High Speed, Low Noise Quad Universal Filter Building Block

February 1998

FEATURES

- **Four Identical 2nd Order Filters in an SSOP Package**
- **Maximum Center Frequency up to 200kHz ($V_S = \pm 5V$)**
- **Center Frequency Error: ±0.3% (Typ)**
- **Low Noise: $\leq 40\mu V_{RMS}$ per 2nd Order Section, Q ≤ 5**
- **High Dynamic Range: THD + Noise ≤ 0.05%**
- Low DC Offsets: ≤10mV per 2nd Order Section
- Clock-to-Center Frequency Ratio: 25:1
- No Aliasing for Input Frequencies up to $50 \times f_{CUTOFF}$
- Operates from ±2.375V to ±5V Power Supplies

APPLICATIONS

- High Selectivity Bandpass Filters (40kHz to 140kHz)
- Dual 4th Order Lowpass Filters up to 200kHz
- Elliptic Lowpass Filters up to 140kHz

DESCRIPTION

The LTC®1068-25 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 lowpass, bandpass, highpass and notch. High precision, high performance, quad 2nd order, dual 4th order or 8th order filters can also be designed with an LTC1068-25. The center frequency of each 2nd order section is tuned by an external clock. The clock-to-center frequency ratio is internally set to 25:1 and can be modified by external resistors.

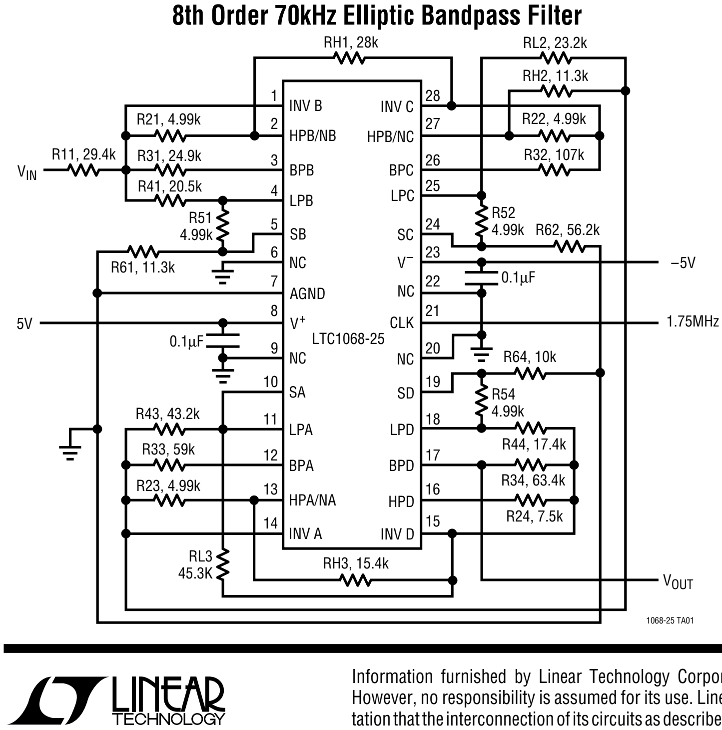
The sampling rate of the LTC1068-25 is twice the clock frequency. The maximum input frequency can approach twice the clock frequency before aliasing occurs.

A customized version of the LTC1068-25 in a 16-lead SO with internal thin film resistors can be obtained. Clock-to-center frequency ratios higher or lower than 25:1 can also be obtained. Please contact LTC Marketing for details.

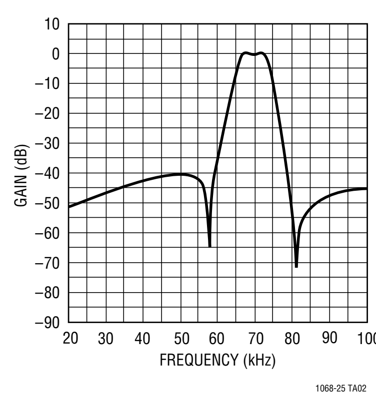
The LTC1068-25 is available in a 28-pin SSOP surface mount package and is supported by FilterCAD™ 2.0 filter design software.

TYPICAL APPLICATION

8th Order 70kHz Elliptic Bandpass Filter



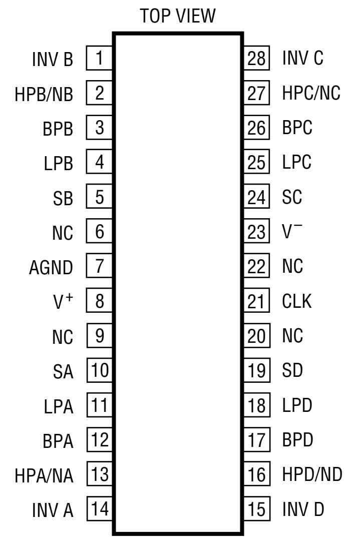
Gain vs Frequency



ABSOLUTE MAXIMUM RATINGS

Total Supply Voltage (V^+ to V^-) 12V
Power Dissipation 500mW
Operating Temperature Range
  LTC1068CG-25 .... 0°C to 70°C
  LTC1068IG-25 .... −40°C to 85°C
Input Voltage at Any Pin ... $V^- - 0.3V \le V_{IN} \le V^+ + 0.3V$
Storage Temperature Range .... −65°C to 150°C
Lead Temperature (Soldering, 10 sec) .... 300°C

PACKAGE/ORDER INFORMATION



G PACKAGE
28-LEAD PLASTIC SSOP
$T_{JMAX} = 125°C, \theta_{JA} = 95°C/W$

ORDER PART NUMBER

LTC1068CG-25
LTC1068IG-25

Consult factory for Military grade parts.

ELECTRICAL CHARACTERISTICS (Internal Op Amps) $V_S = \pm5V$, $T_A = 25°C$, unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Operating Supply Voltage Range			±1.57		±5.5	V
Voltage Swings	$V_S = 3.14V$, $R_L = 5k$ (Note 1) $V_S = 4.75V$, $R_L = 5k$ (Note 2) $V_S = \pm5V$, $R_L = 5k$	● ● ●	1.2 2.6 ±3.4	1.6 3.4 ±4.1		V_{P-P} V_{P-P} V
Output Short-Circuit Current (Source/Sink)	$V_S = 4.75V$ $V_S = \pm5V$			17/6 20/15		mA mA
DC Open-Loop Gain	$R_L = 5k$			85		dB
GBW Product				6		MHz
Slew Rate				10		V/µs

(Complete Filter) $V_S = \pm5V$, $T_A = 25°C$, unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
Clock-to-Center Frequency, f_{CLK}/f_O (Note 5)	$V_S = 4.75V$, $f_{CLK} = 500kHz$, Mode 1 (Note 2), $f_O = 20kHz$, Q = 5, $V_{IN} = 0.5V_{RMS}$, R1 = R3 = 49.9k, R2 = 10k	 ●		25 ± 0.3%	25 ± 0.8% 25 ± 0.9%	
	$V_S = \pm5V$, $f_{CLK} = 1MHz$, Mode 1, $f_O = 40kHz$, Q = 5, $V_{IN} = 1V_{RMS}$, R1 = R3 = 49.9k, R2 = 10k	 ●		25 ± 0.3%	25 ± 0.8% 25 ± 0.9%	
Clock-to-Center Frequency Ratio, Side-to-Side Matching (Note 5)	$V_S = 4.75V$, $f_{CLK} = 500kHz$, Q = 5 (Note 2) $V_S = \pm5V$, $f_{CLK} = 1MHz$, Q = 5	● ●		±0.25 ±0.25	±0.9 ±0.9	% %
Q Accuracy (Note 5)	$V_S = 4.75V$, $f_{CLK} = 500kHz$, Q = 5 (Note 2) $V_S = \pm5V$, $f_{CLK} = 1MHz$, Q = 5	● ●		±1 ±1	±3 ±3	% %

ELECTRICAL CHARACTERISTICS (Complete Filter) $V_S = \pm5V$, $T_A = 25°C$, unless otherwise specified.

PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
f_O Temperature Coefficient				±1		ppm/°C
Q Temperature Coefficient				±5		ppm/°C
DC Offset Voltage (Note 5) (See Table 1)	$V_S = \pm5V$, $f_{CLK} = 1MHz$, V_{OS1} (DC Offset of Input Inverter)	●		0	±15	mV
	$V_S = \pm5V$, $f_{CLK} = 1MHz$, V_{OS2} (DC Offset of First Integrator)	●		−2	±25	mV
	$V_S = \pm5V$, $f_{CLK} = 1MHz$, V_{OS3} (DC Offset of Second Integrator)	●		−5	±40	mV
Clock Feedthrough	$V_S = \pm5V$, $f_{CLK} = 1MHz$			0.25		mV_{RMS}
Maximum Clock Frequency (Note 4)	$V_S = \pm5V$, $Q \le 1.6$, Mode 1			5.6		MHz
Power Supply Current	$V_S = 3.14V$, $f_{CLK} = 1MHz$ (Note 1)	●		3.5	8	mA
	$V_S = 4.75V$, $f_{CLK} = 1MHz$ (Note 2)	●		6.5	11	mA
	$V_S = \pm5V$, $f_{CLK} = 1MHz$	●		9.5	15	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 ±1.57V.

Note 2: Production testing for single 4.75V supply is achieved by using the equivalent dual supplies of ±2.375V.

Note 3: Pin 7 (AGND) is the internal analog ground of the device. For single supply applications this pin should be bypassed with a 1μF capacitor. The biasing voltage of AGND is set with an internal resistive divider from Pin 8 to Pin 23 (see Block Diagram).

Note 4: See performance characteristics.

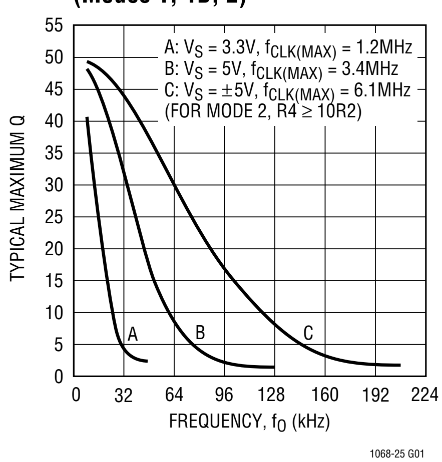
Note 5: Side D is guaranteed by design.

Table 1. Output DC Offsets One 2nd Order Section

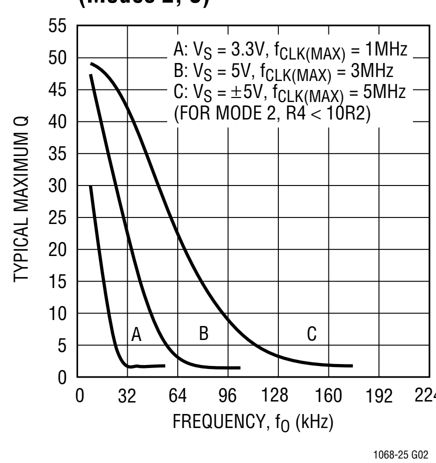
MODE	V_{OSN}	V_{OSBP}	V_{OSLP}
1	$V_{OS1}[(1/Q) + 1 + \lvert\lvert H_{OLP}\rvert\rvert] - V_{OS3}/Q$	V_{OS3}	$V_{OSN} - V_{OS2}$
1B	$V_{OS1}[(1/Q) + 1 + R2/R1] - V_{OS3}/Q$	V_{OS3}	$\sim(V_{OSN} - V_{OS2})(1 + R5/R6)$
2	$[V_{OS1}(1 + R2/R1 + R2/R3 + R2/R4) - V_{OS3}(R2/R3)X$ $[R4/(R2 + R4)] + V_{OS2}[R2/(R2 + R4)]$	V_{OS3}	$V_{OSN} - V_{OS2}$
3	V_{OS2}	V_{OS3}	$V_{OS1}[1 + R4/R1 + R4/R2 + R4/R3] - V_{OS2}(R4/R2) - V_{OS3}(R4/R3)$

TYPICAL PERFORMANCE CHARACTERISTICS

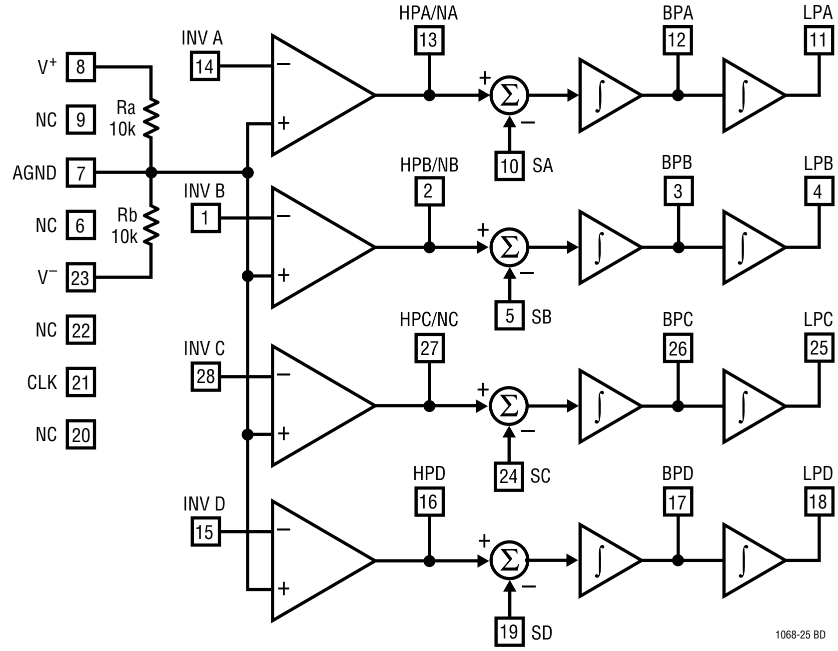
Maximum Q vs Frequency (Modes 1, 1B, 2)



Maximum Q vs Frequency (Modes 2, 3)



BLOCK DIAGRAM

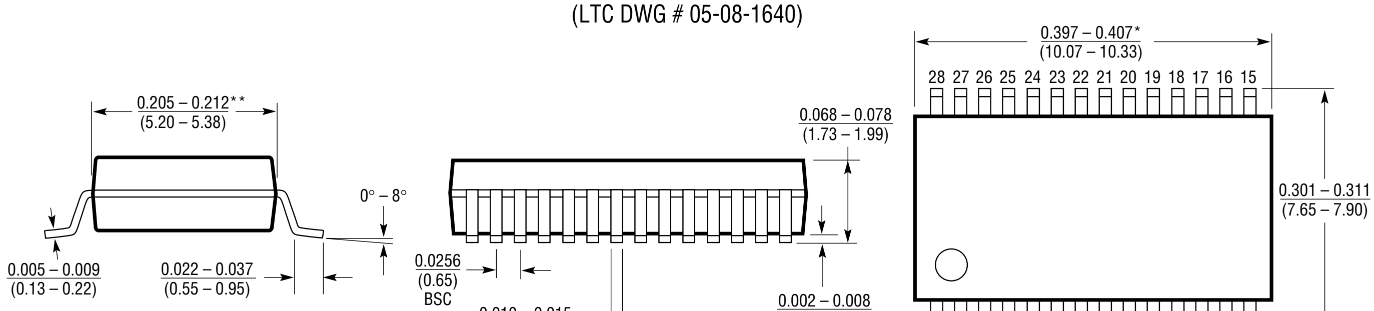


NOTE: THE RATIO OF Ra/Rb CAN VARY BY ±0.8%.
THE ABSOLUTE VALUE OF Ra OR Rb CAN VARY BY ±25%

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

RELATED PARTS

PART NUMBER	DESCRIPTION	COMMENTS
LTC1068	Low Noise Universal Filter	100:1 Clock-to-f_0 Ratio, f_C to 50kHz
LTC1068-50	Low Power Universal Filter	50:1 Clock-to-f_0 Ratio, f_C to 25kHz
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 ±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 ±7.5V
LTC1264	High Speed Universal Filter	20:1 Clock-to-f_0 Ratio, f_C to 200kHz, V_S = Up to ±7.5V

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