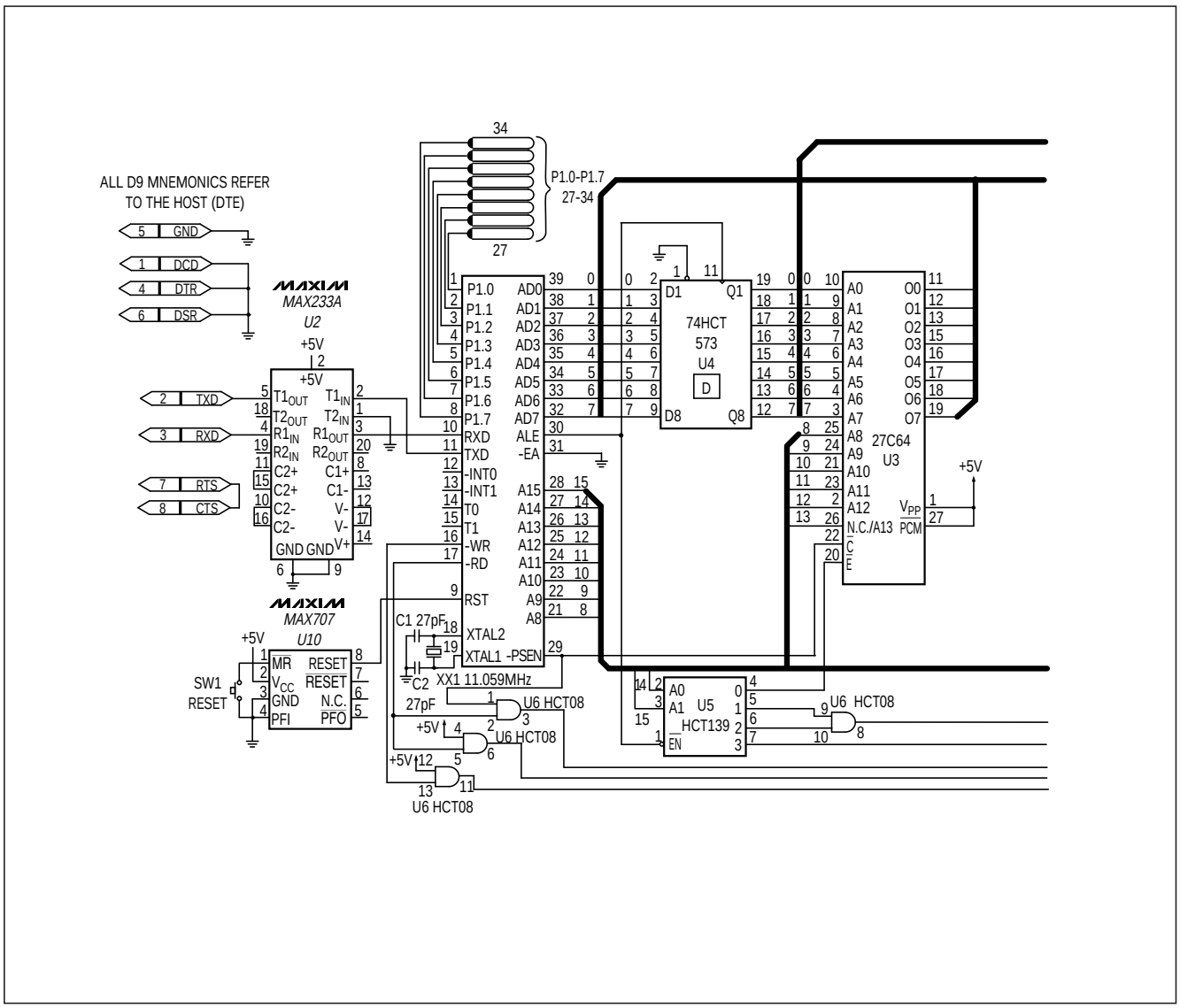

Figure 6. 80C32 Module Schematic

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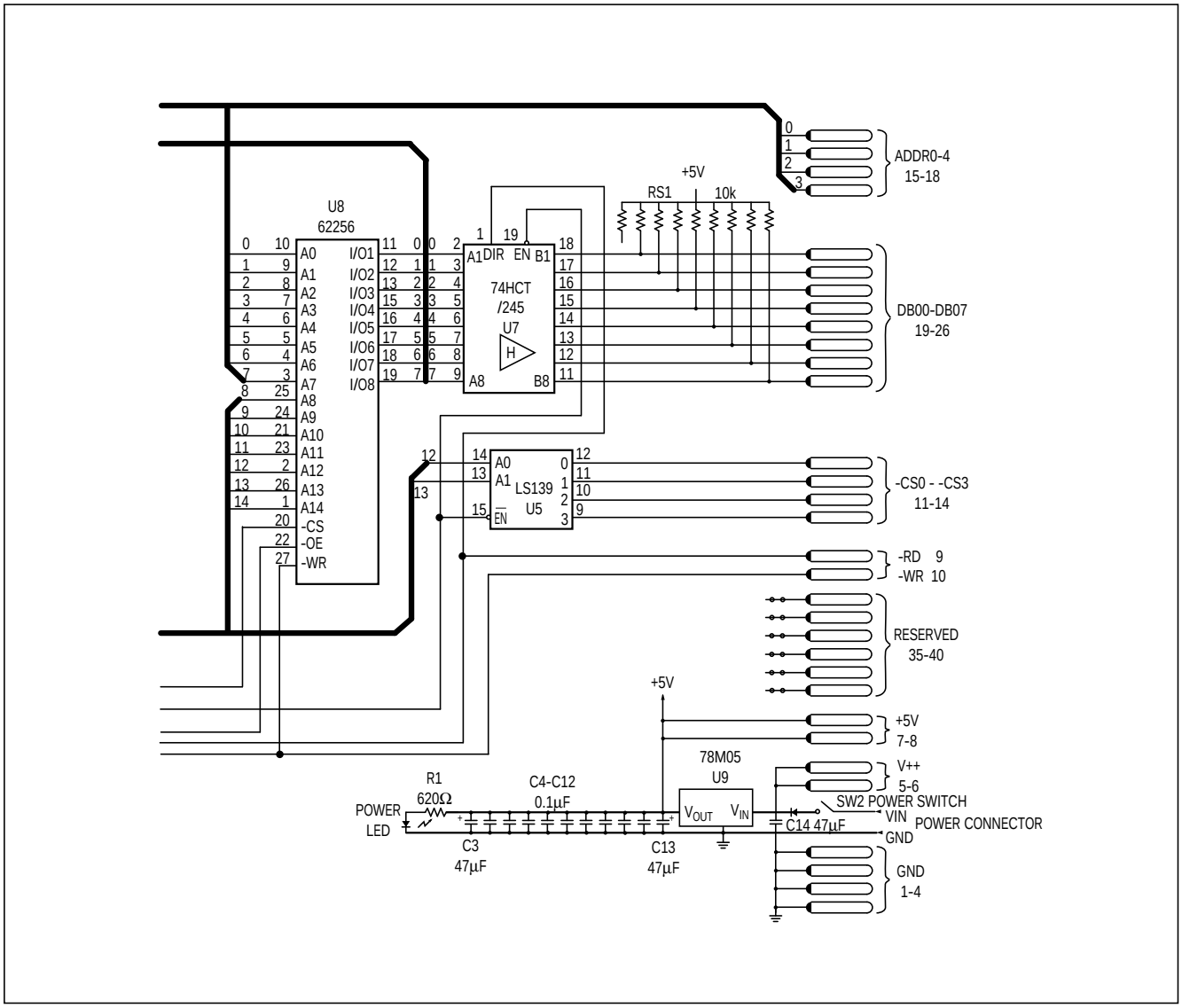

Figure 6. 80C32 Module Schematic (continued)

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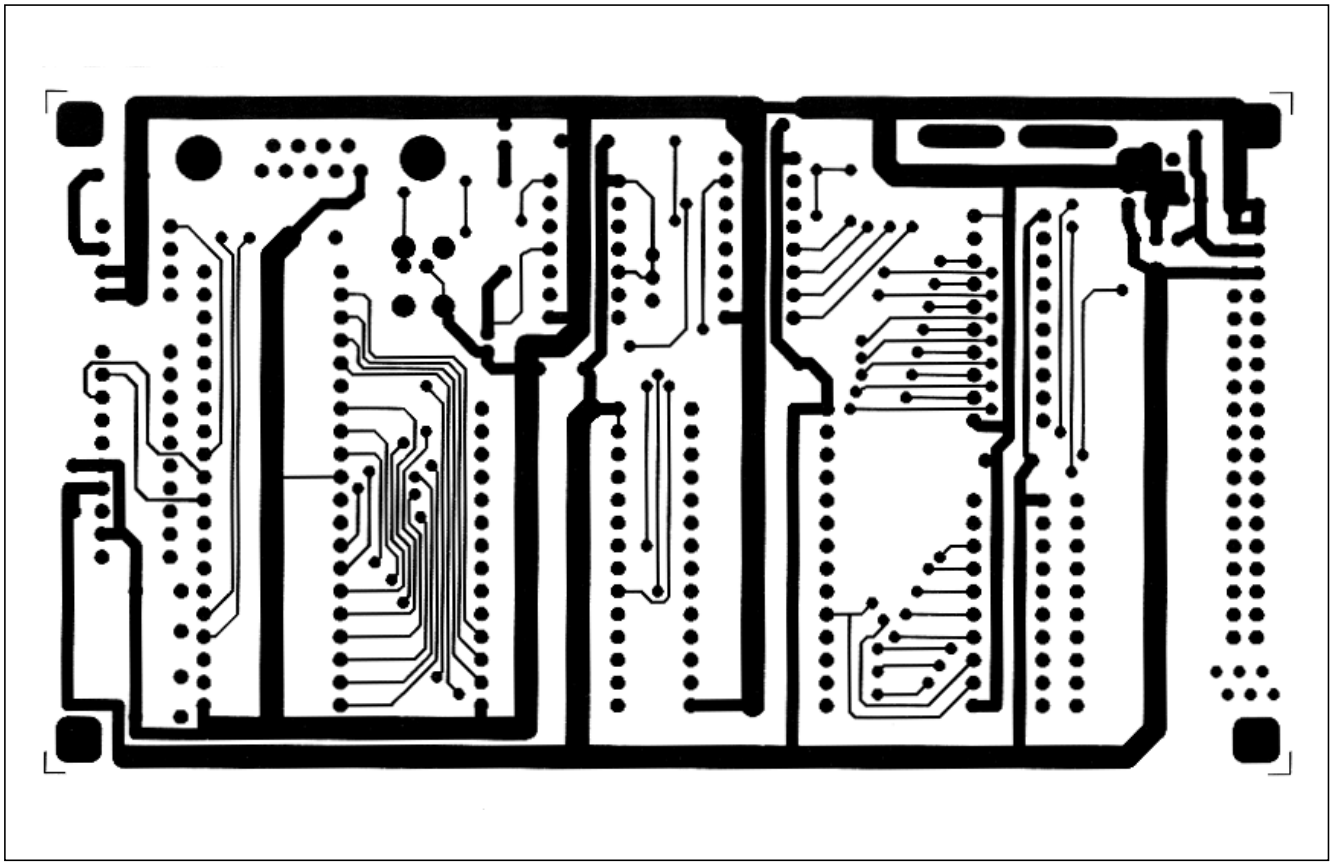

Figure 7. 80C32 Module Component-Side Layout (x2)

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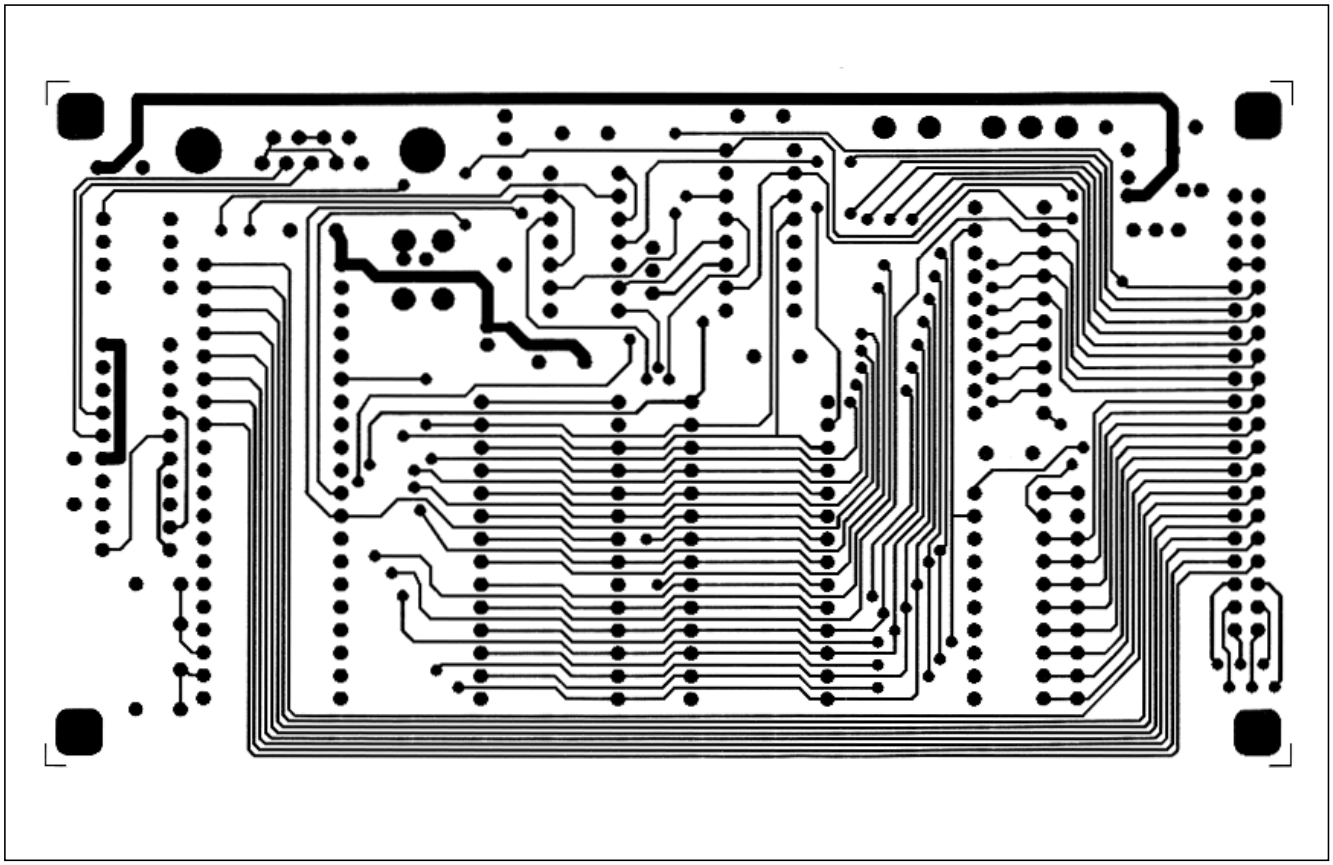

Figure 8. 80C32 Module Solder-Side Layout (x2)

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