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ANALOG DEVICES

Precision, Low Power Differential Amplifier/ADC Driver Family

FEATURES

- **Available with User Set Gain or Fixed Gain of 0.5V/V, 1V/V, or 2V/V**
- **2.9nV/√Hz Input-Referred Noise**
- **2mA Maximum Supply Current**
- **45ppm Max Gain Error**
- **0.5ppm/°C Max Gain Error Drift**
- **94dB Min CMRR**
- **100µV Max Offset Voltage**
- **50nA Max Input Offset Current**
- **Fast Settling: 720ns to 18-Bit, $8V_{P-P}$ Output**
- 2.8V (±1.4V) to 11V (±5.5V) Supply Voltage Range
- Differential Rail-to-Rail Outputs
- Input Common Mode Range Includes Ground
- Low Distortion: 115dB SFDR at 2kHz, $18V_{P-P}$
- 500MHz Gain-Bandwidth Product
- 35MHz –3dB Bandwidth
- Low Power Shutdown: 20µA (V_S = 3V)
- 8-lead MSOP and 2mm × 3mm 8-Lead DFN Packages

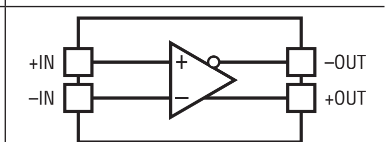
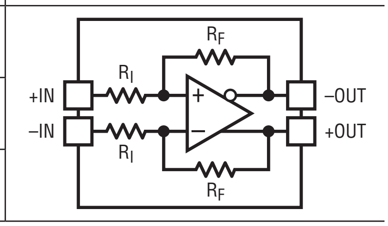
APPLICATIONS

- 20-Bit, 18-Bit and 16-Bit SAR ADC Drivers
- Single-Ended-to-Differential Conversion
- Low Power ADC Drivers
- Level Shifter
- Differential Line Drivers
- Battery-Powered Instrumentation

DESCRIPTION

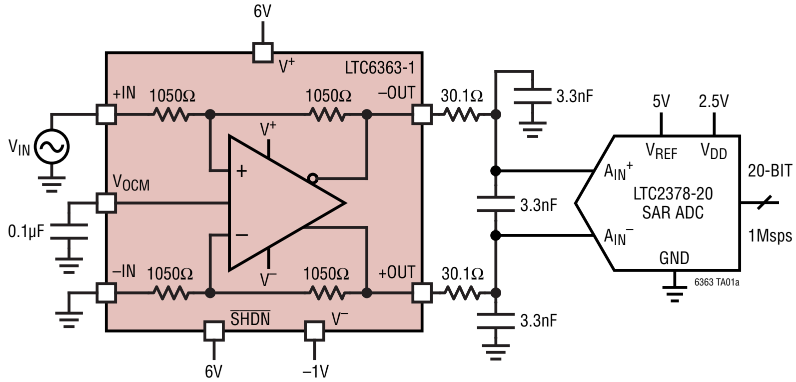
The LTC®6363 family consists of four fully differential, low power, low noise amplifiers with rail-to-rail outputs optimized to drive SAR ADCs. The LTC6363 is a stand-alone differential amplifier, where the gain is typically set using four external resistors. The LTC6363-0.5, LTC6363-1, and LTC6363-2 each have internal matched resistors to create fixed gain blocks with gains of 0.5V/V, 1V/V, and 2V/V respectively. Each of the fixed-gain amplifiers features precision laser trimmed on-chip resistors for accurate, ultrastable gain and excellent CMRR.

Family Selection Table

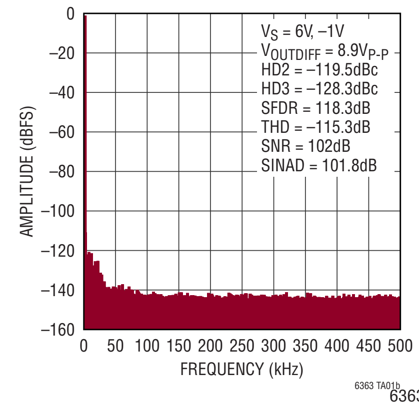
PART NUMBER	GAIN	CONFIGURATION
LTC6363	User Set	
LTC6363-0.5	0.5V/V	
LTC6363-1	1V/V	
LTC6363-2	2V/V	

TYPICAL APPLICATION

DC-Coupled Interface from a Ground-Referenced Single-Ended Input to an LTC2378-20 SAR ADC



LTC6363-1 Driving LTC2378-20 f_{IN} = 2kHz, –1dBFS,131k-Point FFT

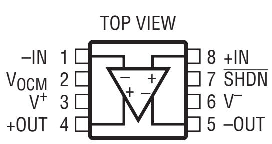


ABSOLUTE MAXIMUM RATINGS (Note 1)

Total Supply Voltage ($V^+ – V^–$) 12V
Input Voltage (+IN, –IN) (Note 2)
LTC6363-0.5................... ($V^–$) – 14.9V to (V^+) + 14.9V
LTC6363-1 ....($V^–$) – 11.1V to (V^+) + 11.1V
LTC6363-2...................... ($V^–$) – 7.45V to (V^+) + 7.45V
Input Current (+IN, –IN) LTC6363 (Note 3) .... ±10mA
Input Current (V_{OCM}, $\overline{SHDN}$) (Note 3) .... ±10mA
Output Short-Circuit Duration
(Note 4) ....Thermally Limited
Operating Temperature Range (Note 5)
LTC6363I/LTC6363I-0.5/LTC6363I-1/
LTC6363I-2...–40°C to 85°C
LTC6363H/LTC6363H-0.5/LTC6363H-1/
LTC6363H-2 .... –40°C to 125°C
Specified Temperature Range (Note 6)
LTC6363I/LTC6363I-0.5/LTC6363I-1/
LTC6363I-2...–40°C to 85°C
LTC6363H/LTC6363H-0.5/LTC6363H-1/
LTC6363H-2 .... –40°C to 125°C
Maximum Junction Temperature .... 150°C
Storage Temperature Range .... –65°C to 150°C
MSOP Lead Temperature (Soldering, 10 sec)........ 300°C

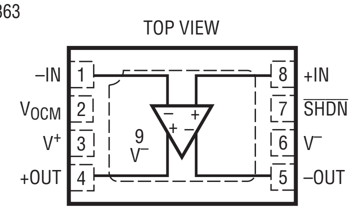
PIN CONFIGURATION

LTC6363



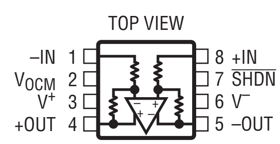
MS8 PACKAGE
8-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 273°C/W

LTC6363



DCB PACKAGE
8-LEAD (2mm × 3mm) PLASTIC DFN
T_{JMAX} = 150°C, θ_{JA} = 64°C/W, θ_{JC} = 10.6°C/W
EXPOSED PAD (PIN 9) IS $V^–$, MUST BE SOLDERED TO PCB

LTC6363-0.5/LTC6363-1/LTC6363-2



MS8 PACKAGE
8-LEAD PLASTIC MSOP
T_{JMAX} = 150°C, θ_{JA} = 273°C/W

ORDER INFORMATION http://www.linear.com/product/LTC6363#orderinfo

TUBE	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LTC6363IMS8#PBF	LTC6363IMS8#TRPBF	LTGSQ	8-Lead Plastic MSOP	–40°C to 85°C
LTC6363HMS8#PBF	LTC6363HMS8#TRPBF	LTGSQ	8-Lead Plastic MSOP	–40°C to 125°C
LTC6363IMS8-0.5#PBF	LTC6363IMS8-0.5#TRPBF	LTGST	8-Lead Plastic MSOP	–40°C to 85°C
LTC6363HMS8-0.5#PBF	LTC6363HMS8-0.5#TRPBF	LTGST	8-Lead Plastic MSOP	–40°C to 125°C
LTC6363IMS8-1#PBF	LTC6363IMS8-1#TRPBF	LTGSR	8-Lead Plastic MSOP	–40°C to 85°C
LTC6363HMS8-1#PBF	LTC6363HMS8-1#TRPBF	LTGSR	8-Lead Plastic MSOP	–40°C to 125°C
LTC6363IMS8-2#PBF	LTC6363IMS8-2#TRPBF	LTGSS	8-Lead Plastic MSOP	–40°C to 85°C
LTC6363HMS8-2#PBF	LTC6363HMS8-2#TRPBF	LTGSS	8-Lead Plastic MSOP	–40°C to 125°C

ORDER INFORMATION

Lead Free Finish

TAPE AND REEL (MINI)	TAPE AND REEL	PART MARKING*	PACKAGE DESCRIPTION	TEMPERATURE RANGE
LTC6363IDCB#TRMPBF	LTC6363IDCB#TRPBF	LGVG	8-Lead (2mm × 3mm) Plastic DFN	–40°C to 85°C
LTC6363HDCB#TRMPBF	LTC6363HDCB#TRPBF	LGVG	8-Lead (2mm × 3mm) Plastic DFN	–40°C to 125°C

TRM = 500 pieces. *Temperature grades are identified by a label on the shipping container.

Consult ADI Marketing for parts specified with wider operating temperature ranges.
For more information on lead free part marking, go to: http://www.linear.com/leadfree/
For more information on tape and reel specifications, go to: http://www.linear.com/tapeandreel/. Some packages are available in 500 unit reels through designated sales channels with #TRMPBF suffix.

ELECTRICAL CHARACTERISTICS

Complete LTC6363 Family. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, $V^–$ = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ – V^–$). V_{OUTCM} is defined as ($V_{+OUT} + V_{–OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{–IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} – V_{–OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
PSRR (Note 7)	Differential Power Supply Rejection ($\Delta V_S/\Delta V_{OSDIFF}$)	V_S = 2.8V to 11V	●	90	125		dB
PSRRCM (Note 7)	Output Common Mode Power Supply Rejection ($\Delta V_S/\Delta V_{OSCM}$)	V_S = 2.8V to 11V	●	70	90		dB
GCM	Common Mode Gain ($\Delta V_{OUTCM}/\Delta V_{OCM}$)	V_S = 3V, V_{OCM} from 0.5V to 2.5V V_S = 5V, V_{OCM} from 0.5V to 4.5V V_S = 10V, V_{OCM} from 0.5V to 9.5V	● ● ●		1 1 1		V/V V/V V/V
ΔGCM	Common Mode Gain Error 100 • (GCM – 1)	V_S = 3V, V_{OCM} from 0.5V to 2.5V V_S = 5V, V_{OCM} from 0.5V to 4.5V V_S = 10V, V_{OCM} from 0.5V to 9.5V	● ● ●		0.2 0.1 0.07	1 0.5 0.4	% % %
BAL	Output Balance ($\Delta V_{OUTCM}/\Delta V_{OUTDIFF}$)	$\Delta V_{OUTDIFF}$ = 2V Single-Ended Input Differential Input	 ● ●		 –58 –58	 –35 –35	 dB dB
V_{OSCM}	Common Mode Offset Voltage ($V_{OUTCM} – V_{OCM}$)	V_S = 3V V_S = 5V V_S = 10V	● ● ●		±1 ±1 ±1	±6 ±6 ±6	mV mV mV
$\Delta V_{OSCM}/\Delta T$	Common Mode Offset Voltage Drift		●		10		µV/°C
V_{OUTCMR} (Note 9)	Output Signal Common Mode Range (Voltage Range for the V_{OCM} Pin)	V_{OCM} Driven Externally, V_S = 3V V_{OCM} Driven Externally, V_S = 5V V_{OCM} Driven Externally, V_S = 10V	● ● ●	0.5 0.5 0.5		2.5 4.5 9.5	V V V
V_{OCM}	Self-Biased Voltage at the V_{OCM} Pin	V_{OCM} Not Connected, V_S = 3V V_{OCM} Not Connected, V_S = 5V V_{OCM} Not Connected, V_S = 10V	● ● ●	1.38 2.33 4.79	1.5 2.5 5	1.82 2.82 5.21	V V V
R_{INVOCM}	Input Resistance, V_{OCM} Pin		●	1.3	1.8	2.3	MΩ
	V_{OCM} Bandwidth				15		MHz
V_S	Supply Voltage Range	Guaranteed by PSRR	●	2.8		11	V

ELECTRICAL CHARACTERISTICS

Complete LTC6363 Family. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_S	Supply Current	V_S = 3V, Active	 ●		1.7	1.8 1.95	mA mA
		V_S = 3V, Shutdown	●		20	40	µA
		V_S = 5V, Active	 ●		1.75	1.85 2	mA mA
		V_S = 5V, Shutdown	●		30	65	µA
		V_S = 10V, Active	 ●		1.9	2 2.2	mA mA
		V_S = 10V, Shutdown	●		70	130	µA
V_{IL}	$\overline{SHDN}$ Input Logic Low		●			$(V^+ + V^-)/2 + 0.4$	V
V_{IH}	$\overline{SHDN}$ Input Logic High		●	$(V^+ + V^-)/2 + 1.2$			V
t_{ON}	Turn-On Time				4		µs
t_{OFF}	Turn-Off Time				2		µs
$R_{\overline{SHDN}}$	Input Resistance, $\overline{SHDN}$ Pin		●	300	500	700	kΩ

LTC6363 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$). Typical specifications apply to the internal amplifier inside all versions.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OSDIFF} (Note 7)	Differential Offset Voltage	V_S = 3V V_{ICM} =1.5V	 ●		25	100 200	µV µV
		V_S = 5V V_{ICM} = 2.5V	 ●		25	100 200	µV µV
		V_S = 10V V_{ICM} = 5V	 ●		25	100 200	µV µV
$\Delta V_{OSDIFF}/\Delta T$ (Notes 7, 8)	Differential Offset Voltage Drift	V_S = 3V V_S = 5V V_S = 10V	● ● ●		0.45 0.45 0.45	1.25 1.25 1.25	µV/°C µV/°C µV/°C
A_{VOL}	Open-Loop Voltage Gain				125		dB
I_B (Note 10)	Input Bias Current	V_S = 3V V_S = 5V V_S = 10V	● ● ●	–1 –1 –1	–0.5 –0.5 –0.5	–0.1 –0.1 –0.1	µA µA µA
I_{OS} (Note 10)	Input Offset Current	V_S = 3V	 ●		±5	±50 ±75	nA nA
		V_S = 5V	 ●		±5	±50 ±75	nA nA
		V_S = 10V	 ●		±5	±50 ±75	nA nA
$\Delta I_{OS}/\Delta T$ (Note 8)	Input Offset Current Drift	V_S = 3V V_S = 5V V_S = 10V	● ● ●		±30 ±30 ±30	±150 ±150 ±150	pA/°C pA/°C pA/°C
R_{IN}	Input Resistance	Common Mode Differential Mode			50 40		MΩ kΩ
C_{IN}	Input Capacitance	Differential Mode			2		pF

ELECTRICAL CHARACTERISTICS

LTC6363 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$). Typical specifications apply to the internal amplifier inside all versions.

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
e_n (Note 7)	Differential Input Noise Voltage Differential Input Noise Voltage Density	0.1Hz to 10Hz f = 100kHz (Not Including R_I/R_F)			2.5 2.9		μV_{P-P} $nV/\sqrt{Hz}$
e_{nvocm}	Common Mode Noise Voltage Density	f = 100kHz			20		$nV/\sqrt{Hz}$
i_n	Input Noise Current Density	f = 100kHz (Not Including R_I/R_F)			0.55		$pA/\sqrt{Hz}$
V_{ICMR} (Note 9)	Input Common Mode Range	V_S = 3V V_S = 5V V_S = 10V	● ● ●	0 0 0		1.8 3.8 8.8	V V V
CMRRI (Note 7)	Input Common Mode Rejection Ratio (Input Referred) $\Delta V_{ICM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{ICM} from 0V to 1.8V V_S = 5V, V_{ICM} from 0V to 3.8V V_S = 10V, V_{ICM} from 0V to 8.8V	● ● ●	78 85 90	110 115 120		dB dB dB
CMRRIO (Note 7)	Output Common Mode Rejection Ratio (Input Referred) $\Delta V_{OCM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{OCM} from 0.5V to 2.5V V_S = 5V, V_{OCM} from 0.5V to 4.5V V_S = 10V, V_{OCM} from 0.5V to 9.5V	● ● ●	70 80 90	120 120 120		dB dB dB
V_{OUT}	Output Voltage, High, Either Output Pin	I_L= 0mA, V_S = 3V I_L = –5mA, V_S = 3V	● ●	2.8 2.75	2.88 2.83		V V
		I_L= 0mA, V_S = 5V I_L = –5mA, V_S = 5V	● ●	4.8 4.75	4.88 4.83		V V
		I_L= 0mA, V_S = 10V I_L = –5mA, V_S = 10V	● ●	9.8 9.7	9.88 9.83		V V
	Output Voltage, Low, Either Output Pin	I_L= 0mA, V_S = 3V I_L = 5mA, V_S = 3V	● ●		0.1 0.15	0.15 0.25	V V
		I_L= 0mA, V_S = 5V I_L = 5mA, V_S = 5V	● ●		0.1 0.15	0.15 0.25	V V
		I_L= 0mA, V_S = 10V I_L = 5mA, V_S = 10V	● ●		0.1 0.15	0.2 0.3	V V
I_{SC}	Output Short-Circuit Current, Either Output Pin, Sinking	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	12 13 14	25 35 40		mA mA mA
	Output Short-Circuit Current, Either Output Pin, Sourcing	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	25 27 30	55 75 90		mA mA mA
GBW	Gain-Bandwidth Product	f_{TEST} = 200kHz	 ●	390 230	500		MHz MHz
f_{-3dB}	–3dB Bandwidth	R_I = R_F =1k			35		MHz
SR	Slew Rate	Differential 18V_{P-P} Output			75		V/µs
FPBW (Note 11)	Full Power Bandwidth	10V_{P-P} Output 18V_{P-P} Output			2.4 1.3		MHz MHz
HD2/HD3	2nd/3rd Order Harmonic Distortion Single-Ended Input	f = 1kHz, V_{OUT} = 18V_{P-P} f = 10kHz, V_{OUT} = 18V_{P-P} f = 100kHz, V_{OUT} = 18V_{P-P}			–123/–128 –120/–108 –92/–85		dBc dBc dBc
t_S	Settling Time to a 8V_{P-P} Output Step	0.1% 0.01% 0.0015% (16-Bit) 4ppm (18-Bit)			290 330 370 720		ns ns ns ns

ELECTRICAL CHARACTERISTICS

LTC6363-0.5 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as (V^+ – V^-). V_{OUTCM} is defined as (V_{+OUT} + $V_{–OUT}$)/2. V_{ICM} is defined as (V_{+IN} + $V_{–IN}$)/2. $V_{OUTDIFF}$ is defined as (V_{+OUT} – $V_{–OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OSDIFF} (Note 7)	Differential Offset Voltage	V_S = 3V V_{ICM} =1.5V	 ●		25	125 250	µV µV
		V_S = 5V V_{ICM} = 2.5V	 ●		25	125 250	µV µV
		V_S = 10V V_{ICM} = 5V	 ●		25	125 250	µV µV
$\Delta V_{OSDIFF}/\Delta T$ (Notes 7, 8)	Differential Offset Voltage Drift	V_S = 3V V_S = 5V V_S = 10V	● ● ●		0.45 0.45 0.45	1.25 1.25 1.25	µV/°C µV/°C µV/°C
G_{DIFF}	Differential Gain	V_{OUT} = $16V_{P-P}$			0.5		V/V
	Differential Gain Error		 ●		±0.002	±0.0045 ±0.0075	% %
	Differential Gain Nonlinearity				0.5		ppm
	Differential Gain Drift vs Temperature (Note 8)		●		±0.2	±0.5	ppm/°C
e_n (Note 7)	Differential Input Referred Noise Voltage Density	f = 100kHz, (Includes Internal Resistor Noise)			15.1		$nV/\sqrt{Hz}$
e_{nvocm}	Common Mode Noise Voltage Density	f = 100kHz			20		$nV/\sqrt{Hz}$
R_{IN}	Input Resistance	Common Mode Differential Mode			1050 2800		Ω Ω
C_{IN}	Input Capacitance	Differential Mode Common Mode			2.5 13.5		pF pF
V_{ICMR} (Note 9)	Input Common Mode Range	V_S = 3V, V_{OCM} = 1.5V V_S = 5V,V_{OCM} = 2.5V V_S = 10V, V_{OCM} = 5V	● ● ●	–3 –5 –10		2.4 6.4 16.4	V V V
CMRRI (Note 7)	Input Common Mode Rejection Ratio (Input Referred) $\Delta V_{ICM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{ICM} from –3V to 2.4V	 ●	90 80	106		dB dB
		V_S = 5V, V_{ICM} from –5V to 6.4V	 ●	94 85	106		dB dB
		V_S = 10V, V_{ICM} from –10V to 16.4V	 ●	94 85	106		dB dB
CMRRIO (Note 7)	Output Common Mode Rejection Ratio (Input Referred) $\Delta V_{OCM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{OCM} from 0.5V to 2.5V	 ●	85 80	100		dB dB
		V_S = 5V, V_{OCM} from 0.5V to 4.5V	 ●	90 85	106		dB dB
		V_S = 10V, V_{OCM} from 0.5V to 9.5V	 ●	90 85	106		dB dB
V_{OUT}	Output Voltage, High, Either Output Pin	I_L= 0mA, V_S = 3V I_L = –5mA, V_S = 3V	● ●	2.77 2.74	2.88 2.83		V V
		I_L= 0mA, V_S = 5V I_L = –5mA, V_S = 5V	● ●	4.75 4.72	4.86 4.81		V V
		I_L= 0mA, V_S = 10V I_L = –5mA, V_S = 10V	● ●	9.72 9.64	9.83 9.78		V V
	Output Voltage, Low, Either Output Pin	I_L= 0mA, V_S = 3V I_L = 5mA, V_S = 3V	● ●		0.11 0.19	0.19 0.27	V V
		I_L= 0mA, V_S = 5V I_L = 5mA, V_S = 5V	● ●		0.13 0.19	0.2 0.28	V V
		I_L= 0mA, V_S = 10V I_L = 5mA, V_S = 10V	● ●		0.17 0.23	0.28 0.38	V V

ELECTRICAL CHARACTERISTICS

LTC6363-0.5 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{SC}	Output Short-Circuit Current, Either Output Pin, Sinking	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	12 13 14	25 35 40		mA mA mA
	Output Short-Circuit Current, Either Output Pin, Sourcing	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	25 27 30	55 75 90		mA mA mA
f_{-3dB}	–3dB Bandwidth				35		MHz
SR	Slew Rate	Differential $18V_{P-P}$ Output			44		V/µs
FPBW (Note 11)	Full Power Bandwidth	$10V_{P-P}$ Output $18V_{P-P}$ Output			1.4 0.8		MHz MHz
HD2/HD3	2nd/3rd order Harmonic Distortion Single-Ended Input	f = 1kHz, V_{OUT} = $10V_{P-P}$ f = 10kHz, V_{OUT} = $10V_{P-P}$ f = 100kHz, V_{OUT} = $10V_{P-P}$			–125/–122 –108/–111 –87/–78		dBc dBc dBc
t_S	Settling Time to a $8V_{P-P}$ Output Step	0.1% 0.01% 0.0015% (16-Bit) 4ppm (18-Bit)			420 440 550 740		ns ns ns ns

LTC6363-1 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OSDIFF} (Note 7)	Differential Offset Voltage	V_S = 3V V_{ICM} =1.5V	 ●		25	125 250	µV µV
		V_S = 5V V_{ICM} = 2.5V	 ●		25	125 250	µV µV
		V_S = 10V V_{ICM} = 5V	 ●		25	125 250	µV µV
$\Delta V_{OSDIFF}/\Delta T$ (Notes 7, 8)	Differential Offset Voltage Drift	V_S = 3V V_S = 5V V_S = 10V	● ● ●		0.45 0.45 0.45	1.25 1.25 1.25	µV/°C µV/°C µV/°C
G_{DIFF}	Differential Gain	V_{OUT} = $16V_{P-P}$			1		V/V
	Differential Gain Error		 ●		±0.002	±0.0045 ±0.0075	% %
	Differential Gain Nonlinearity				0.5		ppm
	Differential Gain Drift vs Temperature (Note 8)		●		±0.2	±0.5	ppm/°C
e_n (Note 7)	Differential Input Referred Noise Voltage Density	f = 100kHz, (Includes Internal Resistor Noise)			10.5		$nV/\sqrt{Hz}$
e_{nvocm}	Common Mode Noise Voltage Density	f = 100kHz			20		$nV/\sqrt{Hz}$
R_{IN}	Input Resistance	Common Mode Differential Mode			1050 2100		Ω Ω
C_{IN}	Input Capacitance	Differential Mode Common Mode			1.5 13.5		pF pF
V_{ICMR} (Note 9)	Input Common Mode Range	V_S = 3V, V_{OCM} = 1.5V V_S = 5V,V_{OCM} = 2.5V V_S = 10V, V_{OCM} = 5V	● ● ●	–1.5 –2.5 –5		2.1 5.1 12.6	V V V

ELECTRICAL CHARACTERISTICS

LTC6363-1 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
CMRRI (Note 7)	Input Common Mode Rejection Ratio (Input Referred) $\Delta V_{ICM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{ICM} from –1.5V to 2.1V	 ●	90 80	100		dB dB
		V_S = 5V, V_{ICM} from –2.5V to 5.1V	 ●	94 85	100		dB dB
		V_S = 10V, V_{ICM} from –5V to 12.6V	 ●	94 85	100		dB dB
CMRRIO (Note 7)	Output Common Mode Rejection Ratio (Input Referred) $\Delta V_{OCM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{OCM} from 0.5V to 2.5V	 ●	90 85	100		dB dB
		V_S = 5V, V_{OCM} from 0.5V to 4.5V	 ●	90 85	100		dB dB
		V_S = 10V, V_{OCM} from 0.5V to 9.5V	 ●	94 90	100		dB dB
V_{OUT}	Output Voltage, High, Either Output Pin	I_L= 0mA, V_S = 3V I_L = –5mA, V_S = 3V	● ●	2.78 2.74	2.89 2.85		V V
		I_L= 0mA, V_S = 5V I_L = –5mA, V_S = 5V	● ●	4.77 4.73	4.87 4.83		V V
		I_L= 0mA, V_S = 10V I_L = –5mA, V_S = 10V	● ●	9.74 9.66	9.85 9.81		V V
	Output Voltage, Low, Either Output Pin	I_L= 0mA, V_S = 3V I_L = 5mA, V_S = 3V	● ●		0.1 0.17	0.18 0.26	V V
		I_L= 0mA, V_S = 5V I_L = 5mA, V_S = 5V	● ●		0.11 0.15	0.19 0.27	V V
		I_L= 0mA, V_S = 10V I_L = 5mA, V_S = 10V	● ●		0.15 0.2	0.26 0.33	V V
I_{SC}	Output Short-Circuit Current, Either Output Pin, Sinking	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	12 13 14	25 35 40		mA mA mA
	Output Short-Circuit Current, Either Output Pin, Sourcing	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	25 27 30	55 75 90		mA mA mA
f_{-3dB}	–3dB Bandwidth				25		MHz
SR	Slew Rate	Differential $18V_{P-P}$ Output			45		V/µs
FPBW (Note 11)	Full Power Bandwidth	$10V_{P-P}$ Output $18V_{P-P}$ Output			1.4 0.8		MHz MHz
HD2/HD3	2nd/3rd order Harmonic Distortion Single-Ended Input	f = 1kHz, V_{OUT} = $10V_{P-P}$ f = 10kHz, V_{OUT} = $10V_{P-P}$ f = 100kHz, V_{OUT} = $10V_{P-P}$			–122/–125 –114/–105 –90/–82		dBc dBc dBc
t_S	Settling Time to a $8V_{P-P}$ Output Step	0.1% 0.01% 0.0015% (16-Bit) 4ppm (18-Bit)			420 470 500 810		ns ns ns ns

ELECTRICAL CHARACTERISTICS

LTC6363-2 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as (V^+ – V^-). V_{OUTCM} is defined as (V_{+OUT} + $V_{–OUT}$)/2. V_{ICM} is defined as (V_{+IN} + $V_{–IN}$)/2. $V_{OUTDIFF}$ is defined as (V_{+OUT} – $V_{–OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
V_{OSDIFF} (Note 7)	Differential Offset Voltage	V_S = 3V V_{ICM} =1.5V	 ●		25	125 250	µV µV
		V_S = 5V V_{ICM} = 2.5V	 ●		25	125 250	µV µV
		V_S = 10V V_{ICM} = 5V	 ●		25	125 250	µV µV
$\Delta V_{OSDIFF}/\Delta T$ (Notes 7, 8)	Differential Offset Voltage Drift	V_S = 3V V_S = 5V V_S = 10V	● ● ●		0.45 0.45 0.45	1.25 1.25 1.25	µV/°C µV/°C µV/°C
G_{DIFF}	Differential Gain	V_{OUT} = 16V_{P-P}			2		V/V
	Differential Gain Error		 ●		±0.002	±0.0045 ±0.0075	% %
	Differential Gain Nonlinearity				0.5		ppm
	Differential Gain Drift vs Temperature (Note 8)		●		±0.2	±0.5	ppm/°C
e_n (Note 7)	Differential Input Referred Noise Voltage Density	f = 100kHz, (Includes Internal Resistor Noise)			7.55		nV/√Hz
e_{nvocm}	Common Mode Noise Voltage Density	f = 100kHz			20		nV/√Hz
R_{IN}	Input Resistance	Common Mode Differential Mode			1050 1400		Ω Ω
C_{IN}	Input Capacitance	Differential Mode Common Mode			0.6 13.5		pF pF
V_{ICMR} (Note 9)	Input Common Mode Range	V_S = 3V, V_{OCM} = 1.5V V_S = 5V,V_{OCM} = 2.5V V_S = 10V, V_{OCM} = 5V	● ● ●	–0.75 –1.25 –2.5		1.95 4.45 10.7	V V V
CMRRI (Note 7)	Input Common Mode Rejection Ratio (Input Referred) $\Delta V_{ICM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{ICM} from –0.75V to 1.95V	 ●	90 80	106		dB dB
		V_S = 5V, V_{ICM} from –1.25V to 4.45V	 ●	94 85	112		dB dB
		V_S = 10V, V_{ICM} from –2.5V to 10.7V	 ●	94 85	112		dB dB
CMRRIO (Note 7)	Output Common Mode Rejection Ratio (Input Referred) $\Delta V_{OCM}/\Delta V_{OSDIFF}$	V_S = 3V, V_{OCM} from 0.5V to 2.5V	 ●	90 85	106		dB dB
		V_S = 5V, V_{OCM} from 0.5V to 4.5V	 ●	94 90	106		dB dB
		V_S = 10V, V_{OCM} from 0.5V to 9.5V	 ●	94 90	106		dB dB
V_{OUT}	Output Voltage, High, Either Output Pin	I_L= 0mA, V_S = 3V I_L = –5mA, V_S = 3V	● ●	2.79 2.74	2.89 2.84		V V
		I_L= 0mA, V_S = 5V I_L = –5mA, V_S = 5V	● ●	4.78 4.73	4.88 4.83		V V
		I_L= 0mA, V_S = 10V I_L = –5mA, V_S = 10V	● ●	9.76 9.67	9.85 9.81		V V
	Output Voltage, Low, Either Output Pin	I_L= 0mA, V_S = 3V I_L = 5mA, V_S = 3V	● ●		0.09 0.17	0.18 0.26	V V
		I_L= 0mA, V_S = 5V I_L = 5mA, V_S = 5V	● ●		0.1 0.17	0.17 0.26	V V
		I_L= 0mA, V_S = 10V I_L = 5mA, V_S = 10V	● ●		0.13 0.19	0.25 0.33	V V

ELECTRICAL CHARACTERISTICS

LTC6363-2 Only. The ● denotes the specifications which apply over the full operating temperature range, otherwise specifications and typical values are at T_A = 25°C. V^+ = 10V, V^- = 0V, V_{CM} = V_{OCM} = V_{ICM} = 5V, $V_{\overline{SHDN}}$ = open. V_S is defined as ($V^+ - V^-$). V_{OUTCM} is defined as ($V_{+OUT} + V_{-OUT}$)/2. V_{ICM} is defined as ($V_{+IN} + V_{-IN}$)/2. $V_{OUTDIFF}$ is defined as ($V_{+OUT} - V_{-OUT}$).

SYMBOL	PARAMETER	CONDITIONS		MIN	TYP	MAX	UNITS
I_{SC}	Output Short-Circuit Current, Either Output Pin, Sinking	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	12 13 14	25 35 40		mA mA mA
	Output Short-Circuit Current, Either Output Pin, Sourcing	V_S = 3V, Output Shorted to 1.5V V_S = 5V, Output Shorted to 2.5V V_S = 10V, Output Shorted to 5V	● ● ●	25 27 30	55 75 90		mA mA mA
f_{-3dB}	–3dB Bandwidth				15		MHz
SR	Slew Rate	Differential 18V_{P-P} Output			46		V/µs
FPBW (Note 11)	Full Power Bandwidth	10V_{P-P} Output 18V_{P-P} Output			1.4 0.8		MHz MHz
HD2/HD3	2nd/3rd order Harmonic Distortion Single-Ended Input	f = 1kHz, V_{OUT} = 10V_{P-P} f = 10kHz, V_{OUT} = 10V_{P-P} f = 100kHz, V_{OUT} = 10V_{P-P}			–116/–123 –114/–103 –92/–81		dBc dBc dBc
t_S	Settling Time to a 8V_{P-P} Output Step	0.1% 0.01% 0.0015% (16-Bit) 4ppm (18-Bit)			430 470 480 830		ns ns ns ns

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: Absolute Maximum input voltage for the LTC6363-0.5/LTC6363-1/LTC6363-2 is conservatively calculated assuming the worst case output voltage. For details on this calculation refer to the Input Pin Protection section.

Note 3: In the LTC6363, if input pins (+IN, –IN, V_{OCM} and $\overline{SHDN}$) must exceed either supply voltage, the input current must be limited to less than 10mA. Additionally, if the differential input voltage exceeds 1.4V, the input current must be limited to less than 10mA. In the LTC6363-0.5/LTC6363-1/LTC6363-2 versions, the same limits apply to V_{OCM}, $\overline{SHDN}$ and the internal amplifier's inputs. Please see the Input Common Mode Voltage Range and Input Pin Protection sections for additional details on calculating the input voltages on the internal amplifier's inputs while in a feedback configuration.

Note 4: A heat sink may be required to keep the junction temperature below the absolute maximum rating when the output is shorted indefinitely.

Note 5: The LTC6363I and LTC6363I-0.5/LTC6363I-1/LTC6363I-2 are guaranteed functional over the operating temperature range of –40°C to 85°C. The LTC6363H and LTC6363H-0.5/LTC6363H-1/LTC6363H-2 are guaranteed functional over the operating temperature range of –40°C to 125°C.

Note 6: The LTC6363I and LTC6363I-0.5/LTC6363I-1/LTC6363I-2 are guaranteed to meet specified performance from –40°C to 85°C. The LTC6363H and LTC6363H-0.5/LTC6363H-1/LTC6363H-2 are guaranteed to meet specified performance from –40°C to 125°C.

Note 7: Differential offset voltage, differential offset voltage drift, and PSRR are referred to the internal amplifier's input (summing junction) to allow for direct comparison of gain blocks with discrete amplifiers. CMRRI, CMRRIO and voltage noise are referenced to the LTC6363-0.5, LTC6363-1 and LTC6363-2's input pins. Refer to the Test Circuits section for more details.

Note 8: Maximum differential offset voltage drift, input offset current drift and differential gain drift are determined by sampling typical parts. Drift is not guaranteed by test or QA sampled at this value.

Note 9: Input common mode range is tested by verifying that at the limits stated in the Electrical Characteristics table, the differential offset (V_{OSDIFF}) and common mode offset (V_{OSCM}) have not deviated by more than ±200µV and ±10mV respectively compared to the V_{ICM} = 5V (at V_S = 10V), V_{ICM} = 2.5V (at V_S = 5V) and V_{ICM} = 1.5V (at V_S = 3V) cases.

Output common mode range is tested by verifying that at the limits stated in the Electrical Characteristics table, the common mode offset (V_{OSCM}) has not deviated by more than ±15mV compared to the V_{OCM} = 5V (at V_S = 10V), V_{OCM} = 2.5V (at V_S = 5V) and V_{OCM} = 1.5V (at V_S = 3V) cases.

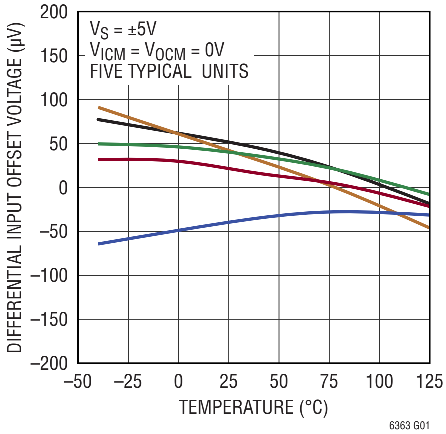
Note 10: Input bias current is defined as the average of the input currents flowing into the input pins (–IN and +IN). Input Offset current is defined as the difference between the input bias currents ($I_{OS} = I_B^+ - I_B^-$).

Note 11: Full power bandwidth is calculated from the slew rate.

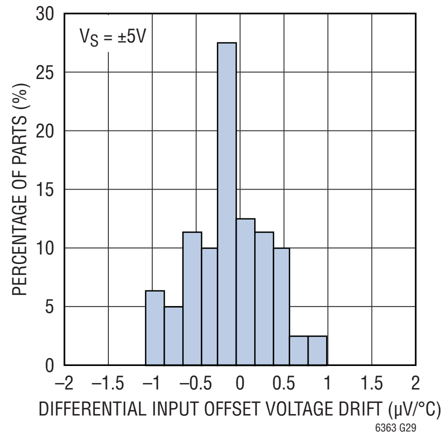
$$FPBW = SR/(2 \cdot \pi \cdot V_P)$$

TYPICAL PERFORMANCE CHARACTERISTICS Applicable to all parts in the LTC6363 family.

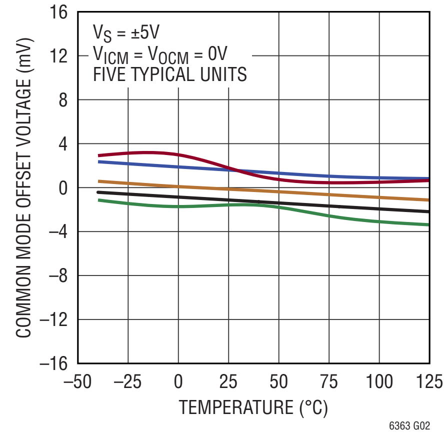
Differential Input Offset Voltage vs Temperature



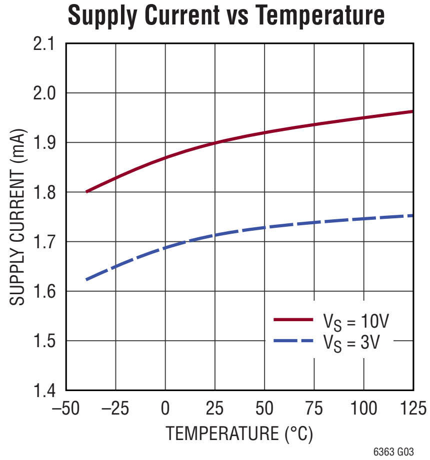
Typical Distribution of Differential Input Offset Voltage Drift



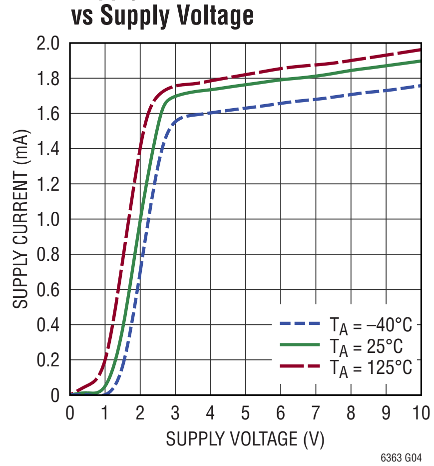
Common Mode Offset Voltage vs Temperature



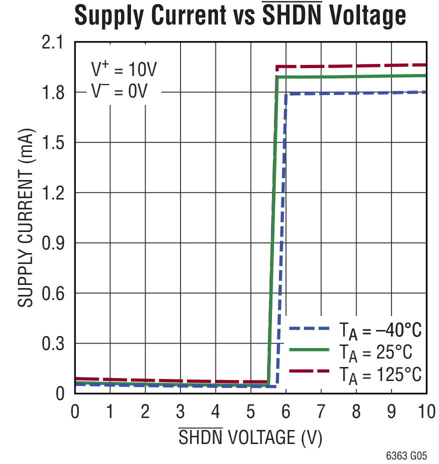
Supply Current vs Temperature



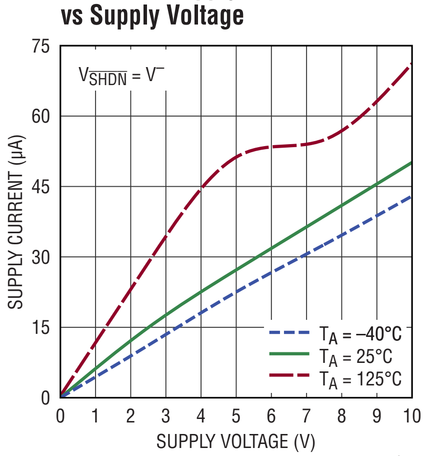
Supply Current vs Supply Voltage



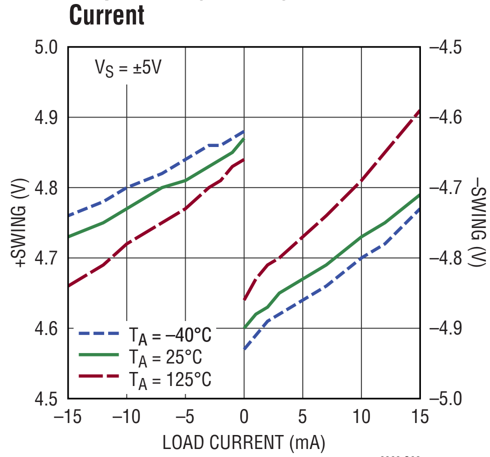
Supply Current vs SHDN Voltage



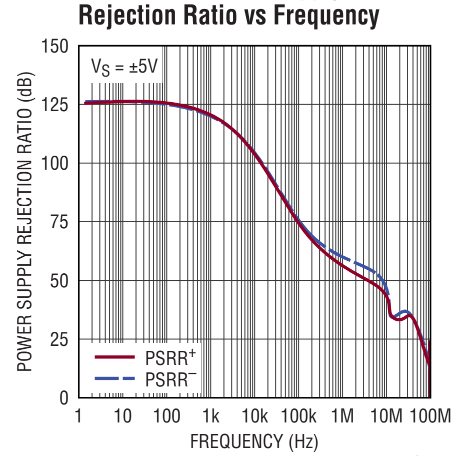
Shutdown Supply Current vs Supply Voltage



Output Voltage Swing vs Load Current

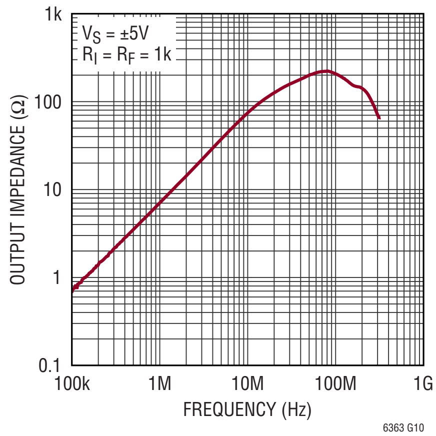


Differential Power Supply Rejection Ratio vs Frequency

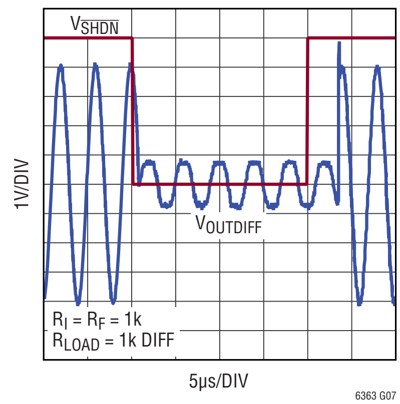


TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363 only.

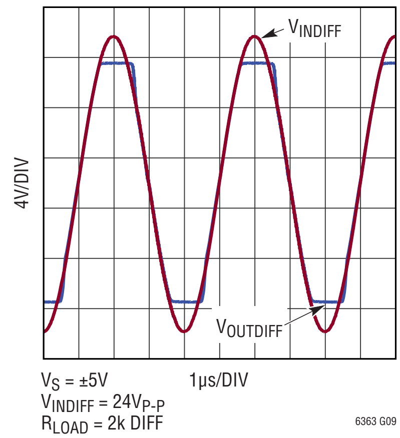
Differential Output Impedance vs Frequency



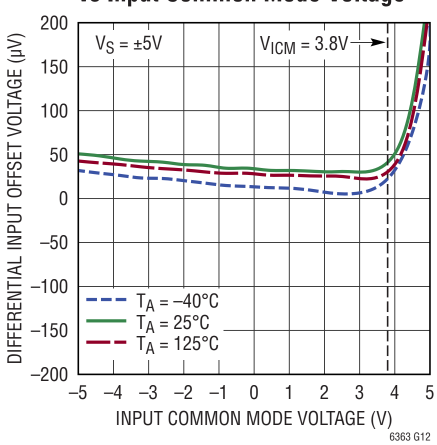
Turn-On and Turn-Off Transient Response



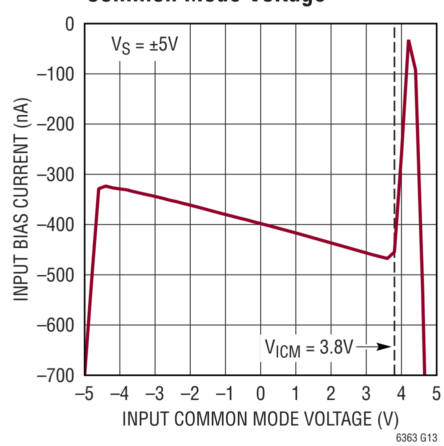
Output Overdrive Recovery



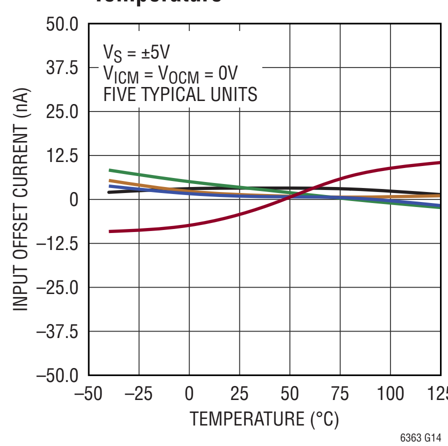
Differential Input Offset Voltage vs Input Common Mode Voltage



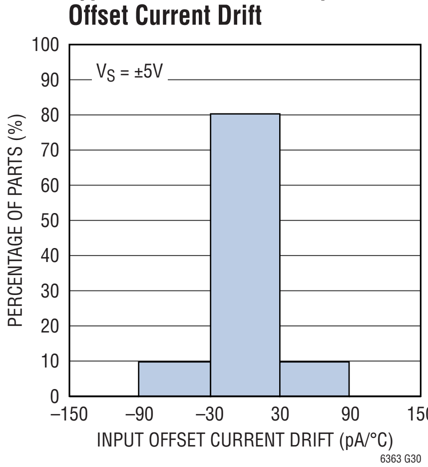
Input Bias Current vs Input Common Mode Voltage



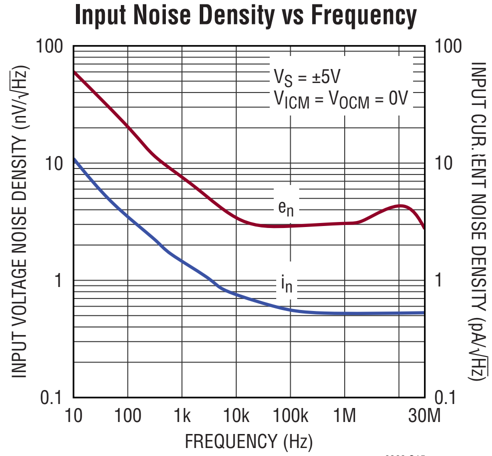
Input Offset Current vs Temperature



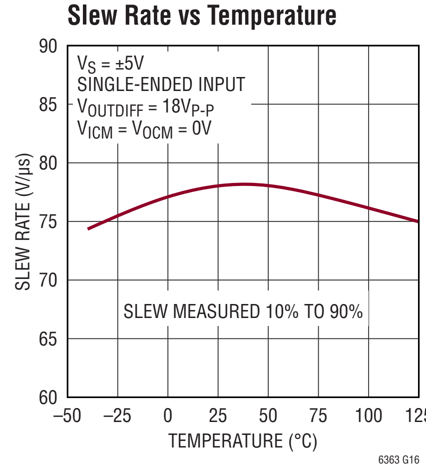
Typical Distribution of Input Offset Current Drift



Input Noise Density vs Frequency

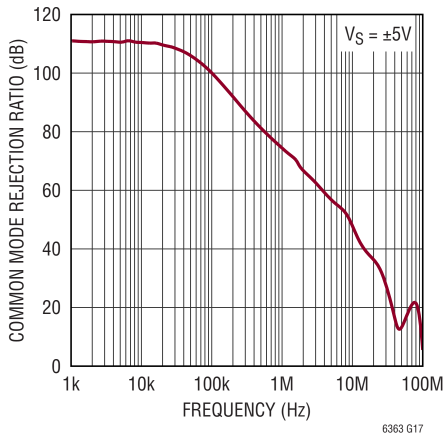


Slew Rate vs Temperature

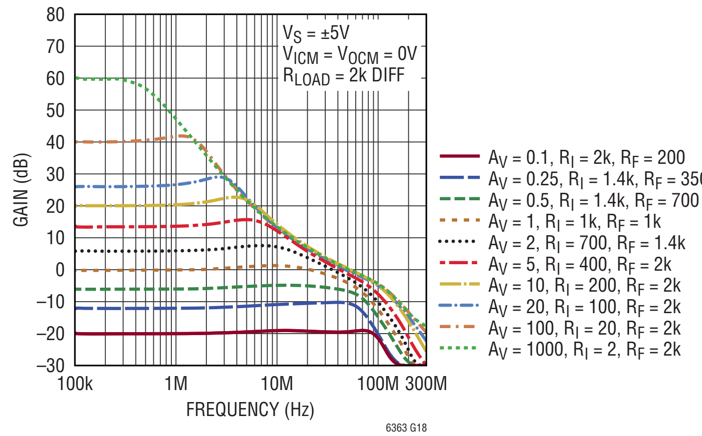


TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363 only.

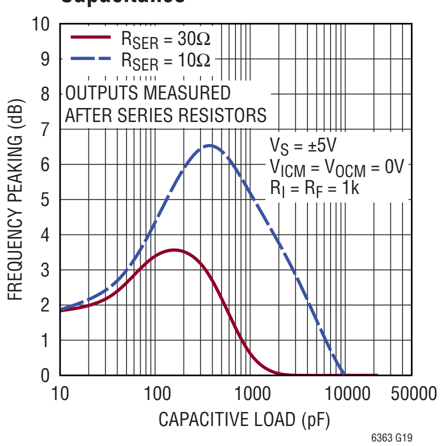
Input Common Mode Rejection Ratio vs Frequency



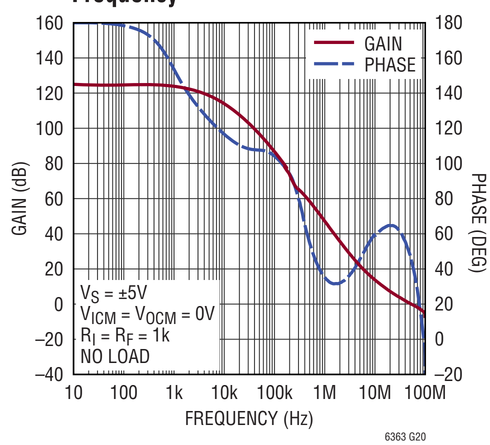
Frequency Response vs Closed-Loop Gain



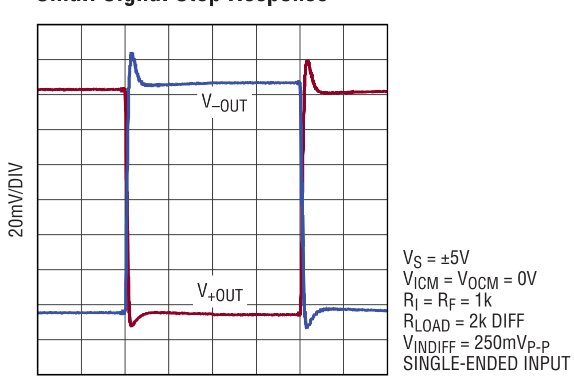
Frequency Peaking vs Load Capacitance



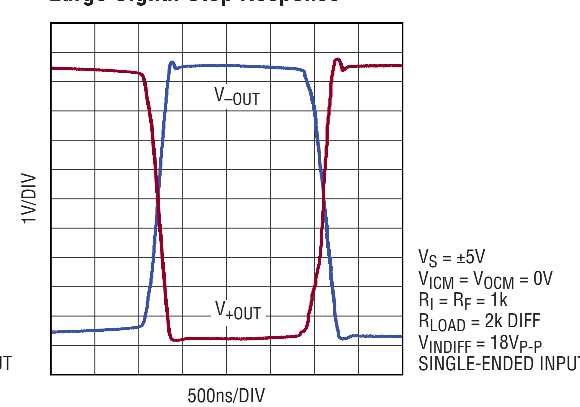
Open-Loop Gain and Phase vs Frequency



Small Signal Step Response

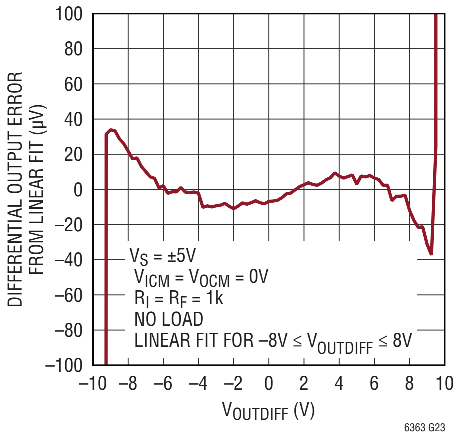


Large Signal Step Response

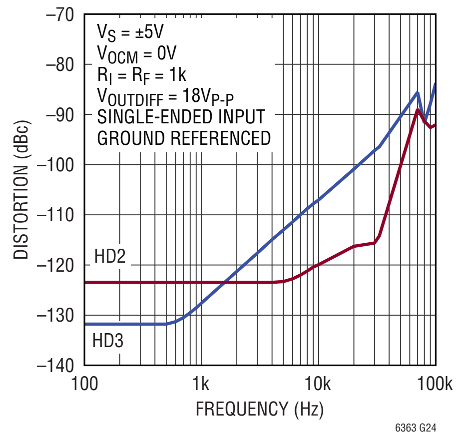


TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363 only.

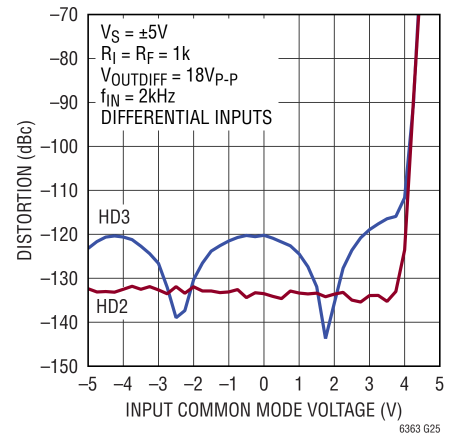
DC Linearity



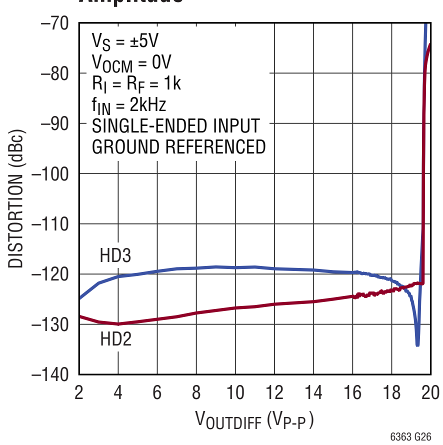
Harmonic Distortion vs Frequency



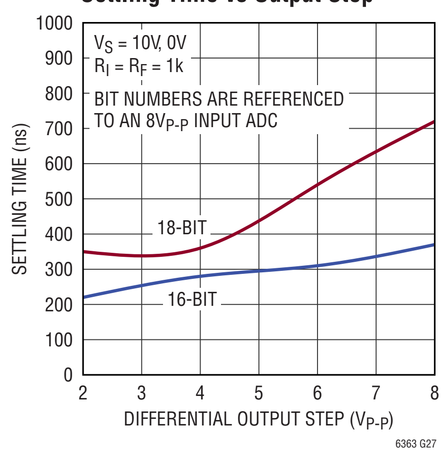
Harmonic Distortion vs Input Common Mode Voltage



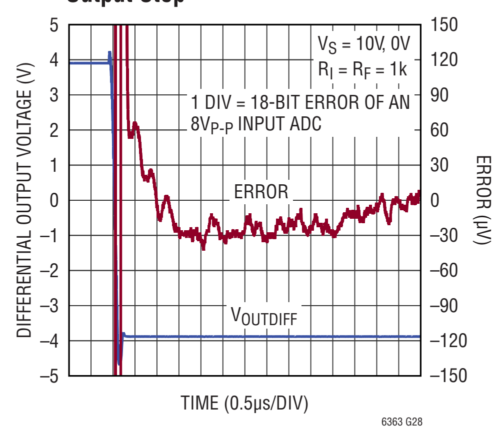
Harmonic Distortion vs Output Amplitude



Settling Time vs Output Step



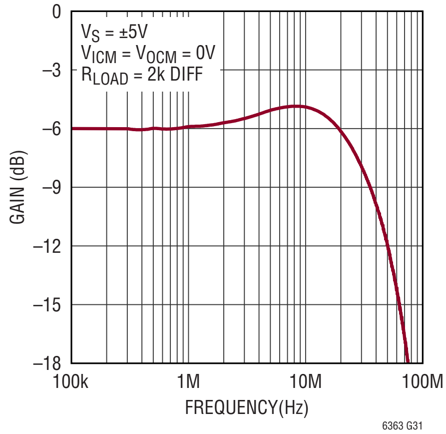
Settling Time to 8V_{P-P} Output Step



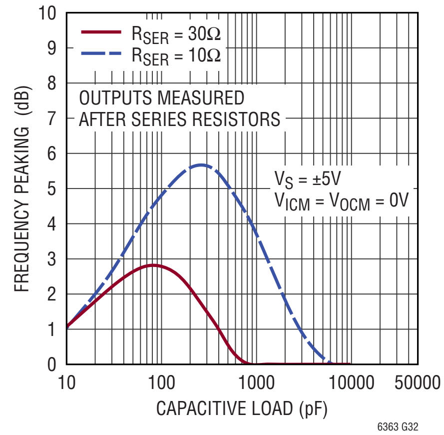
6363fb

TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363-0.5 only.

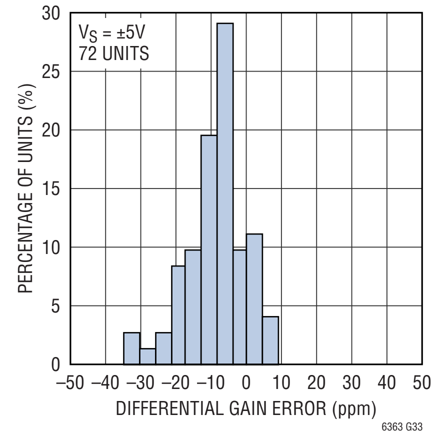
Gain vs Frequency



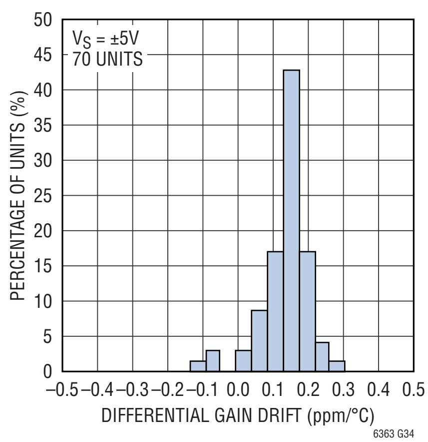
Frequency Peaking vs Load Capacitance



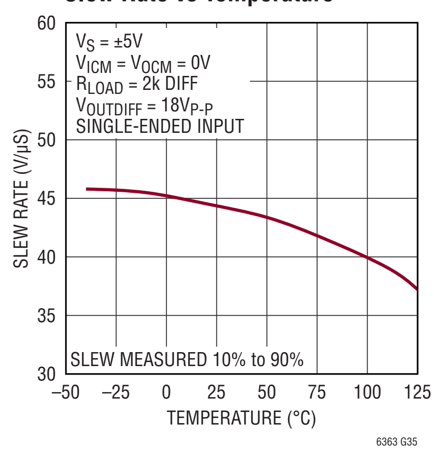
Typical Distribution of Differential Gain Error



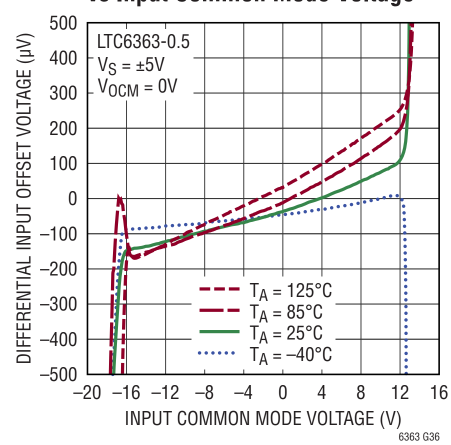
Typical Distribution of Differential Gain Drift



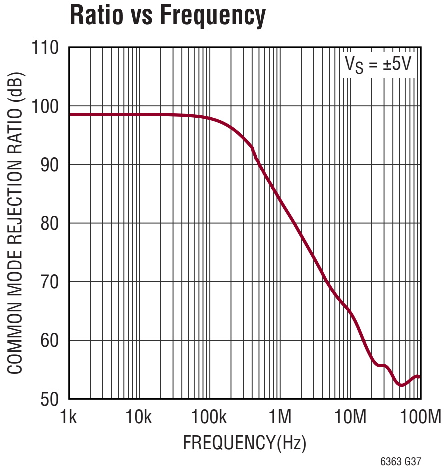
Slew Rate vs Temperature



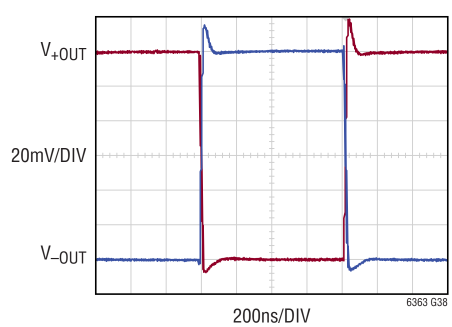
Differential Input Offset Voltage vs Input Common Mode Voltage



Input Common Mode Rejection Ratio vs Frequency

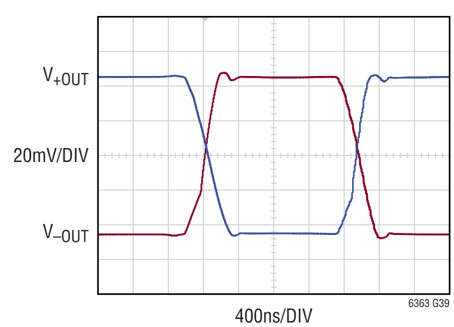


Small Signal Step Response



V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = 500mV_{P-P}
SINGLE-ENDED

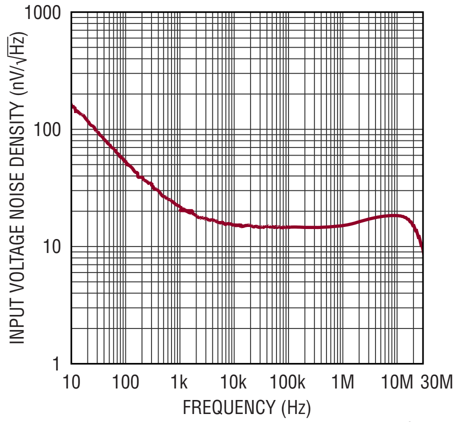
Large Signal Step Response



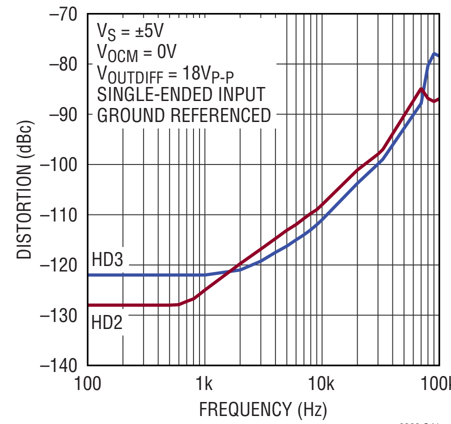
V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = 36V_{P-P}
SINGLE-ENDED INPUT

TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363-0.5 only.

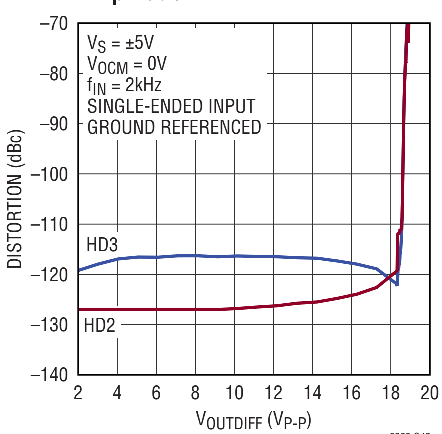
Input Noise Voltage Density vs Frequency



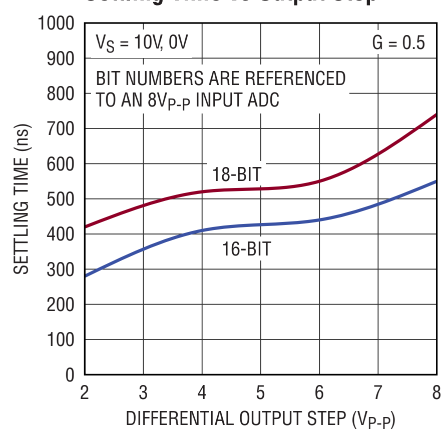
Harmonic Distortion vs Frequency



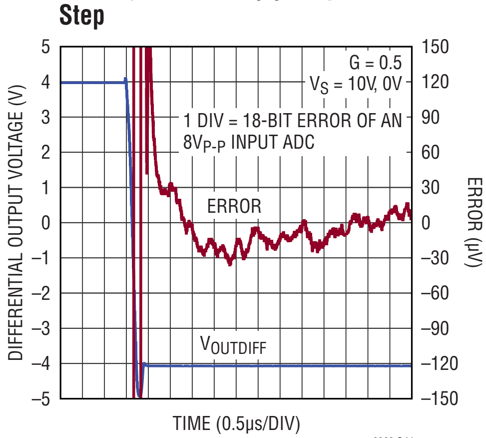
Harmonic Distortion vs Output Amplitude



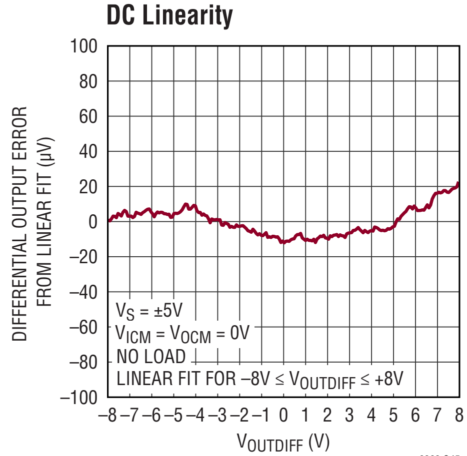
Settling Time vs Output Step



Settling Time to 8VP-P Output Step



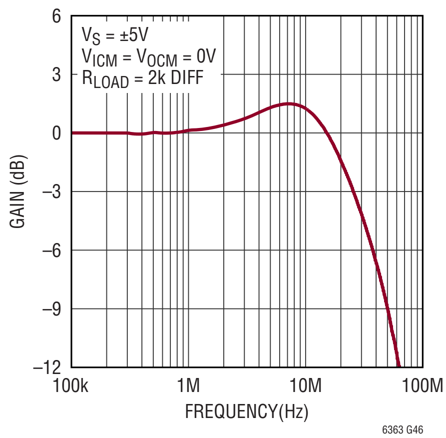
DC Linearity



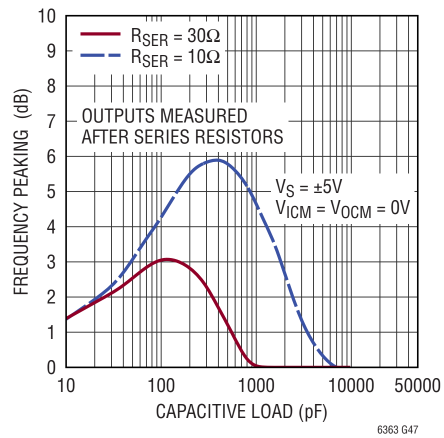
TYPICAL PERFORMANCE CHARACTERISTICS

Applicable to the LTC6363-1 only.

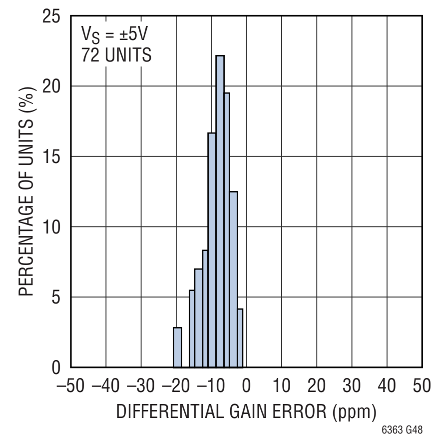
Gain vs Frequency



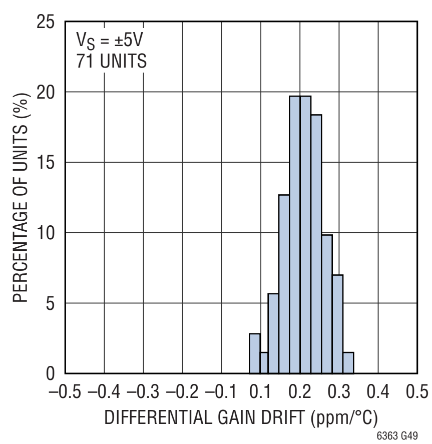
Frequency Peaking vs Load Capacitance



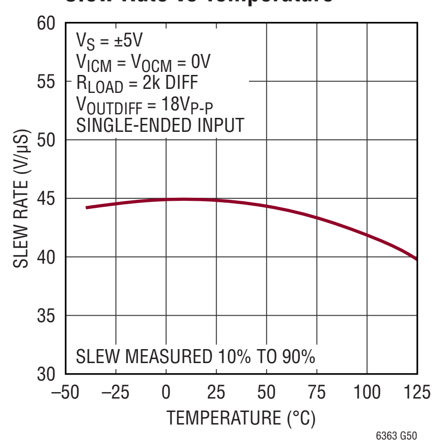
Typical Distribution of Differential Gain Error



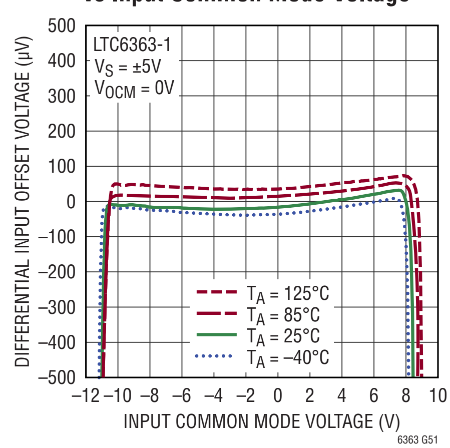
Typical Distribution of Differential Gain Drift



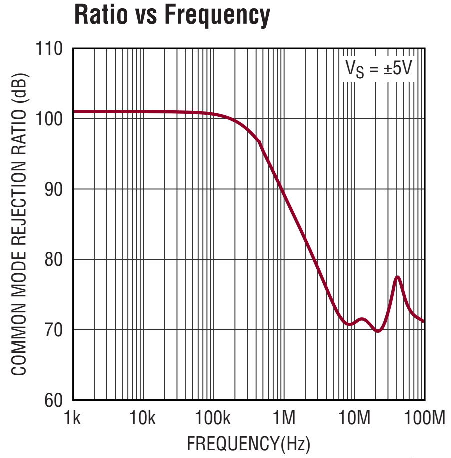
Slew Rate vs Temperature



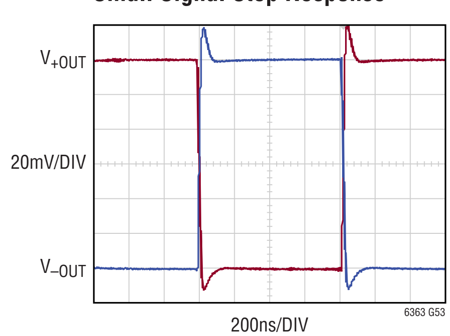
Differential Input Offset Voltage vs Input Common Mode Voltage



Input Common Mode Rejection Ratio vs Frequency

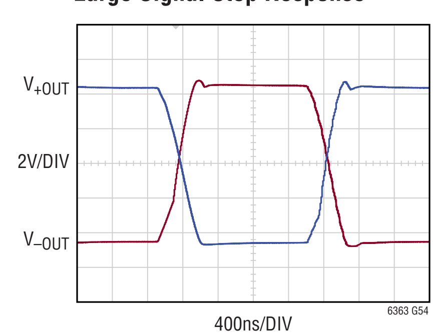


Small Signal Step Response



V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = 250mV_{P-P}
SINGLE-ENDED INPUT

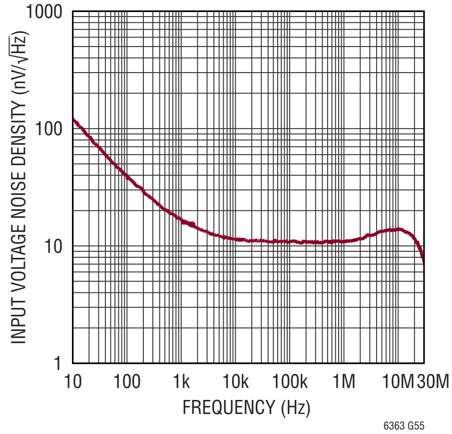
Large Signal Step Response



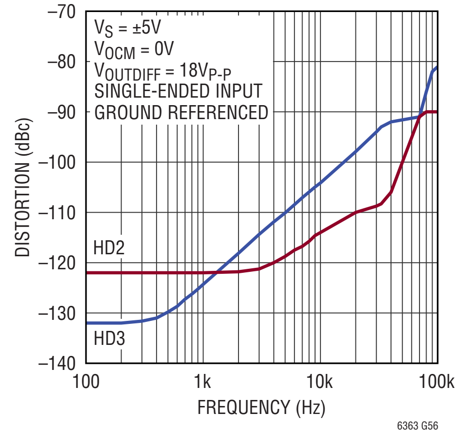
V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = 18V_{P-P}
SINGLE-ENDED INPUT

TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363-1 only.

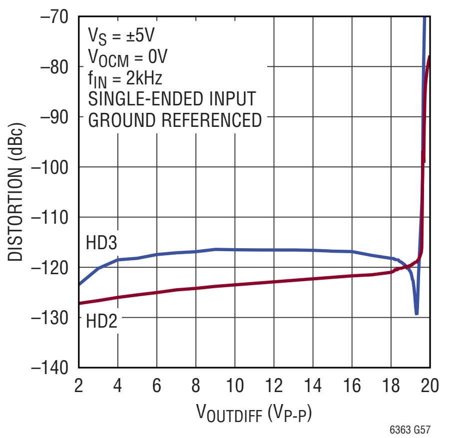
Input Noise Voltage Density vs Frequency



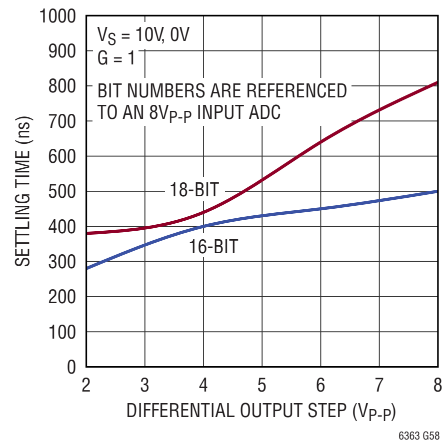
Harmonic Distortion vs Frequency



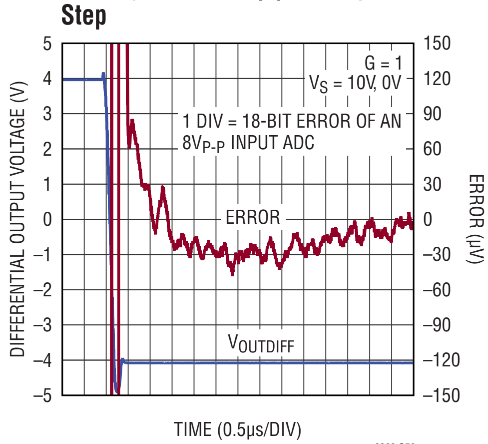
Harmonic Distortion vs Output Amplitude



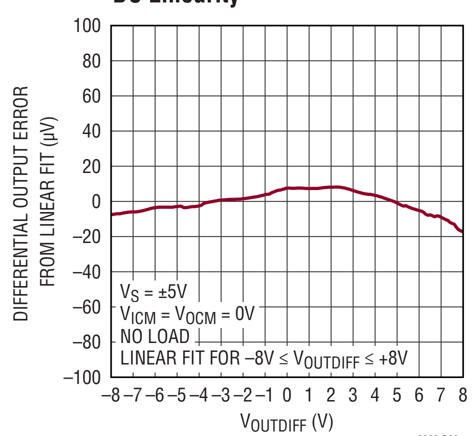
Settling Time vs Output Step



Settling Time to $8V_{P-P}$ vs Output Step

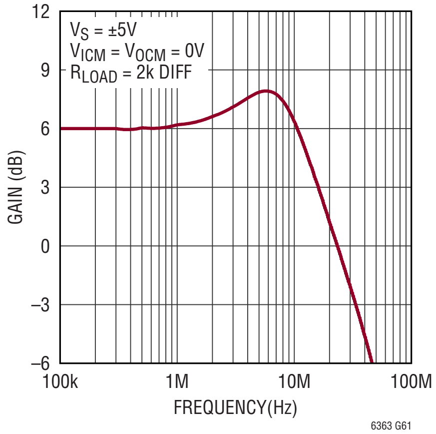


DC Linearity

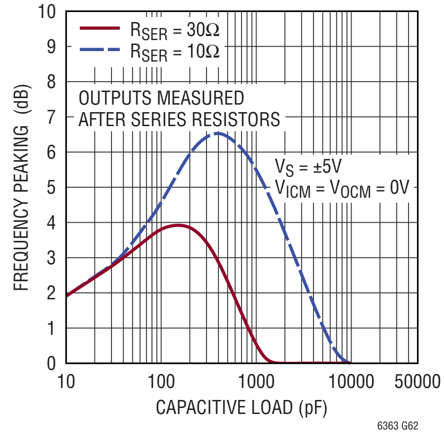


TYPICAL PERFORMANCE CHARACTERISTICS **Applicable to the LTC6363-2 only.**

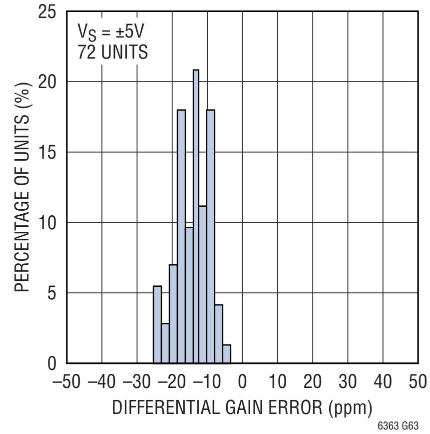
Gain vs Frequency



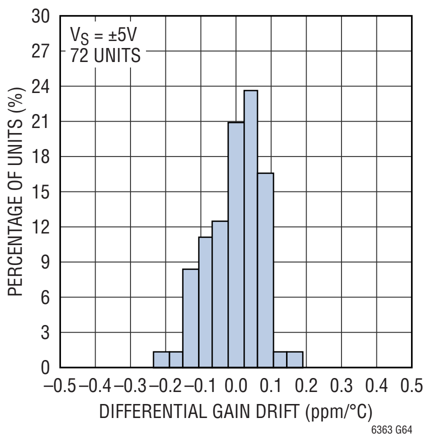
Frequency Peaking vs Load Capacitance



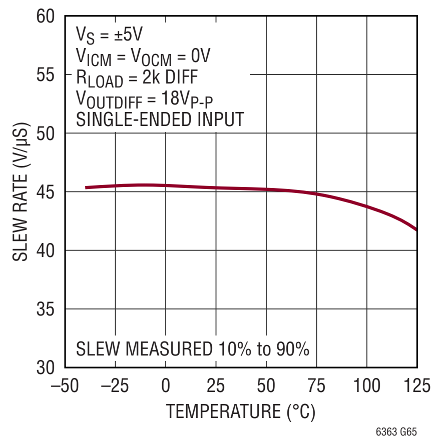
Typical Distribution of Differential Gain Error



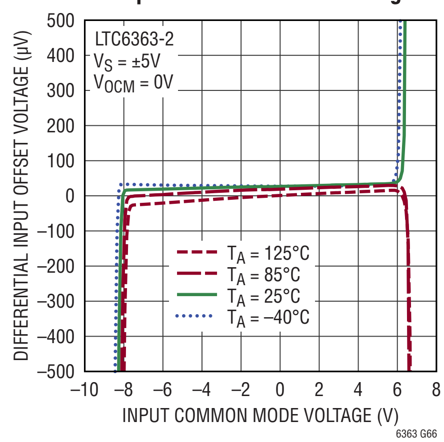
Typical Distribution of Differential Gain Drift



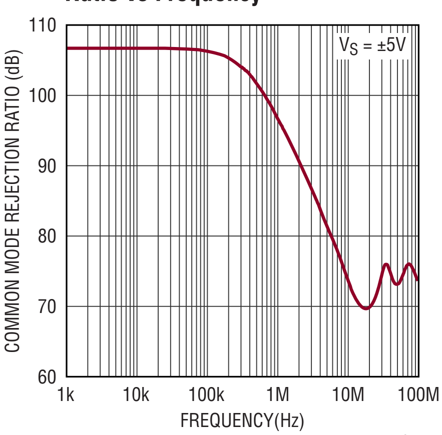
Slew Rate vs Temperature



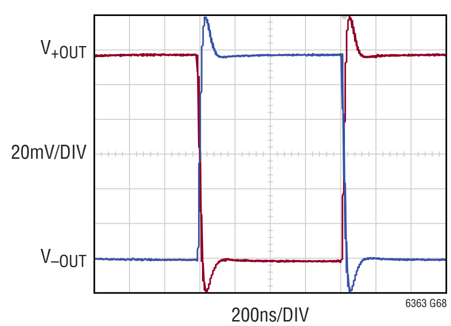
Differential Input Offset Voltage vs Input Common Mode Voltage



Input Common Mode Rejection Ratio vs Frequency

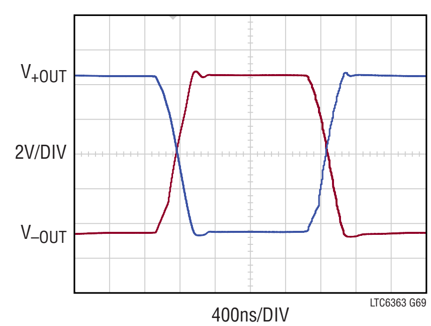


Small Signal Step Response



V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = $125mV_{P-P}$
SINGLE-ENDED INPUT

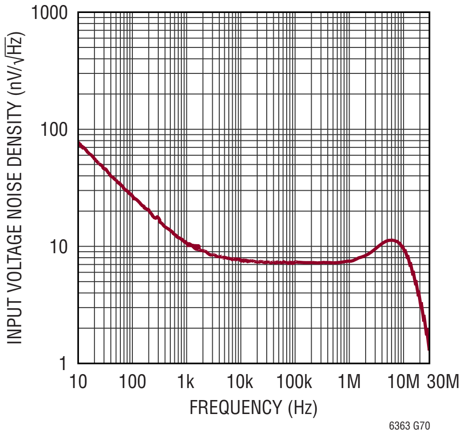
Large Signal Step Response



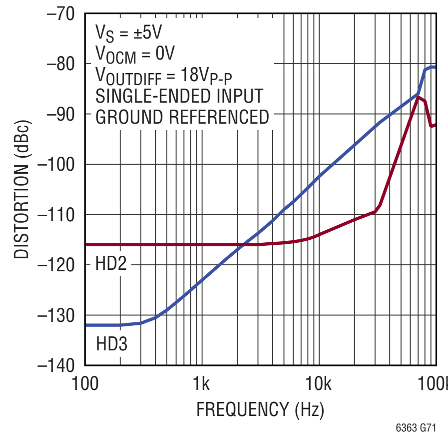
V_S = ±5V
V_{ICM} = V_{OCM} = 0V
R_{LOAD} = 2k DIFF
V_{INDIFF} = $9V_{P-P}$
SINGLE-ENDED INPUT

TYPICAL PERFORMANCE CHARACTERISTICS Applicable to the LTC6363-2 only.

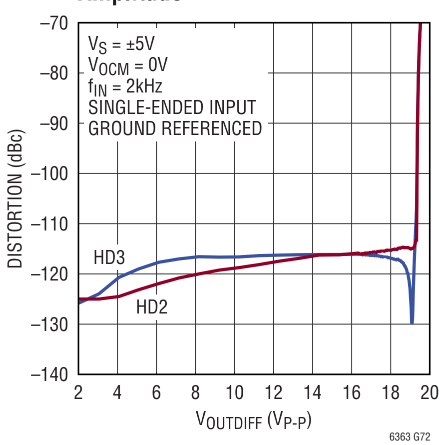
Input Noise Voltage Density vs Frequency



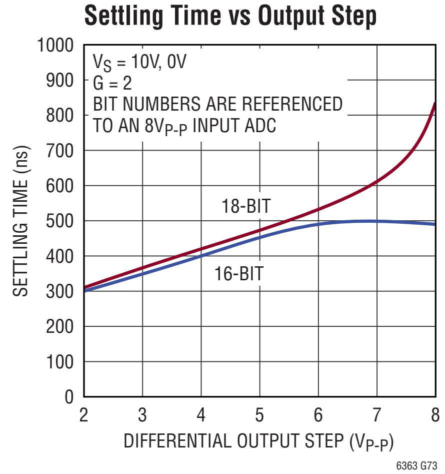
Harmonic Distortion vs Frequency



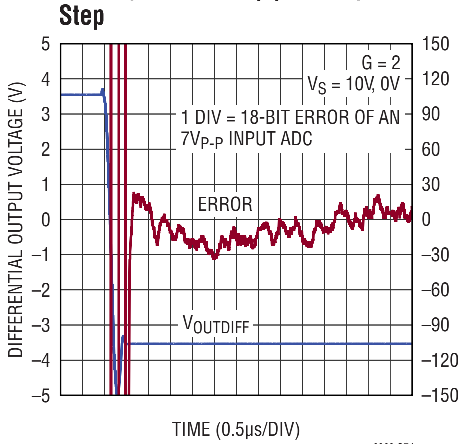
Harmonic Distortion vs Output Amplitude



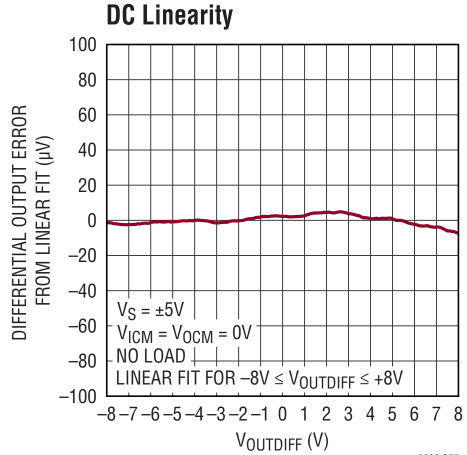
Settling Time vs Output Step



Settling Time to $7V_{P-P}$ vs Output Step



DC Linearity



PIN FUNCTIONS

–IN (Pin 1): Inverting Input of Amplifier. In the fixed-gain LTC6363-0.5/LTC6363-1/LTC6363-2 versions, this pin connects to a precision, on-chip resistor R_I.

V_{OCM} (Pin 2): Output Common Mode Reference Voltage. Voltage applied to this pin sets the output common mode voltage level. If left floating, an internal resistor divider creates a default voltage approximately halfway between V^+ and V^-. The V_{OCM} pin should be decoupled to ground with a minimum of 0.1µF.

V^+ (Pin 3): Positive Power Supply. Operational supply range is 2.8V to 11V when $V^- = 0V$.

+OUT (Pin 4): Positive Output Pin. Output capable of swinging rail-to-rail.

–OUT (Pin 5): Negative Output Pin. Output capable of swinging rail-to-rail.

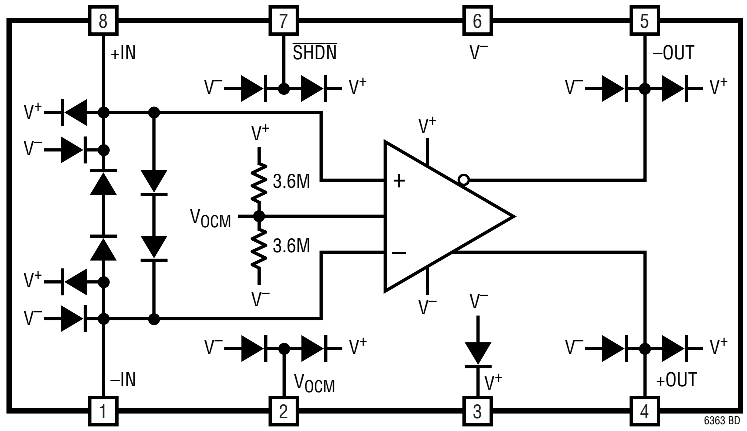
V^- (Pin 6/Exposed Pad Pin 9): Negative Power Supply. Negative supply can be 0V, or taken negative as long as $2.8V \le (V^+ – V^-) \le 11V$.

$\overline{SHDN}$ (Pin 7): When the $\overline{SHDN}$ pin is floating or driven high, the LTC6363 family is in the normal (active) operating mode. When $\overline{SHDN}$ pin is connected to V^- or driven low, the part is disabled and draws approximately 20µA of supply current ($V_S = 3V$).

+IN (Pin 8): Noninverting Input of Amplifier. In the fixed LTC6363-0.5/LTC6363-1/LTC6363-2 versions, this pin connects to a precision,on-chip resistor R_I.

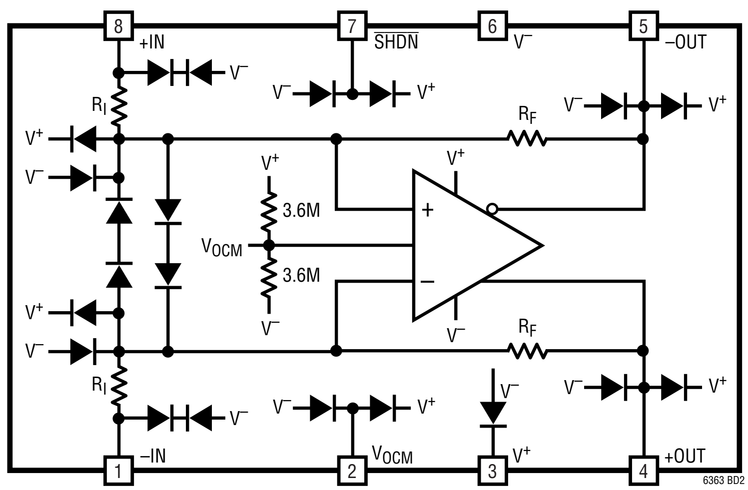
BLOCK DIAGRAMS

LTC6363



LTC6363-0.5/ LTC6363-1/ LTC6363-2

PART	R_I (Ω)	R_F (Ω)
LTC6363-0.5	1400	700
LTC6363-1	1050	1050
LTC6363-2	700	1400



APPLICATIONS INFORMATION

Functional Description

The LTC6363 family consists of four fully differential, low power, low noise, precision amplifiers. The LTC6363 is an unconstrained, fully differential amplifier, typically used with four external resistors. The LTC6363-0.5, LTC6363-1, and LTC6363-2 (gains of 0.5, 1, and 2 respectively) are fully-differential fixed gain blocks featuring precision, laser trimmed, matched internal resistors for accurate, stable gain and excellent CMRR. The entire LT6363 family is optimized to convert a fully differential or single-ended signal to a low impedance, balanced differential output suitable for driving high performance, low power differential sigma-delta or SAR ADCs. The balanced differential nature of the amplifier also provides even-order harmonic distortion cancellation, and low susceptibility to common mode noise (e.g. power supply noise).

The outputs of the LTC6363 family are capable of swinging rail-to-rail and can source up to 90mA or sink up to 40mA of current. The LTC6363 family is optimized for high bandwidth and low power applications. Load capacitances above 50pF to ground or 25pF differentially should be decoupled with 10Ω to 50Ω of series resistance from each output to prevent oscillation or ringing.

$\overline{\text{SHDN}}$ Pin

The LTC6363 family has a $\overline{\text{SHDN}}$ pin which, when tied to V^- or driven to below V_{IL}, will shut down amplifier operation such that only 20µA (at V_S = 3V) to 70µA (at V_S = 10V) is drawn from the supplies. Pull-down circuitry should be capable of sinking at least 12µA to guarantee complete shutdown over all conditions. For normal amplifier operation, the $\overline{\text{SHDN}}$ pin should be left floating or tied to V^+ or driven to above V_{IH}.

General Amplifier Applications

In Figure 1, the gain to $V_{OUTDIFF}$ from V_{INP} and V_{INM} is given by:

$$V_{OUTDIFF} = V_{+OUT} - V_{-OUT} \approx \left(\frac{R_F}{R_I}\right) \bullet (V_{INP} - V_{INM})$$

Note from the previous equation, the differential output voltage ($V_{+OUT} - V_{-OUT}$) is independent of input and output common mode voltages, or the voltage at the common mode pin. This makes the LTC6363 family ideally suited for pre-amplification, pre-attenuation, level shifting and conversion of single-ended signals to differential output signals for driving differential input ADCs or other devices.

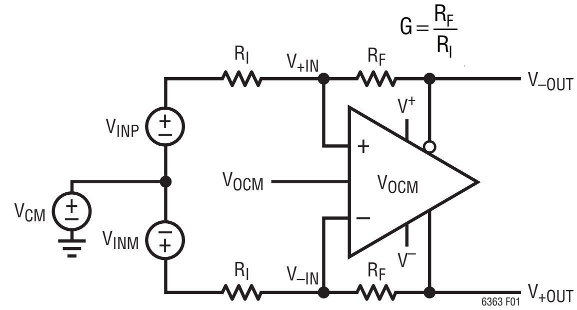


Figure 1. Definitions and Terminology

Output Common Mode and V_{OCM} Pin

The output common mode voltage is defined as the average of the two outputs:

$$V_{OUTCM} = \left(\frac{V_{+OUT} + V_{-OUT}}{2}\right) = V_{OCM}$$

As the equation shows, the output common mode voltage is independent of the input common mode voltage, and is instead determined by the voltage on the V_{OCM} pin, by means of an internal common mode feedback loop.

The V_{OCM} input connects to the base of a PNP transistor and an internal resistor divider network. If the V_{OCM} pin is left open, the resistor divider creates a default voltage approximately halfway between V^+ and V^-. The V_{OCM} pin can be overdriven to another voltage if desired for greater accuracy or flexibility. For example, when driving an ADC, if the ADC makes a reference available for setting the common mode voltage, it can be directly tied to the V_{OCM} pin, as long as the ADC is capable of driving the 1.8M input resistance presented by the V_{OCM} pin. The Electrical Characteristics table specifies the valid range that can be applied to the V_{OCM} pin (V_{OUTCMR}).

Input Common Mode Voltage Range

For all versions of the LTC6363, the input common mode voltage range, V_{ICMR}, specification refers to the voltage at the input pins of the part. The input common mode voltage range of the LTC6363-0.5, LTC6363-1 and LTC6363-2 are extended beyond that of the LTC6363 due to the resistor divider action of the on-chip resistors.

APPLICATIONS INFORMATION

For LTC6363-0.5, LTC6363-1 and LTC6363-2 applications where the input is fully differential, the common mode voltage at the amplifier summing junction can be calculated using the following equation:

$$V_{ICM\_AMP} = V_{ICM} \bullet \left(\frac{G}{G+1}\right) + V_{OCM} \bullet \left(\frac{1}{G+1}\right)$$

Where G is the gain, V_{ICM_AMP} is the common mode voltage at the amplifier's summing junction, V_{OCM} is the voltage applied to the V_{OCM} pin and V_{ICM} is the common mode voltage applied to the input pins of the LTC6363-0.5, LTC6363-1 or LTC6363-2. This equation is more useful when solved for V_{ICM}:

Table 1. Valid Input Common Mode Voltage Range for Fixed-Gain Versions (Differential Inputs)

PART VERSION	GAIN	SUPPLY (V)	V_{OCM} (V)	V_{ICM} (V)
LTC6363-0.5	0.5	3	0.5	–1 to 4.4
LTC6363-0.5	0.5	3	1.5	–3 to 2.4
LTC6363-0.5	0.5	3	2.5	–5 to 0.4
LTC6363-0.5	0.5	5	0.5	–1 to 10.4
LTC6363-0.5	0.5	5	2.5	–5 to 6.4
LTC6363-0.5	0.5	5	4.5	–9 to 2.4
LTC6363-0.5	0.5	10	0.5	–1 to 25.4
LTC6363-0.5	0.5	10	5	–10 to 16.4
LTC6363-0.5	0.5	10	9.5	–19 to 7.4
LTC6363-1	1	3	0.5	–0.5 to 3.1
LTC6363-1	1	3	1.5	–1.5 to 2.1
LTC6363-1	1	3	2.5	–2.5 to 1.1
LTC6363-1	1	5	0.5	–0.5 to 7.1
LTC6363-1	1	5	2.5	–2.5 to 5.1
LTC6363-1	1	5	4.5	–4.5 to 3.1
LTC6363-1	1	10	0.5	–0.5 to 17.1
LTC6363-1	1	10	5	–5 to 12.6
LTC6363-1	1	10	9.5	–9.5 to 8.1
LTC6363-2	2	3	0.5	–0.25 to 2.45
LTC6363-2	2	3	1.5	–0.75 to 1.95
LTC6363-2	2	3	2.5	–1.25 to 1.45
LTC6363-2	2	5	0.5	–0.25 to 5.45
LTC6363-2	2	5	2.5	–1.25 to 4.45
LTC6363-2	2	5	4.5	–2.25 to 3.45
LTC6363-2	2	10	0.5	–0.25 to 12.95
LTC6363-2	2	10	5	–2.5 to 10.7
LTC6363-2	2	10	9.5	–4.75 to 8.45

$$V_{ICM} = \frac{V_{ICM\_AMP} \bullet (G+1) - V_{OCM}}{G}$$

The minimum and maximum valid input common mode voltage can be computed using this equation by substituting for V_{ICM_AMP} the minimum and maximum V_{ICMR} specification of the LTC6363: V^- and V^+ –1.2V respectively. Table 1 lists various solutions to this equation.

The equation changes slightly if the LTC6363-0.5, LTC6363-1 or LTC6363-2 input is single ended since now the input common mode voltage at the amplifiers's summing junction is also a function of the input signal V_{INP} (where V_{INM} = 0):

$$V_{ICM} = \frac{V_{ICM\_AMP} \bullet (G+1) - V_{OCM}}{G} - \frac{V_{INP}}{2}$$

In summary, the common mode voltage at the input pins of the LTC6363-0.5/LTC6363-1/LTC6363-2 (V_{ICM}) is valid if it lies within the following range:

$$\frac{V^-(G+1) - V_{OCM}}{G} \le V_{ICM} \le \frac{(V^+ - 1.2)(G+1) - V_{OCM}}{G}$$

For Differential Inputs

$$\frac{V^-(G+1) - V_{OCM}}{G} - \frac{V_{INP}}{2} \le V_{ICM}$$

$$\le \frac{(V^+ - 1.2)(G+1) - V_{OCM}}{G} - \frac{V_{INP}}{2}$$

For Single-Ended Inputs ($V_{INM} = 0$)

Input Pin Protection

The absolute maximum input current of the LTC6363 amplifier input pins is ±10mA, as specified in the Absolute Maximum Ratings. The amplifier inside the LTC6363-0.5/LTC6363-1/LTC6363-2 also has this same limitation but cannot be directly observed. Absolute maximum input voltage is specified for the LTC6363-0.5/LTC6363-1/LTC6363-2 using the following equations:

$$V^- - 10mA \bullet R_I - \frac{(V_{OUT} - V^- + 0.3)}{G} - 0.3 \text{ to}$$

$$V^+ + 10mA \bullet R_I + \frac{(V^+ + 0.3 - V_{OUT})}{G} + 0.3$$

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The output voltage is a variable in these equations because it affects how much current is flowing in R_F. This current also flows in R_I and increases the voltage which can be applied to the input without exceeding the 10mA limit on the amplifier's inputs. The absolute maximum input voltage is specified conservatively, assuming the output voltage is at V^+ for the positive limit and V^- for the negative limit. This simplifies the equations:

$$V^- - 10mA \bullet R_I - 0.3 \bullet \left(1 + \frac{1}{G}\right) \text{ to}$$

$$V^+ + 10mA \bullet R_I + 0.3 \bullet \left(1 + \frac{1}{G}\right)$$

Input Impedance and Loading Effects

The low frequency input impedance looking into the V_{INP} or V_{INM} input of Figure 1 depends on how the inputs are driven. For fully differential input sources ($V_{INP} = -V_{INM}$), the input impedance seen at either input is simply:

$$R_{INP} = R_{INM} = R_I$$

For single-ended inputs, due to the signal imbalance at the input, the input impedance increases over the balanced differential case. The input impedance looking into either input is:

$$R_{INP} = R_{INM} = \frac{R_I}{1 - \left(\frac{1}{2}\right) \bullet \left(\frac{R_F}{R_I + R_F}\right)}$$

Input signal sources with non-zero impedances can also cause feedback imbalance between the pair of feedback networks. For the best performance, it is recommended that the input source impedance be compensated. If impedance matching is required at the source, a termination resistor R1 should be chosen (see Figure 2) such that:

$$R1 = \frac{R_{INM} \bullet R_S}{R_{INM} - R_S}$$

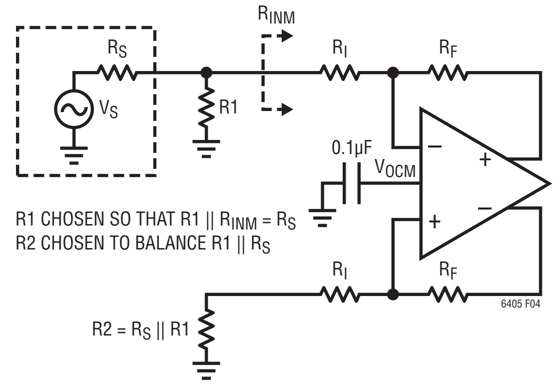

Figure 2. Optimal Compensation for Signal Source Impedance

According to Figure 2, the input impedance looking into the differential amp (R_{INM}) reflects the single-ended source case, given above. Also, R2 is chosen as:

$$R2 = R1 || R_S = \frac{R1 \bullet R_S}{R1 + R_S}$$

Effects of Resistor Pair Mismatch

Figure 3 shows a circuit diagram which takes into consideration resistor mismatch. Often, resistor mismatch limits CMRR well below amplifier specifications. Assuming infinite open-loop gain, the differential output relationship is given by the equation:

$$V_{OUT(DIFF)} = V_{+OUT} - V_{-OUT}$$

$$\approx V_{INDIFF} \bullet \frac{R_F}{R_I} + V_{CM} \bullet \frac{\Delta\beta}{\beta_{AVG}} - V_{OCM} \bullet \frac{\Delta\beta}{\beta_{AVG}}$$

where R_F is the average of R_{F1} and R_{F2}, and R_I is the average of R_{I1} and R_{I2}.

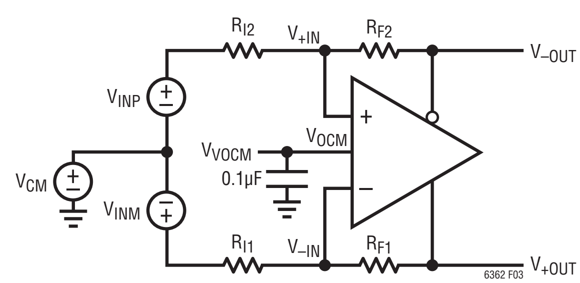

Figure 3. Real-World Application with Feedback Resistor Pair Mismatch