DATEL®
INNOVATION and EXCELLENCE

# SHM-14

## Ultra-Fast, 14-Bit Linear Monolithic Sample-Hold Amplifiers

### FEATURES

- **Fast acquisition time:**
  - **10ns to ±0.1%**
  - **20ns to ±0.024%**
  - **25ns to ±0.012%**
- **±0.0012% Nonlinearity**
- **65µV rms output noise**
- **250MHz small signal bandwidth**
- **70MHz full power bandwidth**
- **–80dB feedthrough**
- **1ps Aperture jitter**
- **250mW power dissipation**
- **Low cost**




### GENERAL DESCRIPTION

The SHM-14 is an extremely high-speed and accurate monolithic sample-and-hold amplifier designed for fast data acquisition applications. The SHM-14 is accurate (±0.5 LSB to 14-bits over the full military temperature range) and is very fast (10ns and 20ns acquisition times to accuracies of 10 and 12 bits respectively). With this high performance and a full power bandwidth of 70MHz, the SHM-14 is an ideal device for driving flash and high-resolution subranging A/D converters.

A careful design optimizes the device for accuracy and speed over the full military temperature range. The droop rate is a low ±2mV/µs and can be further reduced by adding an optional external hold capacitor. The 30mA output current and guaranteed specifications for a 100Ω load provide high drive capability. Operating from ± 5V supplies, the SHM-14 consumes only 250mW of power.

The SHM-14 is built using a fast complementary bipolar process. The device is available in both military and industrial temperature ranges. The SHM-14 is packaged in a 16-pin plastic SOIC or in a 20-pin ceramic LCC.

### INPUT/OUTPUT CONNECTIONS — SOIC

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | –5V SUPPLY | 16 | SAMPLE/$\overline{\text{HOLD}}$ |
| 2 | DO NOT CONNECT | 15 | $\overline{\text{SAMPLE}}$/HOLD |
| 3 | ANALOG INPUT | 14 | +5V SUPPLY |
| 4 | DO NOT CONNECT | 13 | EXT. CAPACITOR |
| 5 | –5V SUPPLY | 12 | GROUND |
| 6 | DO NOT CONNECT | 11 | +5V SUPPLY |
| 7 | DO NOT CONNECT | 10 | +5V SUPPLY |
| 8 | –5V SUPPLY | 9 | ANALOG OUTPUT |

### INPUT/OUTPUT CONNECTIONS — CLCC

| PIN | FUNCTION | PIN | FUNCTION |
|---|---|---|---|
| 1 | NOT CONNECTED | 20 | NOT CONNECTED |
| 2 | –5V SUPPLY | 19 | SAMPLE/$\overline{\text{HOLD}}$ |
| 3 | NOT CONNECTED | 18 | $\overline{\text{SAMPLE}}$/HOLD |
| 4 | ANALOG INPUT | 17 | +5V SUPPLY |
| 5 | NOT CONNECTED | 16 | NOT CONNECTED |
| 6 | DO NOT CONNECT | 15 | EXT. CAPACITOR |
| 7 | –5V SUPPLY | 14 | GROUND |
| 8 | DO NOT CONNECT | 13 | +5V SUPPLY |
| 9 | DO NOT CONNECT | 12 | +5V SUPPLY |
| 10 | –5V SUPPLY | 11 | ANALOG OUTPUT |

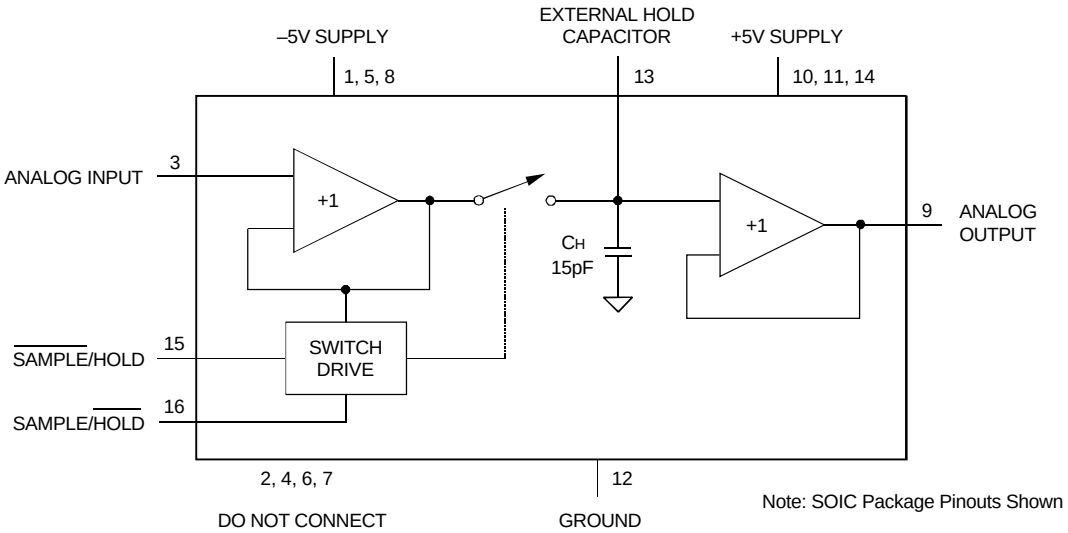



**Figure 1. SHM-14 Functional Block Diagram**

## ABSOLUTE MAXIMUM RATINGS

| PARAMETERS | LIMITS | UNITS |
|---|---|---|
| **+5V Supply** | 0 to +6 | Volts |
| **–5V Supply** | 0 to –6 | Volts |
| **Analog Input** | +5V Supply –1 | Volts |
| | –5V Supply +1 | Volts |
| **Continuous Output Current** | ±50 | mA |
| **Digital Inputs** | <Supply Voltages | Volts |
| **Junction Temperature** | +175 | °C |
| **Lead Temperature** (10 seconds) | +300 | °C |

Output shorted to any supply will cause permanent damage.

## FUNCTIONAL SPECIFICATIONS

(Apply over the operating temperature range using a 100Ω resistive load, 10pF capacitive load, ECL digital input levels, and ±5V nominal supplies, unless specified.)

| INPUTS | MIN. | TYP. | MAX. | UNITS |
|---|---|---|---|---|
| **Input Voltage Range** | –2.5 | — | +2.5 | Volts |
| **Input Impedance** | 0.3 | 1 | — | MΩ |
| **Digitals Inputs** (Balanced ECL) | | | | |
| **Logic Levels** | | | | |
| Logic 1 | –1.5 | — | +1.8 | Volts |
| Logic 0 | –2.5 | — | +0.8 | Volts |
| **Logic Loading** | | | | |
| Logic 1 | — | +10 | +50 | µA |
| Logic 0 | — | –30 | –150 | µA |
| **OUTPUTS** | | | | |
| **Output Voltage Range** | –2.5 | — | +2.5 | Volts |
| **Output Current** ① | ± 30 | — | — | mA |
| **Output Impedance** (dc) | — | 0.3 | 1 | Ω |
| **Stable Capacitive Load** | — | — | 50 | pF |
| **PERFORMANCE** | | | | |
| **Nonlinearity** (±1V) | | | | |
| +25°C | — | ±0.0012 | — | % |
| –40 to +85°C | — | — | ±0.002 | % |
| –55 to +125°C | — | — | ±0.003 | % |
| **Sample Mode Offset** | | | | |
| +25°C | — | ±12 | — | mV |
| –40 to +85°C | — | — | ±20 | mV |
| –55 to +125°C | — | — | ±30 | mV |
| **Pedestal** | | | | |
| +25°C | — | ±3 | — | mV |
| –40 to +85°C | — | — | ±20 | mV |
| –55 to +125°C | — | — | ±20 | mV |
| **Gain**, +25°C | +0.98 | +0.995 | — | V/V |
| **Gain Drift** (±1V) | | | | |
| –40 to +85°C | — | — | ±20 | ppm/°C |
| –55 to +125°C | — | — | ±30 | ppm/°C |
| **Aperture Delay** | | | | |
| –40 to +85°C | — | 2 | — | ns |
| –55 to +125°C | — | 2 | — | ns |
| **Aperture Jitter** | | | | |
| –40 to +85°C | — | 1 | — | ps rms |
| –55 to +125°C | — | 1 | — | ps rms |
| **Harmonic Distortion** (±1V) | | | | |
| dc to 1MHz | — | –72 | — | dB |
| dc to 10MHz | | | | |
| +25°C | — | –58 | — | dB |
| –40 to +85°C | — | — | –50 | dB |
| –55 to +125°C | — | — | –48 | dB |
| **Acquisition Time** (±0.012%, ±2V) | | | | |
| –40 to +85°C | — | 25 | — | ns |
| –55 to +125°C | — | 35 | — | ns |
| **Acquisition Time** (±0.024%, ±2V) | | | | |
| –40 to +85°C | — | 20 | 35 | ns |
| –55 to +125°C | — | 25 | 40 | ns |
| **Acquisition Time** (±0.05%, ±2V) | | | | |
| –40 to +85°C | — | 19 | 30 | ns |
| –55 to +125°C | — | 20 | 35 | ns |

| PERFORMANCE (Cont.) | MIN. | TYP. | MAX. | UNITS |
|---|---|---|---|---|
| **Acquisition Time** (±0.1%, ±2V) | | | | |
| –40 to +85°C | — | 10 | 16 | ns |
| –55 to +125°C | — | 10 | 19 | ns |
| **Hold Mode Settling** (±0.012%) | | | | |
| –40 to +85°C | — | 12 | — | ns |
| –55 to +125°C | — | 15 | — | ns |
| **Hold Mode Settling** (±0.024%) | | | | |
| –40 to +85°C | — | 7 | 18 | ns |
| –55 to +125°C | — | 7 | 18 | ns |
| **Hold Mode Settling** (±0.05%) | | | | |
| –40 to +85°C | — | 6 | 16 | ns |
| –55 to +125°C | — | 6 | 16 | ns |
| **Hold Mode Settling** (±0.1%) | | | | |
| –40 to +85°C | — | 5 | 12 | ns |
| –55 to +125°C | — | 5 | 12 | ns |
| **Slew Rate** | ±300 | ±430 | — | V/µs |
| **Full Power Bandwidth** (±1V) | 45 | 70 | — | MHz |
| **Small Signal Bandwidth** | 100 | 250 | — | MHz |
| **Output Noise, Hold Mode** | — | 65 | — | µVrms |
| **Feedthrough** (2V Step) | — | –80 | — | dB |
| **Droop Rate** | | | | |
| +25°C | — | ±2 | ±6 | mV/µs |
| –40 to +85°C | — | ±5 | ±15 | mV/µs |
| –55 to +125°C | — | ±10 | ±30 | mV/µs |
| **POWER SUPPLY REQUIREMENTS** | | | | |
| **Power Supply Range** | | | | |
| +5V Supply | +4.5 | +5 | +5.5 | Volts |
| –5V Supply | –5.5 | –5 | –4.5 | Volts |
| **Power Supply Current** | | | | |
| +5V Supply | +17 | +25 | +30 | mA |
| –5V Supply | –17 | –25 | –30 | mA |
| **Power Dissipation** | 170 | 250 | 300 | mW |
| **Power Supply Rejection Ratio** | 40 | 60 | — | dB |
| **ENVIRONMENTAL** | | | | |
| **Operating Temp. Range, Case** | | | | |
| SHM-14S, SHM-14L | –40 | — | +85 | °C |
| SHM-14LM | –55 | — | +125 | °C |
| **Storage Temperature Range** | –65 | — | +150 | °C |
| **Package Type** | | | | |
| SHM-14S | 16-Pin plastic SOIC | | | |
| SHM-14L, SHM-14LM | 20-Pin ceramic LCC | | | |

**Footnotes:**

① Short circuit protection at ±50mA.

## TECHNICAL NOTES

The SHM-14 employs an open loop architecture in order to achieve its superior high-speed characteristics. The first stage buffer amplifier, which charges the hold capacitor, incorporates the sample-and-hold switch into its design. This technique allows for a fast acquisition time which is not limited by slew current like the traditional Schottky diode bridge switch. The output amplifier uses a closed loop voltage feedback design which provides a low (0.3Ω, typical) output impedance. Gain and linearity are not affected by heavy loads.

The design has been optimized to achieve the high accuracy associated with fast transient responses over the full military temperature range. During the track-to-hold transient, the integral nonlinearity is not affected and the pedestal remains constant over the full ±2.5V input range.

An external hold capacitor can be added to the 15pF internal hold capacitor to obtain a lower droop rate (the droop rate is proportional to the inverse of the total hold capacitor value) without increasing transient response times by more than few ns. Settling and acquisition times are typically increased by 5ns and 10ns respectively for 47pF and 100pF external hold capacitors. The external hold capacitor should not exceed 100pF.

## GROUNDING AND LAYOUT

Obtaining fully specified performance from the SHM-14 requires careful attention to pc-board layout and power supply decoupling.

For optimal performance, tie all grounds directly to a large analog ground plane beneath and around the package. Bypass all power supplies to ground with 10µF tantalum capacitors in parallel with 0.1µF ceramic capacitors.

Locate the bypass capacitors as close to the unit as possible.

For best performance, controlled impedance transmission line techniques, such as microstrip, should be used. Mount all components as close to the required pins as possible. It is strongly recommended that the SHM-14 not be socket-mounted.

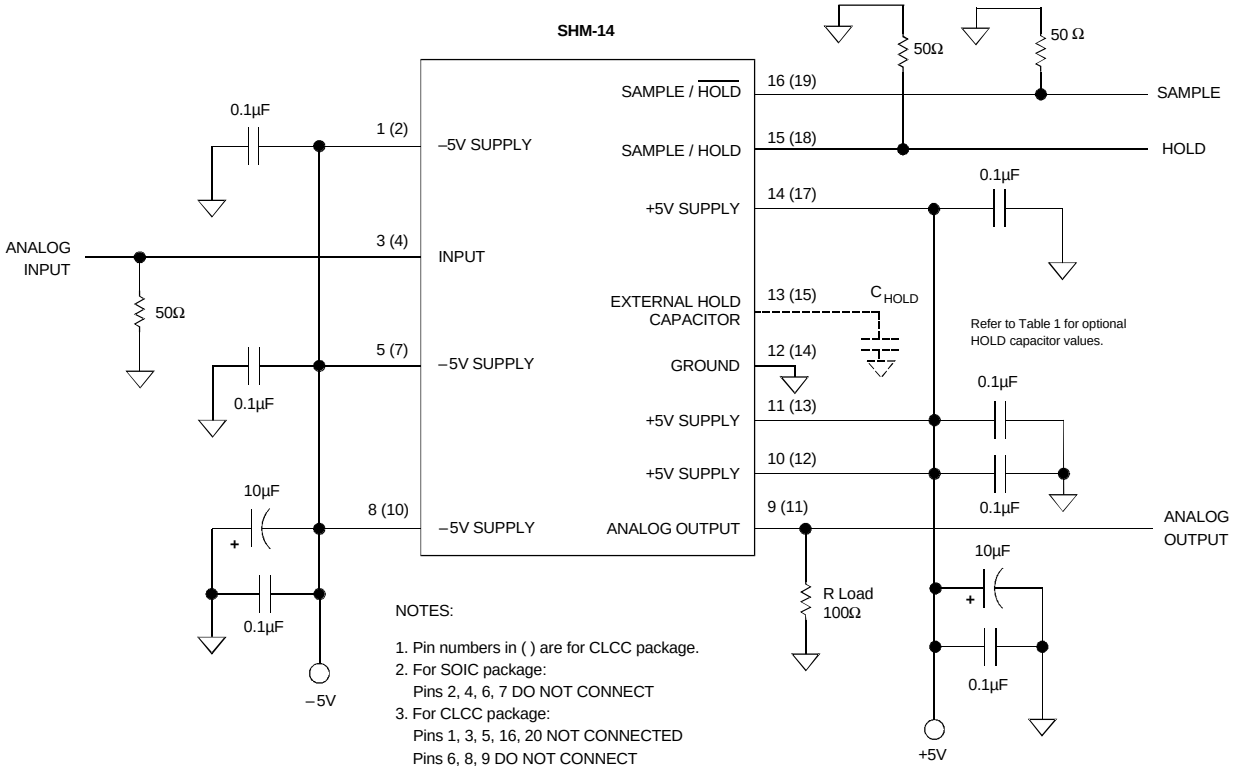



**Figure 2. SHM-14 Simplified Connection Diagram**

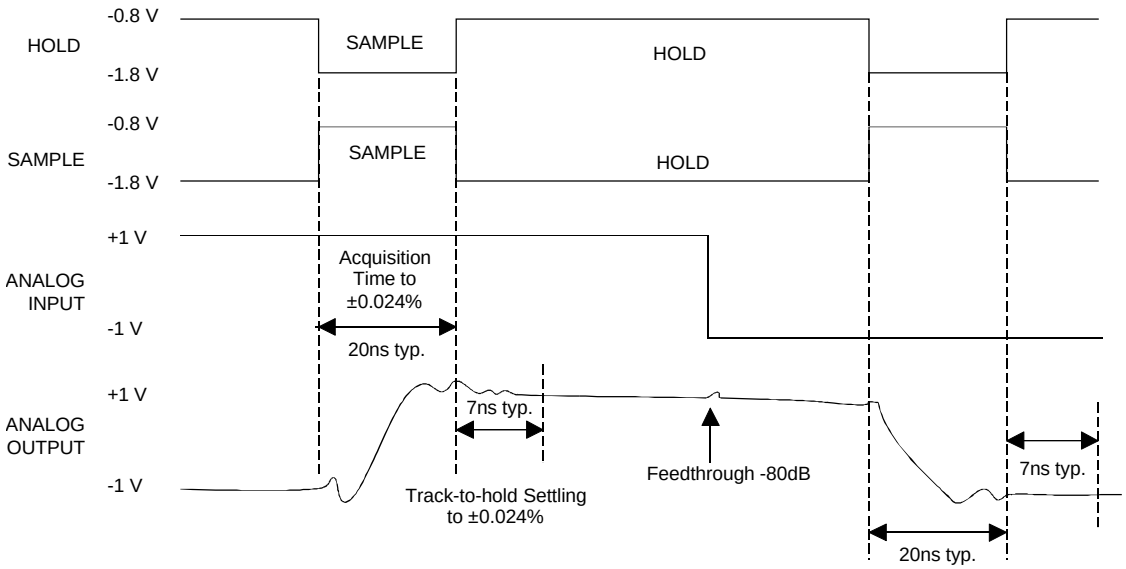



**Figure 3. SHM-14 Control and Timing**

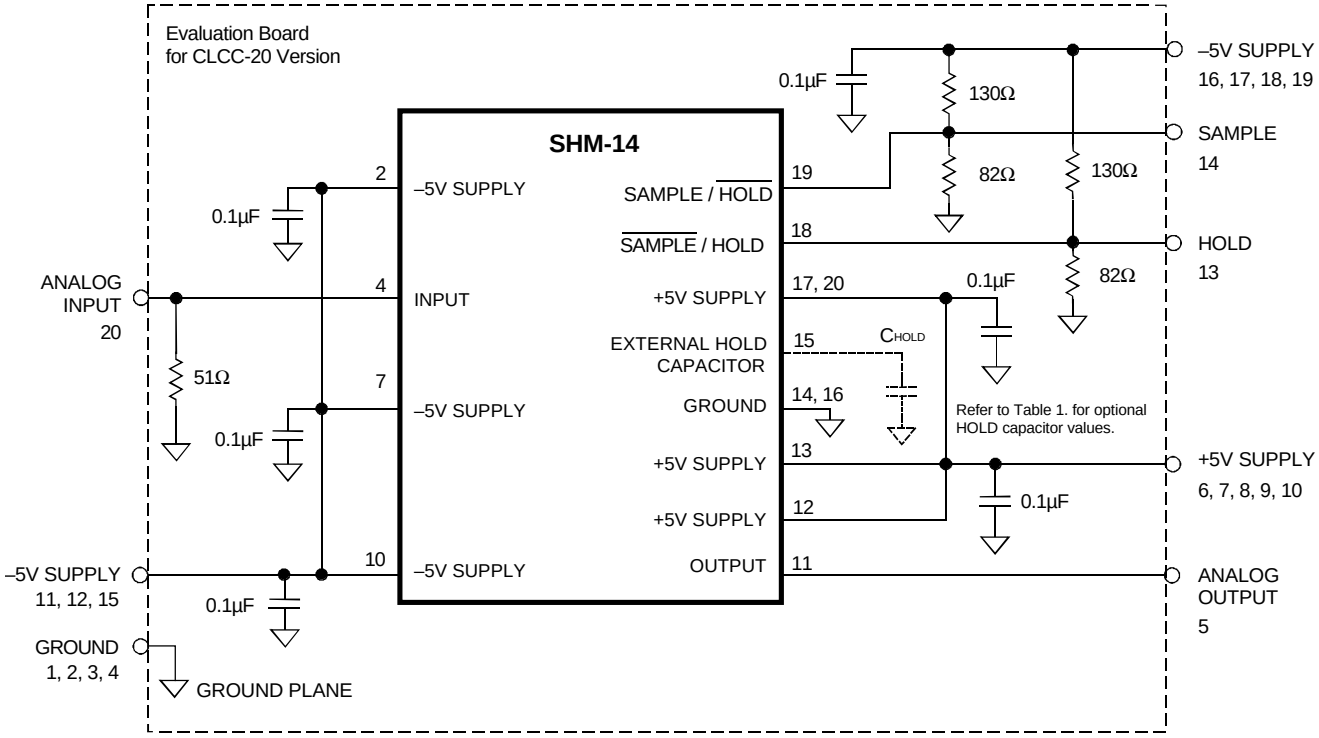



**Figure 4. SHM-14 Evaluation Board Schematic**

**Table 1. Optional External HOLD Capacitor**

| Model | Operating Temperature Range | Type of HOLD Capacitor (Ceramic, ≤100pF, ±10%) |
|---|---|---|
| SHM-14L, -14S | –40 to +85°C | Type I or II, NPO or X7R |
| SHM-14LM | –55 to +125°C | Type I or NPO |

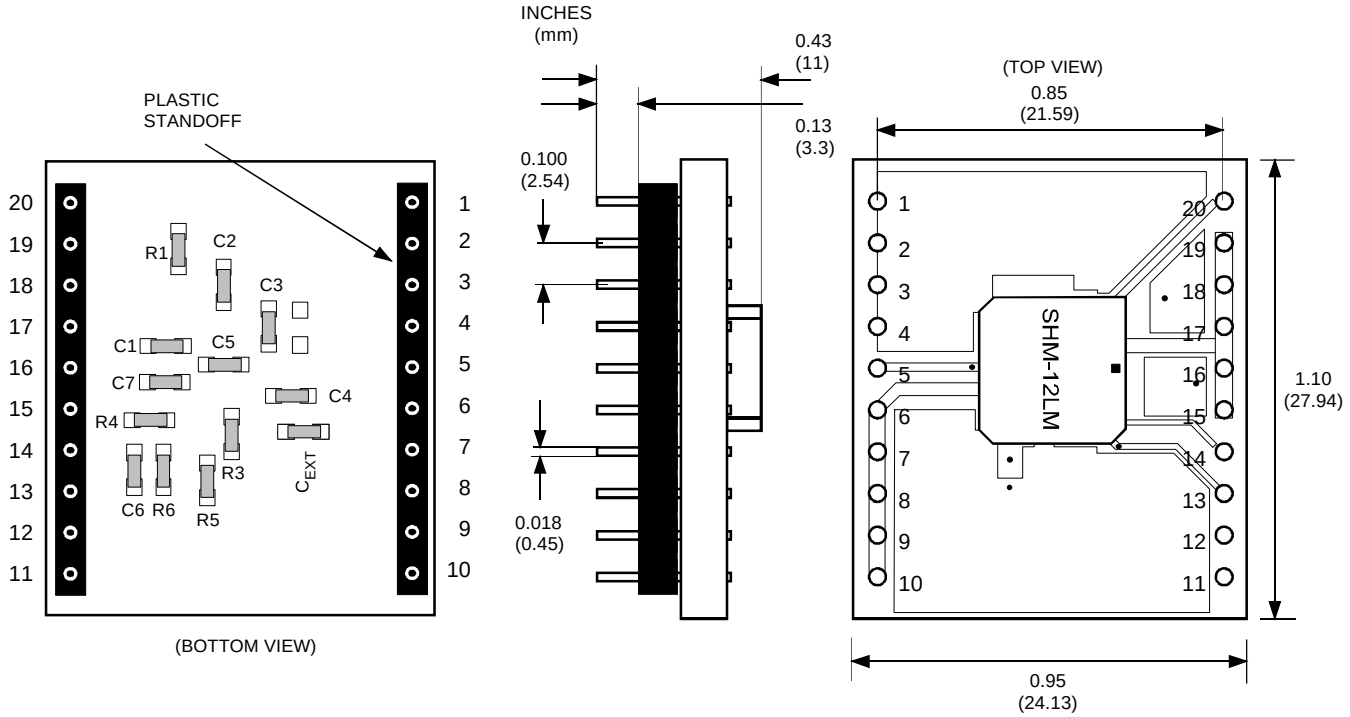


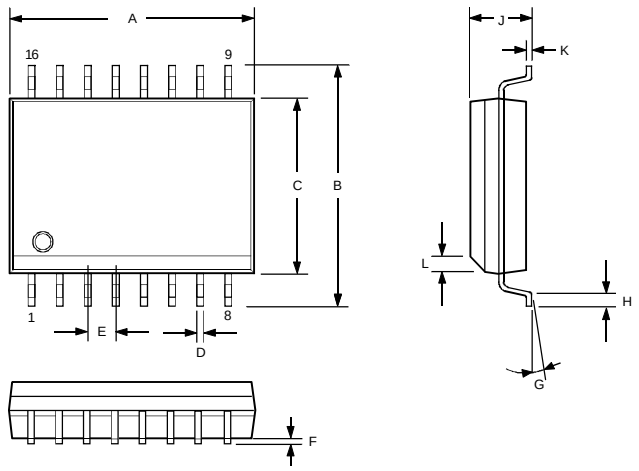

**Figure 5. SHM-14 Evaluation Board Dimensions**

**SHM-14 Evaluation Board Connections**

| PIN | FUNCTION |
|---|---|
| 1 | GROUND |
| 2 | GROUND |
| 3 | GROUND |
| 4 | GROUND |
| 5 | ANALOG OUTPUT |
| 6 | +5V SUPPLY |
| 7 | +5V SUPPLY |
| 8 | +5V SUPPLY |
| 9 | +5V SUPPLY |
| 10 | +5V SUPPLY |
| 11 | –5V SUPPLY |
| 12 | –5V SUPPLY |
| 13 | HOLD |
| 14 | SAMPLE |
| 15 | –5V SUPPLY |
| 16 | –5V SUPPLY |
| 17 | –5V SUPPLY |
| 18 | –5V SUPPLY |
| 19 | –5V SUPPLY |
| 20 | ANALOG INPUT |

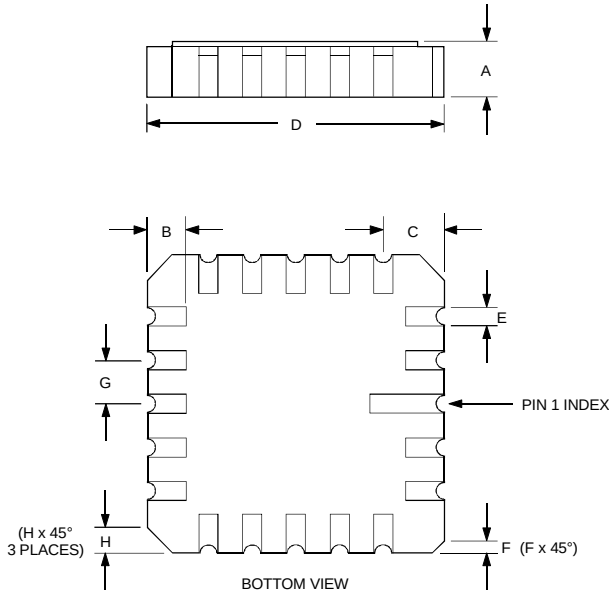
## MECHANICAL DIMENSIONS INCHES (MM)

### SOIC-16 Package




| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| SYMBOL | MIN. | MAX. | MIN. | MAX. |
| A | 0.402 | 0.412 | 10.21 | 10.46 |
| B | 0.400 | 0.410 | 10.16 | 10.41 |
| C | 0.292 | 0.299 | 7.40 | 7.60 |
| D | 0.014 | 0.019 | 0.35 | 0.48 |
| E | 0.0500 BSC | | 1.27 BSC | |
| F | 0.0039 | 0.0112 | 0.10 | 0.30 |
| G | 0° | 8° | 0° | 8° |
| H | 0.020 | 0.040 | 0.51 | 1.02 |
| J | 0.097 | 0.104 | 2.46 | 2.64 |
| K | 0.010 | 0.020 | 0.25 | 0.51 |
| L | 0.0091 | 0.0125 | 0.23 | 0.32 |

### CLCC-20 Package




| | INCHES | | MILLIMETERS | |
|---|---|---|---|---|
| SYMBOL | MIN. | MAX. | MIN. | MAX. |
| A | 0.064 | 0.100 | 1.63 | 2.54 |
| B | 0.045 | 0.055 | 1.14 | 1.40 |
| C | 0.075 REF | | 1.91 REF | |
| D | 0.342 | 0.358 | 8.69 | 9.09 |
| E | 0.022 | 0.028 | 0.56 | 0.71 |
| F | 0.020 REF | | 0.51 | |
| G | 0.050 BSC | | 1.27 BSC | |
| H | 0.040 REF | | 1.02 | |

## ORDERING INFORMATION

| MODEL NUMBER | PACKAGE | TEMPERATURE RANGE |
|---|---|---|
| **SHM-14S** | SOIC-16 | –40 to +85°C |
| **SHM-14L** | CLCC-20 | –40 to +85°C |
| **SHM-14LM** | CLCC-20 | –55 to +125°C |
| **EVB-SHM14** | Evaluation Board (with SHM-14LM) | |

Contact DATEL for availability of high reliability models.

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