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 ±2.37V and ±5V Supply
- Low Power Consumption
- *Guaranteed* Clock-to-Center Frequency Accuracy of 0.8%
- *Guaranteed* Low Offset Voltages Over Temperature
- Very Low Center Frequency and Q Tempco
- Clock Input T^2L 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 LTC®1059 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 2nd 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 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.

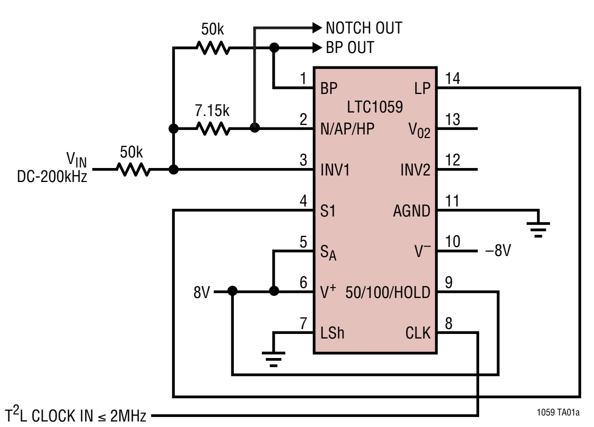
Higher than 2nd order filter functions can be obtained by cascading the LTC1059 with the LTC1060 dual universal filter or the LTC1061 triple universal filter. Any classical filter realization (such as Butterworth, Cauer, Bessel and Chebyshev) can be formed.

The LTC1059 can be operated with single or dual supplies ranging from ±2.37V to ±8V (or 4.74V to 16V single supply).

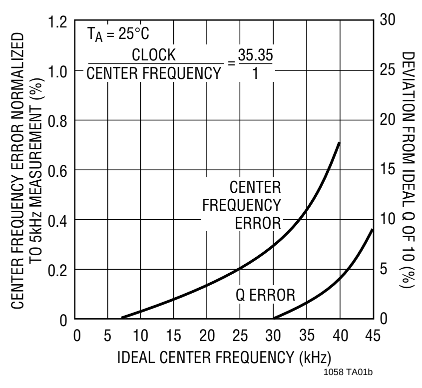
The LTC1059 is manufactured by using Linear Technology's enhanced LTCMOS™ silicon gate process.

TYPICAL APPLICATION

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



Center Frequency and Q Error

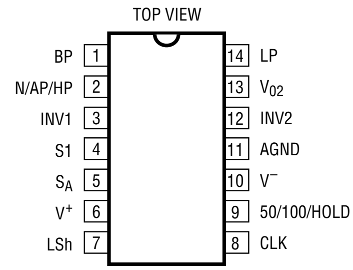


ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage 18V
Power Dissipation 500mW
Operating Temperature Range
LTC1059C .... $-40°C \le T_A \le 85°C$
LTC1059AM, LTC1059M .... $-55°C \le T_A \le 125°C$
Storage Temperature Range .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION



Package	ORDER PART NUMBER
N PACKAGE 14-LEAD PDIP; S PACKAGE 14-LEAD PLASTIC SO $T_{JMAX} = 110°C, \theta_{JA} = 130°C/W$ (N) $T_{JMAX} = 110°C, \theta_{JA} = 110°C/W$ (S)	LTC1059CN LTC1059CS
J PACKAGE 14-LEAD CERDIP $T_{JMAX} = 150°C, \theta_{JA} = 80°C/W$ **OBSOLETE PACKAGE** Consider the N or S Package for Alternate Source	LTC1059ACJ LTC1059AMJ LTC1059CJ LTC1059MJ

Consult LTC Marketing for parts specified with wider operating temperature ranges.

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25°C$.

(Complete Filter) $V_S = \pm5V$, T^2L clock input level unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Center Frequency Range, f_0	$f_0 \bullet Q \le 400kHz$, Mode 1			0.1 - 40k		Hz
	$f_0 \bullet Q \le 1.6MHz$, Mode 1			0.1 - 18k		Hz
	$f_0 \bullet Q \le 250kHz$, Mode 3, $V_S = \pm7.5V$			0.1 - 20k		Hz
	$f_0 \bullet Q \le 1MHz$, Mode 3, $V_S = \pm7.5V$			0.1 - 16k		Hz
Input Frequency Range				0 - 200k		Hz
Clock-to-Center Frequency Ratio	Mode 1, 50:1, $f_{CLK} = 250kHz$, Q = 10	●			50 ± 0.8%	
	Mode 1, 100:1, $f_{CLK} = 500kHz$, Q = 10	●			100 ± 0.8%	
Q Accuracy	Mode 1, 50:1 or 100:1, $f_0 = 5kHz$ Q = 10	●		±0.5	5	%
f_0 Temperature Coefficient	Mode 1, $f_{CLK} < 500kHz$			5		ppm/°C
Q Temperature Coefficient	Mode 1, $f_{CLK} < 500kHz$, Q = 10			15		ppm/°C
DC Offset V_{OS1}		●		2	15	mV
V_{OS2}	$f_{CLK} = 250kHz$, 50:1, S_A High (N Package)	●		3	30	mV
V_{OS2}	$f_{CLK} = 250kHz$, 50:1, S_A High (S Package)	●		3	40	mV
V_{OS2}	$f_{CLK} = 500kHz$, 100:1, S_A High (N Package)	●		6	60	mV
V_{OS2}	$f_{CLK} = 500kHz$, 100:1, S_A High (S Package)	●		6	80	mV
V_{OS2}	$f_{CLK} = 250kHz$, 50:1, S_A Low (N Package)	●		2	20	mV
V_{OS2}	$f_{CLK} = 250kHz$, 50:1, S_A Low (S Package)	●		2	30	mV
V_{OS2}	$f_{CLK} = 500kHz$, 100:1, S_A Low (N Package)	●		4	40	mV
V_{OS2}	$f_{CLK} = 500kHz$, 100:1, S_A Low (S Package)	●		4	60	mV
V_{OS3}	$f_{CLK} = 250kHz$, 50:1 (N Package)	●		2	20	mV
V_{OS3}	$f_{CLK} = 250kHz$, 50:1 (S Package)	●		2	30	mV
V_{OS3}	$f_{CLK} = 500kHz$, 100:1 (N Package)	●		4	40	mV
V_{OS3}	$f_{CLK} = 500kHz$, 100:1 (S Package)	●		4	60	mV

ELECTRICAL CHARACTERISTICS

The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C.

(Complete Filter) V_S = ±5V, T^2L Clock Input Level unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
DC Lowpass Gain Accuracy	Mode 1, R1 = R2 = 50kΩ	●		±0.1	2	%
BP Gain Accuracy at f_0	Mode 1, Q = 10, f_0 = 5kHz			±0.1		%
Clock Feedthrough	f_{CLK} ≤ 1MHz			10		mV
Max Clock Frequency	Mode 1, Q < 5, V_S ≥ ±5V			2		MHz
Power Supply Current		 ●		3.5	5.5 7	mA mA

(Complete Filter) V_S = ±2.37V unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Center Frequency Range	f_0 • Q ≤ 120kHz, Mode 1, 50:1 f_0 • Q ≤ 120kHz, Mode 3, 50:1		0.1 - 12k 0.1 - 10k		Hz Hz
Input Frequency Range			60k		Hz
Clock-to-Center Frequency Ratio	Mode 1, 50:1, f_{CLK} = 250kHz, Q = 10 Mode 1, 100:1, f_{CLK} = 250kHz, Q = 10		50 ± 0.8% 100 ± 0.8%		
Q Accuracy	Mode 1, f_{CLK} = 250kHz, Q = 10 50:1 and 100:1		±2		%
Max Clock Frequency			700		kHz
Power Supply Current			1.5	2.5	mA

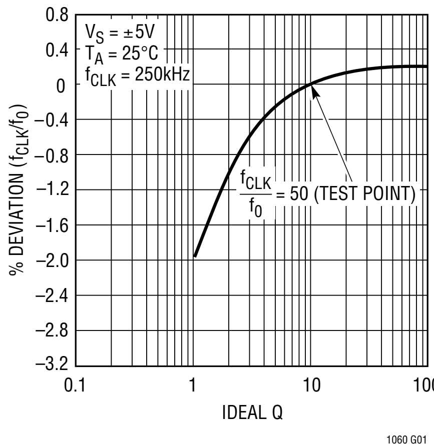
(Internal Op Amps) The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications are at T_A = 25°C.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Supply Voltage Range			±2.375		±8	V
Voltage Swings	V_S = ±5V, R_L = 5k (Pins 1, 14) R_L = 3.5k (Pins 2, 13)	 ●	±3.8 ±3.6	±4.2		V V
Input Offset Voltage		●		1	15	mV
Input Bias Current				3		pA
Output Short-Circuit Current Source/Sink	V_S = ±5V (N Package) V_S = ±5V (S Package)			40/3 25/3		mA mA
DC Open Loop Gain	V_S = ±5V			80		dB
GBW	V_S = ±5V			2		MHz
Slew Rate	V_S = ±5V			7		V/µs

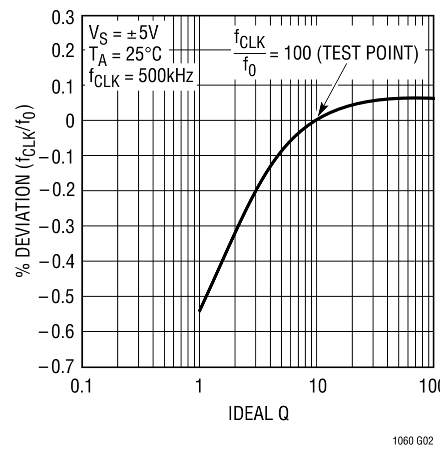
Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired.

TYPICAL PERFORMANCE CHARACTERISTICS

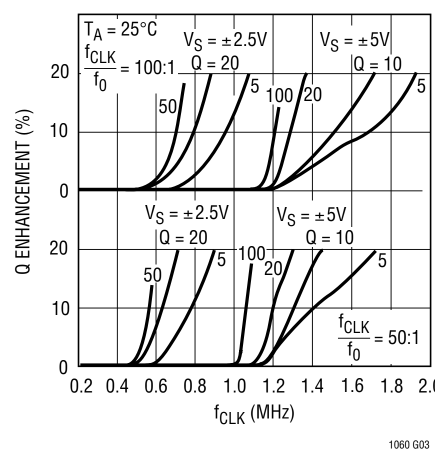
Graph 1. Mode 1: (f_{CLK}/f_0) Deviation vs Q



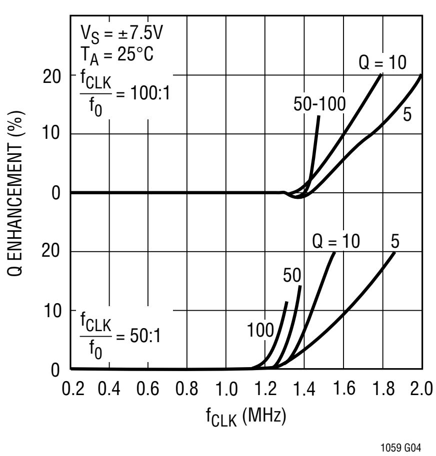
Graph 2. Mode 1: (f_{CLK}/f_0) Deviation vs Q



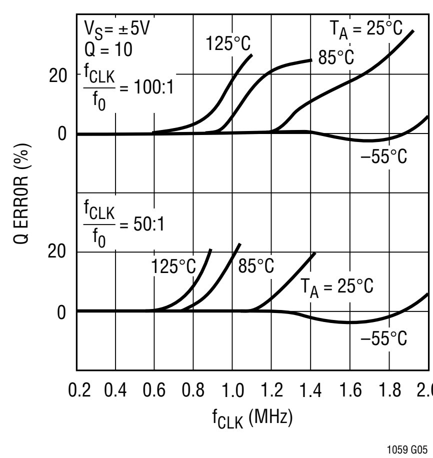
Graph 3. Mode 1: Q Error vs Clock Frequency



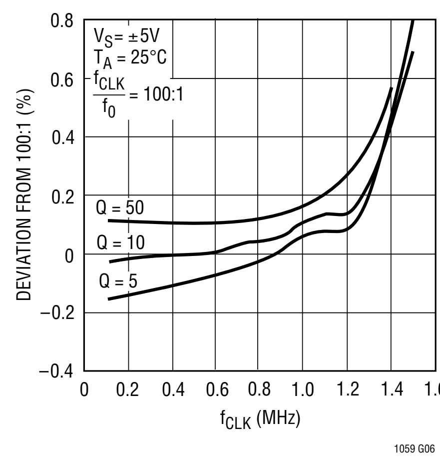
Graph 4. Mode 1: Q Error vs Clock Frequency



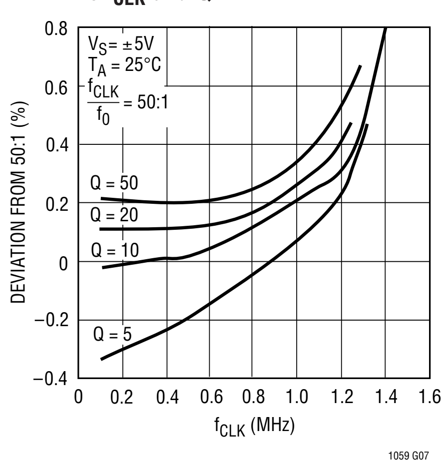
Graph 5. Mode 1: Measured Q vs f_{CLK} and Temperature



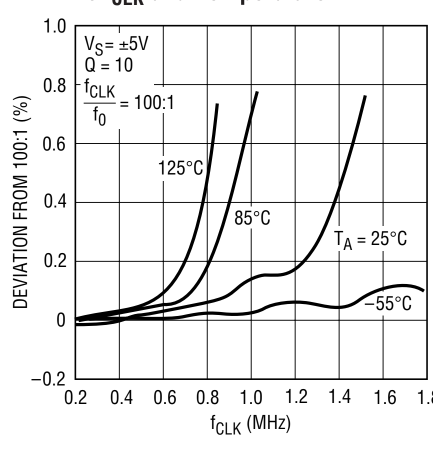
Graph 6. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Q



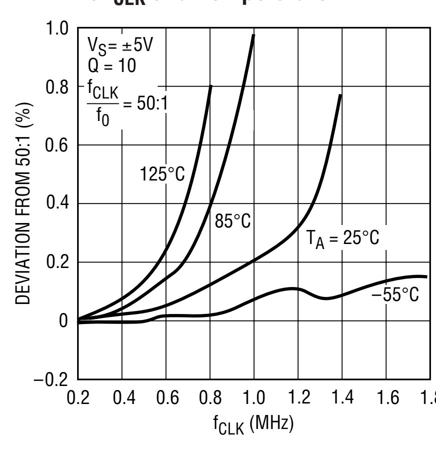
Graph 7. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Q



Graph 8. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Temperature

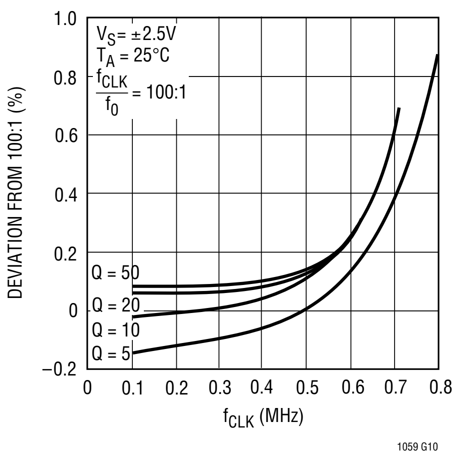


Graph 9. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Temperature

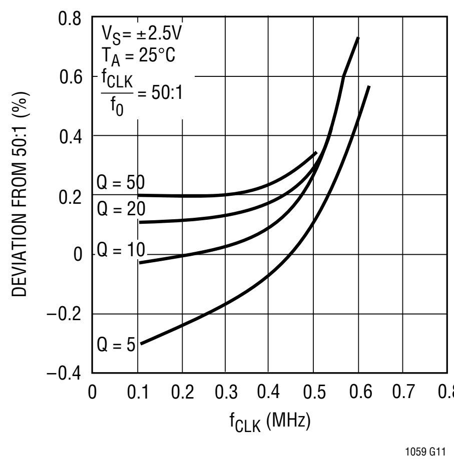


TYPICAL PERFORMANCE CHARACTERISTICS

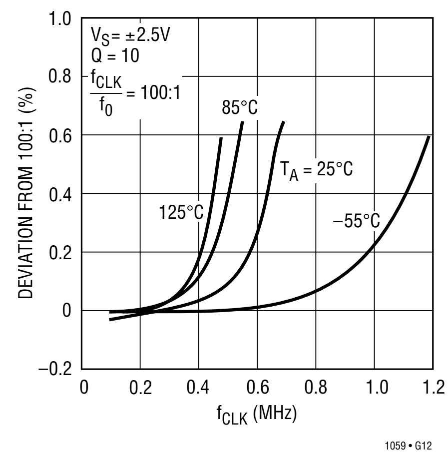
Graph 10. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Q



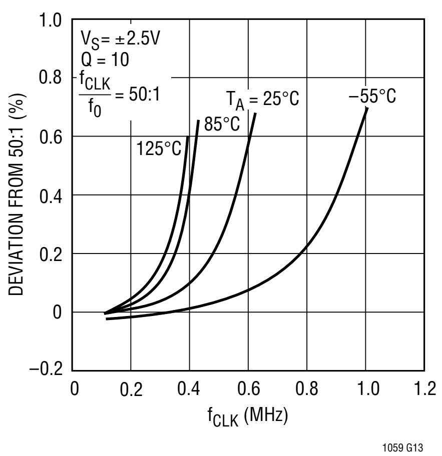
Graph 11. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Q



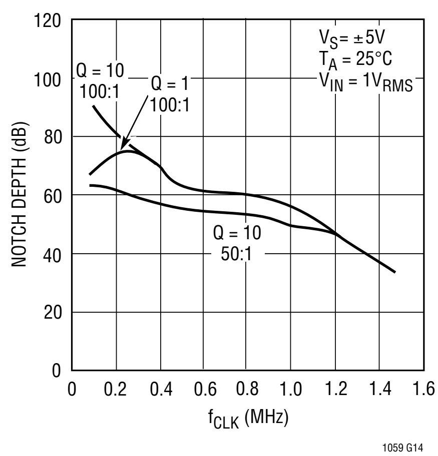
Graph 12. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Temperature



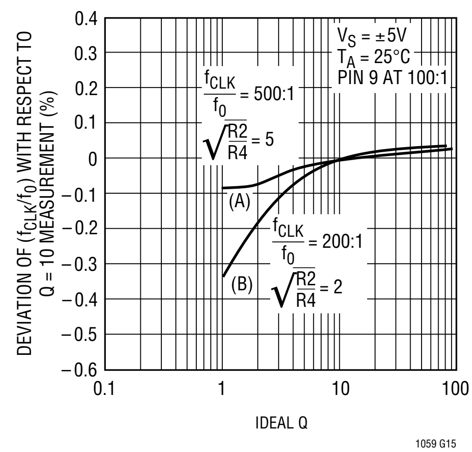
Graph 13. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Temperature



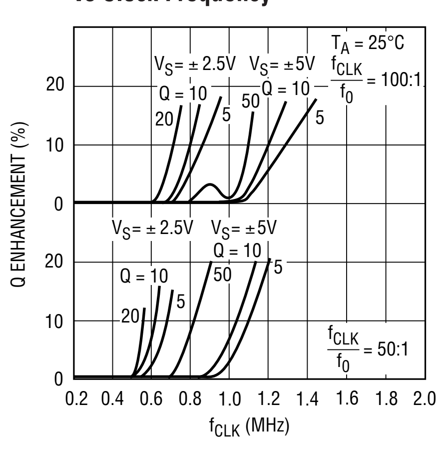
Graph 14. Mode 1: Notch Depth vs Clock Frequency



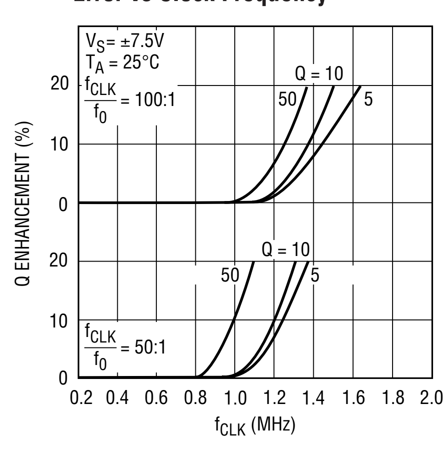
Graph 15. Mode 3: Deviation of (f_{CLK}/f_0) with Respect to Q = 10 Measurement



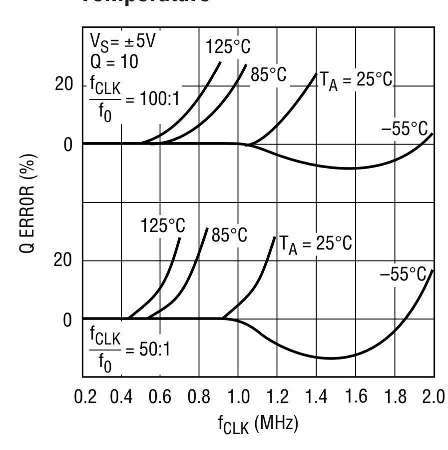
Graph 16. Mode 3: Q Error vs Clock Frequency



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

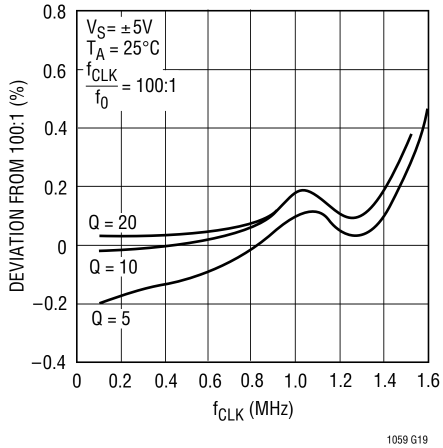


Graph 18. Mode 3 (R2 = R4): Measured Q vs f_{CLK} and Temperature

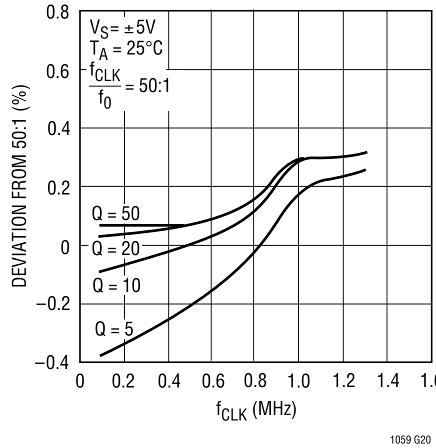


TYPICAL PERFORMANCE CHARACTERISTICS

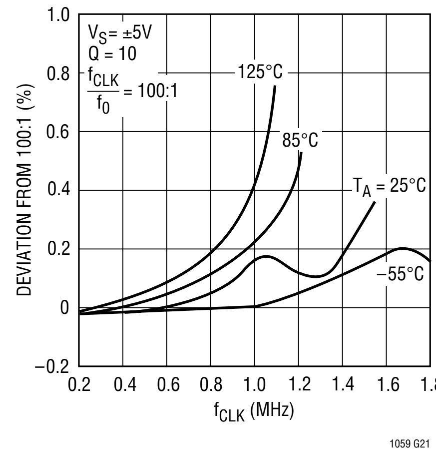
Graph 19. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Q



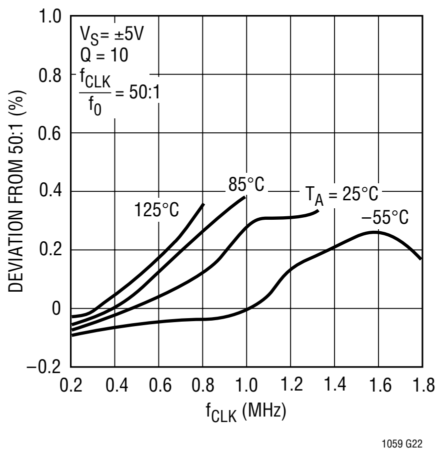
Graph 20. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Q



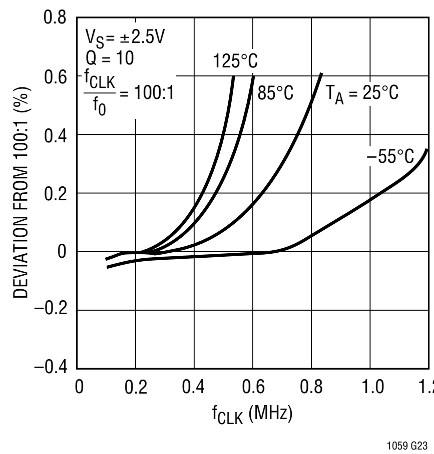
Graph 21. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Temperature



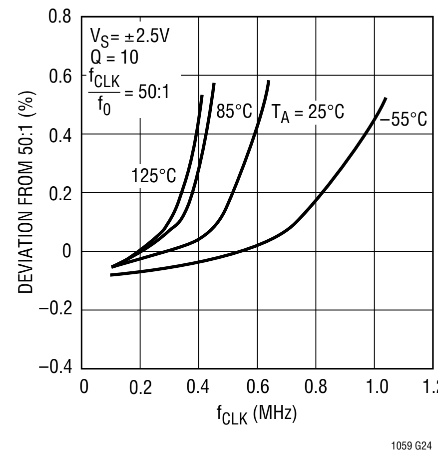
Graph 22. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Temperature



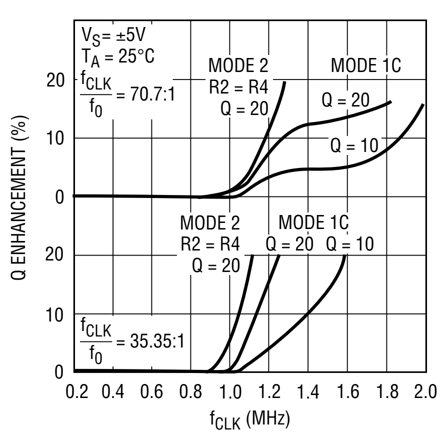
Graph 23. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Temperature



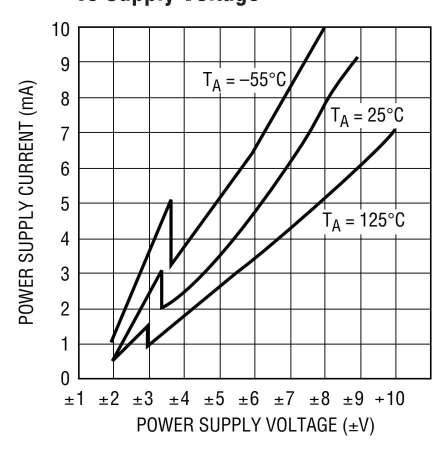
Graph 24. Mode 3 (R2 = R4): (f_{CLK}/f_0) vs f_{CLK} and Temperature



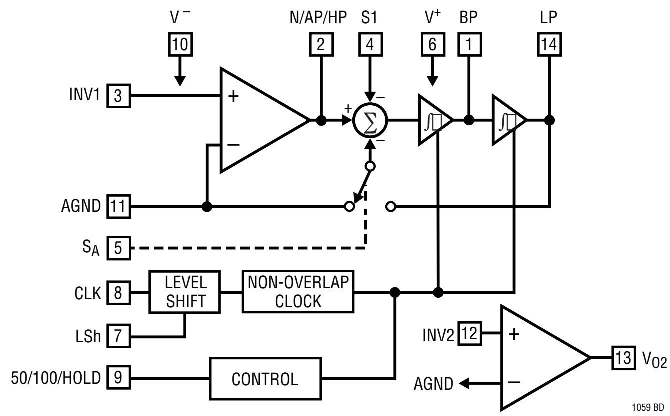
Graph 25. Mode 1c (R5 = 0), Mode 2 (R2 = R4): Q Error vs Clock Frequency



Graph 26. Supply Current vs Supply Voltage



BLOCK DIAGRAM

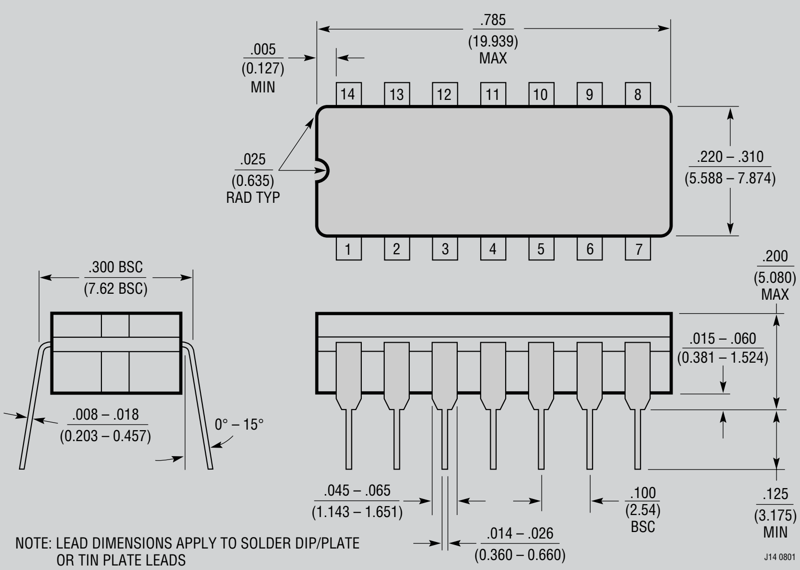


APPLICATIONS INFORMATION

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 ±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 complete discussion of the filter characteristics see the LTC1060 data sheet.

PACKAGE DESCRIPTION

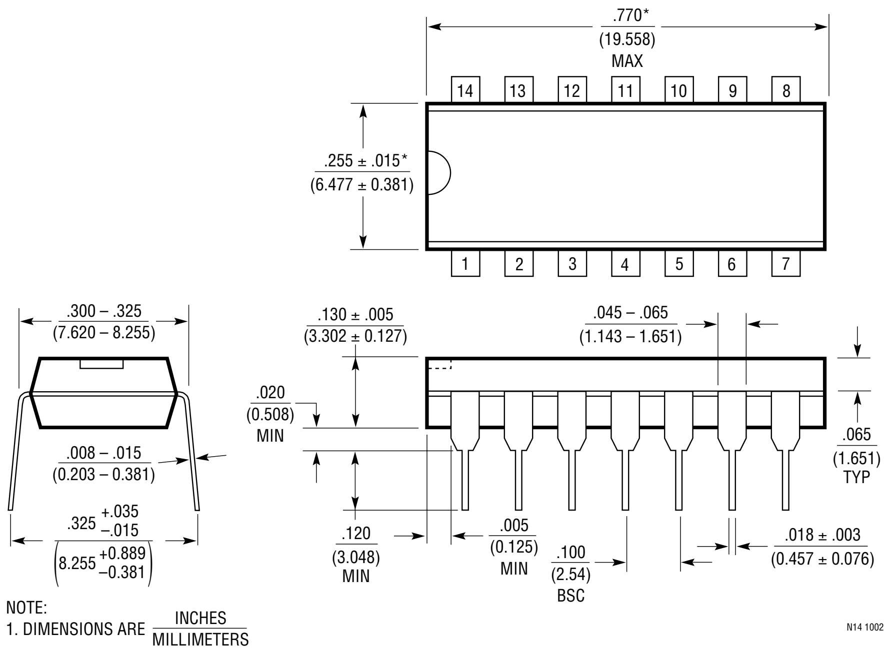
J Package
14-Lead CERDIP (Narrow .300 Inch, Hermetic)
(Reference LTC DWG # 05-08-1110)



OBSOLETE PACKAGE

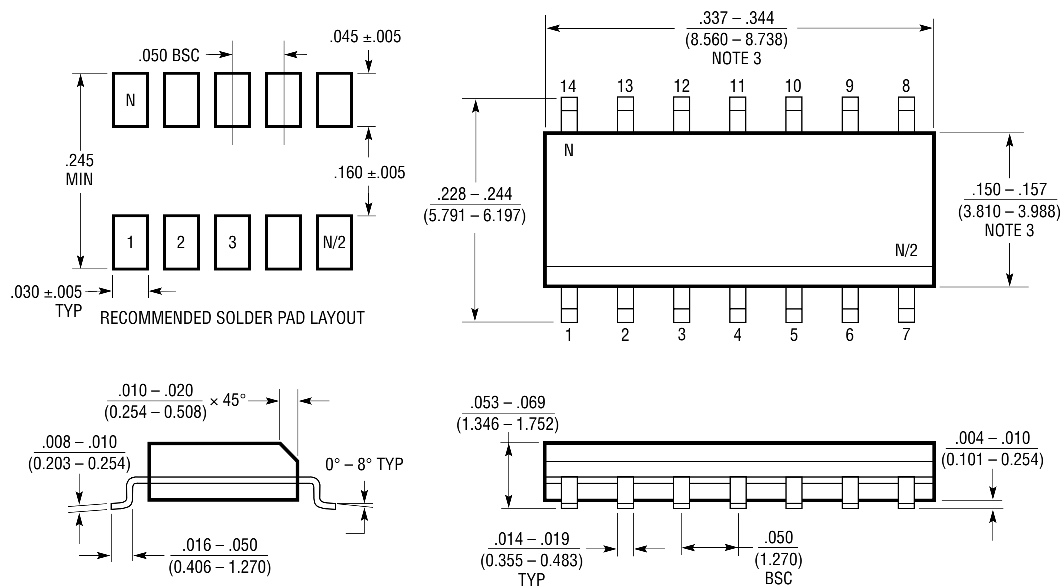
PACKAGE DESCRIPTION

N Package
14-Lead PDIP (Narrow .300 Inch)
(Reference LTC DWG # 05-08-1510)



NOTE:
1. DIMENSIONS ARE INCHES / MILLIMETERS
*THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCH (0.254mm)

S Package
14-Lead Plastic Small Outline (Narrow .150 Inch)
(Reference LTC DWG # 05-08-1610)



NOTE:
1. DIMENSIONS IN INCHES / (MILLIMETERS)
2. DRAWING NOT TO SCALE
3. THESE DIMENSIONS DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS.
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .006" (0.15mm)

Linear Technology Corporation
1630 McCarthy Blvd., Milpitas, CA 95035-7417
(408) 432-1900 • FAX: (408) 434-0507 • www.linear.com

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