



## MAX132 Evaluation Kit

Evaluates: MAX132

### General Description

The MAX132 evaluation kit (EV kit) contains a fully assembled and functional printed circuit board with a MAX132 ADC, 80C32 microcontroller, MAX699 microprocessor supervisor, MAX233 RS-232 interface, and all other components needed for an 18-bit DAS. 8kbytes of EPROM contain the 80C32 program code, and an additional 8kbytes of CMOS RAM is included to store conversion results. A prototyping area of 5in<sup>2</sup> is reserved for breadboarding, signal conditioning or other application-specific circuits.

The kit operates from a single +5V supply, and links to an IBM-compatible personal computer through an RS-232 link. Commands entered on the keyboard are sent to the EV kit board, and conversion results are returned for display. All required IBM-compatible software is included.

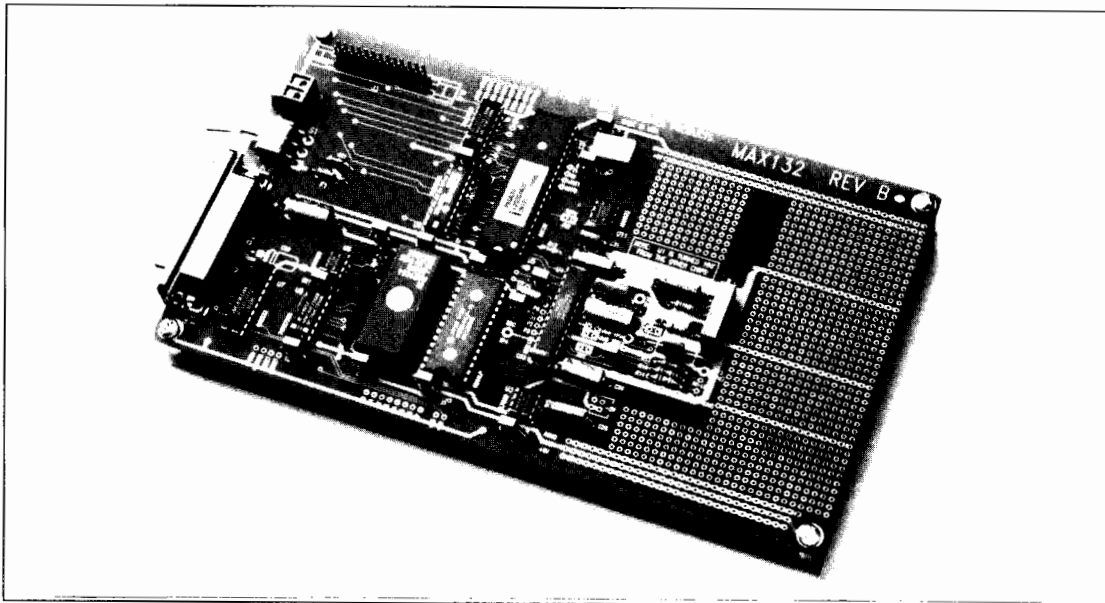
### Features

- ◆ Fully Functional 18-Bit ADC
- ◆  $\pm 5V$  Input Range
- ◆ Single +5V Supply Operation
- ◆ IBM-Compatible Software Included
- ◆ Complete 80C32 Code Listing Provided

### Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX132EVKIT-DIP	0°C to +70°C	Plastic DIP-Through Hole

### EV Kit



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### Component List

DESIGNATION	QTY	DESCRIPTION
C3, C4, C8, C9	4	15pF ceramic capacitors
C31	1	0.047 $\mu$ F monolithic capacitor
C5, C16, C17, C18, C21, C22, C27, C28, C29, C30	10	0.1 $\mu$ F 50V monolithic capacitors
C10, C15, C23	3	1.0 $\mu$ F 50V monolithic capacitors
C13	1	4700pF polystyrene capacitor
C14	1	0.1 $\mu$ F polypropylene capacitor
C12	1	4.7 $\mu$ F electrolytic capacitor
C11, C24, C26	1	10 $\mu$ F electrolytic capacitors
C19	1	100 $\mu$ F electrolytic capacitor
CR1	1	1N4001 diode
F1	1	0.5A picofuse
J1	1	2-pin power connector
J2	1	DB25 right-angle connector
J3	1	26-pin IDC header
JU3	1	2-pin jumper header
R6	1	604k $\Omega$ 1% resistor
R8	1	120k $\Omega$ 1% resistor
R9	1	40.2k $\Omega$ 1% resistor
R10	1	100k $\Omega$ 1% resistor
R11	1	100k $\Omega$ trim pot
R12	1	510 $\Omega$ 5% resistor
R13	1	1.13k $\Omega$ 1% resistor

R14	1	10.2k $\Omega$ 1% resistor
RP1, RP2	2	10k $\Omega$ 10-pin 9-resistor SIP
S1	1	Power switch
U1	1	MAX132
U2	1	74HCT138
U3	1	ICL7660
U4	1	74HCT373
U5	1	80C32
U6	1	MAX699
U7	1	MAX233
U8	1	74HC7266
U9	1	27C64
U10	1	6264LP
U11	1	MAX872
Y1	1	11.059MHz crystal
Y2	1	32.768kHz crystal
N.A.	1	28-pin, 0.600" IC socket for EPROM
N.A.	1	Shunt
N.A.	4	Mounting posts
N.A.	8	4-40 X 1/4" screws
N.A.	4	Rubber feet
N.A.	1	8.5" X 5.0" printed circuit board
N.A.	1	8.5" X 5.0" blank circuit board for ground plane (shield)

### Quick Reference

Setup and operation of the MAX132 EV kit involves the following steps:

- Copy the MAX132 EV kit floppy disk to a blank disk or a directory on a hard disk and store the original in a safe place. Use the copy for normal operation.
- Read the README file for updates and changes to hardware and/or software.
- Connect a cable between a serial port (COM1 or COM2) of the personal computer and the MAX132 EV kit. If a 25-pin (D25) connector is available, a straight-through cable can be used. If only a 9-pin (D9) connector is available, an adapter is required.
- Start the SERCOMM program on the personal computer (type "SERCOMM") and set the indicated active port to agree with the cable location (menu-driven).
- Connect a +5.0V supply to the MAX132 EV kit printed circuit board and turn on the power.
- Type a SPACE to initialize the communication between the personal computer and the EV kit. The board should respond with a logon message.
- Enter a "?" for a list of the available software commands. A complete list can also be found in the SOFTWARE.DOC file on the disk.
- Connect an input source between the IN HI and the IN LO pads on the printed circuit. The input voltage has a  $\pm 512$ mV range. Because the input voltage is attenuated 10:1 by a resistor divider before going to the input of the MAX132,  $\pm 5$ V can be applied to the EV kit input.

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### Hardware Description

The following is an overview of the various circuits found on the MAX132 EV kit. Since it is impractical to fully document each device in this manual, please refer to the individual data sheets for complete descriptions.

#### RS-232 Interface

The RS-232 interface connects an external terminal to the evaluation board. The MAX233 +5V-powered, RS-232 transmitter and receiver interface IC performs the level shifting required between the serial link and the 80C32 serial port. The receiver input shifts the  $\pm 10\text{V}$  RS-232 levels to TTL levels. And the transmitter side shifts TTL levels to  $\pm 10\text{V}$ .

#### 80C32 Microcontroller

The MAX132 EV kit uses the 80C32 8-bit microcontroller. The 80C32 is a member of the 8051 family that requires external EPROM for program storage. Internally, it has 256 bytes of RAM and four 8-bit input/output (I/O) ports. On the EV kit, two of these ports (P0 and P2) are used for address and data lines to the external EPROM and RAM. A third (P3) is needed for the RS-232 serial link and memory control. The remaining port (P1) communicates with the MAX132, toggles the watchdog input, and senses the 50Hz/60Hz jumper.

The user initiates conversions using the personal computer keyboard by running a terminal emulator program such as SERCOMM. The 80C32 receives the instruction over the RS-232 link, performs the conversions and returns the results for display.

The EV kit includes 8kbytes of EPROM (the 27C64) to hold the 80C32 instructions for normal operations, and 8kbytes of CMOS RAM (the 6264) to store conversion results.

#### MAX699 Microprocessor Supervisor

The MAX699 low-cost power-on reset and watchdog-timer controller provides on-board system supervision for the microprocessor ( $\mu\text{P}$ ). The MAX699 generates a RESET signal at power-up and whenever the  $\mu\text{P}$ 's firmware fails to generate a transition on the watchdog input at least once a second. The watchdog input is connected to bit 0 of port 1 (P1.0) through JU3. The watchdog function can be defeated for debugging by removing the shunt across JU3. See the MAX699 data sheet for more information.

#### MAX132

The MAX132/80C32 serial interface is controlled by five bits on port 1 of the 80C32 (P1.1 to P1.5). The function of

each pin is given in Table 1. Data is transferred in both directions during each cycle. A data cycle starts when the Chip Select (CS) pin is taken low and the data field advances as the clock (SCLK) cycles eight times. The input field sets the MAX132 operating mode and selects the data register to output during the next data cycle (see Table 1 and Figure 1). Refer to the MAX132 data sheet for a full description.

A resistor divider is connected to the MAX132's input so that an input of  $\pm 5.12\text{V}$  is reduced to  $\pm 512\text{mV}$  for the ADC. An input filter consisting of a  $100\text{k}\Omega$  resistor and  $0.10\mu\text{F}$  capacitor (R10 and C22) is also provided. The input divider is provided to increase the  $\pm 512\text{mV}$  input range to  $\pm 5.12\text{V}$ . This makes evaluating the MAX132's accuracy and resolution easier. The divider circuit can be removed for most user applications.

Table 1. 80C32 Port 1 Bit Functions

BIT	DESIGNATION	FUNCTION
P1.0	TIC-TOC	Continuous transitions to the MAX699 for watchdog control
P1.1	A2D-CS	MAX132 chip-select driver
P1.2	A2D-DIN	Data to the MAX132 DIN pin
P1.3	A2D-DOUT	Data from the MAX132 DOUT pin
P1.4	A2D-SCLK	Clock signal for MAX132 data transfer
P1.5	A2D-EOC	End-of-conversion signal from the MAX132
P1.6	Not used	
P1.7	60Hz/50Hz	Normally high to signify 60Hz operation. Ground by placing a jumper across JU2 to select 50Hz operation.

#### MAX872 Reference

The MAX132 EV kit uses a MAX872 2.5V reference. The MAX872's 2.500V output is divided down to  $+545\text{mV}$  for the MAX132 reference input (60Hz operation). A trim pot (R11) is provided for final trim voltage adjustment. For 50Hz operation, adjust the potentiometer for a reference voltage of  $655\text{mV}$ . Refer to the MAX132 data sheet for a full discussion of reference voltage selection.

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### Software Description

The MAX132 EV kit software consists of two elements. One is the 80C32 code stored in the EPROM. The other is the SERCOMM terminal emulator program that runs on an IBM-compatible computer. The 5 1/4" floppy disk supplied with the kit contains the source file for the 80C32 code, the SERCOMM program, and documentation. Be sure to return the registration form to receive future updates.

### The SERCOMM Program

Maxim supplies the SERCOMM terminal emulation program for operation with Maxim's EV kits. The SERCOMM.EXE program on the diskette can be copied to a hard disk drive or started from the floppy disk. The program displays the operating status and a menu of the available commands. A terminal emulator program other than SERCOMM can be used if it is set for 8-bit, no-parity, full-duplex operation. To start the SERCOMM program, set DOS to the disk or directory where SERCOMM.EXE is located, then type "SERCOMM".

### EPROM Firmware

The 80C32 code was written using an 8051 assembler from 2500AD Software (phone 719-395-8683). The operating code is stored in a 27C64 EPROM located on the printed circuit board. Available commands are outlined in the *Command Set* section.

When the board is powered up, the firmware initializes and then enters an automatic baud-rate detection loop. The autobaud routine examines the first character received to determine the incoming baud rate.

### THE FIRST CHARACTER THE BOARD RECEIVES AFTER A RESET MUST BE A SPACE.

The space character (20 hex) is expected by the autobaud routine. A different character causes the board to calculate an erroneous baud rate, resulting in garbled communications. If you inadvertently press another key, the board must be reset by cycling the power supply.

### ROM Program Interface

A prompt is displayed after every command is executed signifying that the system is ready for a new command. It displays the present operating mode set by the user. The prompt takes the following form:

```
MAX132 LINE_FREQ OUTPUT_FORMAT OUTPUT_MODE>
```

The line frequency is determined by jumper JU2's condition. If the jumper is left open (default), the system assumes the 60Hz mode. If jumper JU2 is shorted, the system will set the 50Hz bit in the MAX132 status register.

The output format is either hex or binary. The screen display is normally in the hex format. The binary mode

returns the conversion results as a binary value. Since these results are not in ASCII form, displaying these values on your terminal will cause unpredictable results. The binary mode should only be used to collect data to a data file (future program expansion).

The output mode is either normal or extended. The normal mode does not display the three extended LSBs. The polarity of the displayed result is set by the polarity bit in the MAX132 output status register. Note that the most significant bit (MSB) cannot be used as a polarity indicator. Table 2 illustrates the range of bits B18-B3 and the polarity bit.

Table 2. Output Values (Offset Corrected)

Input Device	Displayed Reading	Decimal Counts
+640mV	+A000	+40960*
+576mV	+9000	+36864*
+545mV	+8840	+34880*
+512mV	+8000	+32768
+448mV	+7000	+28672
+384mV	+6000	+24576
+320mV	+5000	+20480
+256mV	+4000	+16384
+192mV	+3000	+12288
+128mV	+2000	+8192
+64mV	+1000	+4096
+15µV	+0001	+1
0	+0000	0
-15µV	-FFFF	-1
-64mV	-F000	-4096
-128mV	-E000	-8192
-192mV	-D000	-12288
-256mV	-C000	-16384
-320mV	-B000	-20480
-384mV	-A000	-24576
-448mV	-9000	-28672
-512mV	-8000	-32768
-545mV	-77C0	-34880*
-576mV	-7000	-36864*
-640mV	-6000	-40960*

\* Soft Overage Operation

**NOTE:** The MAX132 exhibits additional errors when operating in the soft overrange area. Operation in this region is not included in the specifications. The soft overrange values listed in Table 2 do not include error correction.

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## Command Set

The following keyboard commands are available for controlling the MAX132 EV kit. Type a question mark ("?") to view the help list (shown below) whenever the board is operational. Be sure to refer to the disk documentation for possible changes to the command list.

### HELP LIST

Output Display Format Selection Commands:

- H - Hexadecimal format
- ^B - Binary format
- Z [0,1,2,4,...,32] - Set averaging count and read internal zero

Output Display Mode Selection Commands:

- N - Normal 16-bit display
- E - Extended 18-bit display

Conversion Initiation Commands:

- M - Make a single conversion and display the results. A carriage return may also be used.
- C - Continuously convert and display until any key is pressed.
- P [0...F] - Set MAX132 user-programmable output bits

RAM-Related Commands:

- R - RAM test
- S - Store conversions in RAM buffer
- O - Output the values stored in RAM

### Output Display Format Selection

#### H - Hexadecimal Format

The conversion results are normally displayed in hexadecimal format. The polarity bit from the MAX132 status register is displayed as a leading plus or minus sign. The lower three data bits that are output as part of the MAX132 status register are not part of the normal display value. Their value is optionally displayed in the extended display format.

#### ^B - Binary Format

The binary output format is not for display. It is intended for quickly capturing large data samples in a non-ASCII format. Sending binary format to a screen will yield unpredictable results, since binary format data may be misinterpreted as control characters.

### Z [0,1,2,4,...,32] - Set the Averaging Count and Sample Internal Zero

Sets the number of samples to be read and averaged for each display cycle, and reads the internal offset value. This offset reading is stored and subtracted from all future conversion results. The number of samples must be a power of 2, less than or equal to 32 (1,2,4,8,16 or 32). Entering just "Z" will sample the zero reading using the present settings and display the results. Averaging and offset correction may be turned off by entering "Z0".

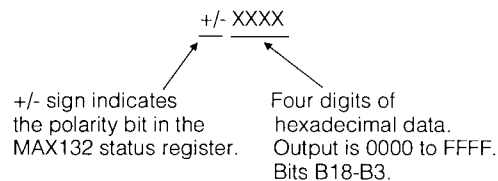
- Z ..... Display the current averaging count and take a new zero reading.
- Z0 ..... Turn off averaging and zero correction.
- Z1-32... Set the averaging count and take a new zero reading.

### Output Display Mode Selection

#### N - Normal 16-Bit Display Mode

Set the display mode to the 16-bit hexadecimal format. The three least significant bits (LSBs) in the MAX132 status register byte are not displayed. The polarity bit is indicated as a leading "+" or "-" sign.

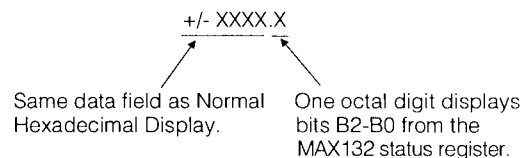
Normal Hexadecimal Display:



#### E - Extended 18-Bit Display Mode

Sets the display mode to show all bits. Bits B18-B3 are displayed as for the normal hexadecimal output. The lower three bits (B2-B0) from the status register are displayed as an octal number following a decimal point.

Extended Hexadecimal Display



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### Conversion Initiation Commands

#### M - Make a Single Conversion

Initiate a single conversion cycle by typing an "M" or a carriage return. Either method will return the conversion results using the display mode indicated in the prompt.

#### C - Continuously Convert

Conversion cycles will repeat until any key on the keyboard is pressed.

#### P [0...F] - Set User Programmable Bits

The MAX132 has four programmable output pins that may be used to control external muxes or logic circuits. The pin outputs are set by entering a "P" followed by a hex number representing the four bits. For example, entering "PA" would set bits P3 and P1 (1010 hex).

### RAM-Related Commands

#### R - RAM Test

The CMOS RAM located on the printed circuit board is filled with bit patterns and then read to verify performance. The system will announce any errors encountered. The RAM test repeats until a key on the keyboard is pressed.

#### S - Store the Conversions in RAM

The conversion results are sent to the RAM instead of the display. Collection continues until 2048 samples have been collected or any key is pressed.

#### O - Output the Values Stored in RAM

The conversion results previously stored in RAM are retrieved for display.

### Applications Information

#### Power-Supply Requirements

The printed circuit board for the MAX132 EV kit requires a single 5.0V  $\pm 5\%$  supply. Avoid using a noisy supply (a linear supply is preferable to a switching type). The typical supply current is 75mA (note that the MAX132 draws only 60 $\mu$ A typ). The MAX132 requires dual  $\pm 5$ V supplies, and an ICL7660 charge-pump voltage inverter is included on the board to generate the -5V supply.

#### Noise Reduction Techniques

The analog circuitry surrounding the MAX132 is extremely susceptible to noise pickup from external sources. The user should take the following precautions in the final product.

1. The user's product should shield the MAX132 circuitry as much as possible. A ground plane connected to analog ground should surround the MAX132 analog section.
2. The integrator resistor (RINT, R6) should be a metal-film low-noise resistor.
3. The MAX132 should have decoupling capacitors as close to the MAX132 supply pins as possible.
4. The input resistor, and any input divider, should be located close to the MAX132 to minimize input trace length.
5. The printed circuit board trace on the integrator input (pin 21) should be as short as possible. This high-impedance node is subject to noise pickup.
6. The MAX132 digital lines should remain static while a conversion is in progress. The user should monitor the MAX132 EOC signal to determine when a conversion is complete.
7. An external ground plane is included in the EV kit. When placed beneath the main circuit board, a ground shield can reduce noise by several microvolts or more.
8. A low-noise reference such as the MAX872 (included in the kit) is recommended.
9. The digital signal traces should be kept away from the MAX132 analog section.
10. Lowest noise is achieved by averaging multiple conversions (see the MAX132 data sheet).
11. To avoid ground loops and noise coupling, the analog and digital grounds should return separately to the power supply ground. For lowest noise, the analog and digital +5V supplies should also be routed separately.

#### Attaching the Terminal

The MAX132 EV kit connects to a personal computer via an RS-232 cable. Both 9-pin and 25-pin connectors are widely used for RS-232 serial ports on IBM-compatible computers. A 25-pin connector is used on the MAX132 EV kit. If a 25-pin serial port is available on the user's PC, only a simple cable is required. If only a 9-pin serial port is available, an adapter (found at most computer stores) is required.

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### Jumper Selections

Two functions are altered by jumpers on the MAX132 EV kit printed circuit board. Jumper JU2 selects 50Hz/60Hz operation. The kit is shipped with JU2 open (60Hz mode). To select 50Hz mode, install a piece of wire across JU2. The kit also includes a 2-pin header for JU3. Installing the shunt across the two pins connects the MAX699's watchdog input to P1.0 of the 80C32. If the shunt is installed, the 80C32 must toggle P1.0 every second to prevent the MAX699 from resetting the system. If the jumper is opened, the MAX699 watchdog function is disabled. The MAX699 will continue to reset the 80C32

**Table 3. EV Kit Jumper Selections**

JUMPER NUMBER	FUNCTION	JUMPER OPEN	JUMPER SHORTED
JU2	50Hz/60Hz Operation	60Hz	50Hz
JU3	Watchdog Function	Disabled	Enabled

whenever the input voltage drops below 4.75V independent of jumper JU3.

### Software Loading

Before doing anything else, make a copy of the disk provided with the MAX132 EV kit. Use the copy for all operations and keep the original in a safe place. If a hard disk is available, all files can be copied to a directory and executed from there.

The disk contains a README file that lists any changes to the hardware or software. Read the README file before proceeding. A list of the available commands is contained in the SOFTWARE.DOC file.

Be sure to fill out and return the User Registration form found on the disk. This will allow you to receive future EV kit updates.

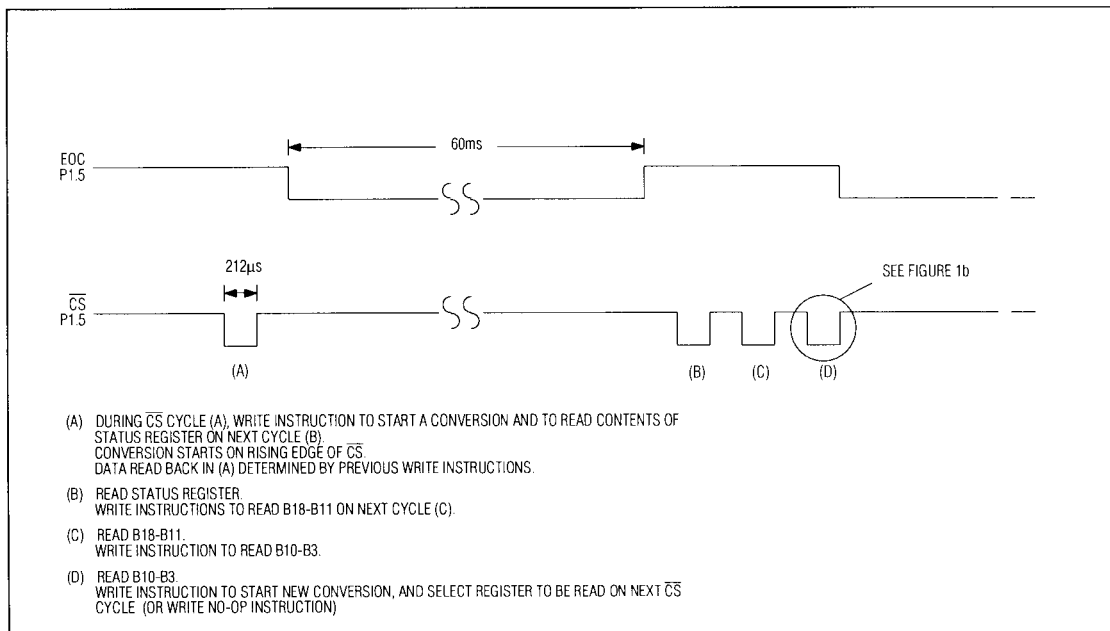


Figure 1a. MAX132 Conversion and I/O Sequence

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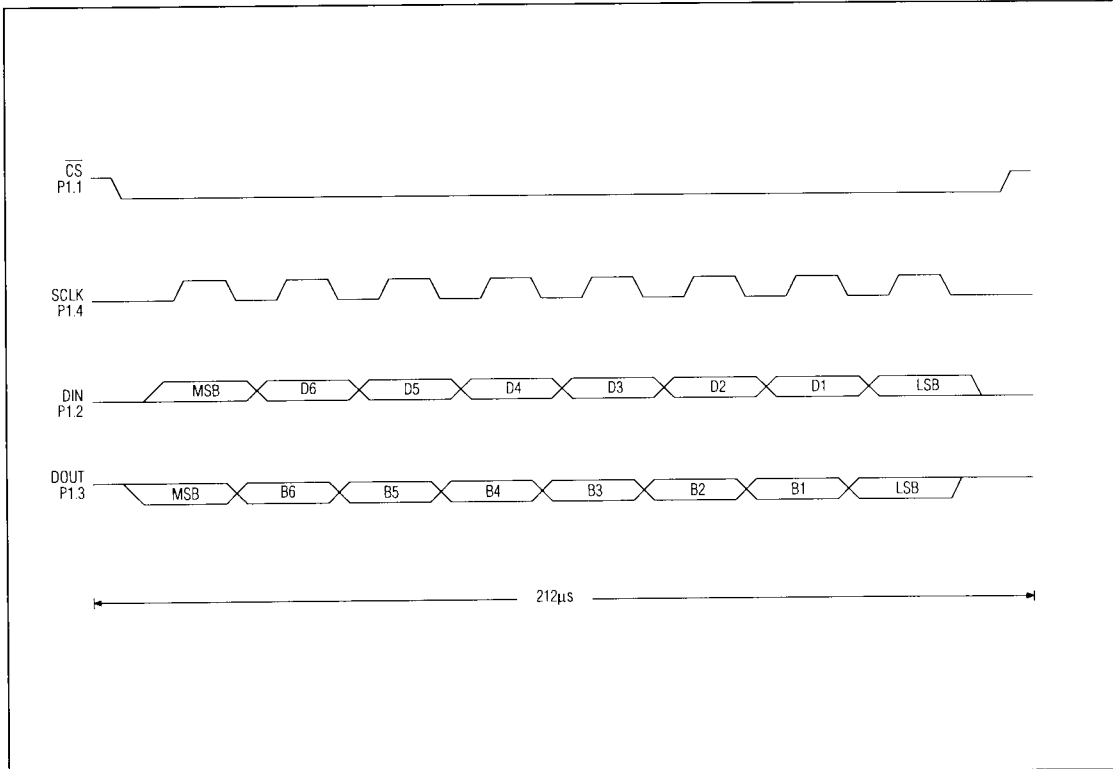


Figure 1b. MAX132/80C32 Detailed I/O Cycle



# MAX132 Evaluation Kit

Evaluates: MAX132

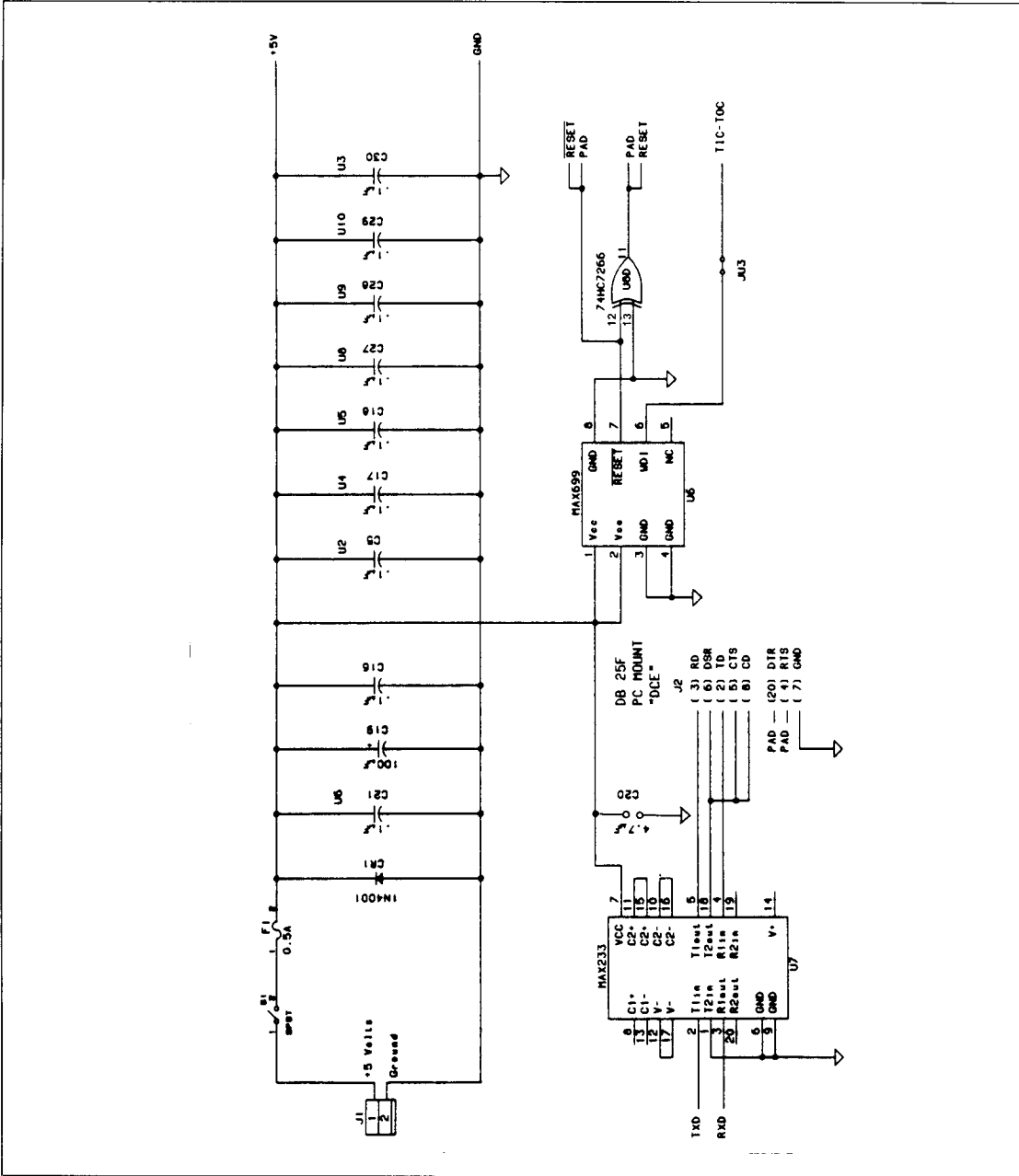


Figure 2. MAX132 Demo Board Power Supply & RS-232 Interface

# Evaluates: MAX132

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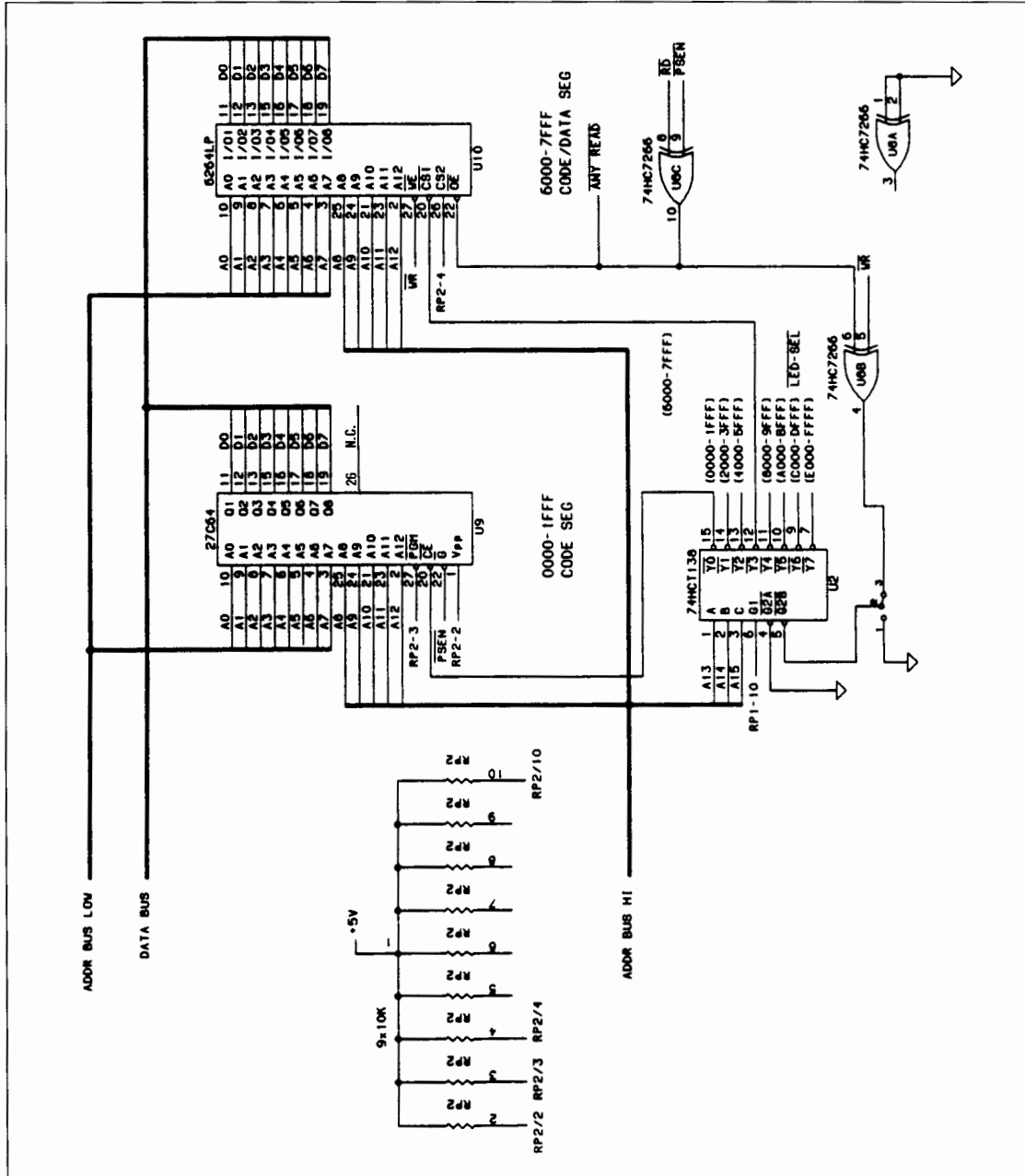


Figure 3. MAX132 Demo Board RAM and ROM Memory

# MAX132 Evaluation Kit

Evaluates: MAX132

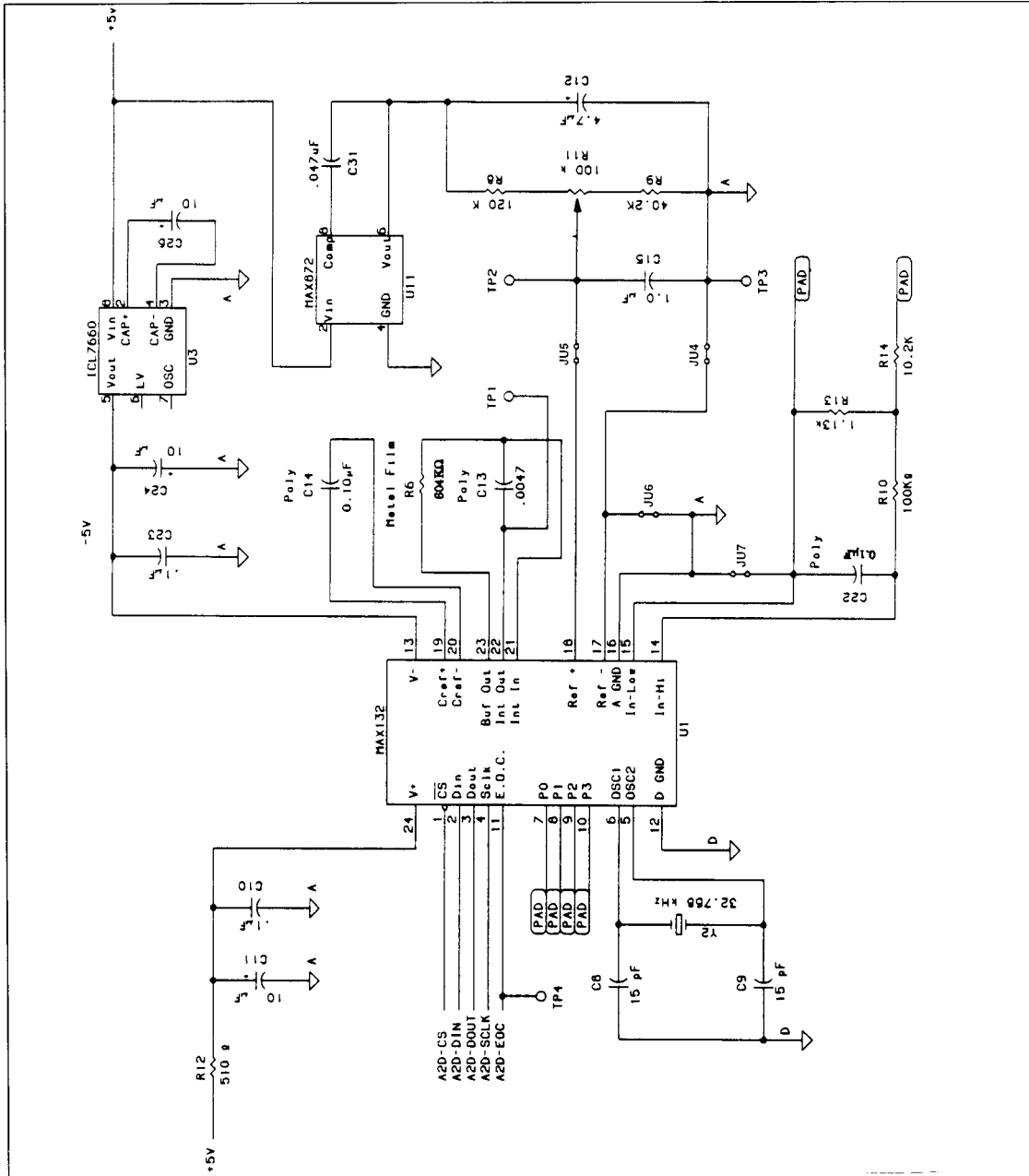


Figure 4. MAX132 Demo Board A/D Converter

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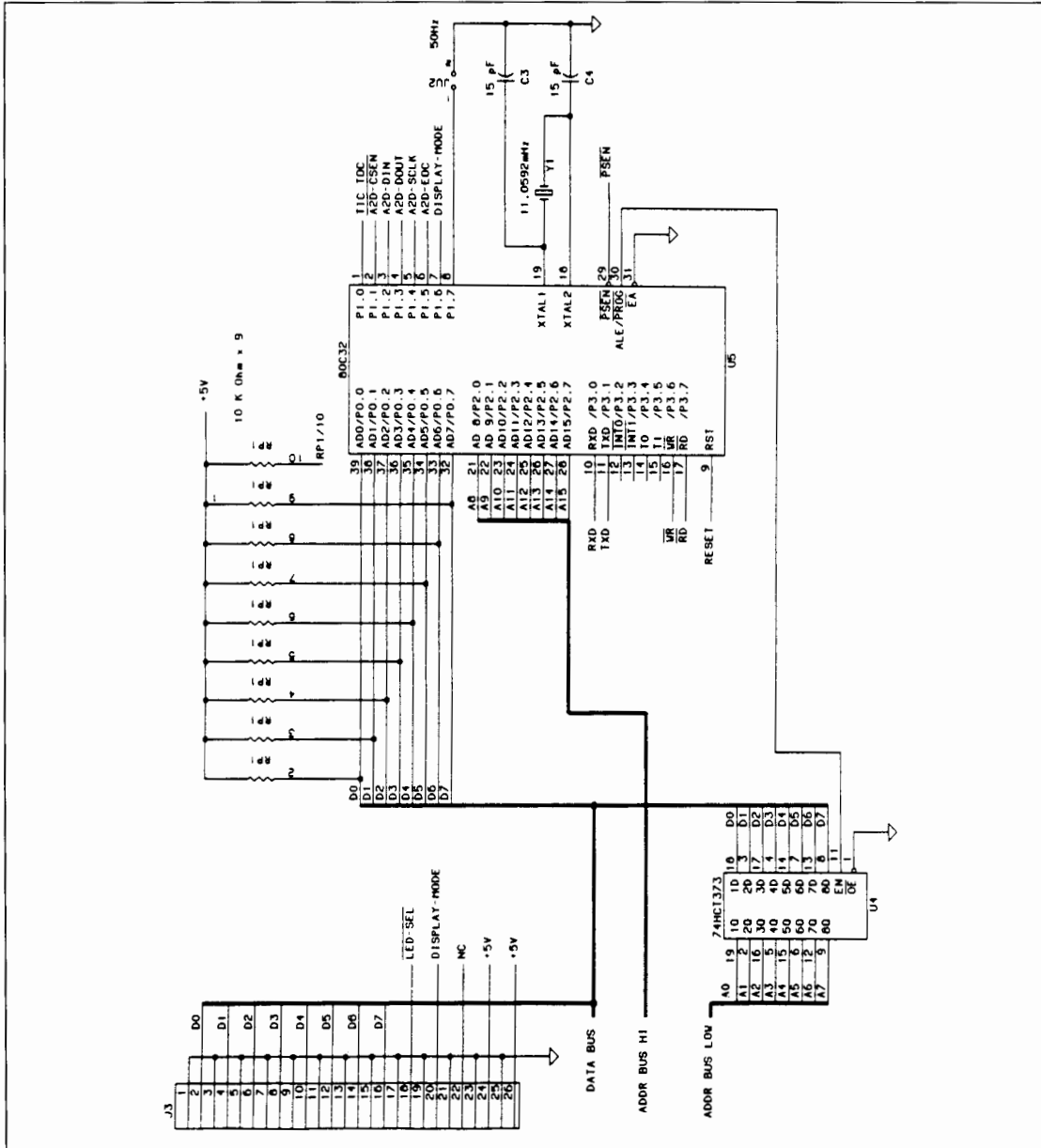


Figure 5. MAX132 Demo Board 80C32 CPU and Memory Interface

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