



Low Power, High Accuracy Quad Universal Filter Building Block

February 1998

FEATURES

- Four Identical 2nd Order Filters in an SSOP Package
- Center Frequency Error: $\pm 0.3\%$
- Low Noise: $\leq 40\mu V_{RMS}$ per 2nd Order Section, $Q \leq 5$
- High Dynamic Range: THD + Noise $\leq 0.01\%$
- Low DC Offsets: $\leq 10mV$ per 2nd Order Section
- Clock-to-Center Frequency Ratio: 50:1
- No Aliasing for Input Frequencies up to $100 \times f_{CUTOFF}$
- Maximum Center Frequency up to 50kHz ($V_S = \pm 5V$)
- Operates from $\pm 1.57V$ to $\pm 5V$ Power Supplies

APPLICATIONS

- Low Power Linear Phase Bandpass Filters (Up to 40kHz, $V_S =$ Single 5V)
- Dual 4th Order Phase Matched Filters (Up to 40kHz, $V_S =$ Single 5V)
- Low Power Tone Detectors (High Selectivity Bandpass Filters up to 30kHz, $V_S =$ Single 5V)

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DESCRIPTION

The LTC[®]1068-50 consists of four identical, low noise, high accuracy 2nd order switched-capacitor filter building blocks. Each building block, together with three to five resistors, can provide 2nd order filter functions like low-pass, bandpass, highpass and notch. High precision, high performance, quad 2nd order, dual 4th order or 8th order filters can also be designed with an LTC1068-50. The center frequency of each 2nd order section is tuned by an external clock. The clock-to-center frequency ratio is internally set to 50:1 and can be modified by external resistors.

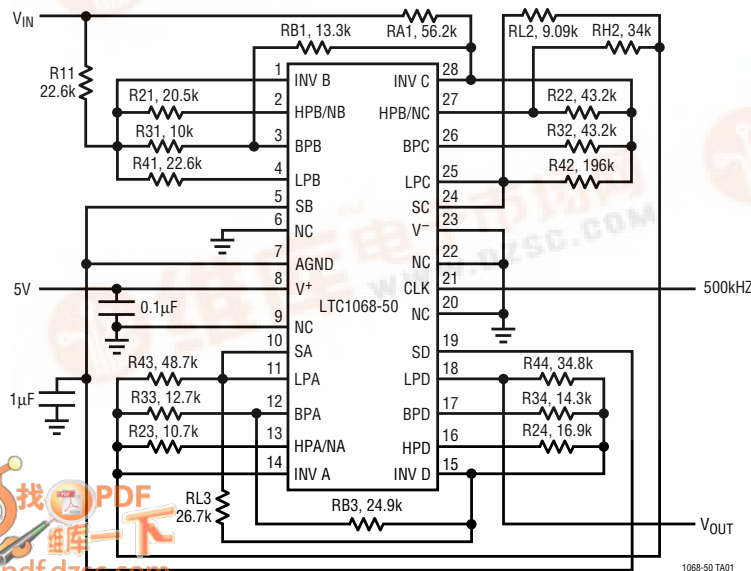
The sampling rate of the LTC1068-50 is twice the clock frequency. The maximum input frequency can approach twice the clock frequency before aliasing occurs.

A customized version of the LTC1068-50 in a 16-lead SO with internal thin film resistors can be obtained. Clock-to-center frequency ratios higher or lower than 50:1 can also be obtained. Please contact LTC Marketing for details.

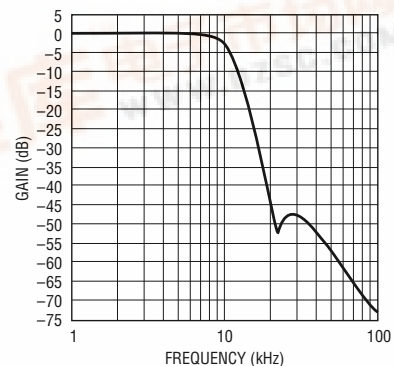
The LTC1068-50 is available in a 28-pin SSOP surface mount package and is supported by FilterCAD[™] 2.0 filter design software.

TYPICAL APPLICATION

Low Power, Single 5V Supply, 10kHz, 8th Order, Linear Phase Lowpass Filter



Frequency Response



1068-50 TA02

1068-50 TA01

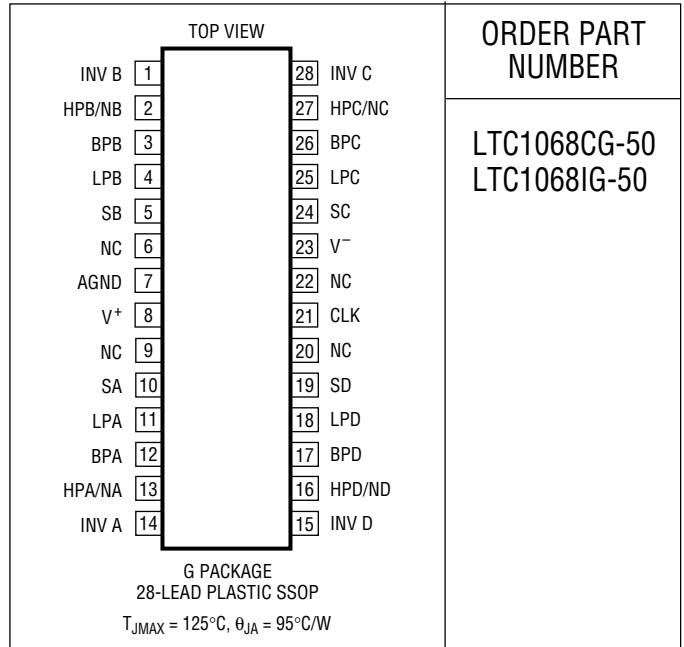


LTC1068-50

ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage (V^+ to V^-)	12V
Power Dissipation	500mW
Operating Temperature Range	
LTC1068CG-50	0°C to 70°C
LTC1068IG-50	-40°C to 85°C
Input Voltage at Any Pin ... $V^- - 0.3V \leq V_{IN} \leq V^+ + 0.3V$	
Storage Temperature Range	-65°C to 150°C
Lead Temperature (Soldering, 10 sec)	300°C

PACKAGE/ORDER INFORMATION



ORDER PART NUMBER

LTC1068CG-50
LTC1068IG-50

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS (Internal Op Amps) $V_S = \pm 5V$, $T_A = 25^\circ C$, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Supply Voltage Range		3.14		± 5.5	V
Voltage Swings	$V_S = 3.14V$, $R_L = 5k$ (Note 1)	● 1.2	1.8		V_{P-P}
	$V_S = 4.75V$, $R_L = 5k$ (Note 2)	● 2.6	3.6		V_{P-P}
	$V_S = \pm 5V$, $R_L = 5k$	● ± 3.4	± 4.1		V
Output Short-Circuit Current (Source/Sink)	$V_S = 3.14V$ (Note 1)		17/6		mA
	$V_S = \pm 5V$		20/15		mA
DC Open-Loop Gain	$R_L = 5k$		85		dB
GBW Product			4		MHz
Slew Rate			10		V/ μs
Analog Ground Voltage	$V_S = 5V$, Voltage at Pin 7 (AGND) (Note 3)		2.175		V

(Complete Filter) $T_A = 25^\circ C$, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
Clock-to-Center Frequency, f_{CLK}/f_0 (Note 5)	$V_S = 3.14V$, $f_{CLK} = 250kHz$, Mode 1 (Note 1), $f_0 = 5kHz$, $Q = 5$, $V_{IN} = 0.34V_{RMS}$, $R1 = R3 = 49.9k$, $R2 = 10k$	●	$50 \pm 0.3\%$	$50 \pm 0.8\%$ $50 \pm 0.9\%$	
	$V_S = \pm 5V$, $f_{CLK} = 500kHz$, Mode 1, $f_0 = 10kHz$, $Q = 5$, $V_{IN} = 1V_{RMS}$, $R1 = R3 = 49.9k$, $R2 = 10k$	●	$50 \pm 0.3\%$	$50 \pm 0.8\%$ $50 \pm 0.9\%$	
Clock-to-Center Frequency Ratio, Side-to-Side Matching (Note 5)	$V_S = 3.14V$, $f_{CLK} = 250kHz$, $Q = 5$ (Note 1)	●	± 0.25	± 0.9	%
	$V_S = \pm 5V$, $f_{CLK} = 500kHz$, $Q = 5$	●	± 0.25	± 0.9	%
Q Accuracy (Note 5)	$V_S = 3.14V$, $f_{CLK} = 250kHz$, $Q = 5$ (Note 1)	●	± 1	± 3	%
	$V_S = \pm 5V$, $f_{CLK} = 500kHz$, $Q = 5$	●	± 1	± 3	%

ELECTRICAL CHARACTERISTICS (Complete Filter) $T_A = 25^\circ\text{C}$, unless otherwise specified.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNITS
f_0 Temperature Coefficient			± 1		ppm/ $^\circ\text{C}$
Q Temperature Coefficient			± 5		ppm/ $^\circ\text{C}$
DC Offset Voltage (Note 5) (See Table 1)	$V_S = \pm 5\text{V}$, $f_{\text{CLK}} = 500\text{kHz}$, V_{OS1} (DC Offset of Input Inverter)	●	0	± 15	mV
	$V_S = \pm 5\text{V}$, $f_{\text{CLK}} = 500\text{kHz}$, V_{OS2} (DC Offset of First Integrator)	●	-2	± 25	mV
	$V_S = \pm 5\text{V}$, $f_{\text{CLK}} = 500\text{kHz}$, V_{OS3} (DC Offset of Second Integrator)	●	-5	± 40	mV
Clock Feedthrough	$V_S = \pm 5\text{V}$, $f_{\text{CLK}} = 500\text{kHz}$		0.16		mV _{RMS}
Maximum Clock Frequency	$V_S = \pm 5\text{V}$, $Q \leq 1.6$, Mode 1		3.4		MHz
Power Supply Current	$V_S = 3.14\text{V}$, $f_{\text{CLK}} = 250\text{kHz}$ (Note 5)	●	3.0	5	mA
	$V_S = 4.75\text{V}$, $f_{\text{CLK}} = 250\text{kHz}$ (Note 2)	●	4.3	8	mA
	$V_S = \pm 5\text{V}$, $f_{\text{CLK}} = 500\text{kHz}$	●	6.0	11	mA

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

Note 1: Production testing for single 3.14V supply is achieved by using the equivalent dual supplies of 1.7696V and -1.3704V. Note 3 is an explanation for using nonsymmetrical power supplies.

Note 2: Production testing for single 4.75V supply is achieved by using the equivalent dual supplies of 2.6771V and -2.0729V. Note 3 is an explanation for using nonsymmetrical power supplies.

Note 3: Pin 7 (AGND) is the internal analog ground of the device. For single supply applications this pin should be bypassed with a 1 μF capacitor. The biasing voltage of AGND is set with an internal resistive divider from Pin 8 to Pin 23, the value of AGND = $0.435 \cdot V^+$.

Note 4: See typical performance characteristics.

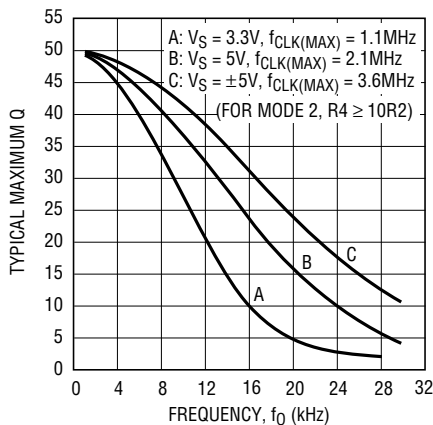
Note 5: Side D is guaranteed by design.

Table 1. Output DC Offsets One 2nd Order Section

MODE	V_{OSN}	V_{OSBP}	V_{OSLP}
1	$V_{\text{OS1}}[(1/Q) + 1 + H_{\text{OLP}}] - V_{\text{OS3}}/Q$	V_{OS3}	$V_{\text{OSN}} - V_{\text{OS2}}$
1B	$V_{\text{OS1}}[(1/Q) + 1 + R_2/R_1] - V_{\text{OS3}}/Q$	V_{OS3}	$\sim(V_{\text{OSN}} - V_{\text{OS2}})(1 + R_5/R_6)$
2	$[V_{\text{OS1}}(1 + R_2/R_1 + R_2/R_3 + R_2/R_4) - V_{\text{OS3}}(R_2/R_3)X$ $[R_4/(R_2 + R_4)] + V_{\text{OS2}}[R_2/(R_2 + R_4)]$	V_{OS3}	$V_{\text{OSN}} - V_{\text{OS2}}$
3	V_{OS2}	V_{OS3}	$V_{\text{OS1}}[1 + R_4/R_1 + R_4/R_2 + R_4/R_3] - V_{\text{OS2}}(R_4/R_2) - V_{\text{OS3}}(R_4/R_3)$

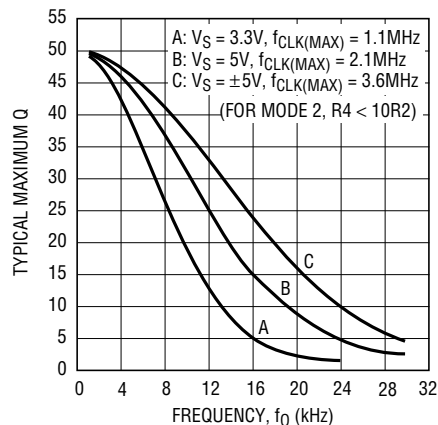
TYPICAL PERFORMANCE CHARACTERISTICS

**Maximum Q vs Frequency
(Modes 1, 1B, 2)**



1068-50 G01

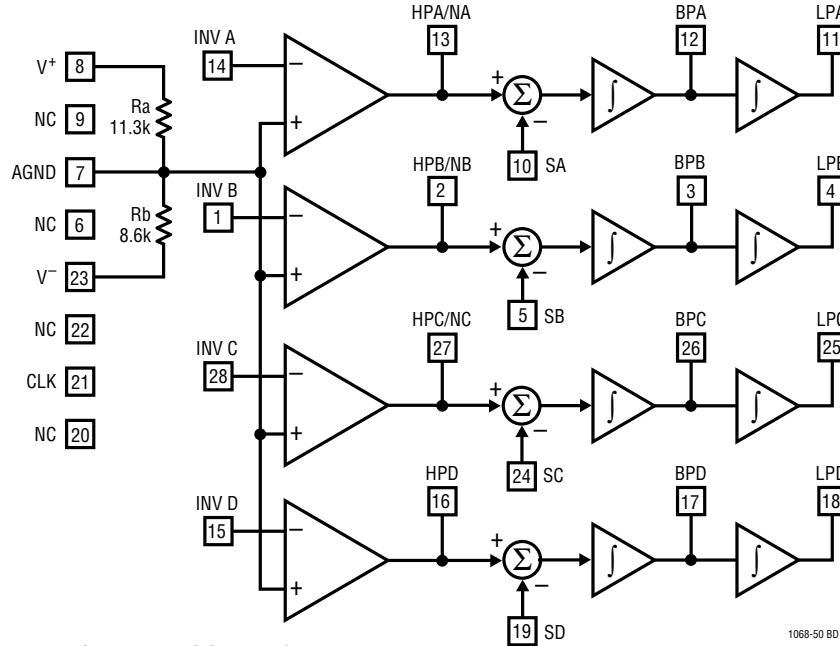
**Maximum Q vs Frequency
(Modes 2, 3)**



1068-50 G02

LTC1068-50

BLOCK DIAGRAM



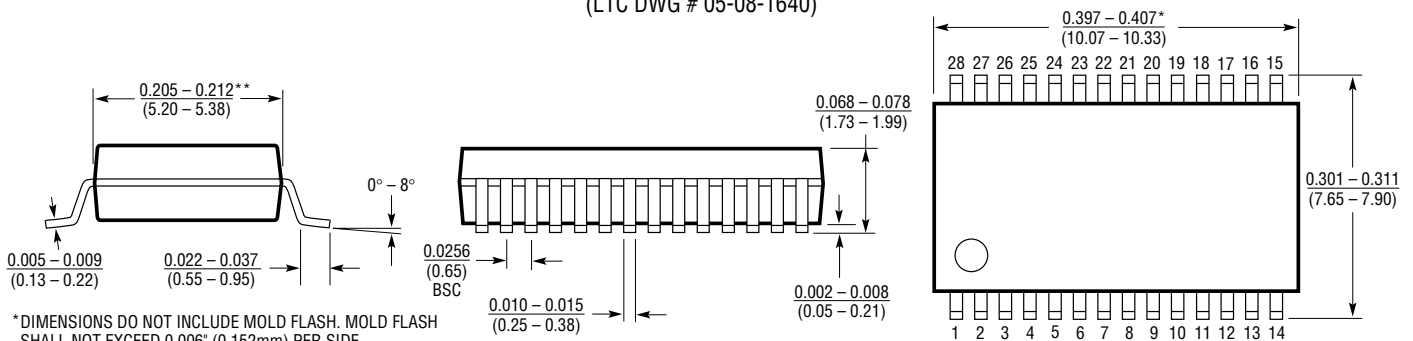
NOTE: THE RATIO OF Ra/Rb CAN VARY BY $\pm 0.8\%$.
THE ABSOLUTE VALUE OF Ra OR Rb CAN VARY BY $\pm 25\%$

1068-50 BD

PACKAGE DESCRIPTION

Dimensions in inches (millimeters) unless otherwise noted.

G Package 28-Lead Plastic SSOP (0.209) (LTC DWG # 05-08-1640)



* DIMENSIONS DO NOT INCLUDE MOLD FLASH. MOLD FLASH SHALL NOT EXCEED 0.006" (0.152mm) PER SIDE

** DIMENSIONS DO NOT INCLUDE INTERLEAD FLASH. INTERLEAD FLASH SHALL NOT EXCEED 0.010" (0.254mm) PER SIDE

G28 SSOP 0694

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1068	Low Noise Universal Filter	100:1 Clock-to- f_0 Ratio, f_c to 50kHz
LTC1068-25	High Speed Universal Filter	25:1 Clock-to- f_0 Ratio, f_c to 200kHz
LTC1068-200	Universal Filter	200:1 Clock-to- f_0 Ratio, f_c to 25kHz
LTC1064	Universal Filter	50:1 and 100:1 Clock-to- f_0 Ratios, f_c to 100kHz, V_S = Up to $\pm 7.5V$
LTC1164	Low Power Universal Filter	50:1 and 100:1 Clock-to- f_0 Ratios, f_c to 20kHz, V_S = Up to $\pm 7.5V$
LTC1264	High Speed Universal Filter	20:1 Clock-to- f_0 Ratio, f_c to 200kHz, V_S = Up to $\pm 7.5V$