

# MAX176 Evaluation Kit

**MAX176 EV Kit**

## EV Kit General Description

The MAX176 evaluation kit (EV kit) provides a proven design and a fully assembled PC board for fast and easy evaluation of the MAX176 at sample rates up to 250k samples per second (ksps). The kit includes a MAX176, 4MHz crystal oscillator, shift registers, and LEDs to display the output code. An op amp is included to buffer the input signal if required. Prototyping space is provided for application-specific circuitry. In addition, a variety of connectors and jumpers offer flexibility and provide easy interface to external systems, evaluation tools, signal analyzers, and signal sources.

## Features

- ◆ Proven 250ksps, 12-Bit Serial ADC Layout and Circuit Design
- ◆ Fully Assembled PC Board
- ◆  $\pm 5V$  Input Range
- ◆ Complete Solution for Serial Interface Timing
- ◆ LED Display for Output Monitoring
- ◆ Prototyping Space for Additional Circuitry

## Ordering Information

PART	TEMP. RANGE	BOARD TYPE
MAX176EVKIT-DIP	0°C to +70°C	Plastic DIP - Through Hole

## Component List

DESIGNATION	QTY	DESCRIPTION
None	1	6.0" x 4.5" printed circuit board
None	1	MAX176 data sheet
U1	1	Maxim OP-27CP
U2	1	MAX176CPA
U3, U4	2	74HC595 8-bit shift registers
U5	1	4MHz oscillator
U6	1	74HCT00 quad NAND gate
U7	1	74HCT393 dual 4-bit counter
J2, J4	2	BNC connectors
Jump6, Jump7	2	3-pin headers
Jump1, Jump2, Jump8	3	2-pin headers
None	5	Shunts
None	1	20-pin header
Power Connector	1	5-wire connector
R1, R2	0	User-supplied resistors
R3, R4	2	51 $\Omega$ 5% resistors
R5	1	3.16k $\Omega$ 1% resistor
R6	1	200 $\Omega$ multi-turn potentiometer
R7	1	3.01k $\Omega$ 1% resistor
R8	1	180 $\Omega$ 5% resistor
R9	1	82k $\Omega$ 5% resistor
R10	1	10k $\Omega$ multi-turn potentiometer
R11-R23	13	620 $\Omega$ 5% resistors
C1, C18	0	User-supplied capacitors
C2, C4, C8, C10, C12	5	10 $\mu$ F electrolytic radial capacitors
C6	1	22 $\mu$ F low-ESR electrolytic capacitor
C3, C5, C7, C9, C11, C13, C14, C15, C16, C17	9	0.1 $\mu$ F capacitors
D1-D13	13	LEDs

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## Quick Reference

You can verify EV kit operation by using the on-board crystal oscillator and conversion start logic. The following steps will configure the board for stand-alone operation with the output code displayed on the row of LEDs.

1. Set the jumpers according to Table 1. Do not turn on the power supplies until all supplies are connected and all jumpers are set.
2. Connect the 5V supply to the 5V terminal of the power connector. The 5V supply should have 200mA capability if the LED display is enabled. A 100mA supply will suffice if the LED display is disabled. Connect the ground lead for the 5V supply to the DGND (digital ground) terminal of the power connector.
3. Connect the -15V supply to the -15V slot on the power connector. The -15V is used only for the MAX176 and the op amp. Connect the ground connection for the -15V supply to the AGND (analog ground) terminal of the power connector. Analog and digital grounds are connected together near the power connector on the printed circuit board.
4. Connect a variable source to the analog input (J1).
5. If an amplifier is located in U1, connect a 15V supply to the 15V slot on the power connector.

6. Turn on the power supplies and vary the voltage input to J1. D2-D13 of the LED display will display the MAX176's output code. D1 should remain on, indicating the state of the leading data bit, which is always high.

**Table 1. Jumper Configuration for Stand-Alone Operation**

JUMPER	CONNECT	FUNCTION
Jump1	Shorted*	Connects the analog input (J1) to the MAX176 AIN.
Jump6	Shunt Across 2 & 3	Connects the on-board crystal oscillator
Jump7	Shunt Across 2 & 3	Connects the conversion start to the on-board logic.
Jump8	Shorted	Enables the LED display.

\* Jump1 should be left open if an op amp is used in socket U1.

## Hardware Description

### Jumper Selection

You may select from several jumper options by placing a shunt in the appropriate position. Table 2 lists the jumpers and the features they select.

**Table 2. Jumper Selection Options**

JUMPER	SELECTION	SHUNT LOCATION	OPERATION
Jump1	Input Select	Open	MAX176 analog input is connected to the output of the buffer amplifier U1.
		Shorted	MAX176 analog input is connected to J1. The op amp, U1, is not used and should be removed.
Jump2	X1 Gain	Open	Input amplifier gain = 2.
		Shorted	Input amplifier gain = 1.
Jump6	Clock Select	1 & 2	An external clock, connected to J4, drives the MAX176 (Note 1).
		2 & 3	The on-board 4MHz crystal oscillator drives the MAX176.
Jump7	Conversion Start Select	1 & 2	An external conversion start signal, connected to J2, triggers the MAX176 (Note 1).
		2 & 3	The conversion start signal is generated by U6 and U7 on the EV kit.
Jump8	LED Enable	Open	The LED display is disabled.
		Shorted	The LED display is enabled.

**Note 1:** When either the Clock Select or Conversion Start Select is configured for external signals the user must satisfy the timing relationships described on the MAX176 data sheet.

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Several other jumper locations on the board provide for flexible use of the output ribbon cable connector. As shown in the schematic (Figure 3), shorting locations Jump3, Jump4, and Jump5 connects the MAX176 serial interface pins (CONVST, CLOCK, DATA) to the data connector for complete user control of the A/D timing. Alternatively, these connector pins may be used for other logic signals as desired. The board is delivered with Jump9 shorted, which connects the shift-register latch pin to the on-board logic. For user control of the shift-register latch signal, Jump9 can be cut, and wired to one of the unused ribbon cable connector pins.

## Input Amplifier

Many application circuits already have an amplifier that will drive the input to the MAX176. For those high-impedance inputs that require an additional buffer, the MAX176 EV kit has provision for an input amplifier stage (U1). The input stage can be configured for unity gain or a gain of two.

To use the op amp, remove the shunt across Jump1. Installing a shunt across Jump2 will operate the op amp as a unity-gain buffer. Without the shunt, the stage is configured as a gain of two amplifier with adjustable gain and offset.

In addition, the user must supply a resistor and capacitor for R2 and C1. R2 and C1 form an input lowpass filter. The rolloff frequency should be no more than one-half the MAX176 sampling rate:

$$R2 \times C1 \geq \frac{1}{2\pi (1/2 f_{\text{SAMPLE}})}$$

To adjust the input buffer offset, ground the input and adjust R10 for a zero output code. You can observe the MAX176 data output pin, or use the LED display for adjustments.

To adjust the input buffer gain, adjust the analog input to -2.500V and adjust potentiometer R6 for a negative full-scale code. The negative full-scale code is 1000 0000 0000. So D1 (always high) and D2 (the MSB LED) will be on. All other LEDs will be off. Trim R6 so that D13 (the LSB LED) is just turned off.

The noise level of many input signals can be improved by adding a capacitor between the MAX176 analog input and analog ground. You can install this user-supplied capacitor at location C18 on the board. The capacitor is recommended whenever the input source will tolerate a capacitive load.

## MAX176

The MAX176 is referenced to a separate ground called analog ground. It is desirable to have such a ground in most systems. Its main purpose is to separate high current transients, common in digital systems, from the ground used in critical analog sections. However, it is necessary to connect the two grounds together at some point to ensure that all the circuit elements have a common reference. On the MAX176 EV kit circuit board, the two grounds are tied together near the power connector. Having the two grounds connect at only one point prevents a current path through the analog section for the digital current transients.

The input range for the MAX176 is  $\pm 5.0V$ . The input amplifier (U1) can be used as a unity-gain buffer ( $\pm 5.0V$  input) or in a gain of two ( $\pm 2.5V$  input). Refer to the *Input Amplifier* section for more information about input requirements.

## Data Latches

Shift registers U3 and U4 are used to convert the serial output of the MAX176 to a parallel form that may be examined or displayed by the LEDs. Because the first bit of the MAX176 data stream is always high, Qg of U3 should always be high. The first LED (D1) displays this leading bit. The next twelve bits latched by the 74HC595s are determined by the value of the MAX176 analog input. LEDs D2-D13 display the value of these bits.

The timing is shown in Figures 1 and 2.

## Clock and Conversion Start Circuits

The 74HCT00 quad NAND gate and the 74HCT393 dual 4-bit counter chips are used to generate the proper timing relationships for clocks up to 4MHz. Figures 1 and 2 are timing diagrams for the MAX176 digital interface. If you choose to use external MAX176 timing signals, be sure that all timing specifications on the MAX176 data sheet are satisfied by your circuit.

The MAX176 evaluation kit has a 4MHz crystal oscillator, a 74HCT00 quad NAND gate, and a 74HC393 counter on the board to provide clocking and conversion control signals for the MAX176. Figures 1 and 2 illustrate the waveforms generated by these devices. Figure 1 details the timing relationships for the start of conversion cycles. Figure 2 covers a full conversion cycle.

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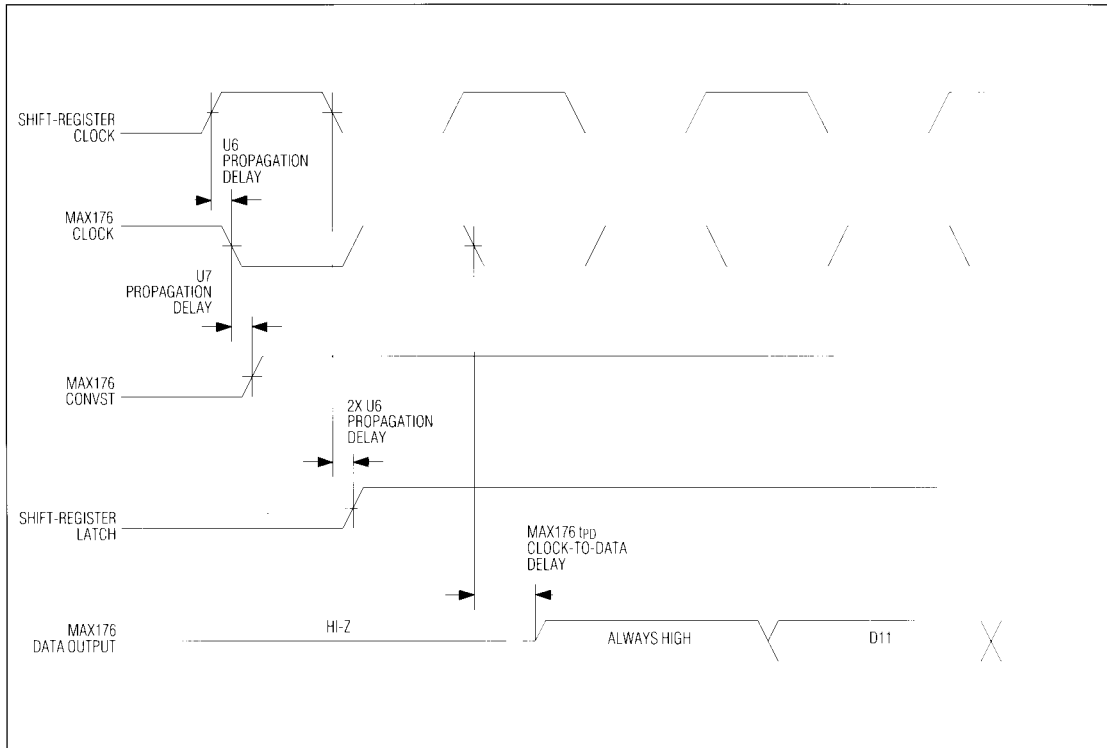


Figure 1. Conversion-Start Timing Diagram

The MAX176's data output is shifted into a shift register and latched every 16 clock cycles for display. Data is shifted through the 74HC595s on the rising edge of the clock input line. Displayed data is latched on the rising edge of the shift-register latch signal. The latching edge is generated on the falling edge of the shift clock to insure proper clocking of the data.

The shift-register clock is inverted and used to clock the MAX176. The combined propagation delay of the inverter and MAX176 provides a small hold time for the 74HC595 inputs. This technique allows nearly a full clock period for the MAX176 clock-to-data delay, which

is specified at 170ns max over temperature (see data sheet).

The MAX176 conversion start (CONVST) signal is generated by a divide-by-16 counter (74HC393). The propagation delay of the 74HC393 insures that the rising edge of the conversion start signal trails the falling edge of the MAX176 clock signal. Therefore, a conversion will not start until the next falling edge of the MAX176 clock.

Figure 2 is the timing diagram for a complete conversion cycle.

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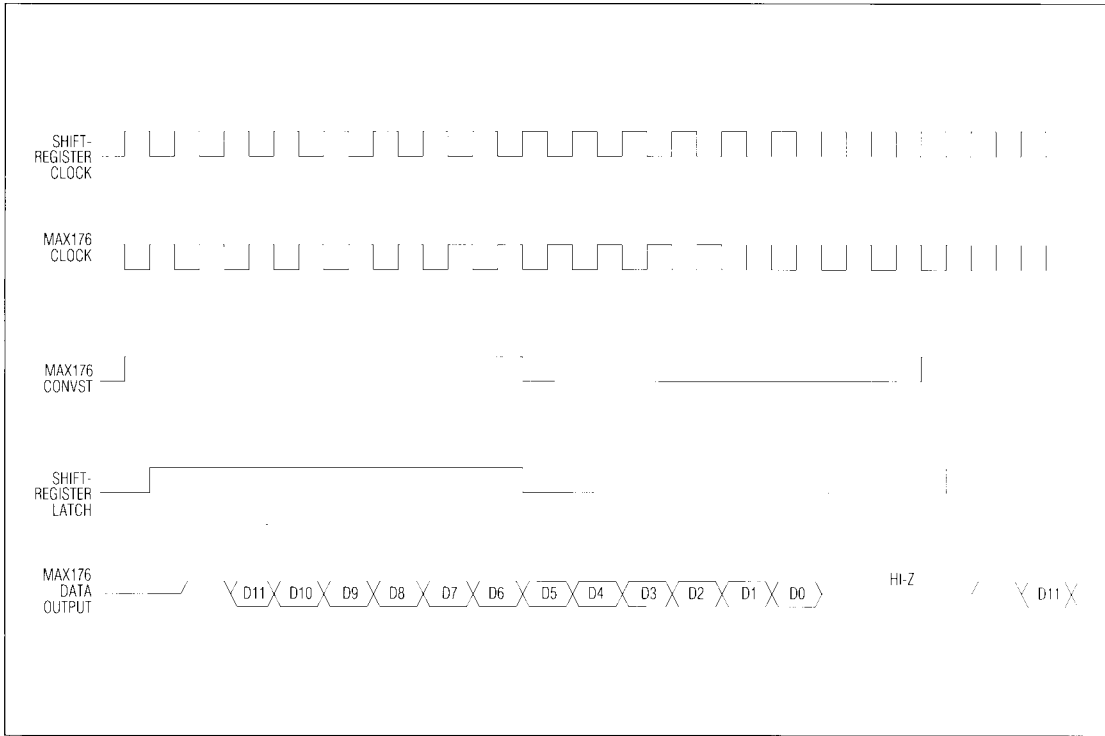


Figure 2. Conversion-Cycle Timing Diagram

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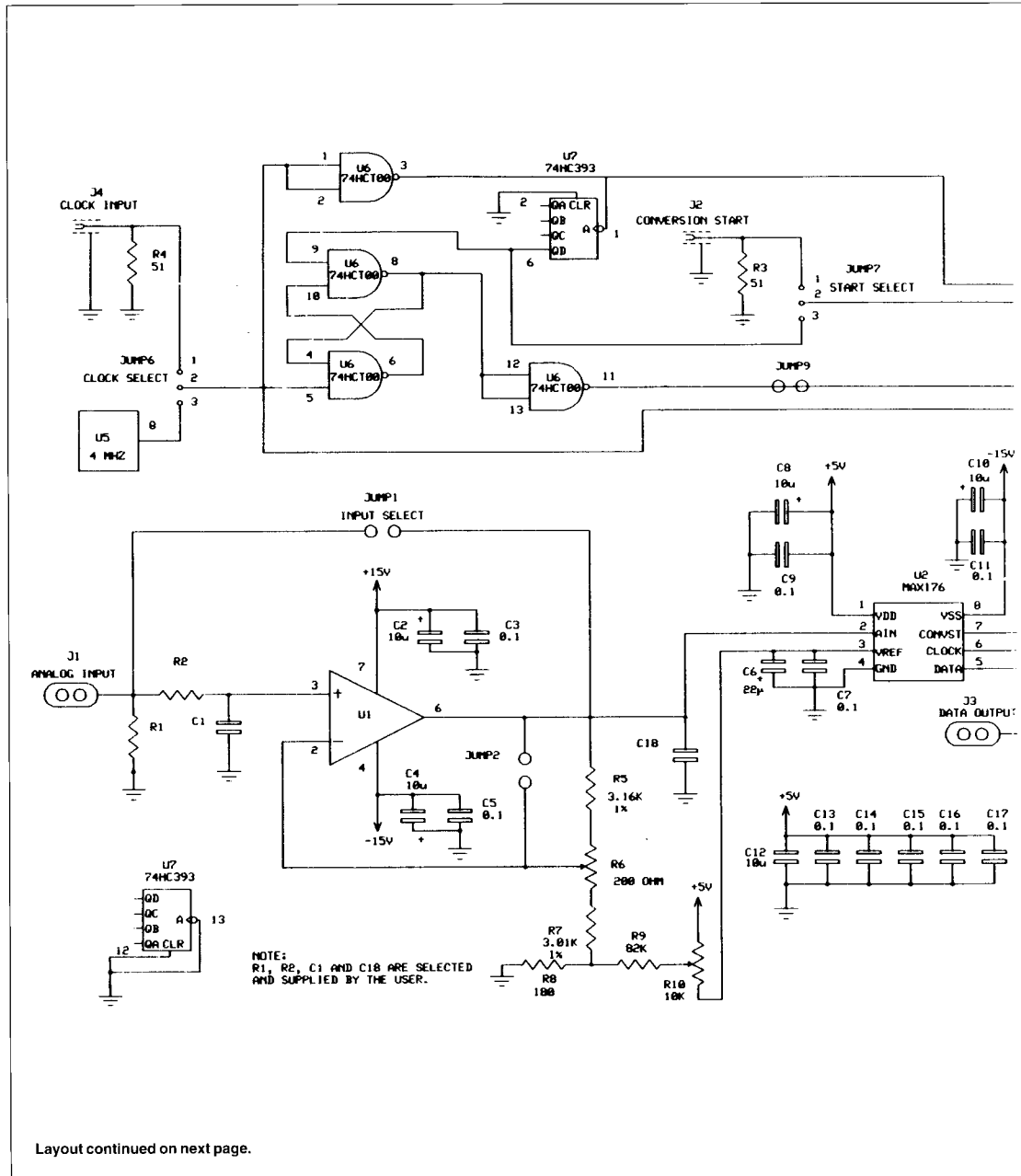


Figure 3. MAX176 EV Kit

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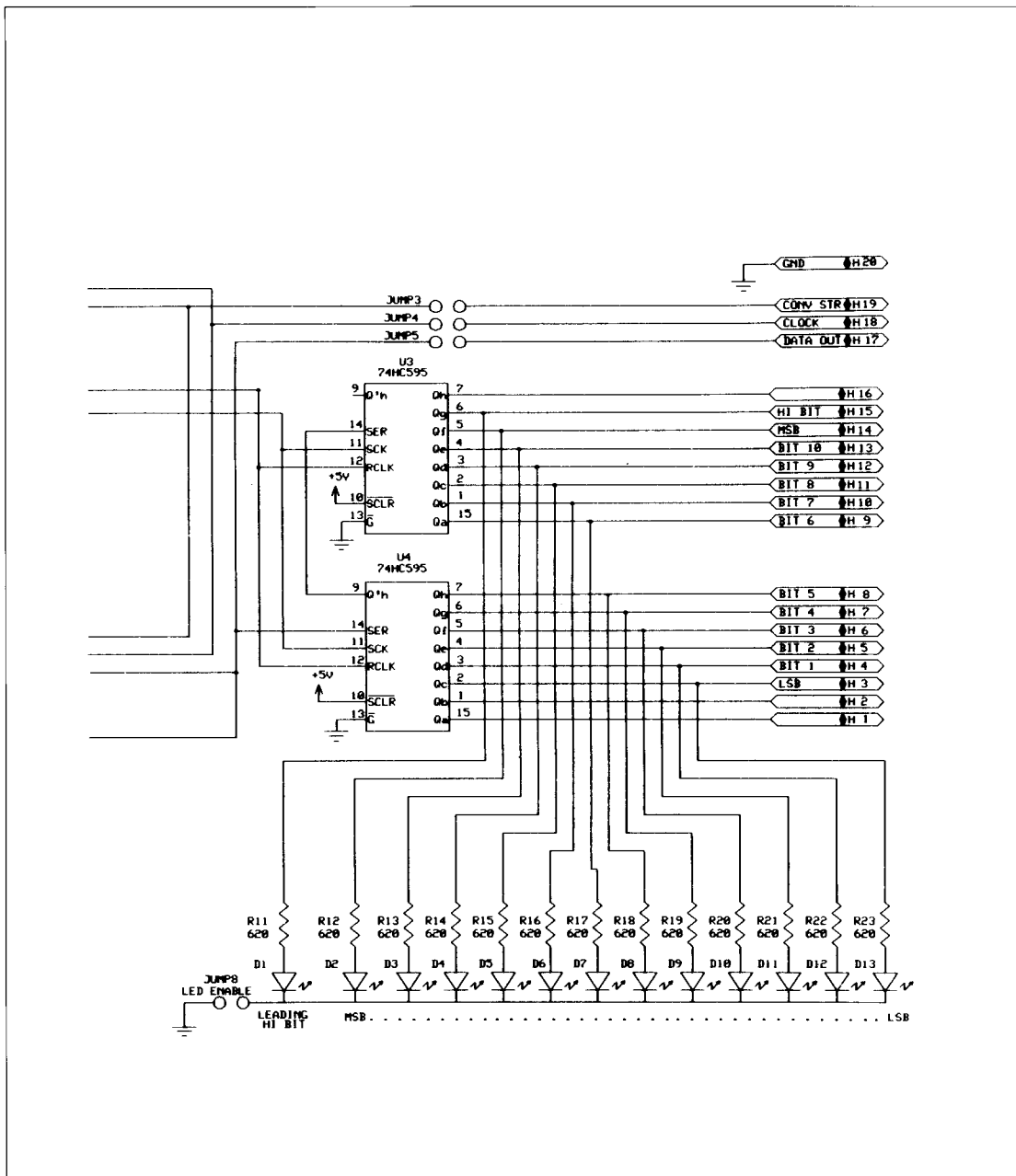


Figure 3. MAX176 EV Kit (continued)