# MAXIM

# 3½ Digit A/D Converter With Display Hold



## General Description

The Maxim ICL7116 and ICL7117 are 3½ digit monolithic analog to digital converters. They differ from the Maxim ICL7106 and ICL7107 in that the ICL7116 and ICL7117 have a Hold pin which makes it possible to hold or "freeze" a reading. These integrating A/D converters have very high input impedances and directly drive LCD (ICL7116) and LED (ICL7117) displays.

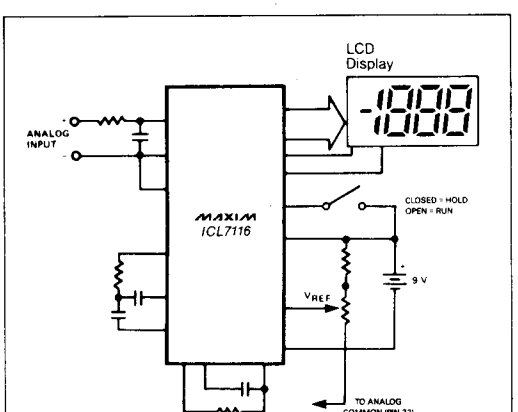
Versatility and accuracy are inherent features of these converters. The dual-slope conversion technique automatically rejects interference signals common in industrial environments. The true differential input is particularly useful when making ratiometric measurements (ohms or bridge transducers). Maxim has added a zero-integrator phase to the ICL7116 and ICL7117, eliminating overrange hangover and hysteresis effects. Finally, these devices offer high accuracy by lowering rollover error to less than one count and zero reading drift to less than 1μV/°C.

## Applications

These devices can be used in a wide range of digital panel meter applications. Most applications, however, involve the measurement and display of analog data:

| | |
|---|---|
| Pressure | Conductance |
| Voltage | Current |
| Resistance | Speed |
| Temperature | Material Thickness |

## Typical Operating Circuit




*(Detailed Circuit Diagram—See last page)*

## Features

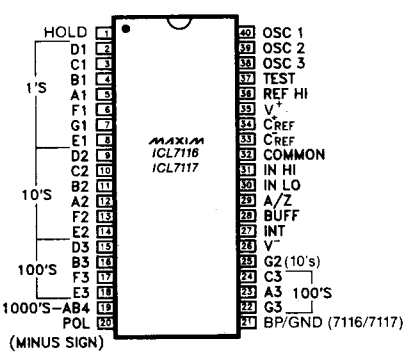
- **Improved 2nd Source! (See 3rd page of this data sheet for "Maxim Advantage™")**
- **Hold pin allows indefinite display hold.**
- **Guaranteed first reading recovery from overrange**
- **On board Display Drive Capability—no external circuitry required: LCD-ICL7116, LED-ICL7117**
- **High Impedance CMOS Differential Inputs**
- **Low Noise (< 15μV p-p) without hysteresis or overrange hangover**
- **Clock and Reference On-Chip**
- **Zero Input Gives Zero Reading**
- **True Polarity Indication for Precision Null Applications**

## Ordering Information

| PART | TEMP. RANGE | PACKAGE |
|---|---|---|
| ICL7116CPL | 0°C to +70°C | 40 Lead Plastic DIP |
| ICL7116CJL | 0°C to +70°C | 40 Lead CERDIP |
| ICL7116CQH | 0°C to +70°C | 44 Lead Plastic Chip Carrier |
| ICL7116C/D | 0°C to +70°C | Dice |
| ICL7117CPL | 0°C to +70°C | 40 Lead Plastic DIP |
| ICL7117CJL | 0°C to +70°C | 40 Lead CERDIP |
| ICL7117CQH | 0°C to +70°C | 44 Lead Plastic Chip Carrier |
| ICL7117C/D | 0°C to +70°C | Dice |

## Pin Configuration

**Top View**




*See last page for Plastic Chip Carrier Pin Configuration*

*The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.*

# 3½ Digit A/D Converter With Display Hold

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage
- ICL7116, $V^+$ to $V^-$ ..... 15V
- ICL7117, $V^+$ to GND ..... +6V
- ICL7117, $V^-$ to GND ..... −9V

Analog Input Voltage (either input)(Note 1) ..... $V^+$ to $V^-$
Reference Input Voltage (either input) ..... $V^+$ to $V^-$
Clock Input
- ICL7116 ..... TEST to $V^+$
- ICL7117 ..... GND to $V^+$

Power Dissipation (Note 2)
- Cerdip Package ..... 1000mW
- Plastic Package ..... 800mW

Operating Temperature Range ..... 0°C to +70°C
Storage Temperature Range ..... −65°C to +160°C
Lead Temperature (Soldering, 60 sec.) ..... +300°C

**Note 1:** Input voltages may exceed the supply voltages, provided the input current is limited to ±100μA.

**Note 2:** Dissipation rating assumes device is mounted with all leads soldered to printed circuit board.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS (Note 3)

| CHARACTERISTICS | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| Zero Input Reading | $V_{IN}$ = 0.0V<br>Full Scale = 200.0mV | -000.0 | ±000.0 | +000.0 | Digital Reading |
| Ratiometric Reading | $V_{IN} = V_{REF}$ = 100mV | 999 | 999/1000 | 1000 | Digital Reading |
| Rollover Error (Difference in reading for equal positive and negative reading near Full Scale) | $-V_{IN} = +V_{IN} \approx$ 200.0mV | -1 | ±.2 | +1 | Counts |
| Linearity (Max. deviation from best straight line fit) | Full scale = 200mV<br>or full scale = 2.000V | -1 | ±.2 | +1 | Counts |
| Common Mode Rejection Ratio (Note 4) | $V_{CM}$ = ±1V, $V_{IN}$ = 0V.<br>Full Scale = 200.0mV | | 50 | | μV/V |
| Noise (Pk-Pk value not exceeded 95% of time) | $V_{IN}$ = 0V<br>Full Scale = 200.0mV | | 15 | | μV |
| Leakage Current @ Input | $V_{IN}$ = 0 | | 1 | 10 | pA |
| Zero Reading Drift | $V_{IN}$ = 0, 0°C < $T_A$ < 70°C | | 0.2 | 1 | μV/°C |
| Scale Factor Temperature Coefficient | $V_{IN}$ = 199.0mV<br>0° < $T_A$ < 70°C<br>(Ext. Ref. 0ppm/°C) | | 1 | 5 | ppm/°C |
| $V^+$ Supply Current (Does not include LED current for 7107) | $V_{IN}$ = 0 | | 0.8 | 1.8 | mA |
| $V^-$ supply current 7107 only | | | 0.6 | 1.8 | mA |
| Analog Common Voltage (With respect to Pos. Supply) | 25kΩ between Common & Pos. Supply | 2.4 | 2.8 | 3.2 | V |
| Temp. Coeff. of Analog Common (With respect to Pos. Supply) | 25kΩ between Common & Pos. Supply | | 80 | | ppm/°C |
| Input Resistance, Pin 1 (Note 6) | | 30 | 70 | | kΩ |
| $V_{IL}$, Pin 1 (7116 only) | | | | TEST +1.5 | V |
| $V_{IL}$, Pin 1 (7117 only) | | | | GND +1.5 | V |
| $V_{IH}$, Pin 1 (Both) | | $V^+$ -1.5 | | | V |
| 7116 ONLY (Note 5)<br>Pk-Pk Segment Drive Voltage,<br>Pk-Pk Backplane Drive Voltage | $V^+$ to $V^-$ = 9V | 4<br><br>4 | 5<br><br>5 | 6<br><br>6 | V |
| 7117 ONLY (Except Pin 19)<br>Segment Sinking Current<br>(Pin 19 only) | $V^+$ = 5.0V<br>Segment voltage = 3V | 5<br><br>10 | 8.0<br><br>16 | | mA |

**Note 3:** Unless otherwise noted, specifications apply to both the 7116 and 7117 at $T_A$ = 25°C, $f_{clock}$ = 48kHz. 7116 is tested in the circuit of Figure 1. 7117 is tested in the circuit of Figure 2.

**Note 4:** Refer to "Differential Input" discussion. (See Maxim's ICL7106/ICL7107 data sheet).

**Note 5:** Back plane drive is in phase with segment drive for 'off' segment, 180° out of phase for 'on' segment. Frequency is 20 times conversion rate. Average DC component is less than 50mV.

**Note 6:** The 7116 logic input has an internal pull-down resistor connected from HLDR, pin 1, to TEST, pin 37. The 7117 logic input has an internal pull-down resistor connected from HLDR, pin 1 to GROUND, pin 21.

*The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted (1983/1984) data book. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with the descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.*

# 3½ Digit A/D Converter With Display Hold



- **Guaranteed Overload Recovery Time**
- **Significantly Improved ESD Protection (Note 8)**
- **Low Noise**
- **Key Parameters Guaranteed over Temperature**
- **Negligible Hysteresis**
- **Maxim Quality and Reliability**
- **Increased Maximum Rating for Input Current (Note 9)**

## ABSOLUTE MAXIMUM RATINGS:

This device conforms to the Absolute Maximum Ratings on adjacent page.

## ELECTRICAL CHARACTERISTICS:

Specifications below satisfy or exceed all "tested" parameters on adjacent page.

($V^+$ = 9V; $T_A$ = 25°C; $f_{CLOCK}$ = 48kHz; test circuit - Figure 1 (ICL7116), Figure 2 (ICL7117) unless noted)

| PARAMETERS | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|
| **Zero Input Reading** | $V_{IN}$ = 0.0V, Full Scale = 200.0mV<br>$T_A$ = 25°C (Note 7)<br>**0° ≤ $T_A$ ≤ 70°C (Note 11)** | −000.0<br>**−000.0** | ±000.0<br>**±000.0** | +000.0<br>**+000.0** | Digital Reading |
| **Ratiometric Reading** | $V_{IN}$ = $V_{REF}$, $V_{REF}$ = 100mV<br>$T_A$ = 25°C (Note 7)<br>**0° ≤ $T_A$ ≤ 70°C (Note 11)** | 999<br>**998** | 999/1000<br>**999/1000** | 1000<br>**1001** | Digital Reading |
| Rollover Error (Difference in reading for equal positive and negative reading near Full Scale) | $-V_{IN}$ = $+V_{IN}$ ≅ 200.0mV<br>$T_A$ = 25°C (Note 7)<br>0° ≤ $T_A$ ≤ 70°C (Note 11) | −1 | ±.2<br>±.2 | +1 | Counts |
| Linearity (Max. deviation from best straight line fit) | Full Scale = 200.0mV<br>or full scale = 2.000V | −1 | ±.2 | +1 | Counts |
| Common Mode Rejection Ratio | $V_{CM}$ = ±1V, $V_{IN}$ = 0V<br>Full Scale = 200.0mV | | 50 | | µV/V |
| Noise (Pk-Pk value not exceeded 95% of time) | $V_{IN}$ = 0V<br>Full Scale = 200.0mV | | 15 | | µV |
| **Input Leakage Current** | $V_{IN}$ = 0, $T_A$ = 25°C (Note 7)<br>**0° ≤ $T_A$ ≤ 70°C** | | 1<br>**20** | 10<br>**200** | pA |
| Zero Reading Drift | $V_{IN}$ = 0<br>0° ≤ $T_A$ ≤ 70°C (Note 7) | | 0.2 | 1 | µV/°C |
| Scale Factor Temperature Coefficient | $V_{IN}$ = 199.0mV<br>0° ≤ $T_A$ ≤ 70°C<br>(Ext. Ref. 0ppm/°C) (Note 7) | | 1 | 5 | ppm/°C |
| **$V^+$ Supply Current (Does not include LED current for 7117)** | $V_{IN}$ = 0<br>$T_A$ = 25°C<br>**0° ≤ $T_A$ ≤ 70°C** | | 0.6 | 1.8<br>**2** | mA |
| $V^-$ Supply Current (7117 only) | | | 0.6 | 1.8 | mA |
| Analog Common Voltage (with respect to Pos. Supply) | 25kΩ between Common & Pos. Supply | 2.4 | 2.8 | 3.2 | V |
| Temp. Coeff. of Analog Common (with respect to Pos. Supply) | 25kΩ between Common & Pos. Supply | | 75 | | ppm/°C |
| Input Resistance, Pin 1 (Note 6) | | 30 | 70 | | kΩ |
| $V_{IL}$, Pin 1 (7116 only) | | | | TEST +1.5 | V |
| $V_{IL}$, Pin 1 (7117 only) | | | | GND +1.5 | V |
| $V_{IH}$, Pin 1 (Both) | | $V^+$ -1.5 | | | V |
| 7116 Only (Note 5)<br>Pk-Pk Segment Drive Voltage,<br>Pk-Pk Backplane Drive Voltage | $V^+$ to $V^-$ = 9V | 4 | 5 | 6 | V |
| 7117 Only—Segment Sinking Current<br>(Except Pin 19)<br>(Pin 19 only) | $V^+$ = 5.0V<br>Segment Voltage = 3V | 5<br>10 | 8.0<br>16 | | mA<br>mA |
| **7116 Only—Test Pin Voltage** | **With Respect to $V^+$** | **4** | **5** | **6** | **V** |
| **Overload Recovery Time (Note 10)** | **$V_{IN}$ changing from ± 10V to 0V** | | **0** | **1** | **Measurement Cycles** |

**Note 7:** Test condition is $V_{IN}$ applied between pins IN-HI and IN-LO. i.e., 1MΩ resistor in Figures 1 and 2.

**Note 8:** All pins are designed to withstand electrostatic discharge (ESD) levels in excess of 2000V. (Test circuit per Mil. Std 883C, Method 3015.2)

**Note 9:** Input voltages may exceed the supply voltage provided the input current is limited to ±1mA (This revises Note 1 on adjacent page).

**Note 10:** Number of measurement cycles for display to give accurate reading.

**Note 11:** 1MΩ resistor is removed in Figures 1 and 2.

# 3½ Digit A/D Converter With Display Hold

## Detailed Description

The Maxim ICL7116 and ICL7117 3½ digit A/D converter are similar to the Maxim ICL7106 and ICL7107, except for the addition of a Hold pin. For a detailed product description, package dimensions, and applications information (other than the operation of the Hold pin described below) refer to Maxim's ICL7106 and ICL7107 data sheet.

### Hold Input

The Hold input is a digital input with a logic threshold approximately midway between $V^+$ and Test (ICL7116) or $V^+$ and Ground (ICL7117). The ICL7116/7117 continuously performs conversions, independent of the Hold input. When the Hold input is connected to $V^+$, however, the display latch pulse is inhibited, and the display latches are not updated. The Hold input has a 70 kilohm pulldown resistor to Test (ICL7116) or Ground (ICL7117) and the Hold input will be pulled low if it is left open. When Hold is low the ICL7116/ICL7117 updates the display at the end of each conversion. The Hold input is CMOS compatible, and can also be driven by a switch connected to $V^+$ (Figure 1 and 2) or by a PNP transistor.

Unlike the ICL7106 and ICL7107, the ICL7116 and ICL7117 do not have a Reference Low input. Apply the reference voltage between Reference High (REF HI) and Common.

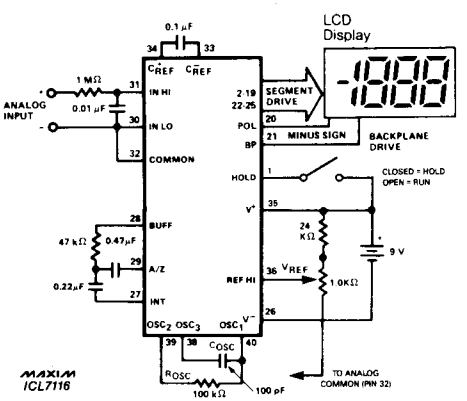



*Figure 1. Maxim ICL7116 Typical Operating Circuit, 200mV Reference*

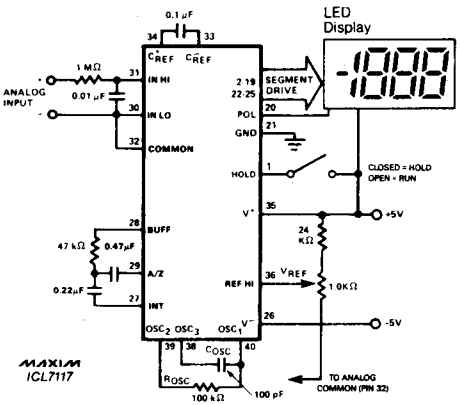
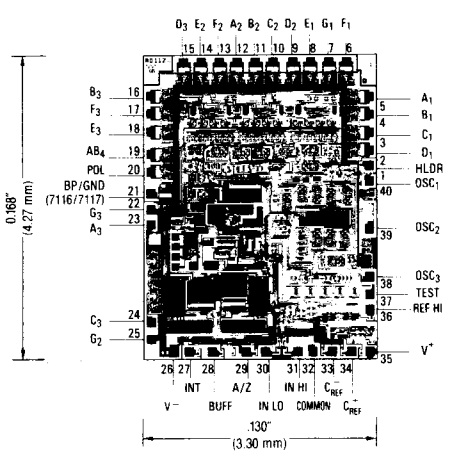
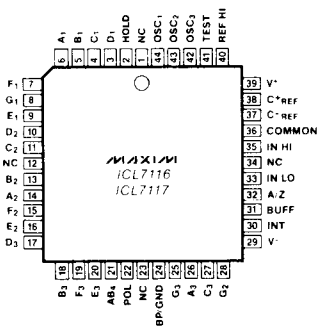



*Figure 2. Maxim ICL7117 Typical Operating Circuit, 200mV Reference*

## Chip Topography




## Pin Configuration




**44 Lead Plastic Chip Carrier (Quad Pack)**