

# High Performance Switched Capacitor Universal Filter

## FEATURES

- All Filter Parameters *Guaranteed* over Temperature
- Wide Center Frequency Range (0.1Hz to 40kHz)
- Low Noise Wide Dynamic Range
- *Guaranteed* Operation for  $\pm 2.37V$  and  $\pm 5V$  Supply
- Low Power Consumption
- *Guaranteed* Clock to Center Frequency Accuracy of 0.3% (LTC1059A)
- *Guaranteed* Low Offset Voltages over Temperature
- Very Low Center Frequency and Q Tempco
- Clock Input T<sup>2</sup>L or CMOS Compatible
- Separate Highpass (or Notch or Allpass), Bandpass, Lowpass Outputs

## APPLICATIONS

- Sinewave Oscillators
- Sweepable Bandpass/Notch Filters
- Full Audio Frequency Filters
- Tracking Filters

## DESCRIPTION

The LTC1059 consists of a general purpose, high performance, active filter building block and an uncommitted op amp. The filter building block together with an external clock and 2 to 5 resistors can produce various second order functions which are available at its three output pins. Two out of three always provide lowpass and bandpass functions while the third output pin can produce notch or highpass or allpass. The center frequency of these functions can be tuned from 0.1Hz to 40kHz and it is dependent on an external clock or an external clock and a resistor ratio. The filter can handle input frequencies up to 100kHz. The uncommitted op amp can be used to obtain additional allpass and notch functions, for gain adjustment or for cascading techniques.

Higher than second order filter functions can be obtained by cascading the LTC1059 with the LTC1060 dual universal filter or LTC1061 triple universal filter. Any classical filter realization (such as Butterworth, Cauer, Bessel and Chebyshev) can be formed.

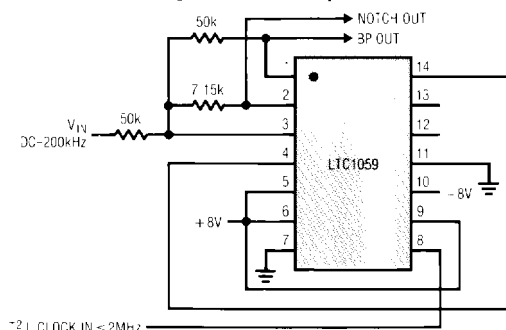
The LTC1059 can be operated with single or dual supplies ranging from  $\pm 2.37V$  to  $\pm 8V$  (or 4.74V to 16V single supply) and is pinout compatible with MF5.

The LTC1059 is manufactured by using Linear Technology's enhanced LTCMOS™ silicon gate process.

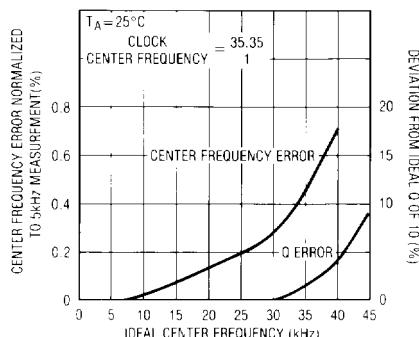
LTCMOS™ is a trademark of Linear Technology Corp.

## TYPICAL APPLICATION

Wide Range 2nd Order Bandpass/Notch Filter with Q = 10



Center Frequency and Q Error



## ABSOLUTE MAXIMUM RATINGS

Supply Voltage .....	18V
Power Dissipation .....	500mW
Operating Temperature Range	
LTC1059AC, LTC1059C .....	$-40^{\circ}\text{C} \leq T_A \leq 85^{\circ}\text{C}$
LTC1059AM, LTC1059M .....	$-55^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
Storage Temperature Range .....	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$
Lead Temperature (Soldering, 10sec) .....	$300^{\circ}\text{C}$

## PACKAGE/ORDER INFORMATION

<p>J PACKAGE 14-LEAD CERAMIC DIP</p> <p>N PACKAGE 14-LEAD PLASTIC DIP</p> <p><math>T_{JMAX} = 150^{\circ}\text{C}</math>, <math>\theta_{JA} = 80^{\circ}\text{C/W}</math> (J)  <math>T_{JMAX} = 110^{\circ}\text{C}</math>, <math>\theta_{JA} = 130^{\circ}\text{C/W}</math> (N)</p>	ORDER PART NUMBER
	LTC1059ACJ LTC1059ACN LTC1059AMJ LTC1059CJ LTC1059CN LTC1059MJ

Consult factory for Industrial grade parts

## ELECTRICAL CHARACTERISTICS

(Complete Filter)  $V_S = \pm 5\text{V}$ ,  $T_A = 25^{\circ}\text{C}$ ,  $T^2\text{L}$  clock input level unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Center Frequency Range, $f_0$	$f_0 \times Q \leq 400\text{kHz}$ , Mode 1 $f_0 \times Q \leq 1.6\text{MHz}$ , Mode 1 $f_0 \times Q \leq 250\text{kHz}$ , Mode 3, $V_S = \pm 7.5\text{V}$ $f_0 \times Q \leq 1\text{MHz}$ , Mode 3, $V_S = \pm 7.5\text{V}$		0.1-40k 0.1-18k 0.1-20k 0.1-16k		Hz Hz Hz Hz
Input Frequency Range			0-200k		Hz
Clock to Center Frequency Ratio					
LTC1059A	Mode 1, 50:1, $f_{CLK} = 250\text{kHz}$ , $Q = 10$	●		$50 \pm 0.3\%$	
LTC1059	Mode 1, 50:1, $f_{CLK} = 250\text{kHz}$ , $Q = 10$	●		$50 \pm 0.8\%$	
LTC1059A	Mode 1, 100:1, $f_{CLK} = 500\text{kHz}$ , $Q = 10$	●		$100 \pm 0.3\%$	
LTC1059	Mode 1, 100:1, $f_{CLK} = 500\text{kHz}$ , $Q = 10$	●		$100 \pm 0.8\%$	
Q Accuracy					
LTC1059A	Mode 1, 50:1 or 100:1, $f_0 = 5\text{kHz}$	●	$\pm 0.5$	3	%
LTC1059	$Q = 10$	●	$\pm 0.5$	5	%
$f_0$ Temperature Coefficient	Mode 1, $f_{CLK} < 500\text{kHz}$		5		ppm/ $^{\circ}\text{C}$
Q Temperature Coefficient	Mode 1, $f_{CLK} < 500\text{kHz}$ , $Q = 10$		15		ppm/ $^{\circ}\text{C}$
DC Offset $V_{OS1}$		●	2	15	mV
$V_{OS2}$	$f_{CLK} = 250\text{kHz}$ , 50:1, $S_{A/B}$ High	●	3	30	mV
$V_{OS2}$	$f_{CLK} = 500\text{kHz}$ , 100:1, $S_{A/B}$ High	●	6	60	mV
$V_{OS2}$	$f_{CLK} = 250\text{kHz}$ , 50:1, $S_{A/B}$ Low	●	2	20	mV
$V_{OS2}$	$f_{CLK} = 500\text{kHz}$ , 100:1, $S_{A/B}$ Low	●	4	40	mV
$V_{OS3}$	$f_{CLK} = 250\text{kHz}$ , 50:1	●	2	20	mV
$V_{OS3}$	$f_{CLK} = 500\text{kHz}$ , 100:1	●	4	40	mV
DC Low Pass Gain Accuracy	Mode 1, $R1 = R2 = 50\text{k}\Omega$	●	$\pm 0.1$	2	%
BP Gain Accuracy at $f_0$	Mode 1, $Q = 10$ , $f_0 = 5\text{kHz}$		$\pm 0.1$		%
Clock Feedthrough	$f_{CLK} \leq 1\text{MHz}$		10		mV
Max. Clock Frequency	Mode 1, $Q < 5$ , $V_S \geq \pm 5\text{V}$		2		MHz
Power Supply Current		●	3.5	5.5	mA
				7	mA

## ELECTRICAL CHARACTERISTICS (Complete Filter) $V_S = \pm 2.37V$ , $T_A = 25^\circ C$ unless otherwise specified

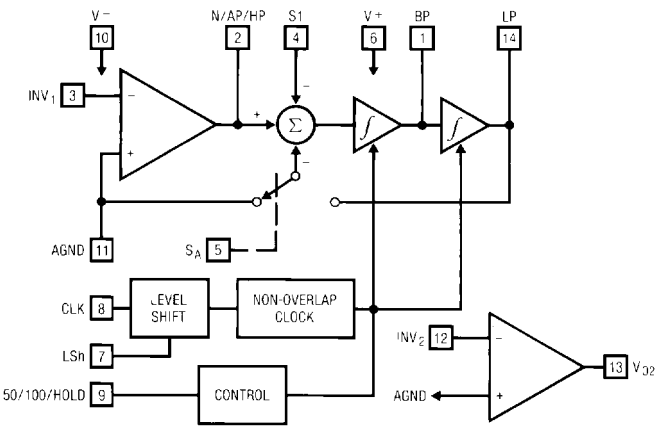
PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Center Frequency Range	$f_o \times Q \leq 120kHz$ , Mode 1, 50:1 $f_o \times Q \leq 120kHz$ , Mode 3, 50:1		0.1–12k 0.1–10k		Hz Hz
Input Frequency Range			60k		Hz
Clock to Center Frequency Ratio					
LTC1059A	Mode 1, 50:1, $f_{CLK} = 250kHz$ , $Q = 10$		50 $\pm$ 0.5%		
LTC1059	Mode 1, 50:1, $f_{CLK} = 250kHz$ , $Q = 10$		50 $\pm$ 0.8%		
LTC1059A	Mode 1, 100:1, $f_{CLK} = 250kHz$ , $Q = 10$		100 $\pm$ 0.5%		
LTC1059	Mode 1, 100:1, $f_{CLK} = 250kHz$ , $Q = 10$		100 $\pm$ 0.8%		
Q Accuracy					
LTC1059A	Mode 1, $f_{CLK} = 250kHz$ , $Q = 10$		$\pm 1$		%
LTC1059	50:1 and 100:1		$\pm 2$		%
Max. Clock Frequency			700k		Hz
Power Supply Current			1.5	2.5	mA

## ELECTRICAL CHARACTERISTICS (Internal Op Amps) $T_A = 25^\circ C$ unless otherwise specified

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage Range		$\pm 2.375$		$\pm 8$	V
Voltage Swings					
LTC1059A	$V_S = \pm 5V$ , $R_L = 5k$ (Pins 1, 14)	$\pm 4$	$\pm 4.2$		V
LTC1059	$R_L = 3.5k$ (Pins 2, 13)	$\pm 3.8$	$\pm 4.2$		V
LTC1059, LTC1059A	●	$\pm 3.6$			V
Input Offset Voltage			1	15	mV
Input Bias Current			3		pA
Output Short Circuit Current	$V_S = \pm 5V$		40/3		mA
Source/Sink					
DC Open Loop Gain	$V_S = \pm 5V$		80		dB
GBW	$V_S = \pm 5V$		2		MHz
Slew Rate	$V_S = \pm 5V$		7		V/ $\mu s$

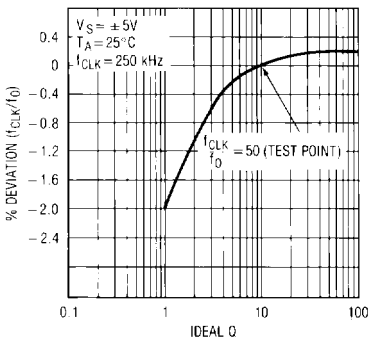
The ● denotes the specifications which apply over the full operating temperature range.

BLOCK DIAGRAM

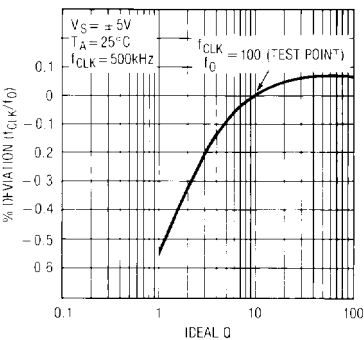


TYPICAL PERFORMANCE CHARACTERISTICS

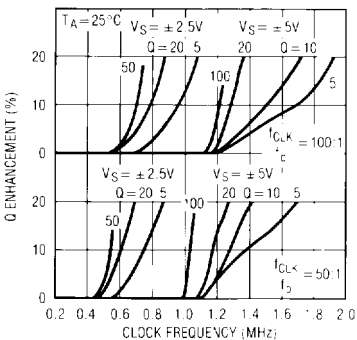
Graph 1. Mode 1:  
(f<sub>CLK</sub>/f<sub>o</sub>) Deviation vs Q



Graph 2. Mode 1:  
(f<sub>CLK</sub>/f<sub>o</sub>) Deviation vs Q

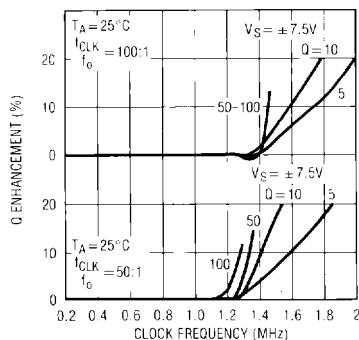
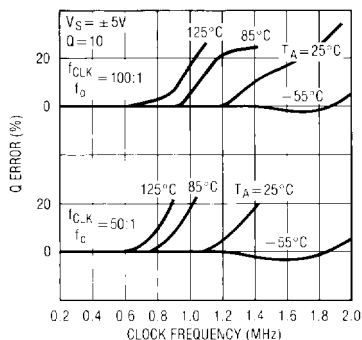
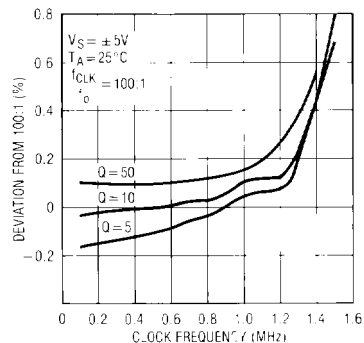
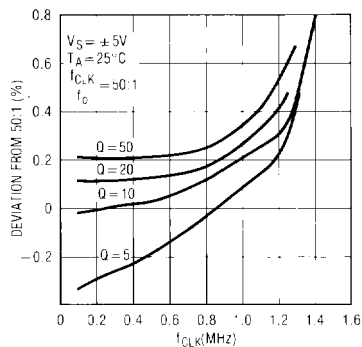
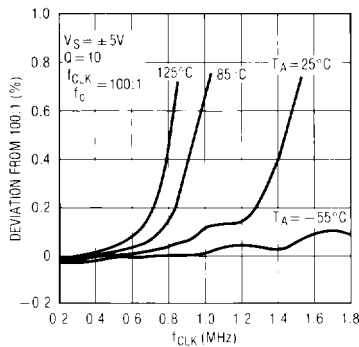
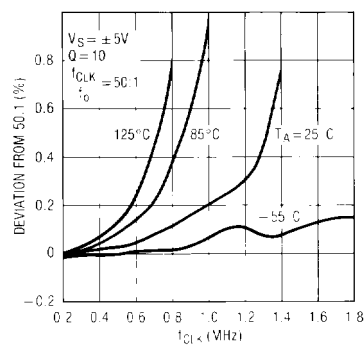
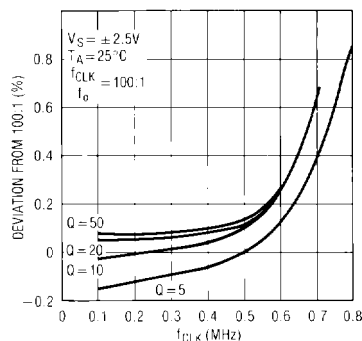
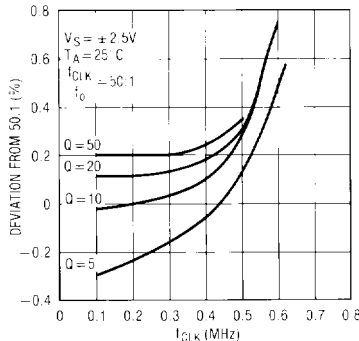
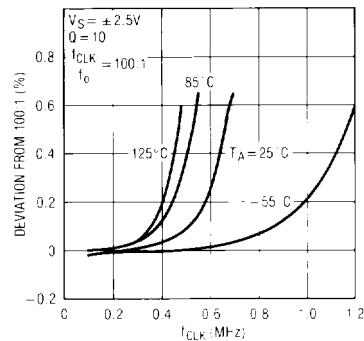


Graph 3. Mode 1: Q Error vs Clock Frequency

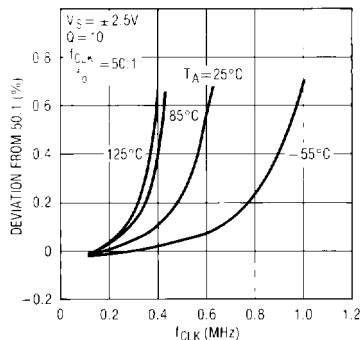


## TYPICAL PERFORMANCE CHARACTERISTICS

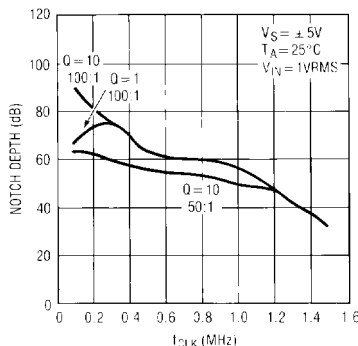
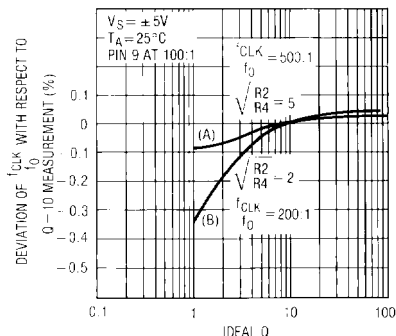
Graph 4. Mode 1: Q Error vs Clock Frequency

Graph 5. Mode 1: Measured Q vs  $f_{CLK}$  and TemperatureGraph 6. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and QGraph 7. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and QGraph 8. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and TemperatureGraph 9. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and TemperatureGraph 10. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and QGraph 11. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and QGraph 12. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and Temperature

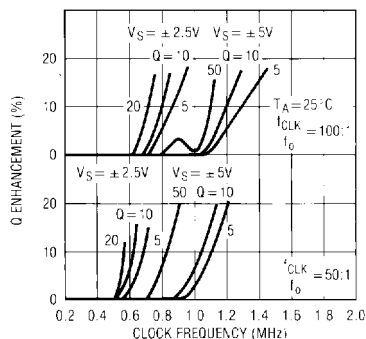
## TYPICAL PERFORMANCE CHARACTERISTICS

Graph 13. Mode 1:  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and Temperature

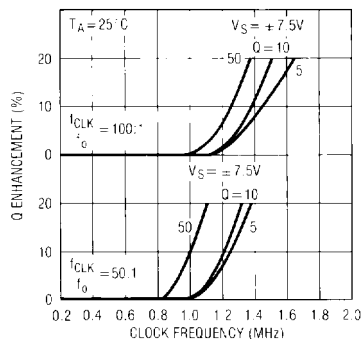
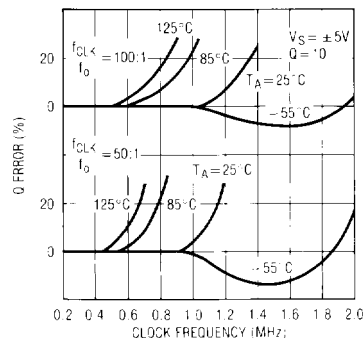
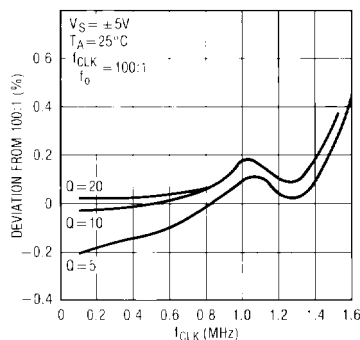
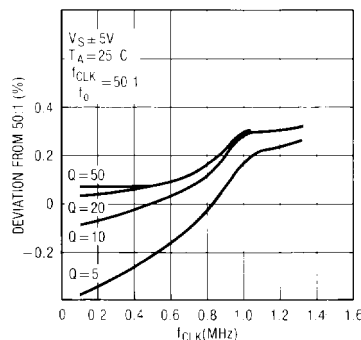
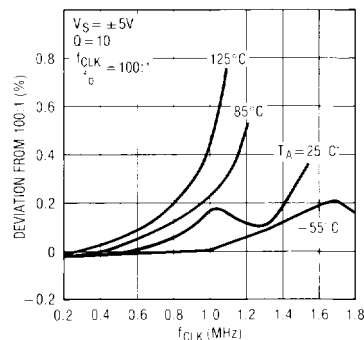
Graph 14. Mode 1: Notch Depth vs Clock Frequency

Graph 15. Mode 3: Deviation of  $(f_{CLK}/f_o)$  with Respect to Q = 10 Measurement

Graph 16. Mode 3: Q Error vs Clock Frequency

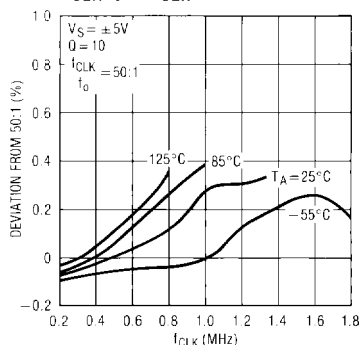


Graph 17. Mode 3 (R2 = R4): Q Error vs Clock Frequency

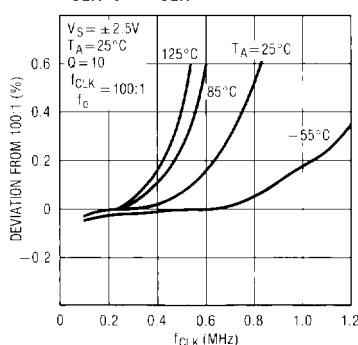
Graph 18. Mode 3 (R2 = R4): Measured Q vs  $f_{CLK}$  and TemperatureGraph 19. Mode 3 (R2 = R4):  $f_{CLK}/f_o$  vs  $f_{CLK}$  and QGraph 20. Mode 3 (R2 = R4):  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and QGraph 21. Mode 3 (R2 = R4):  $(f_{CLK}/f_o)$  vs  $f_{CLK}$  and Temperature

## TYPICAL PERFORMANCE CHARACTERISTICS

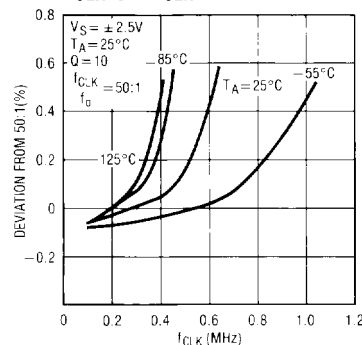
Graph 22. Mode 3 (R2 = R4):  
( $f_{CLK}/f_o$ ) vs  $f_{CLK}$  and Temperature



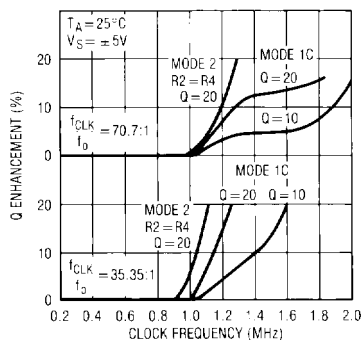
Graph 23. Mode 3 (R2 = R4):  
( $f_{CLK}/f_o$ ) vs  $f_{CLK}$  and Temperature



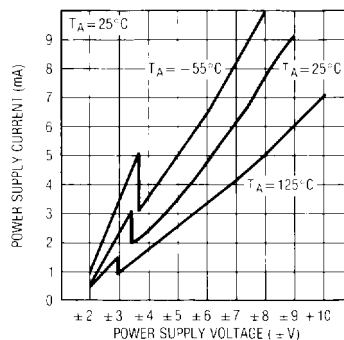
Graph 24. Mode 3 (R2 = R4):  
( $f_{CLK}/f_o$ ) vs  $f_{CLK}$  and Temperature



Graph 25. Mode 1c (R5 = 0),  
Mode 2 (R2 = R4) Q Error vs Clock  
Frequency



Graph 26. Supply Current vs  
Supply Voltage



## APPLICATIONS INFORMATION

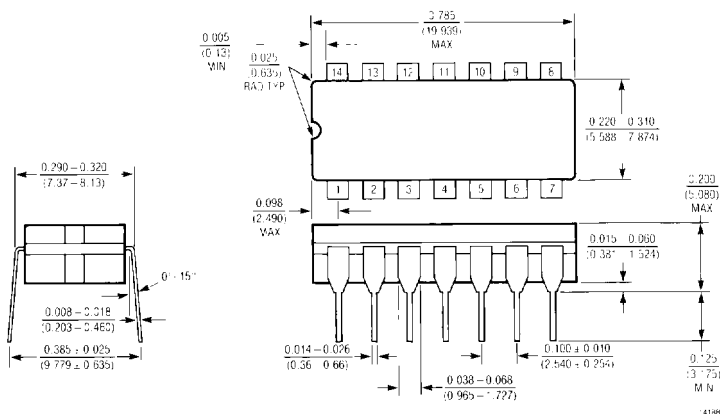
The LTC1059 is compatible with the LTC1060. All the LTC1059 pins are functionally equivalent to the LTC1060 pins bearing the same title. For a detailed pin description and definition of various modes of operation refer to the LTC1060 data sheet. The LTC1059 is typically "faster" than the LTC1060 especially under single 5V (or  $\pm 2.5V$ )

supply operation. This becomes apparent through the typical performance characteristics of the part. All the graphs shown in this data sheet have been drawn under the same test conditions as in the LTC1060 data sheet; they are also numbered in the same order. For a complete discussion of the filter characteristics see the LTC1060 data sheet.

# PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

## J Package 14-Lead Ceramic DIP



## N Package 14-Lead Plastic DIP

