



MAX194 Evaluation System/Evaluation Kit

General Description

The *MAX194 Evaluation System* (MAX194EVC16-DIP) includes the MAX194 evaluation kit and Maxim's 68HC16 module. Evaluation software supplied with the kit demonstrates the use of the MAX194 (or the MAX195) with Motorola's high-speed QSPI serial interface. Complete source code is included. The EV system requires an IBM PC with a serial port and a 5 1/4" disk drive.

The stand-alone *MAX194 Evaluation Kit* (MAX194EVKIT-DIP) is an assembled and tested PC board that embodies the standard application circuit. Separate power, digital, and analog ground planes minimize noise. Jumpers allow several operating modes. The board generates its own interface timing signals, or can be connected to a user-provided serial interface.

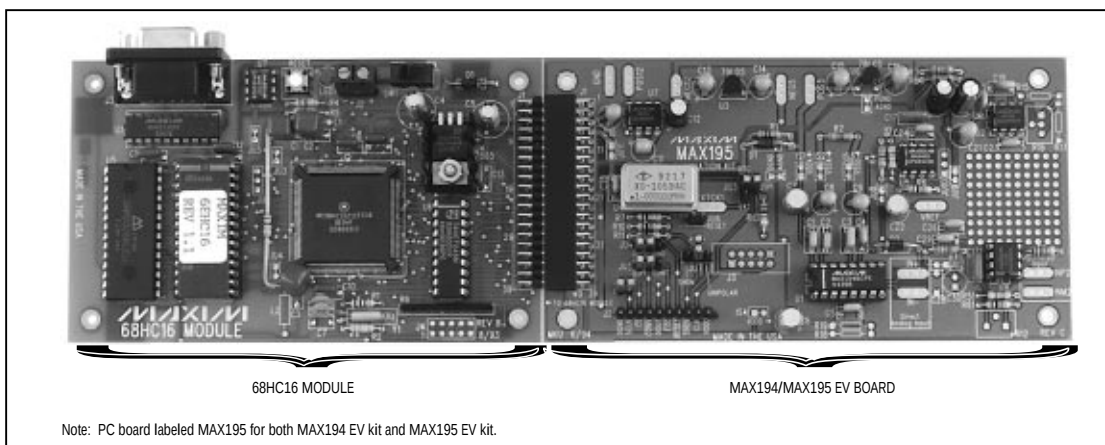
Features

- ♦ Proven PC Board Layout
- ♦ Complete Source Code Provided
- ♦ Shutdown-Mode Evaluation
- ♦ High-Speed Serial Interface
- ♦ Convenient Test Points Provided On-Board
- ♦ Operates from a Single 9V to 15V DC Power Supply
- ♦ Evaluates Both the 14-Bit MAX194 and the 16-Bit MAX195

Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX194EVC16-DIP	0°C to +70°C	Through-Hole
MAX194EVKIT-DIP	0°C to +70°C	Through-Hole
68HC16MODULE	0°C to +70°C	Through-Hole

EV System



Evaluates: MAX194/MAX195



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EV System Component List

QUANTITY	DESCRIPTION
1	MAX194 Evaluation Kit (MAX194EVKIT-DIP)
1	68HC16 C Module (68HC16MODULE)

MAX194 EV System Quick Start

This section applies only to the use of the MAX194 EV kit with the 68HC16 module.

- 1) Copy the files from the distribution disk to your hard disk. Store the MAX194 EV kit software in its own directory.
- 2) Carefully align the 40-pin header of the MAX194 EV kit with the 40-pin connector of the μ C module. Gently press them together. The two boards should be flush against each other. Note: The MAX194 EV kit is not supported by the 80C32 module.
- 3) Make sure the jumpers are configured in accordance with Table 1.
- 4) Connect a 9V to 15V DC power source to the μ C module, using a small screwdriver. The terminal block is located next to the on/off switch, in the upper right corner of the μ C module. Plus and minus are marked on the board.
- 5) Connect a cable from the computer's serial port to the μ C module. If using a 9-pin serial port, use a straight-through 9-pin female-to-male cable. If the

available serial port uses a 25-pin connector, use a standard 25-pin to 9-pin adapter.

- 6) To start up the MAX194 software on the IBM PC, set the current directory to match the directory where the Maxim software is stored, and then type the program name "MAX194".
- 7) The program will ask which serial port is connected to the μ C module. Press the space bar until the correct port is highlighted, then press ENTER. The MAX194 program will switch to terminal-emulation mode.
- 8) At this point, apply power to the 68HC16 module. The LED should light, and within 5 seconds the program will display a logon banner. Note that the LED is a status indicator, not a power light. It flashes to indicate module readiness.
- 9) To download and run the RAM resident code on the μ C module, press ALT+L (that is, hold down the ALT key as you strike the L key). The program prompts for the file name. Press the ENTER key to download and run the file KIT194.S19 on the 68HC16 module.

The KIT194.S19 RAM resident program offers a menu of commands listed in Table 2.

To evaluate the MAX195, replace U1 with the MAX195.

Table 1. Jumper Configuration when Used with 68HC16 Module

JUMPER	STATE	FUNCTION
JU1	Closed	Ground the SCLK pin
JU3	QSPI	Conversion clock comes from QSPI clock
JU4	QSPI	Chip-select is driven by QSPI PCS0
JU5	QSPI	Conversion start is driven by QSPI PCS0
JU6	Open	Open = Normal Operation. Closed = Reset; do not close this jumper when using the μ C module, because the μ C drives the reset pin.
JU7	AUTO	68HC16 module selects bipolar/unipolar/shutdown modes

Table 2. List of Commands Available in KIT194.S19

COMMAND	FUNCTION
?	List available commands.
R	Read the MAX194.
—	Perform continuous conversions.
O	Oscilloscope demonstration—observe system timing relationships by operating the MAX194 at full speed without processing data.
!	Reset the MAX194.
B	Select bipolar mode.
U	Select unipolar mode.
H	Select hexadecimal output.
D	Select decimal output.
L	Toggle low-power mode on/off.
T	Set power-up delay and sleep time.
S	Collect a fixed number of samples.

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Stand-Alone EV Kit Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C4, C5, C19, C20, C23–C26, C29	11	0.1µF ceramic capacitors
C3	1	1µF ceramic capacitor
C6, C7	2	15µF, 20V low-ESR capacitors Sanyo OS-CON 20SA14
C8–C11, C13–C16, C21	9	10µF, 25V tantalum capacitors
C12, C18, C27	3	100µF, 25V electrolytic capacitors
C17, C171	2	0.01µF ceramic capacitors
C22	1	47µF low-ESR capacitor Sanyo OS-CON 6SA47M
D1, D2	2	1N5819 Schottky diodes
J1	1	2x20 female data connector
J2	1	10-pin header
JU1, JU6	2	2-pin headers
JU3, JU7	2	3-way headers
JU4, JU5	2	3-pin headers
R1, R2	2	10Ω, 5% resistors
R3, R8	2	680Ω, 5% resistors
R4, R41	2	22Ω, 5% resistors
R5, R51	2	47kΩ, 5% resistors
R6, R10, R11, R13, R61	5	1kΩ, 5% resistors
R7	1	10kΩ, 5% resistor
R9	1	10MΩ, 5% resistor
U1	1	Maxim MAX194
U2	1	Maxim MAX874
U3	1	79L05 negative linear regulator
U4	1	Optional crystal oscillator
U5, U8	2	Maxim MAX400
U6	1	78L05 positive linear regulator
U7	1	ICL7662 inverter

Stand-Alone MAX194 EV Kit Quick Start

This section applies only to the use of the MAX194 EV kit by itself, without the µC module.

- 1) Make sure the jumpers are configured in accordance with Table 3.
- 2) Connect the oscilloscope's channel A probe to the $\overline{\text{EOC}}$ test point on header J2, and the channel B probe to the DOUT test point. Ground the scope probes to the DGND test point or to the GND power pad. Trigger on the positive edge of channel A. Set the time base to 2µs per division, and set the vertical gain to 2V per division.
- 3) Apply +12V DC to the terminals labeled +12V and GROUND. The board draws less than 30mA of supply current.
- 4) Momentarily close JU6 to reset the MAX194 EV kit. Leave JU6 open for normal operation.
- 5) Apply a 0V to 4V signal source between the terminals labeled INPUT+ and INPUT-. The conversion codes may be observed on the oscilloscope's channel A. See the appropriate data sheet for timing information.

Table 3. Jumper Configuration for Stand-Alone MAX194 EV Kit

JUMPER	STATE	FUNCTION
JU1	Closed	Ground the SCLK pin
JU3	OSC	Conversion clock comes from crystal oscillator module
JU4	GND	Tie $\overline{\text{CS}}$ to GND, enabling data output on DOUT
JU5	CONT	Tie $\overline{\text{CONV}}$ to $\overline{\text{EOC}}$, continuous-conversion mode
JU6	Open	Open = Normal Operation Closed = Reset
JU7	UNI	Select unipolar mode

Evaluates: MAX194/MAX195

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__Detailed Description of Software

EPROM Resident Program

A small bootstrap program is stored in the EPROM located on the 68HC16 board. The EPROM resident program initializes the 68HC16, tests the static RAM, configures the chip-select logic, establishes serial communications with the host, and downloads program KIT194 into RAM. It starts operating on power-up or whenever the RESET button is pressed. After RESET, it tests the RAM, then waits to receive a serial character on its serial port before transmitting its identification banner.

RAM Resident Program

KIT194.S19 is a 68HC16 RAM-resident program that is transferred from disk to the static RAM on the 68HC16 module. When the KIT194 program is running, it offers the commands listed in Table 2.

Personal Computer Program

MAX194.EXE, which runs on an IBM-compatible computer, is a terminal program that establishes communication with the 68HC16 module and allows the user to download and run the Maxim-provided RAM resident program. The serial communication baud rate is initiated at 1200 baud (default setting) to ensure proper operation with basic systems.

The MAX194.EXE program provides several commands that are associated with the host computer. These commands are listed in Table 4.

The MAX194.EXE program can store the text of a terminal session in a log file. To begin recording the terminal session, press ALT+O [the letter O]. The program will ask for a file name. Press ENTER to accept the default file name, or type in a different name. If a file with that

Table 4. Commands Available in MAX194.EXE Terminal Program

KEY	COMMAND
ALT+L	Load and run resident code on 68HC16.
ALT+X	Exit to DOS.
ALT+P	Change port (COM1, COM2).
ALT+R	Send RESET command to 68HC16.
ALT+O	Open a log file.
ALT+C	Close the log file.
ALT+B	Display baud rate menu.
ALT+1	1200 baud
ALT+4	4800 baud
ALT+9	9600 baud
ALT+2	19200 baud

name already exists, the old file will be erased. To close the file, press ALT+C. The log file will contain the complete text of the terminal session from the time the file is opened until it is closed.

Using the QSPI to Read the MAX194

The 68HC16 module uses its Queued Serial Peripheral Interface (QSPI) in master mode to read the MAX194. The MAX194 EV kit software uses the algorithm described below. Refer to the example program of Listing 1, which assigns QSPI entries 0 and 1 and programmable chip-select PCS0 to the MAX194. Note: This interface scheme requires that the QSPI clock be active during the MAX194 reset (see *Reset and Calibration Procedure* section).

- 1) Initialize the QSPI parameters as follows:

PARAMETER	VALUE	EXPLANATION
SPBR	5	1.68MHz serial clock
CPOL	0	Serial clock is low when idle
CPHA	1	CPOL $\neq$ CPHA, data valid on falling clock edge
BITS	\$0A	Ten bits per QSPI transfer. Use two consecutive QSPI transfers to read the MAX194.
DSCKL	2	Delay 119ns between $\overline{CS}$ and first clock in the first QSPI transfer to satisfy MAX194 t_{DQ} .
COMD.0	\$D0	Control RAM for first QSPI transfer: CONT = 1, BITSE = 1, DTL = 0, DSCK = 1, PSC0 = 0
COMD.1	\$40	Control RAM for second QSPI transfer: CONT = 0, BITSE = 1, DTL = 0, DSCK = 0, PSC0 = 0
NEWQP	0	Index of first queue entry to execute
ENDQP	1	Index of last valid queue entry

- 2) Verify that $\overline{EOC}$ is low before starting the conversion.
- 3) Start the QSPI transfer.
- 4) Wait until QSPI transfer is complete. The CPU may perform other tasks while waiting.
- 5) Extract the significant bits from QSPI RAM. Bits B13–B06 are located in QSPI receive RAM entry RR0 bits 7–0, and bits B05–B00 are located in entry RR1 bits 9–4. RR1 bits 3–2 are the sub-LSB bits of the MAX194 (see Table 5).

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Listing 1. Sample Code for 68HC16 Interface

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; Code Fragment to show how to read the MAX194 with the 68HC16 QSPI.
; Compiled under Motorola 68HC Macro Assembler, Version 4.1

INIT:
    LDAA #$30          ; ResetPin, ShdnPin high
    STAA GPTPDR
    LDAA #$30          ; ResetPin, ShdnPin are outputs
    STAA PDDR
    LDAA #$08          ; clock idle state is low
    STAA QPDR
    LDAA #$0F          ; QSPI uses CS, SCK, MISO, MOSI
    STAA QPAR
    LDAA #$0E          ; outputs are CS, SCK, MOSI
    STAA QDDR
    LDAA #$00          ; continue + BITSE + DSCK, PSC0=low
    STAA CR0           ; QSPI control ram for first half of MAX194 read
    LDAA #$40          ; BITSE, PCS0=low
    STAA CR1           ; QSPI control ram for second half of MAX194 read
    CLR SPCR3          ; set up QSPI in master mode
    LDD #$A905         ; BITS=10, SPBR=5, Master Mode, CPOL=0, CPHA=1
    STD SPCR0
    LDD #$0200         ; DSCKL=2
    STD SPCR1
    LDD #$0100         ; ENDQP=1, NEWQP=0
    STD SPCR2         ; setup queue, no wrap

    JSR ResetMAX194    ; re-calibrate the MAX194 now that everything's settled

MAIN:
    JSR ReadMAX194     ; Read the MAX194
    BRA MAIN           ; This demo loop doesn't do anything with the value read

ResetMAX194:
    LDD #$6100         ; Reset (Re-calibrate) the MAX194:
    STD SPCR2          ; continuous QSPI transfers
    LDAA #$D1          ; continue + BITSE + DSCK, PSC0=high
    STAA CR0           ; QSPI control ram entry 0
    LDAA #$41          ; BITSE, PCS0=high
    STAA CR1           ; QSPI control ram entry 1
    BCLR GPTPDR,#ResetPin ; take MAX194 RESET pin low
    ; Start the conversion clock in background
    BSETW SPCR1,#$8000 ; set QSPIEnable bit
    BCLR SPSR,#$80     ; clear SPIF bit

WaitHigh1:
    BRCLR GPTPDR,#EOCPin,WaitHigh1 ; wait until EOC goes high
    BSET GPTPDR,#ResetPin ; take MAX194 RESET pin high

WaitLow1:
    BRSET GPTPDR,#EOCPin,WaitLow1 ; wait until EOC goes low
    LDD #$0100
    STD SPCR2          ; setup queue for no wrap
    ; wait until SPIF bit is set

ResetWait:
    BRCLR SPSR,#$80,ResetWait
    LDAA #$D0          ; restore MAX194
    STAA CR0           ; QSPI control ram
    LDAA #$60
    STAA CR1
    RTS

ReadMAX194:
    ; Read the MAX194 in Unipolar mode:
    ; Verify that EOC is low before we begin.
    BRSET GPTPDR,#EOCPin,ReadMAX194NotReady
    BSET GPTPDR,#ShdnPin ; take SHDN high to turn MAX187 on in unipolar mode
    BSET PDDR,#ShdnPin ; make sure SHDN is an output
    LDD #$0100         ; set up QSPI to read the MAX194 once
    STD SPCR2
    BSETW SPCR1,#$8000 ; start the QSPI
    BCLR SPSR,#$80     ; clear SPIF bit
    ; wait until the QSPI finishes

WaitForQSPI:
    BRCLR SPSR,#$80,WaitForQSPI
    LDD RR1            ; get 16 bit result
    RORD              ; from QSPI receive ram
    RORD              ; and left-justify the result
    LDAA RR0+1
    TSTD             ; clear carry to indicate success
    RTS

ReadMAX194NotReady:
    COMD              ; set carry flag
    RTS              ; to indicate MAX194 not ready
    
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Using Bit-Pushing to Read the MAX194
The MAX194 may be interfaced using a bit-pushing algorithm, such as the following:

- 1) Verify that $\overline{\text{EOC}}$ is low before starting the conversion.
- 2) Assert $\overline{\text{CONV}}$ low to begin conversion.
- 3) Wait until $\overline{\text{EOC}}$ becomes high. Conversion has begun.
- 4) Set $\overline{\text{CONV}}$ high.
- 5) Wait until $\overline{\text{EOC}}$ becomes low. Conversion is complete.
- 6) Assert $\overline{\text{SCLK}}$ low.
- 7) Assert $\overline{\text{CS}}$ low.
- 8) Clear the 16-bit result register.
- 9) Repeat 16 times:
 - 9-1. Set $\overline{\text{SCLK}}$ high.
 - 9-2. Rotate the 16-bit result register left.
 - 9-3. Read DOUT into least significant bit of the result register.
 - 9-4. Assert $\overline{\text{SCLK}}$ low.
- 10) Set $\overline{\text{CS}}$ high.

Reset and Calibration Procedure

When the MAX194 is installed in an environment with an unregulated temperature, thermal variation can cause DC offset errors. Transients on the power supply or reference during the power-on calibration are also a source of DC offset error. These errors can be eliminated by performing re-calibration, as outlined below:

- 1) Assert the MAX194 $\overline{\text{RESET}}$ pin low.
- 2) Run the conversion clock until $\overline{\text{EOC}}$ becomes high.
- 3) Set the MAX194 $\overline{\text{RESET}}$ pin high.
- 4) Run the conversion clock until $\overline{\text{EOC}}$ becomes low.

For best accuracy, a typical application circuit should allow time for the power supply and ambient temperature to settle before re-calibrating the MAX194. Refer to the *Calibration* section of the MAX194 data sheet.

Detailed Description of Hardware

Jumper Options

Several jumper blocks allow different configurations of the MAX194. Jumper functions are listed in Table 6. See the *Voltage Reference* and *Measuring Supply Current* sections.

Table 6. Jumper Settings

JUMPER	POSITION	FUNCTION
JU1	Closed	Ground the SCLK pin.
	Open	Allows the SCLK pin to be driven by the user.
JU3	"OSC"	Conversion clock is driven by crystal oscillator U4.
	"EXT"	Conversion clock is driven by the EXTCLK input pad.
	"QSPI"	Conversion clock is driven by the QSPI serial clock.
JU4	"QSPI"	Connects $\overline{\text{CS}}$ to QSPI chip-select PCS0.
	"GND"	Connects $\overline{\text{CS}}$ to ground; data output is always enabled.
JU5	"QSPI"	Connects $\overline{\text{CONV}}$ to QSPI chip-select PCS0.
	"CONT"	Connects $\overline{\text{CONV}}$ to $\overline{\text{EOC}}$ for continuous conversion mode.
JU6	Open	Normal operating mode.
	Closed	Momentary closure resets and re-calibrates the MAX194. Do not close this jumper if the μC module is connected.
JU7	"SHDN"	Select shutdown mode.
	"AUTO"	Lets 68HC16 drive the BP/UP/SHDN pin. If no μC is connected, bipolar input mode is selected.
	"UNI"	Select unipolar mode.
	Open	Select bipolar mode.

Data Connector Interface

The 68HC16 module and MAX194 communicate through the QSPI port on the 40-pin data connector. Table 7 lists the function of each pin.

Table 5. QSPI Receive Format for MAX194

ADDR	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
RR0	x	x	x	x	x	x	x	x	B13	B12	B11	B10	B9	B8	B7	B6
RR1	x	x	x	x	x	x	B5	B4	B3	B2	B1	B0	sub	sub	x	x

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Analog Input Buffer

The analog input to the MAX194 may be buffered by U8. A MAX400 is used because of its low V_{OS} drift. The feedback circuit consists of four passive components: R41, R61, C171, and R51. R41 isolates the op-amp's output from the dynamic capacitive load at the AIN input. R61 makes the network accurate at the reference input (without R61, the reference voltage would appear at the output of the op amp). C171 compensates the high-frequency response by making R51 dominate at high frequencies.

Input offset may be improved by adding a 1000pF to 0.01μF ceramic capacitor at site C28.

Voltage Reference

The voltage reference U2 provides a 4.096V reference, which is buffered by U5. The buffer isolates the reference from the MAX194's capacitive switching load. To eliminate the buffer circuit, cut traces JU8 and JU9 and connect a wire from JU9 pin 1 to the VREF pad.

Reference Buffer

The reference input to the MAX194 may be buffered by U5. The MAX400 op amp is used because of its low V_{OS} drift. By using a bipolar (instead of CMOS) op amp, the substrate can be connected to the quiet analog ground, reducing the noise coupled through the power supplies. The feedback circuit consists of four passive components: R4, R6, C17, and R5. R4 isolates the op-amp's output from the heavy capacitive load that bypasses the VREF pin. R6 makes the network accurate at the reference input (without R6, the reference voltage would appear at the output of the op amp). C17 compensates the high-frequency response

by making R5 dominate at high frequencies.

The reference buffer U5 draws its power through the lowpass filter formed by R3 and C18. The filter provides the necessary power-supply rejection. U5 is powered by the unregulated input supply to ensure enough headroom to buffer the 4.096V reference.

Layout, Power Supplies, and Grounding

Good PC board layout necessary to achieve specified performance, and an analog ground plane is essential for optimum performance. The PC board layout artist must be provided with explicit instructions, preferably a pencil sketch of the placement of sensitive analog components and the routing of ground connections. See the EV kit PC board layout for an example. Use the following guidelines:

- 1) At the schematic level, keep the analog power supplies and grounds separate from all other power supplies and grounds. Digital power may be connected to analog power through a 10Ω series resistor to attenuate digital noise.
- 2) Cluster the MAX194, the voltage reference, and any input or reference buffers near the site where the analog signal enters the board. Place 0.1μF ceramic decoupling capacitors within 10mm of the MAX194's power-supply and voltage-reference pins.
- 3) Keep the analog-input signal ground return separate from the analog ground plane, connecting to analog ground only at the AGND pin of the MAX194. The analog input and its signal ground-return traces should both follow the same route to help reject common-mode noise.

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Table 7. Data-Interface Connections

PIN NO.	68HC16 SIGNAL	MAX194 SIGNAL	FUNCTION
1–4	GND	GND	Ground
5, 6	+12V	+12V	Unregulated 12V DC Supply
7, 8	+5V	VDDD	Regulated +5V DC from 68HC16 Module
9–26	Reserved	Reserved	Reserved
27	IC1	EOC	End-of-Conversion Output from MAX194
28, 29, 30	Reserved	Reserved	Reserved
31	OC2	$\overline{\text{RESET}}$	Active-Low $\overline{\text{RESET}}$ to MAX194
32	OC3	BP/UP/SHDN	Shutdown/Bipolar/Unipolar Input to MAX194
33, 34	Reserved	Reserved	Reserved
35	MISO	DOUT	QSPI Master Input; Serial Data Output from MAX194
36	Reserved	Reserved	Reserved
37	SCK	CLK	QSPI Serial Clock from 68HC16
38	PCS0	CS	QSPI Chip-Select from 68HC16
39, 40	Reserved	Reserved	Reserved

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The MAX194 evaluation board generates its own high-quality power supplies from a single DC input (8V to 20V), such as a plug-in wall transformer. When the MAX194 evaluation board is connected to the 68HC16 μ C module, the μ C module uses the unregulated input supply to generate its own separate +5V digital supply.

U6 converts the unfiltered input down to +5V to provide the VDDA analog supply. Current spikes from the digital supply VDDD are attenuated by R1. Schottky diode D1 protects the device substrate. U7 inverts the +12V to -12V, and U3 regulates the -12V to -5V, providing the VSSA analog supply.

Measuring Supply Current

To measure the supply current drawn by the MAX194, turn off the power and prepare the board by carefully cutting the traces at IS1, IS2, IS3, and IS4, and installing 2-pin headers and shunts (see Table 8).

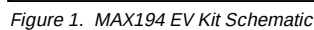
Table 8. Current-Sense Jumpers

JUMPER	POWER SUPPLY	DESCRIPTION
IS1	VDDA	Analog +5V
IS2	VSSA	Analog -5V
IS3	VSSD	Digital -5V
IS4	VDDD	Digital +5V

Each supply may be measured by replacing the corresponding shunt with a current-meter connection. For example, to measure the current drawn by the +5V digital supply, replace the shunt at IS4 with a current meter. The direction of current flow is marked with arrows on the silkscreen. Do not connect or disconnect the current meter while the power is on.

After observing supply current in operating and shut-down modes, the board may be restored by installing shunts at IS1–IS4.

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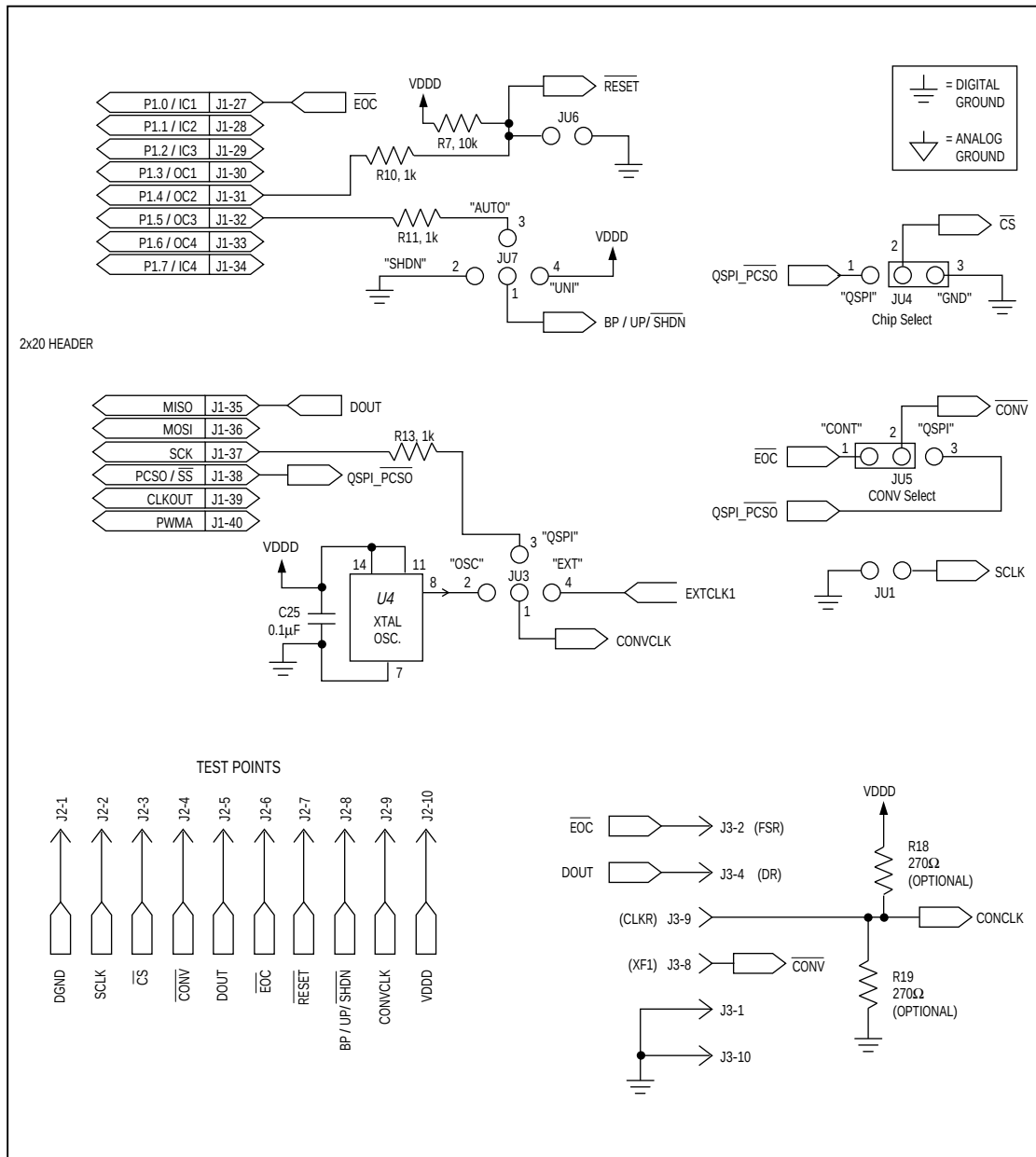


Figure 1. MAX194 EV Kit Schematic (continued)

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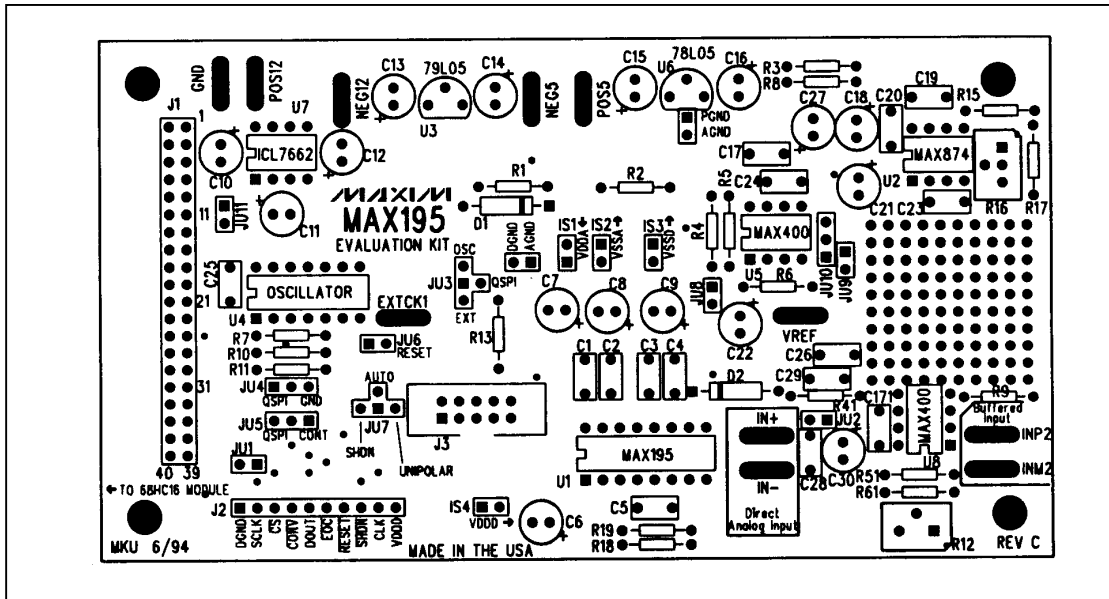


Figure 2. MAX194 EV Kit Component Placement Guide—Component Side

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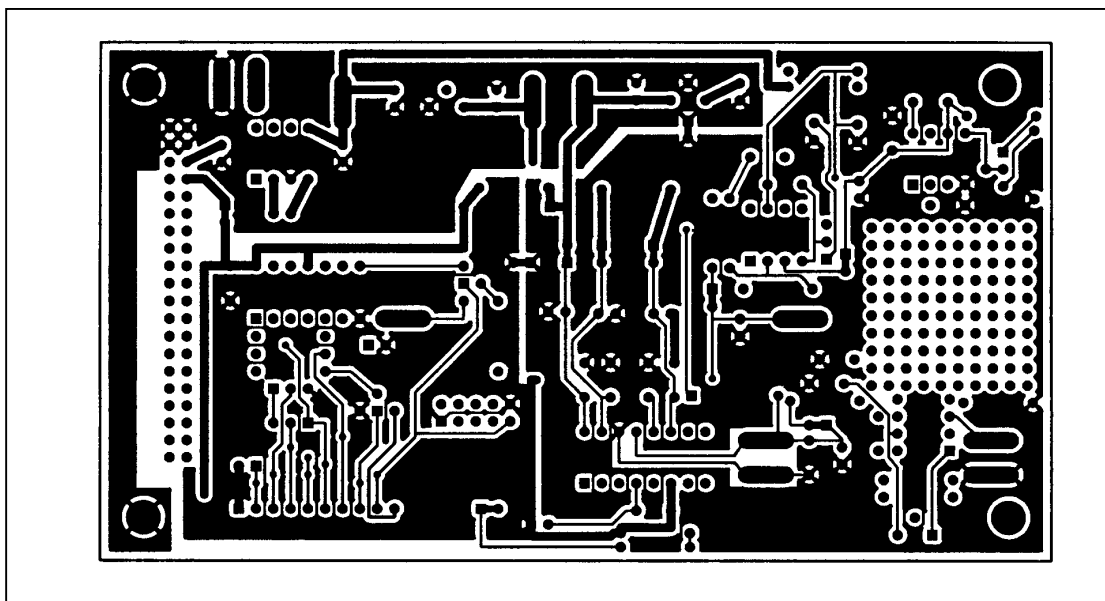


Figure 3. MAX194 EV Kit PC Board Layout—Component Side

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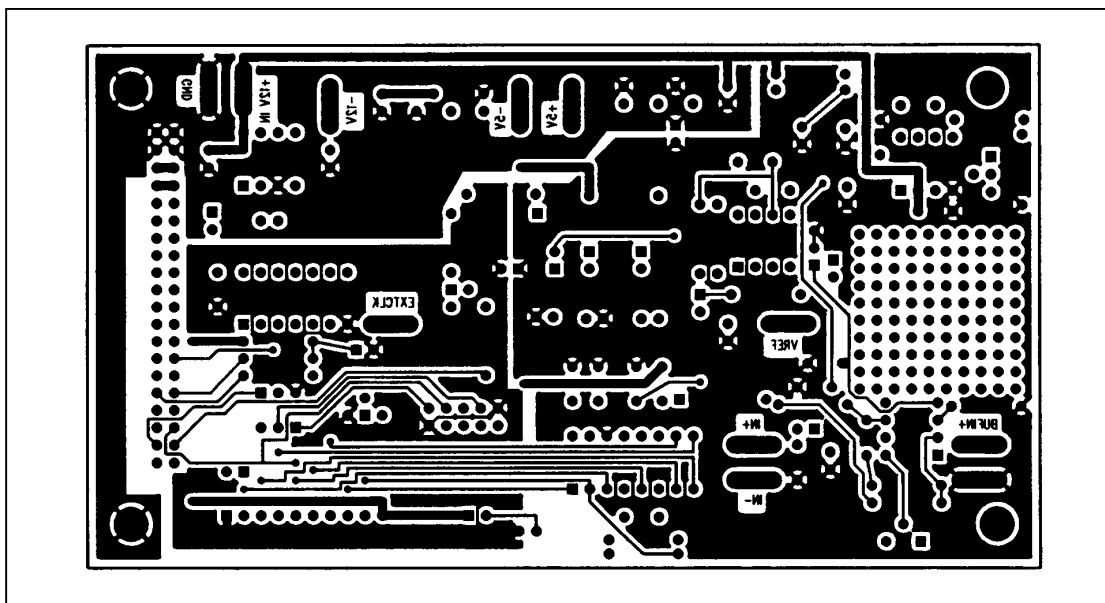


Figure 4. MAX194 EV Kit PC Board Layout—Solder Side

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68HC16 Module Component List

DESIGNATION	QTY	DESCRIPTION
C1, C2, C3	3	1μF ceramic capacitors
C4, C5	2	22μF, 25V radial-lead electrolytic capacitors
C6, C7	2	22pF capacitors
C8	1	0.01μF capacitor
C9	0	Reference designator, not used
C10–C14	5	0.1μF capacitors
D1	1	1N4001 diode
J1	1	40-pin right-angle male connector
J2	1	2-circuit terminal block
J3	1	Right-angle printed circuit board mount, DB9 female socket
J4	0	Empty
JU1	0	Empty
JU2	0	Reference designator, not used
JU3	0	Empty
JU4	0	Empty
JU5	0	Empty
L1	0	Empty
L2	0	Empty
LED1	1	Light-emitting diode
R1	1	10MΩ, 5% resistor

68HC16 Module General Description

The 68HC16 module is an assembled and tested printed-circuit board intended for use with Maxim's high-speed serial-interface evaluation kits (EV kits). The module uses an inexpensive 8-bit implementation of Motorola's MC68HC16Z1 microcontroller (μC) to collect data samples at high speed using the QSPI™ interface. It requires an IBM-compatible personal computer and an external DC power supply, typically 12V DC or as specified in EV kit manual.

Maxim's 68HC16 module is provided to allow customers to evaluate selected Maxim products. It is not intended to be used as a microprocessor development platform, and such use is not supported by Maxim.

DESIGNATION	QTY	DESCRIPTION
C1, C2, C3	3	1μF ceramic capacitors
C4, C5	2	22μF, 25V radial-lead electrolytic capacitors
C6, C7	2	22pF capacitors
C8	1	0.01μF capacitor
C9	0	Reference designator, not used
C10–C14	5	0.1μF capacitors
D1	1	1N4001 diode
J1	1	40-pin right-angle male connector
J2	1	2-circuit terminal block
J3	1	Right-angle printed circuit board mount, DB9 female socket
J4	0	Empty
JU1	0	Empty
JU2	0	Reference designator, not used
JU3	0	Empty
JU4	0	Empty
JU5	0	Empty
L1	0	Empty
L2	0	Empty
LED1	1	Light-emitting diode
R1	1	10MΩ, 5% resistor

68HC16 Module Detailed Description

Power Input Connector J2

The 68HC16 module draws its power from a user-supplied power source connected to terminal block J2. Be sure to note the positive and negative markings on the board. A three-terminal 5V regulator allows input voltages between 8V and an absolute maximum of 20V. The 68HC16 module typically requires 200mA of input current.

68HC16 Microcontroller

U1 is Motorola's 68HC16Z1 μC. Contact Motorola for μC information, development, and support. Maxim EV kits use the high-speed queued serial peripheral interface (QSPI) and the internal chip-select generation.

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.

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™ QSPI is a trademark of Motorola Corp.

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The 68HC16 uses a phase-locked loop (PLL) to set its bus speed. Crystal Y1 is a 32.768kHz frequency reference. The internal oscillator runs 256 times faster than the external crystal. When the 68HC16 is reset, it waits for the PLL to lock before it executes any software. After the PLL locks onto the reference frequency, the software doubles the clock speed by writing to the clock synthesizer control register, selecting a bus speed of 16.78MHz.

U5, the user RAM area, is a 32kbyte CMOS static RAM.

The 74HCT245 octal buffer lets the 68HC16 module access an 8-bit port on the 40-pin interface connector. This memory-mapped port consists of separate read and write strobes, four chip selects, four address LSBs, and eight data bits.

Serial Communications

J3 is an RS-232 serial port, designed to be compatible with the IBM PC 9-pin serial port. Use a straight-through DB9 male-to-female cable to connect J3 to this port. If the only available serial port has a 25-pin connector, you may use a standard 25-pin to 9-pin adapter. Table 9 shows the pinout of J3.

The MAX233 is an RS-232 interface voltage level shifter with two transmitters and two receivers. It includes a built-in charge pump with internal capacitors that generates the output voltages necessary to drive RS-232 lines.

40-Pin Data Connector J1

The 20 x 2 pin header connects the 68HC16 module to a Maxim EV kit. Table 10 lists the function of each pin. Note that 68HC16 object code is not compatible with 68HC11 object code. Use the 68HC16 module only with those modules that are designed to support it, and only download code that is targeted for the 68HC16 module. Downloading incorrect object code into the 68HC16 module will have unpredictable results.

Address Ranges

The 68HC16 μ C generates various enable signals for different address ranges. The ROM and RAM enable signals are fed directly to the respective chips. Several additional signals (J1.11–J1.14) are available on the data connector to be used by Maxim EV kits. Table 11 outlines the address ranges for each of the elements found on the 68HC16 module, and Table 12 is a truth table that describes the logic for each of the 68HC16's chip-select outputs. Because the addresses are not completely decoded, the boot ROM and user RAM have shadows.

Table 9. Serial Communications Port J3

PIN	NAME	FUNCTION
1	DCD	Handshake; hard-wired to DTR and DSR
2	RXD	RS-232-compatible data output from 68HC16 module
3	TXD	RS-232-compatible data input to 68HC16 module
4	DTR	Handshake; hard-wired to DCD and DSR
5	GND	Signal ground connection
6	DSR	Handshake; hard-wired to DCD and DTR
7	RTS	Handshake; hard-wired to CTS
8	CTS	Handshake; hard-wired to RTS
9	None	Unused

Table 10. 40-Pin Data-Connector Signals

PIN	NAME	FUNCTION
1–4	GND	Ground
5, 6	VPREREG	Unregulated input voltage
7, 8	VCC	+5V from on-board regulator
9	$\overline{RD}$	Read strobe
10	$\overline{WR}$	Write strobe
11	$\overline{7E000}$	Chip select for 7E000–7E7FF
12	$\overline{7E800}$	Chip select for 7E800–7EFFF
13	$\overline{7F000}$	Chip select for 7F000–7F7FF
14	$\overline{7F800}$	Chip select for 7F800–7FFFF
15	A00	Address bit 0 (LSB)
16	A01	Address bit 1
17	A02	Address bit 2
18	A03	Address bit 3
19	EXTD0	Buffered data bus 0 (LSB)
20–26	EXTD1–7	Buffered data bus bits 1–7
27	IC1	General I/O port bit 0 (LSB)
28	IC2	General I/O port bit 1
29	IC3	General I/O port bit 2
30	OC1	General I/O port bit 3
31	OC2	General I/O port bit 4
32	OC3	General I/O port bit 5
33	OC4	General I/O port bit 6
34	IC4	General I/O port bit 7
35	MISO	QSPI master-in, slave-out
36	MOSI	QSPI master-out, slave-in
37	SCK	QSPI serial clock
38	PCS0/SS	QSPI chip-select output
39	CLKOUT	System clock output
40	PWMA	Pulse-width-modulator output

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Table 11. 68HC16 Module Memory Map
(all address values are in 20-bit hex)

PIN	FUNCTION
00000–07FFF	Boot ROM (U3, strobed by CSBOOT)
08000–0FFFF	Shadow of boot ROM
10000–17FFF	User RAM (U5, strobed by CS0 and CS2)
18000–1FFFF	Shadow of user RAM
20000–203FF	Internal standby RAM; 1kbyte
20400–7DFFF	Unused
7E000–7E7FF	External chip select (J1 pin 11) (CS7)
7E800–7EFFF	External chip select (J1 pin 12) (CS8)
7F000–7F7FF	External chip select (J1 pin 13) (CS9)
7F800–7FFFF	External chip select (J1 pin 14) (CS10)
80000–F7FFF	Not accessed by the 68HC16
F8000–FF6FF	Unused
FF700–FF73F	68HC16's built-in ADC (not used)
FF740–FF8FF	Unused
FF900–FF93F	General-purpose timer module (GPT)
FF940–FF9FF	Unused
FFA00–FFA7F	System integration module (SIM)
FFA80–FFAFF	Unused
FFB00–FFB07	Internal standby RAM (SRAM) control registers
FFB08–FFBFF	Unused
FFC00–FFDFF	Queued serial module (QSM)
FFE00–FFFFF	Unused

Boot ROM

The boot ROM, U3, is configured as an 8-bit memory device. Resistor R4 pulls data bit 0 low during system reset, forcing the μ C to fetch instructions using only the upper eight data bits. The boot ROM checks the system and waits for commands from the host. Refer to the EV kit manual for specific start-up procedures.

Software

All software is supplied on a disk with the EV kit. Instructions for operating the software are included in the EV kit manual. Refer to the EV kit manual for more information.

68HC16 Module Self Check

To test the 68HC16 module's integrity, connect the power supply to the power terminals (J2). Do not connect anything to J1 or J3. Slide the power switch SW1 to the "ON" position. The LED will light up, and will flash within 5 seconds.

If the LED flashes with a 50%-on/50%-off duty cycle, then it passed its self check. Note that this test does not exercise the RS-232 port or the EV kit 40-pin interface, but it does confirm that the power supply, micro-processor, ROM, and RAM passed the self test.

If the LED flashes with a 10%-on/90%-off duty cycle, then it failed its self check. Most likely, the RAM chip (U5) is bad.

If the LED remains on and does not flash, then the problem is either U3 (the EPROM), U1 (the micro-processor), U4 (the regulator), the MAX707 reset generator, or the power supply. Use a voltmeter to verify that the power supplies are good. Check the power-supply input and the +5V output from the regulator. Use an oscilloscope to see if the 32.768kHz reference oscillator is running.

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Table 12. 68HC16 Chip-Select Outputs Truth Table

ADDRESS RANGE	CSBOOT	CS0	CS1	CS2	CS5	CS6	CS7	CS8	CS9	CS10
0xxxx read	L	H	H	H	H	H	H	H	H	H
1xxxx read	H	H	H	L	H	H	H	H	H	H
1xxxx write	H	L	H	H	H	H	H	H	H	H
7E0xx read	H	H	L	H	H	L	L	H	H	H
7E0xx write	H	H	H	H	L	L	L	H	H	H
7E8xx read	H	H	L	H	H	L	H	L	H	H
7E8xx write	H	H	H	H	L	L	H	L	H	H
7F0xx read	H	H	L	H	H	L	H	H	L	H
7F0xx write	H	H	H	H	L	L	H	H	L	H
7F8xx read	H	H	L	H	H	L	H	H	H	L
7F8xx write	H	H	H	H	L	L	H	H	H	L

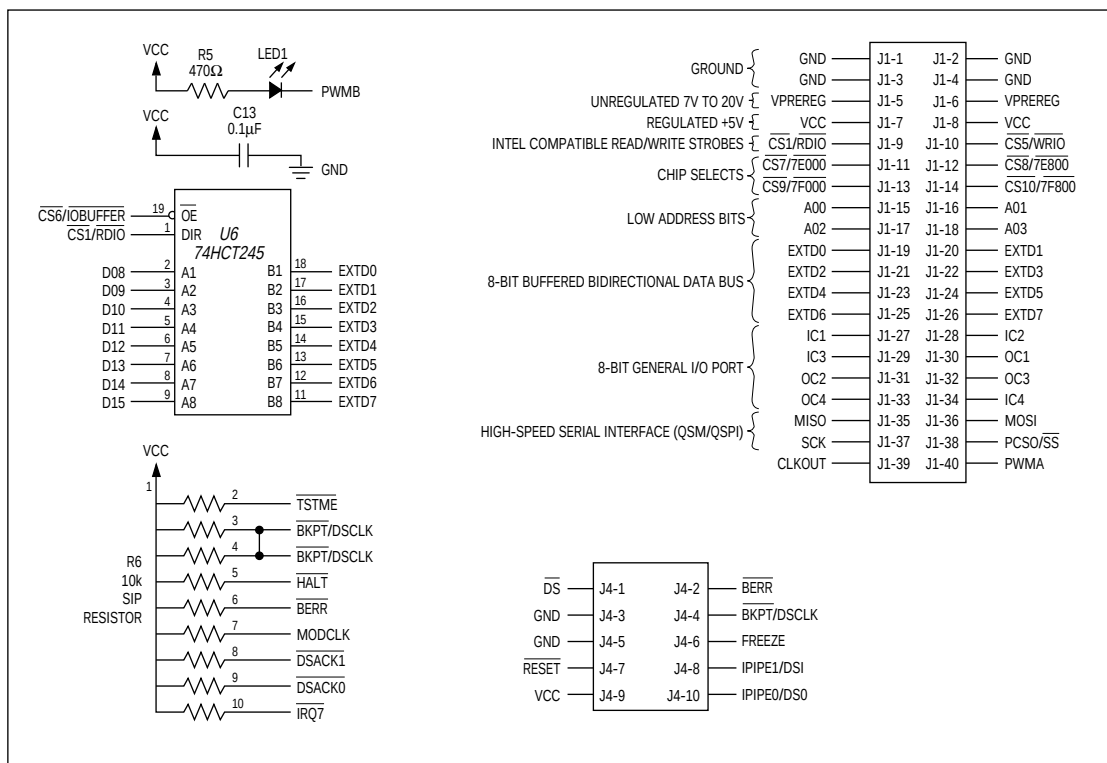
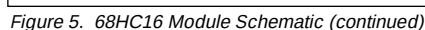


Figure 5. 68HC16 Module Schematic

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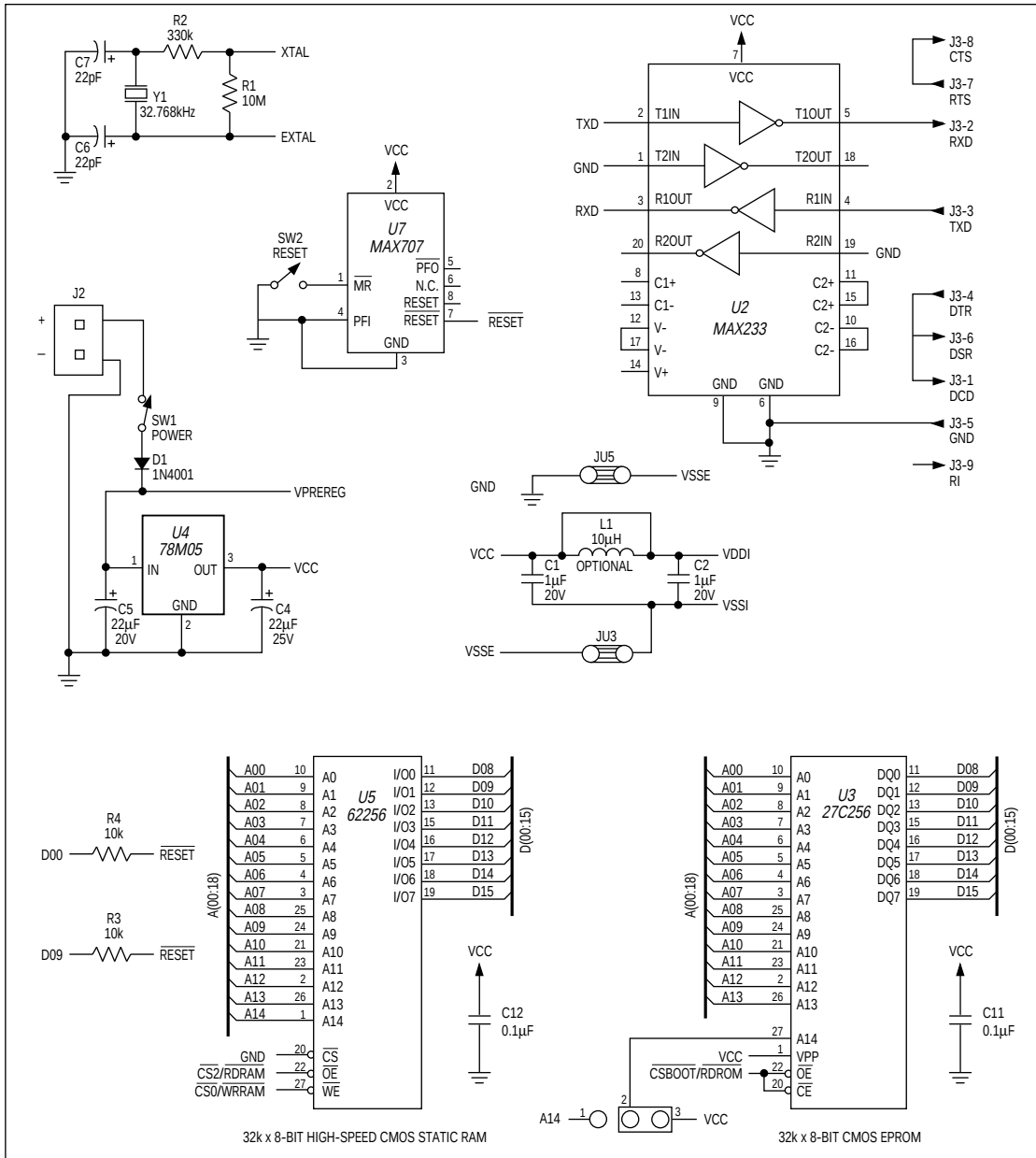


Figure 5. 68HC16 Module Schematic (continued)

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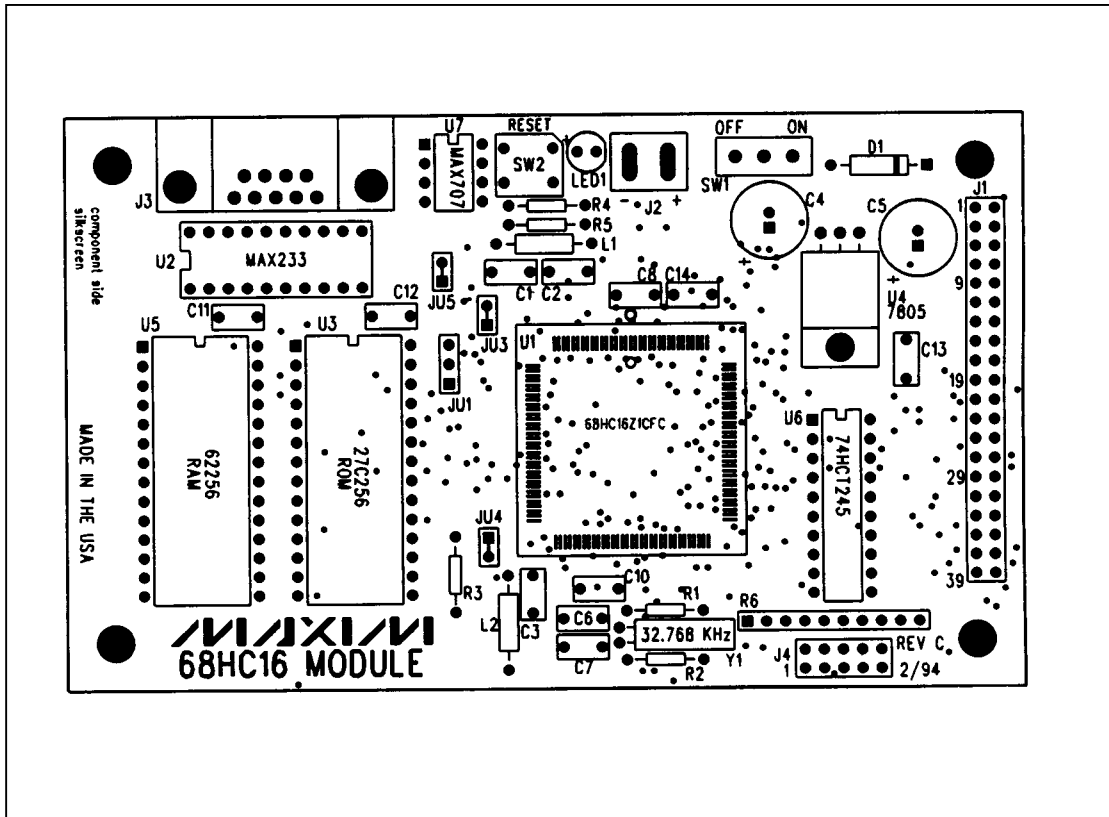


Figure 6. 68HC16 Module Component Placement Guide—Component Side

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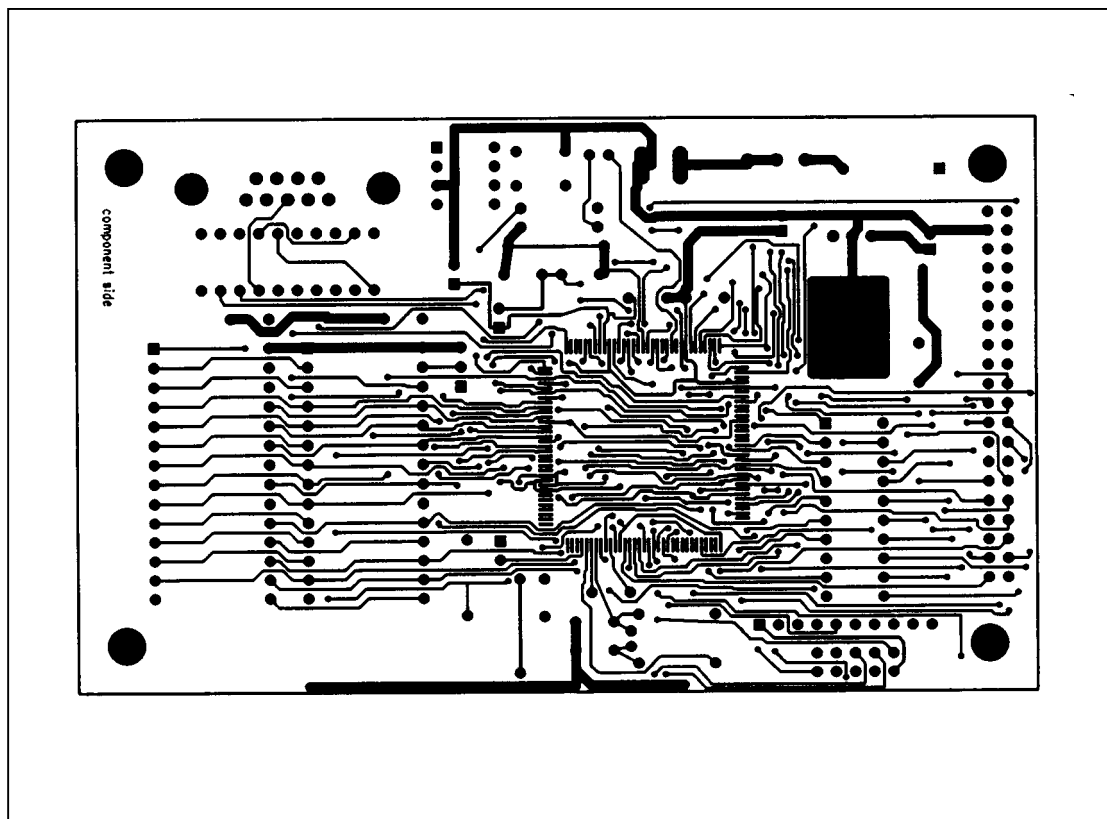


Figure 7. 68HC16 Module PC Board Layout—Component Side

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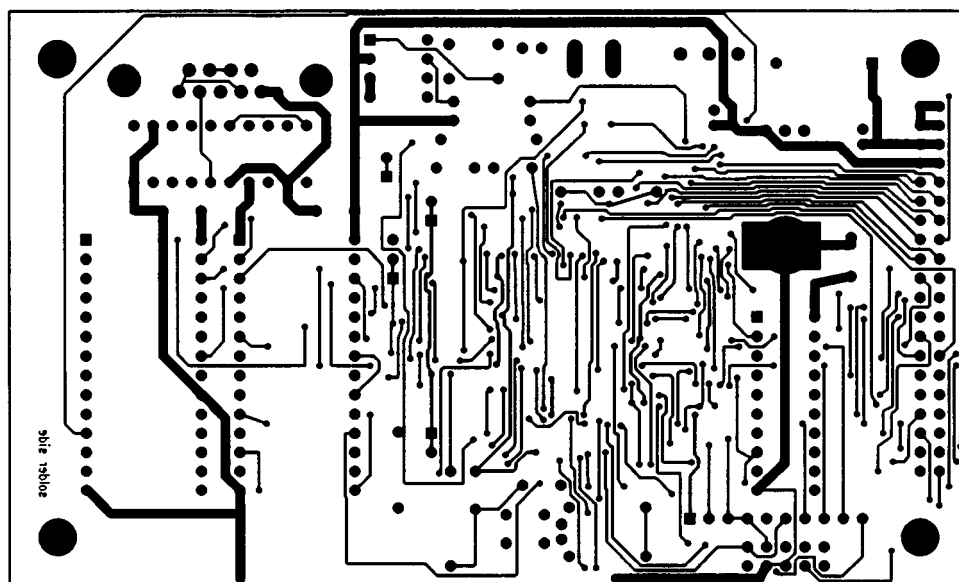


Figure 8. 68HC16 Module PC Board Layout—Solder Side

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