Data Sheet | December 1, 2005 | FN3082.8

$3^1/_2$ Digit, LCD/LED Display, A/D Converters

The Intersil ICL7106 and ICL7107 are high performance, low power, $3^1/_2$ 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/^{o}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 lCL7107
- Low Noise - Less Than 15μV_{P-P}
- 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

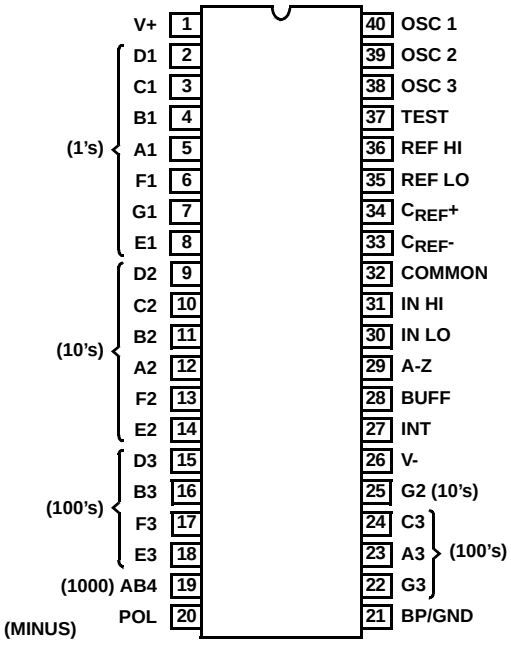
PART NO.	PART MARKING	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
ICL7106CPL	ICL7106CPL	0 to 70	40 Ld PDIP	E40.6
ICL7106CPLZ (Note 2)	ICL7106CPLZ	0 to 70	40 Ld PDIP(Pb-free) (Note 3)	E40.6
ICL7106CM44	ICL7106CM44	0 to 70	44 Ld MQFP	Q44.10x10
ICL7106CM44Z (Note 2)	ICL7106CM44Z	0 to 70	44 Ld MQFP (Pb-free)	Q44.10x10
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:

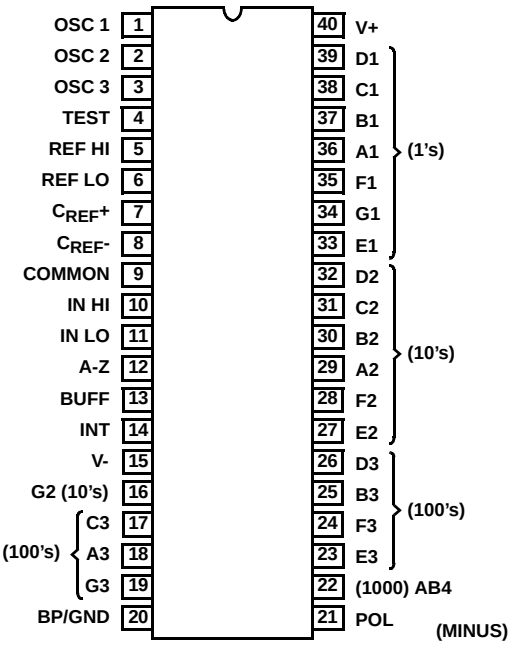
1. “R” indicates device with reversed leads for mounting to PC board underside. “S” indicates enhanced stability.
2. Intersil Pb-free plus anneal products employ special Pb-free material sets; molding compounds/die attach materials and 100% matte tin plate termination finish, which are RoHS compliant 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

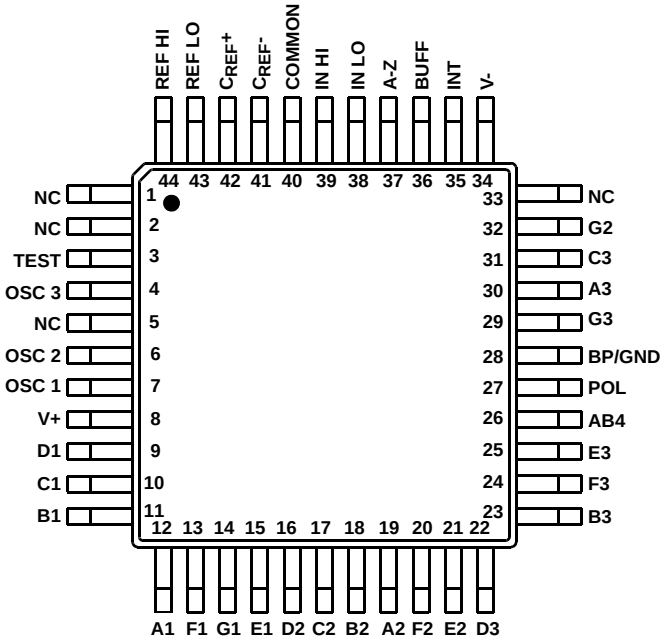
ICL7106, ICL7107 (PDIP)
TOP VIEW



ICL7107R (PDIP)
TOP VIEW



ICL7106, ICL7107 (MQFP)
TOP VIEW



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^oC to 70^oC

Thermal Information

Thermal Resistance (Typical, Note 2)	θ_{JA} ($^oC/W$)
PDIP Package	50
MQFP Package	75

Maximum Junction Temperature . . . . . 150^oC
Maximum Storage Temperature Range . . . . . -65^oC to 150^oC
Maximum Lead Temperature (Soldering 10s) . . . . . 300^oC
(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.

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 ±100µA.
2. θ_{JA} is measured with the component mounted on a low effective thermal conductivity test board in free air. See Tech Brief TB379 for details.

Electrical Specifications (Note 3)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
SYSTEM PERFORMANCE					
Zero Input Reading	V_{IN} = 0.0V, Full Scale = 200mV	-000.0	±000.0	+000.0	Digital Reading
Stability (Last Digit) (ICL7106S, ICL7107S Only)	Fixed Input Voltage (Note 6)	-000.0	±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	-	±0.2	±1	Counts
Linearity	Full Scale = 200mV or Full Scale = 2V Maximum Deviation from Best Straight Line Fit (Note 5)	-	±0.2	±1	Counts
Common Mode Rejection Ratio	V_{CM} = 1V, V_{IN} = 0V, Full Scale = 200mV (Note 5)	-	50	-	µV/V
Noise	V_{IN} = 0V, Full Scale = 200mV (Peak-To-Peak Value Not Exceeded 95% of Time)	-	15	-	µV
Leakage Current Input	V_{IN} = 0 (Note 5)	-	1	10	pA
Zero Reading Drift	V_{IN} = 0, 0^oC To 70^oC (Note 5)	-	0.2	1	$\mu V/^oC$
Scale Factor Temperature Coefficient	V_{IN} = 199mV, 0^oC To 70^oC, (Ext. Ref. 0ppm/$\times^oC$) (Note 5)	-	1	5	$ppm/^oC$
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	25kΩ Between Common and Positive Supply (With Respect to + Supply)	2.4	3.0	3.2	V
Temperature Coefficient of Analog Common	25kΩ Between Common and Positive Supply (With Respect to + Supply)	-	80	-	$ppm/^oC$
DISPLAY DRIVER ICL7106 ONLY					
Peak-To-Peak Segment Drive Voltage Peak-To-Peak Backplane Drive Voltage	V+ = to V- = 9V (Note 4)	4	5.5	6	V

Electrical Specifications (Note 3) (Continued)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
DISPLAY DRIVER ICL7107 ONLY					
Segment Sinking Current	V+ = 5V, Segment Voltage = 3V				
Except Pins AB4 and POL		5	8	-	mA
Pin AB4 Only		10	16	-	mA
Pin POL Only		4	7	-	mA

NOTES:

3. Unless otherwise noted, specifications apply to both the ICL7106 and ICL7107 at $T_A = 25^oC$, $f_{CLOCK} = 48kHz$. ICL7106 is tested in the circuit of Figure 1. ICL7107 is tested in the circuit of Figure 2.
4. 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.
5. Not tested, guaranteed by design.
6. Sample Tested.

Typical Applications and Test Circuits

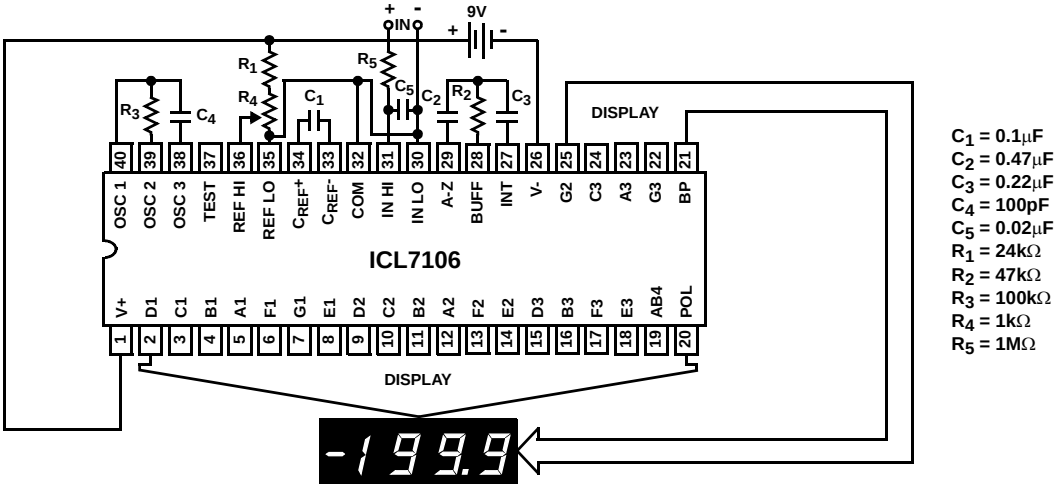


FIGURE 1. ICL7106 TEST CIRCUIT AND TYPICAL APPLICATION WITH LCD DISPLAY COMPONENTS SELECTED FOR 200mV FULL SCALE

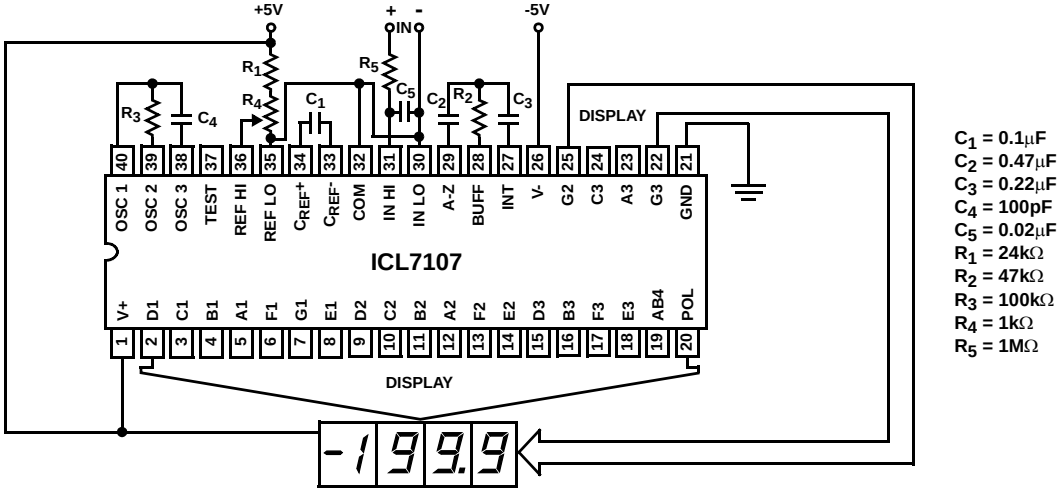


FIGURE 2. ICL7107 TEST CIRCUIT AND TYPICAL APPLICATION WITH LED DISPLAY COMPONENTS SELECTED FOR 200mV FULL SCALE

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} or t_{INT}/t_{60Hz} = Integer

- **OPTIMUM INTEGRATION CURRENT**

  $I_{INT} = 4\mu A$

- **FULL SCALE ANALOG INPUT VOLTAGE**

  V_{INFS} (Typ) = 200mV 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**

  $t_{CYC} = t_{CL0CK} \times 4000$
  $t_{CYC} = t_{OSC} \times 16,000$
  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 Vi and V-.

- **$V_{COM} \cong$ V+ - 2.8V**
  Regulation lost when V+ to V- < ≅6.8V
  If V_{COM} is externally pulled down to (V+ to V-)/2, the V_{COM} circuit will turn off.

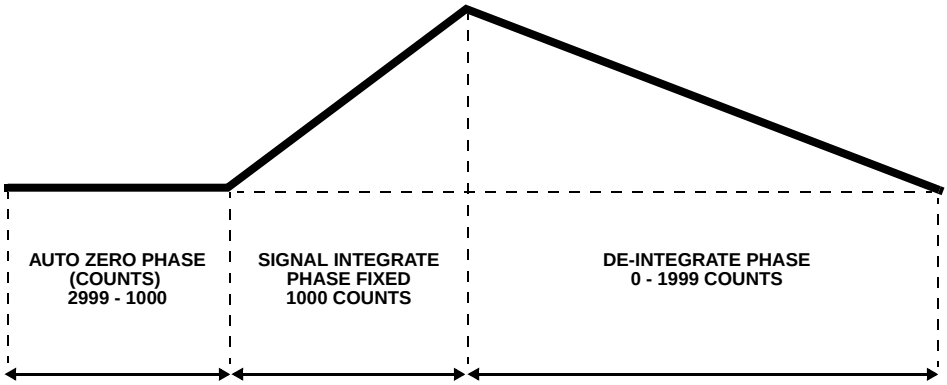
- **ICL7106 POWER SUPPLY: SINGLE 9V**
  V+ - V- = 9V
  Digital supply is generated internally
  $V_{GND} \cong$ V+ - 4.5V

- **ICL7106 DISPLAY: LCD**
  Type: Direct drive with digital logic supply amplitude.

- **ICL7107 POWER SUPPLY: DUAL ±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)



TOTAL CONVERSION TIME = 4000 x t_{CLOCK} = 16,000 x t_{OSC}

Typical Applications

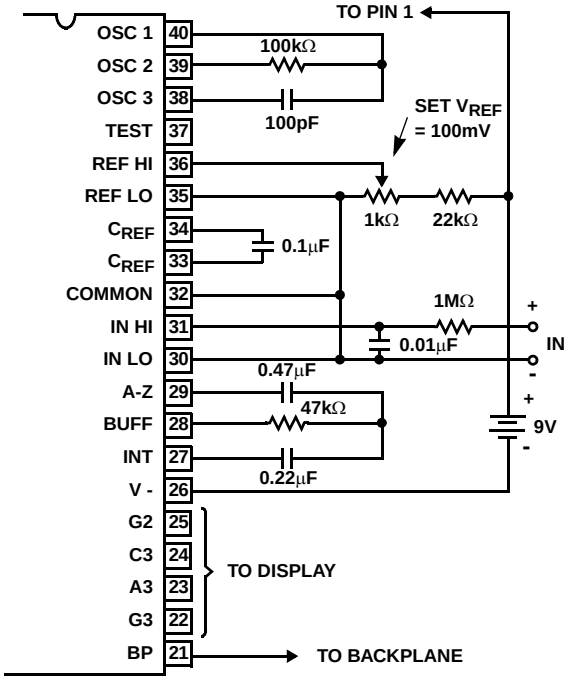
The ICL7106 and ICL7107 may be used in a wide variety of configurations. The circuits which follow show some of the possibilities, and serve to illustrate the exceptional versatility of these A/D converters.

The following application notes contain very useful information on understanding and applying this part and are available from Intersil Corporation.

Application Notes

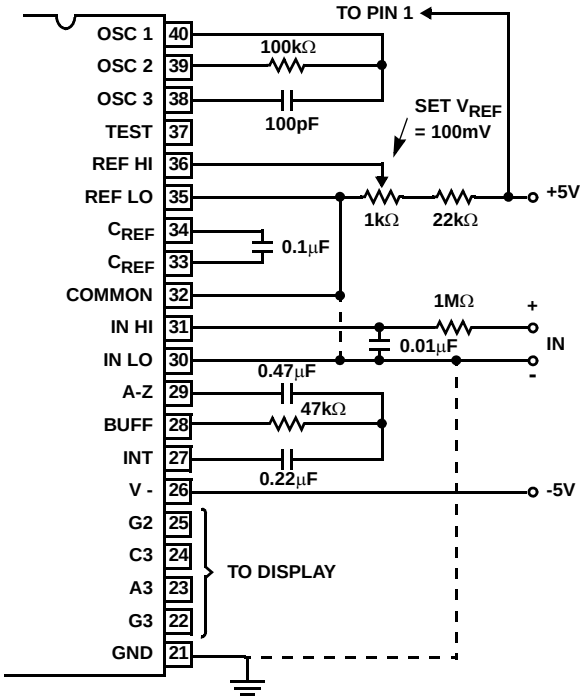
NOTE #	DESCRIPTION
AN016	“Selecting A/D Converters”
AN017	“The Integrating A/D Converter”
AN018	“Do’s and Don’ts of Applying A/D Converters”
AN023	“Low Cost Digital Panel Meter Designs”
AN032	“Understanding the Auto-Zero and Common Mode Performance of the ICL7136/7/9 Family”
AN046	“Building a Battery-Operated Auto Ranging DVM with the ICL7106”
AN052	“Tips for Using Single Chip $3^1/_2$ Digit A/D Converters”
AN9609	“Overcoming Common Mode Range Issues When Using Intersil Integrating Converters”

Typical Applications



Values shown are for 200mV full scale, 3 readings/sec., floating supply voltage (9V battery).

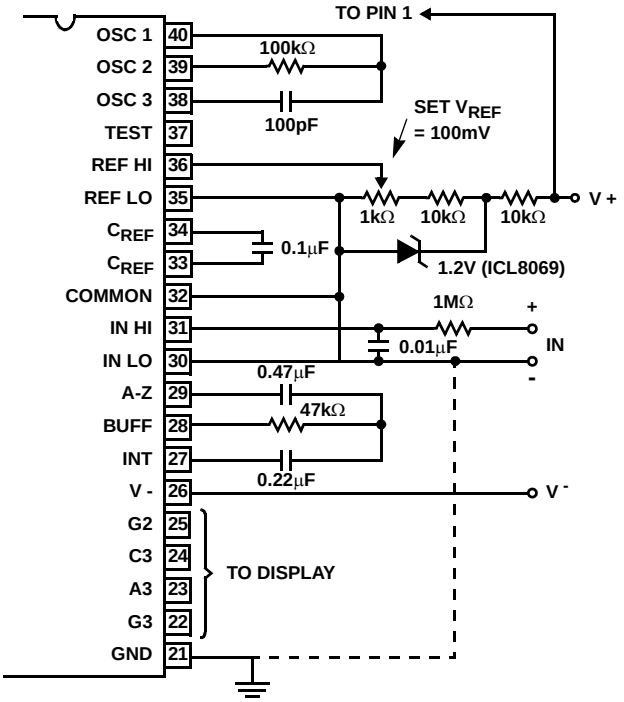
FIGURE 11. ICL7106 USING THE INTERNAL REFERENCE



Values shown are for 200mV full scale, 3 readings/sec. IN LO may be tied to either COMMON for inputs floating with respect to supplies, or GND for single ended inputs. (See discussion under Analog COMMON).

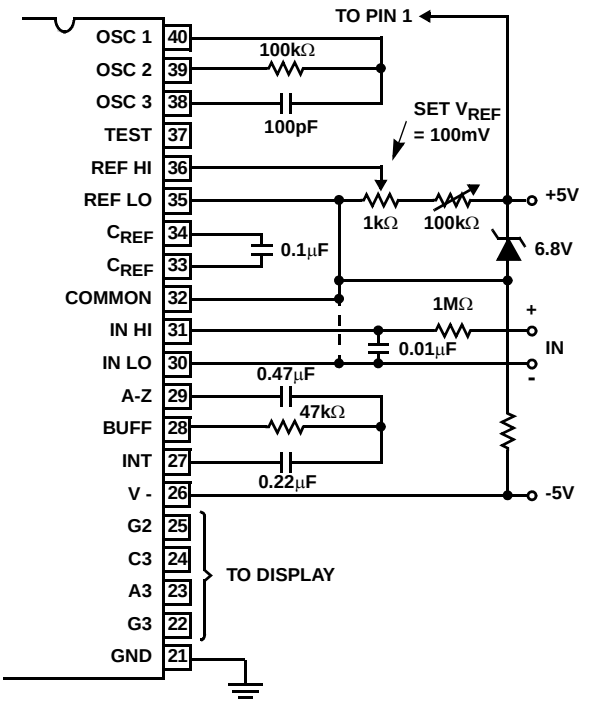
FIGURE 12. ICL7107 USING THE INTERNAL REFERENCE

Typical Applications (Continued)



IN LO is tied to supply COMMON establishing the correct common mode voltage. If COMMON is not shorted to GND, the input voltage may float with respect to the power supply and COMMON acts as a pre-regulator for the reference. If COMMON is shorted to GND, the input is single ended (referred to supply GND) and the pre-regulator is overridden.

FIGURE 13. ICL7107 WITH AN EXTERNAL BAND-GAP REFERENCE (1.2V TYPE)



Since low TC zeners have breakdown voltages ~ 6.8V, diode must be placed across the total supply (10V). As in the case of Figure 12, IN LO may be tied to either COMMON or GND.

FIGURE 14. ICL7107 WITH ZENER DIODE REFERENCE

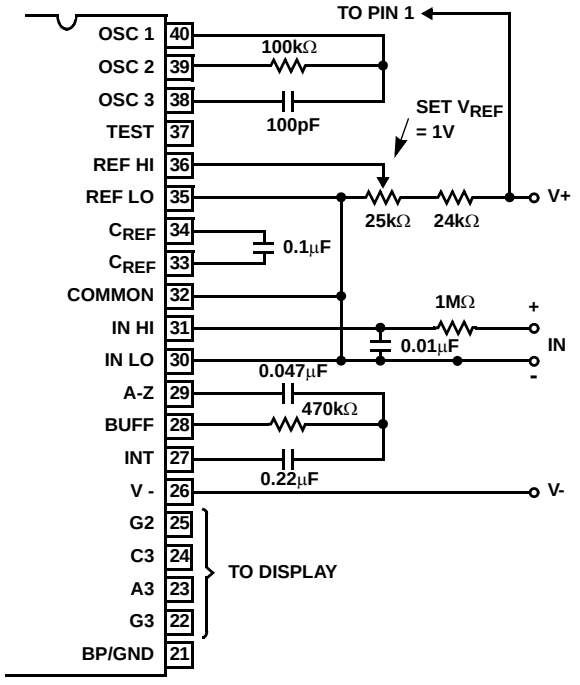
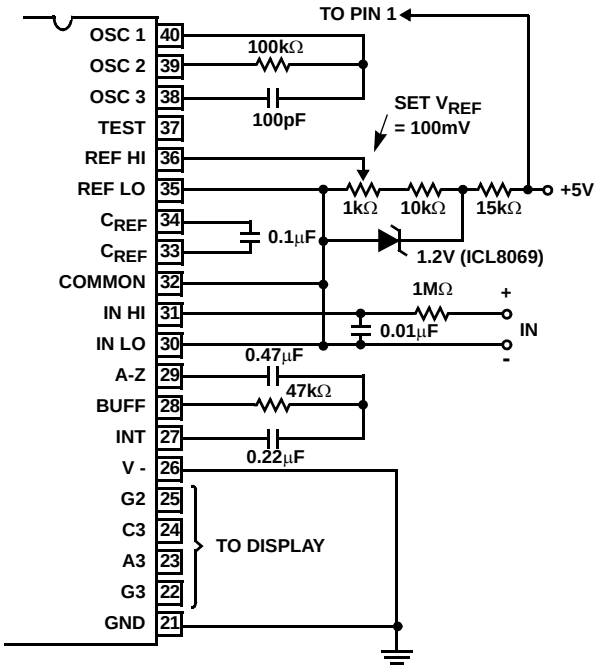


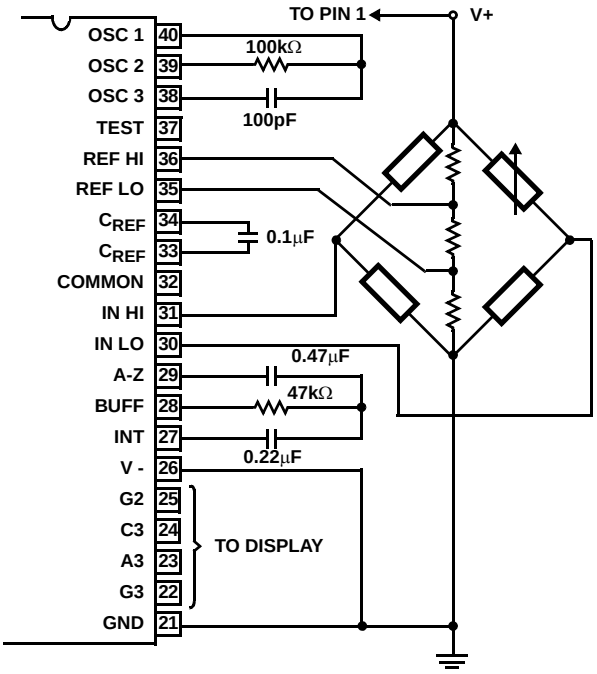
FIGURE 15. ICL7106 AND ICL7107: RECOMMENDED COMPONENT VALUES FOR 2V FULL SCALE



An external reference must be used in this application, since the voltage between V+ and V- is insufficient for correct operation of the internal reference.

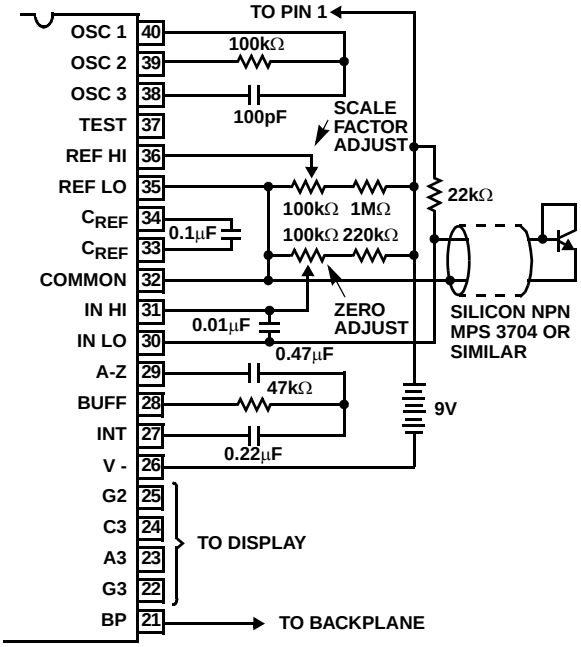
FIGURE 16. ICL7107 OPERATED FROM SINGLE +5V

Typical Applications (Continued)



The resistor values within the bridge are determined by the desired sensitivity.

FIGURE 17. ICL7107 MEASUREING RATIOMETRIC VALUES OF QUAD LOAD CELL



A silicon diode-connected transistor has a temperature coefficient of about -2mV/^{o}C. Calibration is achieved by placing the sensing transistor in ice water and adjusting the zeroing potentiometer for a 000.0 reading. The sensor should then be placed in boiling water and the scale-factor potentiometer adjusted for a 100.0 reading.

FIGURE 18. ICL7106 USED AS A DIGITAL CENTIGRADE THERMOMETER

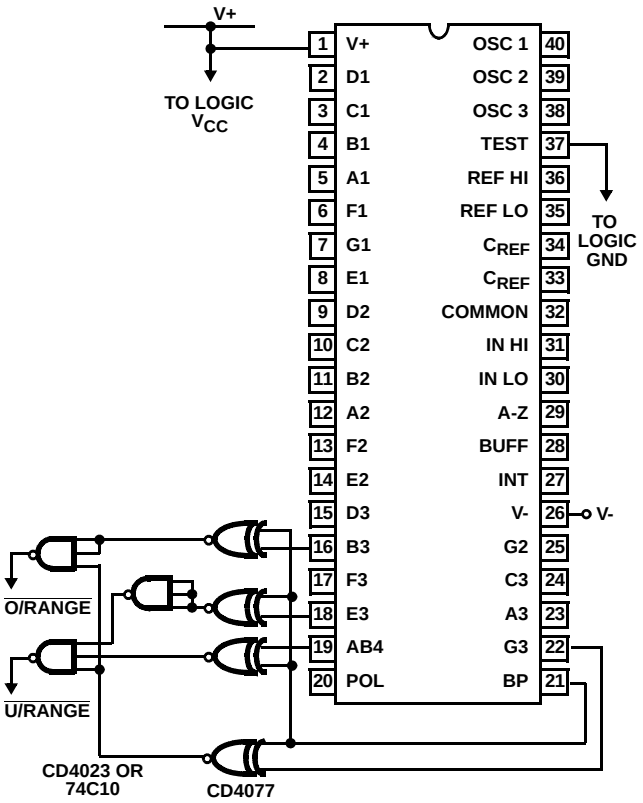


FIGURE 19. CIRCUIT FOR DEVELOPING UNDERRANGE AND OVERRANGE SIGNAL FROM ICL7106 OUTPUTS

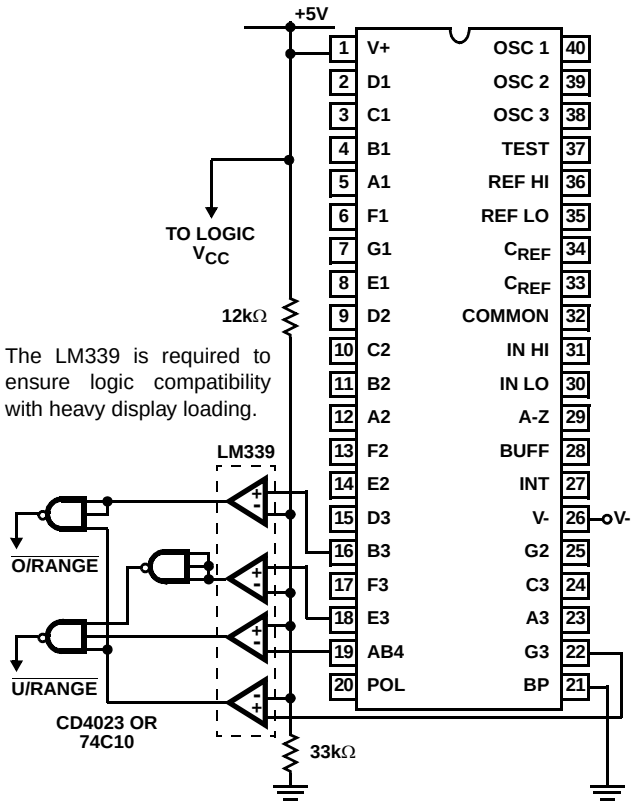
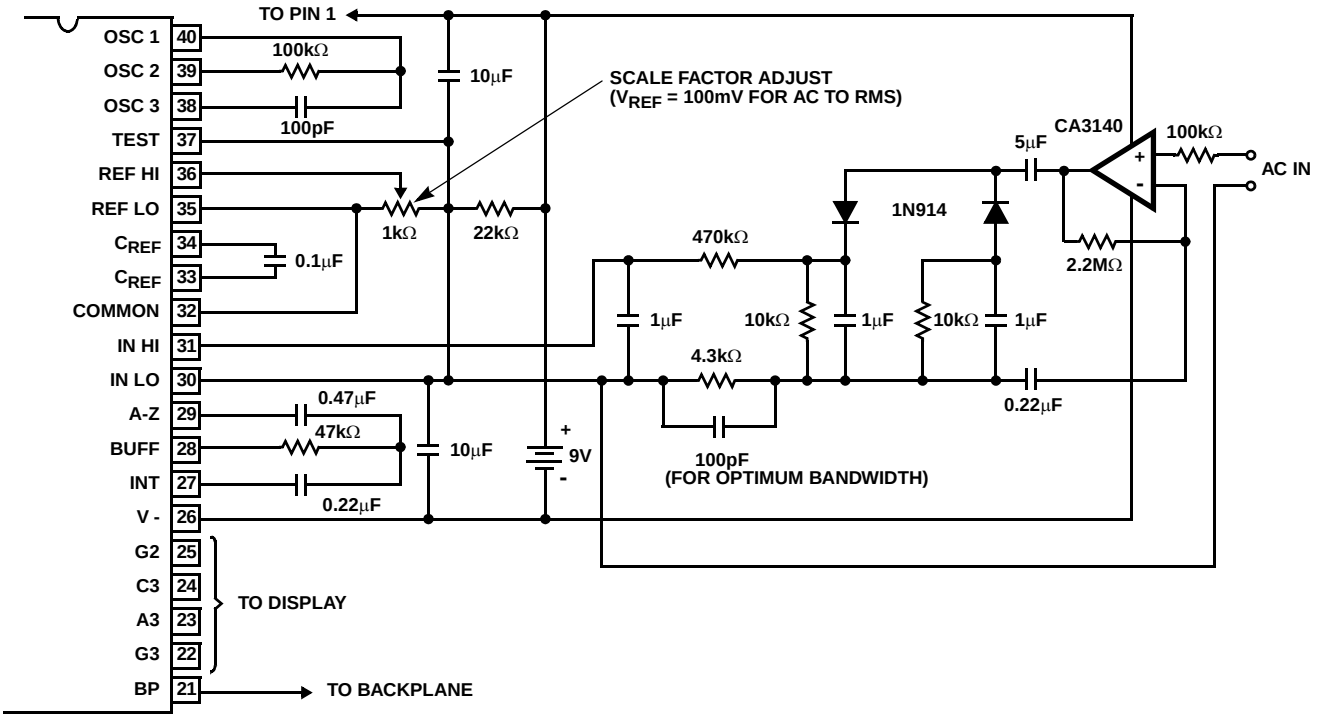


FIGURE 20. CIRCUIT FOR DEVELOPING UNDERRANGE AND OVERRANGE SIGNALS FROM ICL7107 OUTPUT

Typical Applications (Continued)



Test is used as a common-mode reference level to ensure compatibility with most op amps.

FIGURE 21. AC TO DC CONVERTER WITH ICL7106

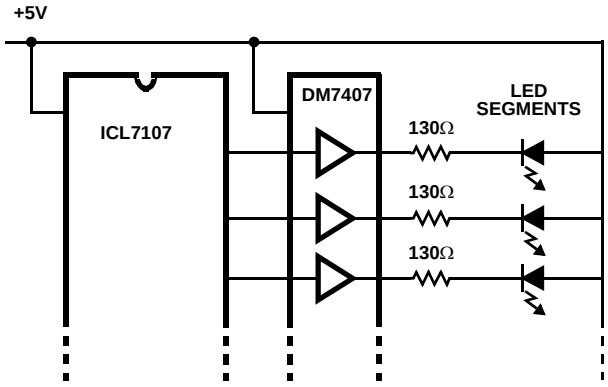
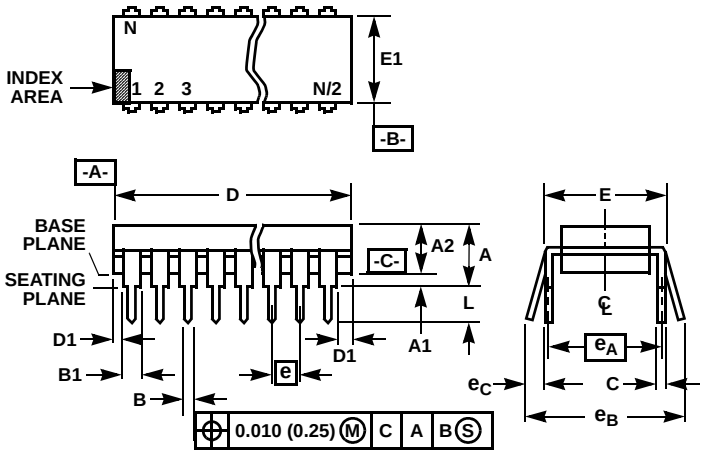


FIGURE 22. DISPLAY BUFFERING FOR INCREASED DRIVE CURRENT

Dual-In-Line Plastic Packages (PDIP)



NOTES:

1. Controlling Dimensions: INCH. In case of conflict between English and Metric dimensions, the inch dimensions control.
2. Dimensioning and tolerancing per ANSI Y14.5M-1982.
3. Symbols are defined in the “MO Series Symbol List” in Section 2.2 of Publication No. 95.
4. Dimensions A, A1 and L are measured with the package seated in JEDEC seating plane gauge GS-3.
5. D, D1, and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.010 inch (0.25mm).
6. E and e_A are measured with the leads constrained to be perpendicular to datum -C-.
7. e_B and e_C are measured at the lead tips with the leads unconstrained. e_C must be zero or greater.
8. B1 maximum dimensions do not include dambar protrusions. Dambar protrusions shall not exceed 0.010 inch (0.25mm).
9. N is the maximum number of terminal positions.
10. Corner leads (1, N, N/2 and N/2 + 1) for E8.3, E16.3, E18.3, E28.3, E42.6 will have a B1 dimension of 0.030 - 0.045 inch (0.76 - 1.14mm).

E40.6 (JEDEC MS-011-AC ISSUE B)
40 LEAD DUAL-IN-LINE PLASTIC PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.250	-	6.35	4
A1	0.015	-	0.39	-	4
A2	0.125	0.195	3.18	4.95	-
B	0.014	0.022	0.356	0.558	-
B1	0.030	0.070	0.77	1.77	8
C	0.008	0.015	0.204	0.381	-
D	1.980	2.095	50.3	53.2	5
D1	0.005	-	0.13	-	5
E	0.600	0.625	15.24	15.87	6
E1	0.485	0.580	12.32	14.73	5
e	0.100 BSC		2.54 BSC		-
e_A	0.600 BSC		15.24 BSC		6
e_B	-	0.700	-	17.78	7
L	0.115	0.200	2.93	5.08	4
N	40		40		9

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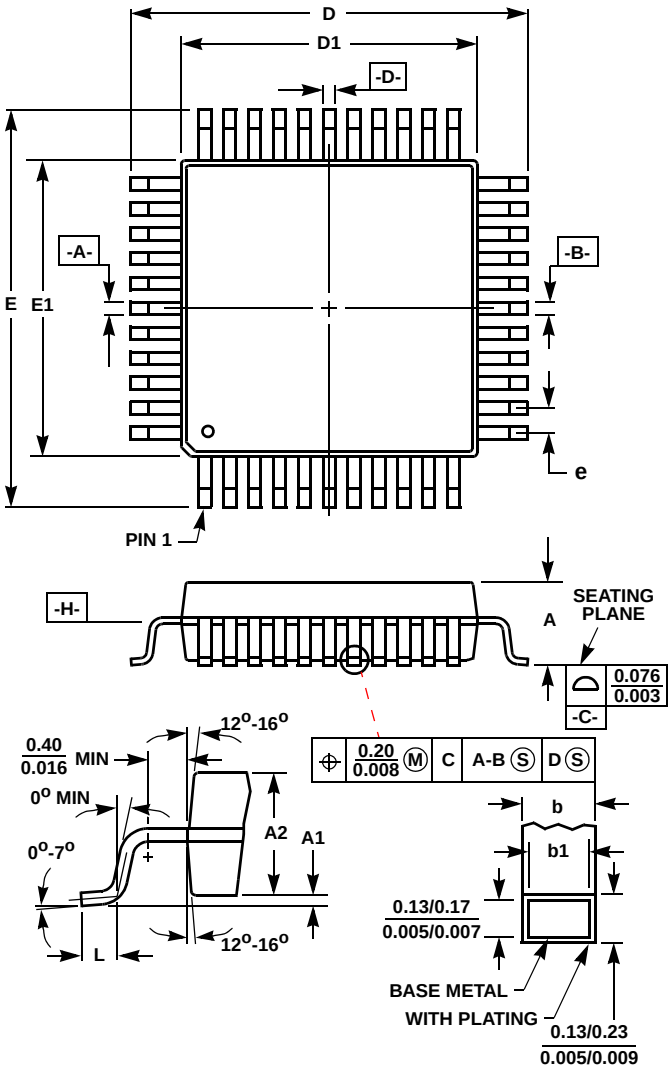
Metric Plastic Quad Flatpack Packages (MQFP)



Q44.10x10 (JEDEC MS-022AB ISSUE B)
44 LEAD METRIC PLASTIC QUAD FLATPACK PACKAGE

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.096	-	2.45	-
A1	0.004	0.010	0.10	0.25	-
A2	0.077	0.083	1.95	2.10	-
b	0.012	0.018	0.30	0.45	6
b1	0.012	0.016	0.30	0.40	-
D	0.515	0.524	13.08	13.32	3
D1	0.389	0.399	9.88	10.12	4, 5
E	0.516	0.523	13.10	13.30	3
E1	0.390	0.398	9.90	10.10	4, 5
L	0.029	0.040	0.73	1.03	-
N	44		44		7
e	0.032 BSC		0.80 BSC		-

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NOTES:

1. Controlling dimension: MILLIMETER. Converted inch dimensions are not necessarily exact.
2. All dimensions and tolerances per ANSI Y14.5M-1982.
3. Dimensions D and E to be determined at seating plane -C-.
4. Dimensions D1 and E1 to be determined at datum plane -H-.
5. Dimensions D1 and E1 do not include mold protrusion. Allowable protrusion is 0.25mm (0.010 inch) per side.
6. Dimension b does not include dambar protrusion. Allowable dambar protrusion shall be 0.08mm (0.003 inch) total.
7. “N” is the number of terminal positions.