LTC 1059

TECHNOLOGY

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 T²L 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

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DESCRIPTION

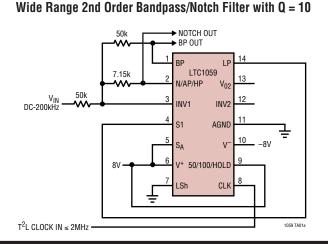
The LTC[®]1059 consists of a general purpose, high performance, active filter building block and an uncommitted op amp. The filter building block together with an external clock and 2 to 5 resistors can produce various 2nd order functions which are available at its three output pins. Two out of three 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.

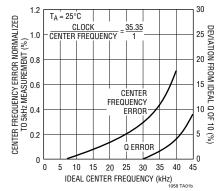
The LTC1059 can be operated with single or dual supplies ranging from $\pm 2.37V$ to $\pm 8V$ (or 4.74V to 16V single supply).

The LTC1059 is manufactured by using Linear Technology's enhanced LTCMOS $^{\rm TM}$ silicon gate process.

TYPICAL APPLICATION



Center Frequency and Q Error



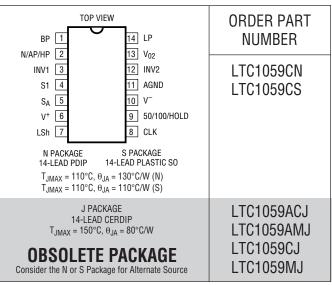
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ABSOLUTE MAXIMUM RATINGS

(Note 1)

Supply Voltage Power Dissipation	
•	
Operating Temperature Range	
LTC1059C	$-40^{\circ}C \le T_{A} \le 85^{\circ}C$
LTC1059AM, LTC1059M	−55°C \leq T _A \leq 125°C
Storage Temperature Range	65°C to 150°C
Lead Temperature (Soldering, 1	0 sec) 300°C

PACKAGE/ORDER INFORMATION



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 $T_A = 25^{\circ}C$.

(Complete Filter) $V_S = \pm 5V$, T^2	. clock input level unless	otherwise specified.
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PARAMETER	CONDITIONS		MIN TYP	MAX	UNITS
Center Frequency Range, f_0 $f_0 \bullet Q \le 400$ kHz, Mode 1			0.1 - 40	K	Hz
	$f_0 \bullet Q \le 1.6 MHz$, Mode 1		0.1 - 18	K	Hz
	$f_0 \bullet Q \le 250$ kHz, Mode 3, $V_S = \pm 7.5$ V		0.1 - 20	<	Hz
	$f_0 \bullet Q \le 1$ MHz, Mode 3, $V_S = \pm 7.5$ V		0.1 - 16	K	Hz
Input Frequency Range			0 - 200	(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, $f_{CLK} < 500 \text{kHz}$, Q = 10		15		ppm/°C
DC Offset V _{OS1}		•	2	15	mV
V _{0S2}	f _{CLK} = 250kHz, 50:1, S _A High (N Package)	•	3	30	mV
V _{0S2}	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



1059fd

ELECTRICAL CHARACTERISTICS The \bullet denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^{\circ}C$.

(Complete Filter) $V_S = \pm 5V$, T²L Clock Input Level unless otherwise specified.

PARAMETER	CONDITIONS		MIN	ТҮР	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, $V_S \ge \pm 5V$			2		MHz
Power Supply Current		•		3.5	5.5 7	mA mA

(Complete Filter) $V_S = \pm 2.37V$ unless otherwise specified.

PARAMETER	CONDITIONS	MIN TYP MAX	UNITS
Center Frequency Range	$f_0 \bullet Q \le 120 \text{kHz}, \text{ Mode } 1, 50:1$	0.1 - 12k	Hz
	f ₀ • Q ≤ 120kHz, Mode 3, 50:1	0.1 - 10k	Hz
Input Frequency Range		60k	Hz
Clock-to-Center Frequency Ratio			
	Mode 1, 50:1, f _{CLK} = 250kHz, Q = 10	$50 \pm 0.8\%$	
	Mode 1, 100:1, f _{CLK} = 250kHz, Q = 10	$100 \pm 0.8\%$	
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

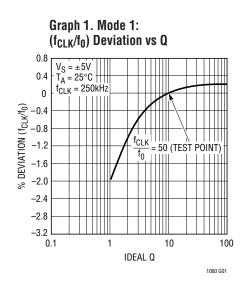
(Internal Op Amps) The • denotes the specifications which apply over the full operating temperature range, otherwise specifications are at $T_A = 25^{\circ}C$.

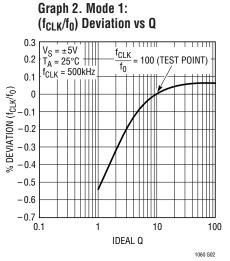
PARAMETER	CONDITIONS		MIN	ТҮР	MAX	UNITS
Supply Voltage Range			±2.375		±8	V
Voltage Swings						
	$V_{S} = \pm 5V, R_{L} = 5k$ (Pins 1, 14)		±3.8	±4.2		V
	R _L = 3.5k (Pins 2, 13)	•	±3.6			V
Input Offset Voltage		•		1	15	mV
Input Bias Current				3		рА
Output Short-Circuit Current Source/Sink	$V_{\rm S} = \pm 5 V (N \text{ Package})$			40/3		mA
	$V_{S} = \pm 5V$ (S Package)			25/3		mA
DC Open Loop Gain	$V_{\rm S} = \pm 5 V$			80		dB
GBW	$V_{\rm S} = \pm 5 V$			2		MHz
Slew Rate	$V_{S} = \pm 5V$			7		V/µs

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

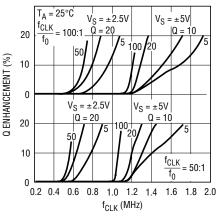


TYPICAL PERFORMANCE CHARACTERISTICS



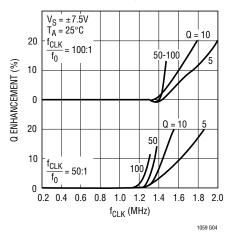


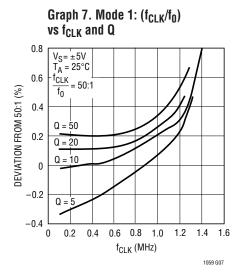




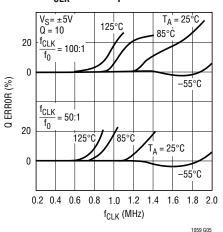


Graph 4. Mode 1: Q Error vs Clock Frequency

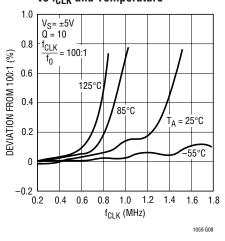




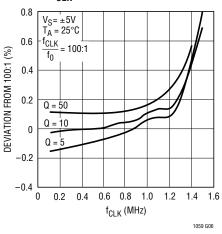
Graph 5. Mode 1: Measured Q vs f_{CLK} and Temperature



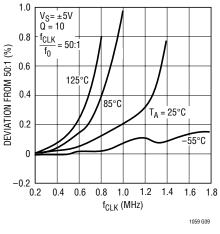
Graph 8. Mode 1: (f_{CLK}/f₀) vs f_{CLK} and Temperature



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



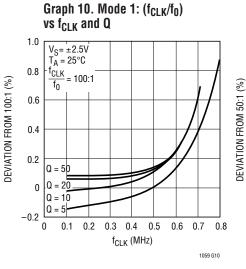
Graph 9. Mode 1: (f_{CLK}/f_0) vs f_{CLK} and Temperature

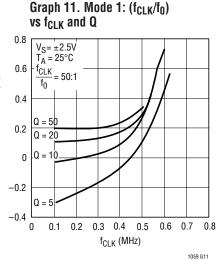


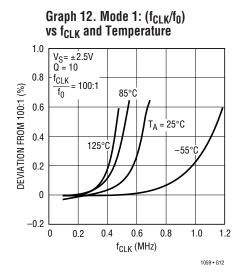
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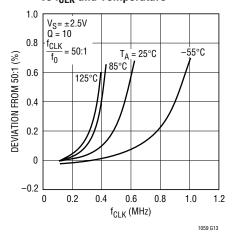
TYPICAL PERFORMANCE CHARACTERISTICS



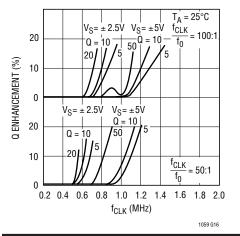




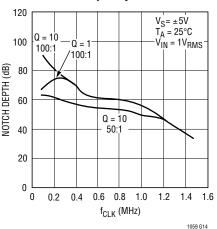
Graph 13. Mode 1: (f_{CLK}/f₀) vs f_{CLK} and Temperature



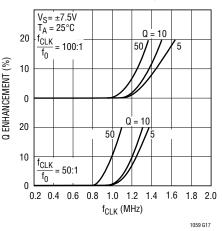
Graph 16. Mode 3: Q Error vs Clock Frequency



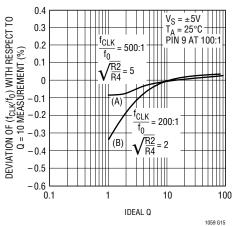
Graph 14. Mode 1: Notch Depth vs Clock Frequency



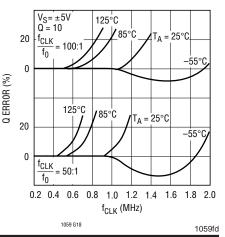
Graph 17. Mode 3 (R2 = R4): Q Error vs Clock Frequency



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



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



LINEAR TECHNOLOGY

TYPICAL PERFORMANCE CHARACTERISTICS

Q = 20

1.0 1.2

f_{CLK} (MHz)

1.4 1.6

1.8 2.0

1059 G25

10

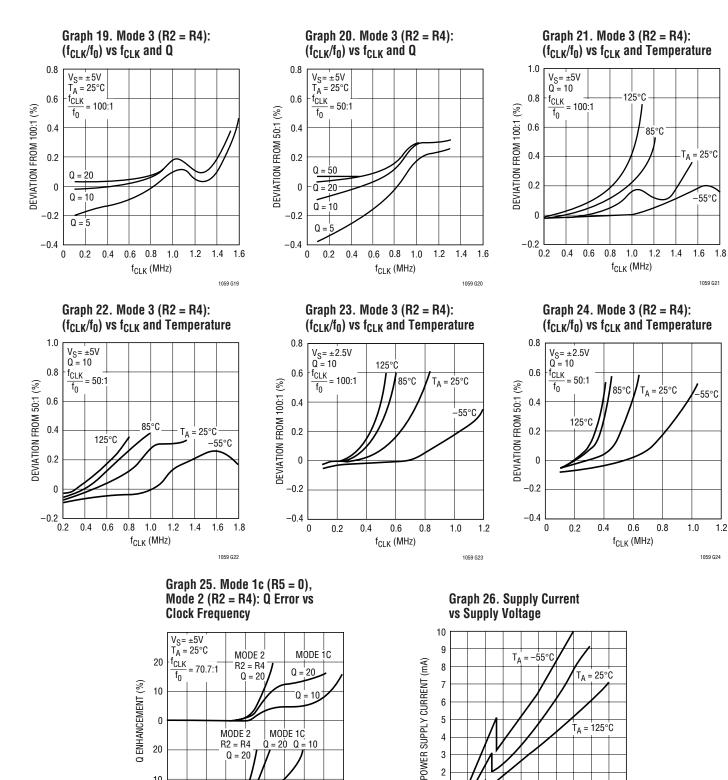
0

0.2 0.4

<u>f_{CLK}</u> = 35.35:1

0.6 0.8

f₀



2

1

0

±1 ±2

±3 ±4 ±5 ±6 ±7 ±8 ±9 +10

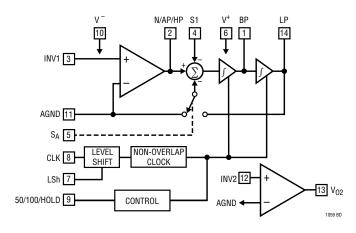
POWER SUPPLY VOLTAGE (±V)



1059fd

1059 626

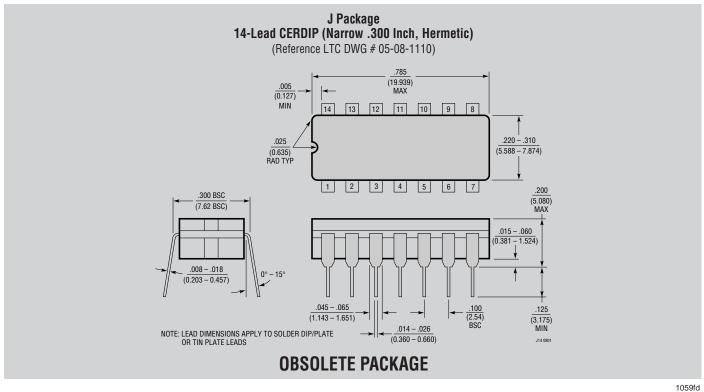
BLOCK DIAGRAM



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 $\pm 2.5V$) 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 complete discussion of the filter characteristics see the LTC1060 data sheet.

PACKAGE DESCRIPTION





Information furnished by Linear Technology Corporation is believed to be accurate and reliable. However, no responsibility is assumed for its use. Linear Technology Corporation makes no representation that the interconnection of its circuits as described herein will not infringe on existing patent rights.