

## 3<sup>1</sup>/<sub>2</sub> Digit, LCD/LED Display, A/D Converters

The Intersil ICL7106 and ICL7107 are high performance, low power, 3<sup>1</sup>/<sub>2</sub> digit A/D converters. Included are seven segment decoders, display drivers, a reference, and a clock. The ICL7106 is designed to interface with a liquid crystal display (LCD) and includes a multiplexed backplane drive; the ICL7107 will directly drive an instrument size light emitting diode (LED) display.

The ICL7106 and ICL7107 bring together a combination of high accuracy, versatility, and true economy. It features auto-zero to less than 10μV, zero drift of less than 1μV/°C, input bias current of 10pA (Max), and rollover error of less than one count. True differential inputs and reference are useful in all systems, but give the designer an uncommon advantage when measuring load cells, strain gauges and other bridge type transducers. Finally, the true economy of single power supply operation (ICL7106), enables a high performance panel meter to be built with the addition of only 10 passive components and a display.

## Features

- Guaranteed Zero Reading for 0V Input on All Scales
- True Polarity at Zero for Precise Null Detection
- 1pA Typical Input Current
- True Differential Input and Reference, Direct Display Drive
  - LCD ICL7106, LED ICL7107
- Low Noise - Less Than 15μV<sub>p-p</sub>
- On Chip Clock and Reference
- Low Power Dissipation - Typically Less Than 10mW
- No Additional Active Circuits Required
- Enhanced Display Stability
- Pb-Free Plus Anneal Available (RoHS Compliant)

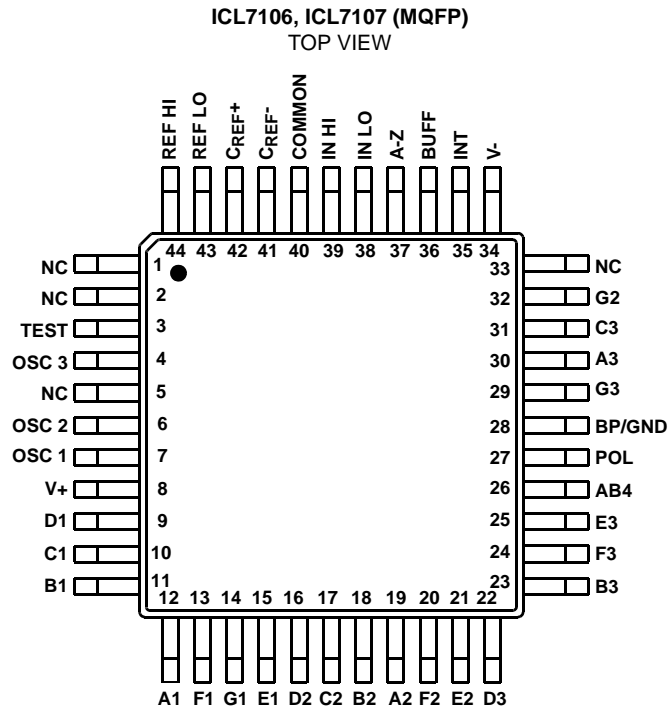
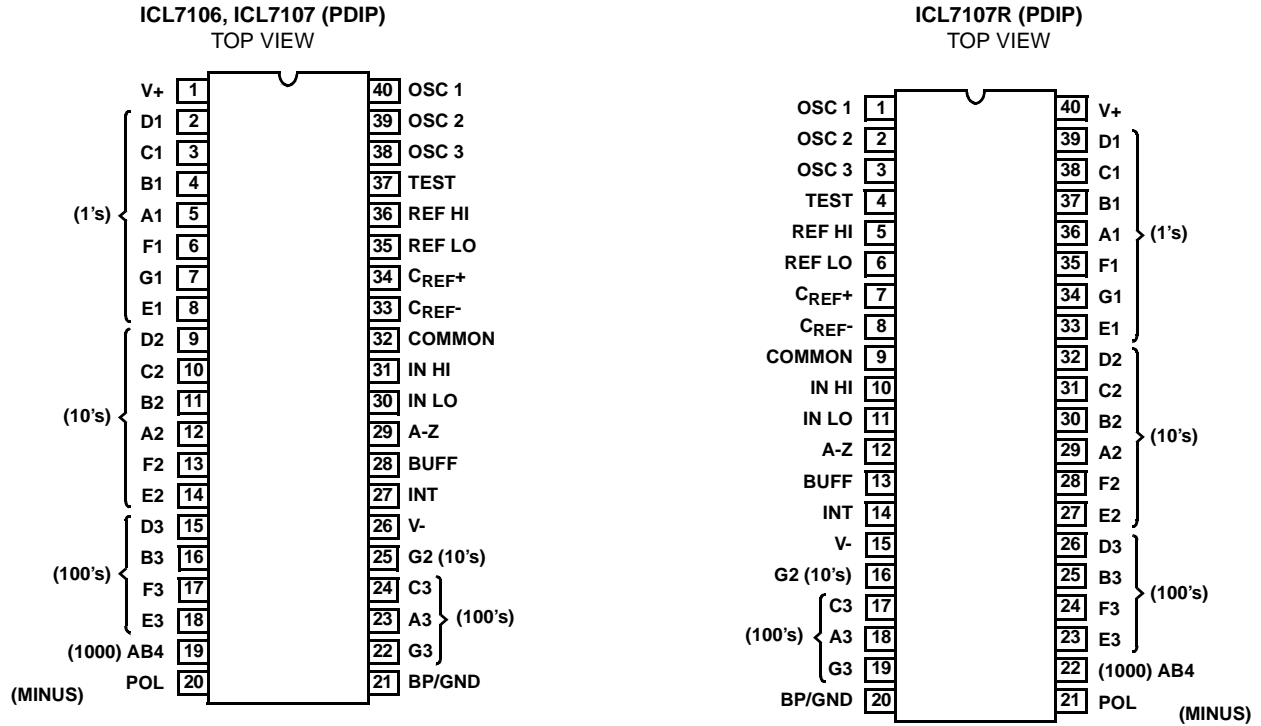
## Ordering Information

PART NO.	PART MARKING	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
ICL7106CPL	ICL7106CPL	0 to 70	40 Ld PDIP	E40.6
ICL7106CPLZ (Note 2)	ICL7106CPLZ	0 to 70	40 Ld PDIP (Pb-free) (Note 3)	E40.6
ICL7106CM44	ICL7106CM44	0 to 70	44 Ld MQFP	Q44.10x10
ICL7106CM44Z (Note 2)	ICL7106CM44Z	0 to 70	44 Ld MQFP (Pb-free)	Q44.10x10
ICL7106CM44ZT (Note 2)	ICL7106CM44Z	0 to 70	44 Ld MQFP Tape and Reel (Pb-free)	Q44.10x10
ICL7107CPL	ICL7107CPL	0 to 70	40 Ld PDIP	E40.6
ICL7107CPLZ (Note 2)	ICL7107CPLZ	0 to 70	40 Ld PDIP (Pb-free) (Note 3)	E40.6
ICL7107RCPL	ICL7107RCPL	0 to 70	40 Ld PDIP (Note 1)	E40.6
ICL7107RCPLZ (Note 2)	ICL7107RCPLZ	0 to 70	40 Ld PDIP (Pb-free) (Notes 1, 3)	E40.6
ICL7107SCPL	ICL7107SCPL	0 to 70	40 Ld PDIP (Notes 1, 3)	E40.6
ICL7107SCPLZ (Note 2)	ICL7107SCPLZ	0 to 70	40 Ld PDIP (Pb-free) (Notes 1, 3)	E40.6
ICL7107CM44	ICL7107CM44	0 to 70	44 Ld MQFP	Q44.10x10
ICL7107CM44T	ICL7107CM44	0 to 70	44 Ld MQFP Tape and Reel	Q44.10x10
ICL7107CM44Z (Note 2)	ICL7107CM44Z	0 to 70	44 Ld MQFP (Pb-free)	Q44.10x10
ICL7107CM44ZT (Note 2)	ICL7107CM44Z	0 to 70	44 Ld MQFP Tape and Reel (Pb-free)	Q44.10x10

### NOTES:

1. "R" indicates device with reversed leads for mounting to PC board underside. "S" indicates enhanced stability.
2. Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant and compatible with both SnPb and Pb-free soldering operations. Intersil Pb-free products are MSL classified at Pb-free peak reflow temperatures that meet or exceed the Pb-free requirements of IPC/JEDEC J STD-020.
3. Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in Reflow solder processing applications.

## Pinouts



# ICL7106, ICL7107, ICL7107S

## Absolute Maximum Ratings

Supply Voltage	
ICL7106, V+ to V- .....	15V
ICL7107, V+ to GND .....	.6V
ICL7107, V- to GND .....	-9V
Analog Input Voltage (Either Input) (Note 1) .....	V+ to V-
Reference Input Voltage (Either Input) .....	V+ to V-
Clock Input	
ICL7106 .....	TEST to V+
ICL7107 .....	GND to V+

## Operating Conditions

Temperature Range ..... 0°C to 70°C

**CAUTION:** Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

### NOTES:

1. Input voltages may exceed the supply voltages provided the input current is limited to  $\pm 100\mu\text{A}$ .
2.  $\theta_{JA}$  is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

## Thermal Information

Thermal Resistance (Typical, Note 2)	$\theta_{JA}$ (°C/W)
PDIP Package .....	50
MQFP Package .....	75
Maximum Junction Temperature .....	150°C
Maximum Storage Temperature Range .....	-65°C to 150°C
Maximum Lead Temperature (Soldering 10s) .....	300°C
(MQFP - Lead Tips Only)	

**NOTE:** Pb-free PDIPs can be used for through hole wave solder processing only. They are not intended for use in Reflow solder processing applications.

## Electrical Specifications (Note 3)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>SYSTEM PERFORMANCE</b>					
Zero Input Reading	$V_{IN} = 0.0V$ , Full Scale = 200mV	-000.0	$\pm 000.0$	+000.0	Digital Reading
Stability (Last Digit) (ICL7106S, ICL7107S Only)	Fixed Input Voltage (Note 6)	-000.0	$\pm 000.0$	+000.0	Digital Reading
Ratiometric Reading	$V_{IN} = V_{REF}$ , $V_{REF} = 100mV$	999	999/1000	1000	Digital Reading
Rollover Error	$-V_{IN} = +V_{IN} \cong 200mV$ Difference in Reading for Equal Positive and Negative Inputs Near Full Scale	-	$\pm 0.2$	$\pm 1$	Counts
Linearity	Full Scale = 200mV or Full Scale = 2V Maximum Deviation from Best Straight Line Fit (Note 5)	-	$\pm 0.2$	$\pm 1$	Counts
Common Mode Rejection Ratio	$V_{CM} = 1V$ , $V_{IN} = 0V$ , Full Scale = 200mV (Note 5)	-	50	-	$\mu V/V$
Noise	$V_{IN} = 0V$ , Full Scale = 200mV (Peak-To-Peak Value Not Exceeded 95% of Time)	-	15	-	$\mu V$
Leakage Current Input	$V_{IN} = 0$ (Note 5)	-	1	10	pA
Zero Reading Drift	$V_{IN} = 0$ , 0°C To 70°C (Note 5)	-	0.2	1	$\mu V/^{\circ}C$
Scale Factor Temperature Coefficient	$V_{IN} = 199mV$ , 0°C To 70°C, (Ext. Ref. 0ppm/ $^{\circ}C$ ) (Note 5)	-	1	5	ppm/ $^{\circ}C$
End Power Supply Character V+ Supply Current	$V_{IN} = 0$ (Does Not Include LED Current for ICL7107)	-	1.0	1.8	mA
End Power Supply Character V- Supply Current	ICL7107 Only	-	0.6	1.8	mA
COMMON Pin Analog Common Voltage	25k $\Omega$ Between Common and Positive Supply (With Respect to + Supply)	2.4	3.0	3.2	V
Temperature Coefficient of Analog Common	25k $\Omega$ Between Common and Positive Supply (With Respect to + Supply)	-	80	-	ppm/ $^{\circ}C$
<b>DISPLAY DRIVER ICL7106 ONLY</b>					
Peak-To-Peak Segment Drive Voltage	V+ = to V- = 9V (Note 4)	4	5.5	6	V
Peak-To-Peak Backplane Drive Voltage					

## Electrical Specifications (Note 3) (Continued)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
<b>DISPLAY DRIVER ICL7107 ONLY</b>					
Segment Sinking Current	$V_+ = 5V$ , Segment Voltage = $3V$				
Except Pins 19 and 20		5	8	-	mA
Pin 19 Only		10	16	-	mA
Pin 20 Only		4	7	-	mA

### NOTES:

- Unless otherwise noted, specifications apply to both the ICL7106 and ICL7107 at  $T_A = 25^\circ C$ ,  $f_{CLOCK} = 48kHz$ . ICL7106 is tested in the circuit of Figure 1. ICL7107 is tested in the circuit of Figure 2.
- Back plane drive is in phase with segment drive for "off" segment, 180 degrees out of phase for "on" segment. Frequency is 20 times conversion rate. Average DC component is less than 50mV.
- Not tested, guaranteed by design.
- Sample Tested.

## Typical Applications and Test Circuits

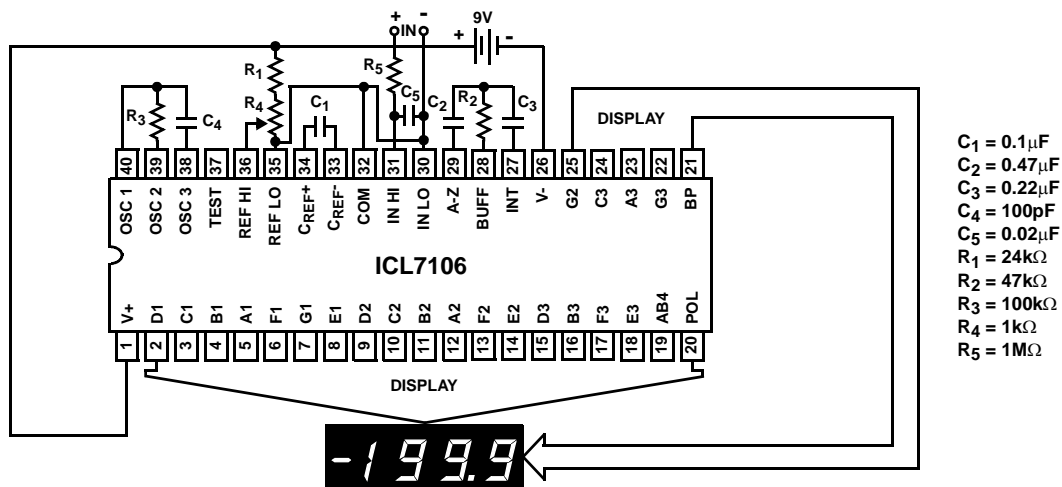


FIGURE 1. ICL7106 TEST CIRCUIT AND TYPICAL APPLICATION WITH LCD DISPLAY COMPONENTS SELECTED FOR 200mV FULL SCALE

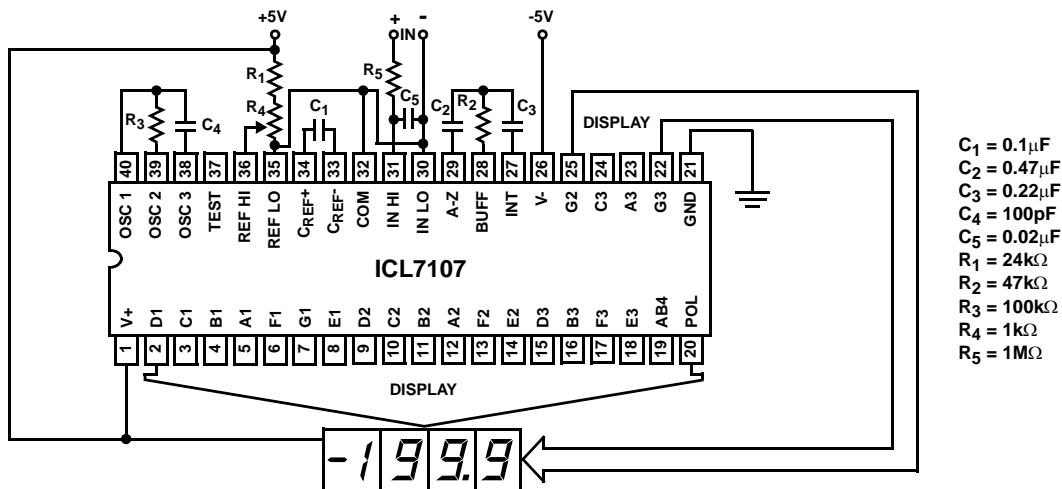


FIGURE 2. ICL7107 TEST CIRCUIT AND TYPICAL APPLICATION WITH LED DISPLAY COMPONENTS SELECTED FOR 200mV FULL SCALE

## Design Information Summary Sheet

### • OSCILLATOR FREQUENCY

$$f_{OSC} = 0.45/RC$$

$$C_{OSC} > 50pF; R_{OSC} > 50k\Omega$$

$$f_{OSC} (Typ) = 48kHz$$

### • OSCILLATOR PERIOD

$$t_{OSC} = RC/0.45$$

### • INTEGRATION CLOCK FREQUENCY

$$f_{CLOCK} = f_{OSC}/4$$

### • INTEGRATION PERIOD

$$t_{INT} = 1000 \times (4/f_{OSC})$$

### • 60/50Hz REJECTION CRITERION

$$t_{INT}/t_{60Hz} \text{ or } t_{INT}/t_{50Hz} = \text{Integer}$$

### • OPTIMUM INTEGRATION CURRENT

$$I_{INT} = 4\mu A$$

### • FULL SCALE ANALOG INPUT VOLTAGE

$$V_{INFS} (Typ) = 200mV \text{ or } 2V$$

### • INTEGRATE RESISTOR

$$R_{INT} = \frac{V_{INFS}}{I_{INT}}$$

### • INTEGRATE CAPACITOR

$$C_{INT} = \frac{(t_{INT})(I_{INT})}{V_{INT}}$$

### • INTEGRATOR OUTPUT VOLTAGE SWING

$$V_{INT} = \frac{(t_{INT})(I_{INT})}{C_{INT}}$$

### • $V_{INT}$ MAXIMUM SWING:

$$(V^- + 0.5V) < V_{INT} < (V^+ - 0.5V), V_{INT} (Typ) = 2V$$

### • DISPLAY COUNT

$$COUNT = 1000 \times \frac{V_{IN}}{V_{REF}}$$

### • CONVERSION CYCLE

$$t_{CYC} = t_{CLOCK} \times 4000$$

$$t_{CYC} = t_{OSC} \times 16,000$$

when  $f_{OSC} = 48kHz$ ;  $t_{CYC} = 333ms$

### • COMMON MODE INPUT VOLTAGE

$$(V^- + 1V) < V_{IN} < (V^+ - 0.5V)$$

### • AUTO-ZERO CAPACITOR

$$0.01\mu F < C_{AZ} < 1\mu F$$

### • REFERENCE CAPACITOR

$$0.1\mu F < C_{REF} < 1\mu F$$

### • $V_{COM}$

Biased between  $V_i$  and  $V^-$ .

### • $V_{COM} \cong V^+ - 2.8V$

Regulation lost when  $V^+$  to  $V^- < \cong 6.8V$   
If  $V_{COM}$  is externally pulled down to  $(V^+ \text{ to } V^-)/2$ , the  $V_{COM}$  circuit will turn off.

### • ICL7106 POWER SUPPLY: SINGLE 9V

$V^+ - V^- = 9V$   
Digital supply is generated internally  
 $V_{GND} \cong V^+ - 4.5V$

### • ICL7106 DISPLAY: LCD

Type: Direct drive with digital logic supply amplitude.

### • ICL7107 POWER SUPPLY: DUAL $\pm 5.0V$

$V^+ = +5V$  to GND  
 $V^- = -5V$  to GND  
Digital Logic and LED driver supply  $V^+$  to GND

### • ICL7107 DISPLAY: LED

Type: Non-Multiplexed Common Anode

## Typical Integrator Amplifier Output Waveform (INT Pin)

