National Semiconductor

May 28, 2008

LM7341 Rail-to-Rail Input/Output ±15V, 4.6 MHz GBW, Operational Amplifier in SOT-23 Package

General Description

The LM7341 is a rail-to-rail input and output amplifier in a small SOT-23 package with a wide supply voltage and temperature range. The LM7341 has a 4.6 MHz gain bandwidth and a 1.9 volt per microsecond slew rate, and draws 0.75 mA of supply current at no load.

The LM7341 is tested at −40°C, 125°C and 25°C with modern automatic test equipment. Detailed performance specifications at 2.7V, ±5V, and ±15V and over a wide temperature range make the LM7341 a good choice for automotive, industrial, and other demanding applications.

Greater than rail-to-rail input common mode range with a minimum 76 dB of common mode rejection at ±15V makes the LM7341 a good choice for both high and low side sensing applications.

LM7341 performance is consistent over a wide voltage range, making the part useful for applications where the supply voltage can change, such as automotive electrical systems and battery powered electronics.

The LM7341 uses a small SOT23-5 package, which takes up little board space, and can be placed near signal sources to reduce noise pickup.

Features

(V_S = ±15V, T_A = 25°C, typical values.)

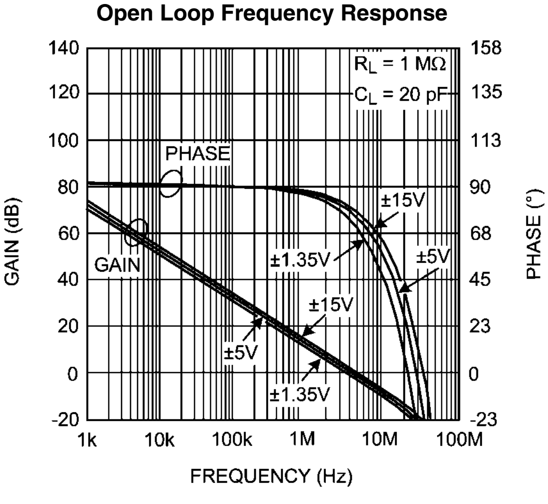
- Tiny 5-pin SOT-23 package saves space
- Greater than rail-to-rail input CMVR −15.3V to 15.3V
- Rail-to-rail output swing −14.84V to 14.86V
- Supply current 0.7 mA
- Gain bandwidth 4.6 MHz
- Slew Rate 1.9 V/µs
- Wide supply range 2.7V to 32V
- High power supply rejection ratio 106 dB
- High common mode rejection ratio 115 dB
- Excellent gain 106 dB
- Temperature range −40°C to 125°C
- Tested at −40°C, 125°C and 25°C at 2.7V, ±5V and ±15V

Applications

- Automotive
- Industrial Robotics
- Sensor output buffers
- Multiple voltage power supplies
- Reverse biasing of photodiodes
- Low current optocouplers
- High side sensing
- Battery chargers
- Test point output buffers
- Below ground current sensing

Typical Performance Characteristics

Open Loop Frequency Response



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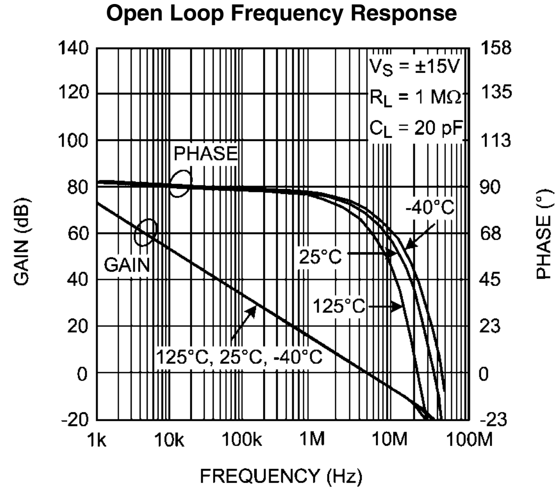
Open Loop Frequency Response



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Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

ESD Tolerance (Note 2)	
Human Body Model	2000V
Machine Model	200V
Charge-Device Model	1000V
V_{IN} Differential	15V
Voltage at Input/Output Pin	$(V^+) + 0.3V$, $(V^-) -0.3V$
Supply Voltage ($V_S = V^+ - V^-$)	35V
Input Current	±10 mA
Output Current(Note 3)	±20 mA
Power Supply Current	25 mA
Soldering Information	
Infrared or Convection (20 sec)	235°C
Wave Soldering Lead Temp. (10 sec.)	260°C
Storage Temperature Range	−65°C to +150°C
Junction Temperature (Note 4)	150°C

Operating Ratings (Note 1)

Supply Voltage ($V_S = V^+ - V^-$)	2.5V to 32V
Temperature Range (Note 4)	−40°C to 125°C
Package Thermal Resistance (θ_{JA})	
5-Pin SOT-23	325°C/W

2.7V Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_A = 25°C, V^+ = 2.7V, V^- = 0V, V_{CM} = 0.5V, V_{OUT} = 1.35V and R_L > 1 MΩ to 1.35V. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage	V_{CM} = 0.5V and V_{CM} = 2.2V	−4 **−5**	±0.2	+4 **+5**	mV
TCV_{OS}	Input Offset Voltage Temperature Drift			±2		μV/°C
I_B	Input Bias Current	V_{CM} = 0.5V	−180 **−200**	−90		nA
		V_{CM} = 2.2V		30	60 **70**	
I_{OS}	Input Offset Current	V_{CM} = 0.5V and V_{CM} = 2.2V		1	40 **50**	nA
CMRR	Common Mode Rejection Ratio	0V ≤ V_{CM} ≤ 1.0V	82 **80**	106		dB
		0V ≤ V_{CM} ≤ 2.7V	62 **60**	80		
PSRR	Power Supply Rejection Ratio	2.7V ≤ V_S ≤ 30V V_{CM} = 0.5V	86 **84**	106		dB
CMVR	Common Mode Voltage Range	CMRR > 60 dB		−0.3	**0.0**	V
			2.7	3.0		
A_{VOL}	Open Loop Voltage Gain	0.5V ≤ V_O ≤ 2.2V R_L = 10 kΩ to 1.35V	12 **8**	65		V/mV
V_{OUT}	Output Swing High	R_L = 10 kΩ to 1.35V V_{ID} = 100 mV		50	120 **150**	mV from either rail
		R_L = 2 kΩ to 1.35V V_{ID} = 100 mV		95	150 **200**	
	Output Swing Low	R_L = 10 kΩ to 1.35V V_{ID} = −100 mV		55	120 **150**	
		R_L = 2 kΩ to 1.35V V_{ID} = −100 mV		100	150 **200**	
I_{OUT}	Output Current	Sourcing, V_{OUT} = 0V V_{ID} = 200 mV	6 **4**	12		mA
		Sinking, V_{OUT} = 0V V_{ID} = −200 mV	5 **3**	10		
I_S	Supply Current	V_{CM} = 0.5V and V_{CM} = 2.2V		0.6	0.9 **1.0**	mA
SR	Slew Rate	±1V Step		1.5		V/μs

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
GBW	Gain Bandwidth	f = 100 kHz, R_L = 100 kΩ		3.6		MHz
e_n	Input Referred Voltage Noise Density	f = 1 kHz		35		$nV/\sqrt{Hz}$
i_n	Input Referred Voltage Noise Density	f = 1 kHz		0.28		$pA/\sqrt{Hz}$
THD+N	Total Harmonic Distortion + Noise	f = 10 kHz		−66		dB

±5V Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_A = 25°C, V+ = +5V, V− = −5V, V_{CM} = V_{OUT} = 0V and R_L > 1 MΩ to 0V. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage	V_{CM} = −4.5V and V_{CM} = 4.5V	−4 **−5**	±0.2	+4 **+5**	mV
TCV_{OS}	Input Offset Voltage Temperature Drift			±2		μV/°C
I_B	Input Bias Current	V_{CM} = −4.5V	−200 **−250**	−95		nA
		V_{CM} = 4.5V		35	70 **80**	
I_{OS}	Input Offset Current	V_{CM} = −4.5V and V_{CM} = 4.5V		1	40 **50**	nA
CMRR	Common Mode Rejection Ratio	−5V ≤ V_{CM} ≤ 3V	84 **82**	112		dB
		−5V ≤ V_{CM} ≤ 5V	72 **70**	92		
PSRR	Power Supply Rejection Ratio	2.7V ≤ V_S ≤ 30V, V_{CM} = −4.5V	86 **84**	106		dB
CMVR	Common Mode Voltage Range	CMRR ≥ 65 dB		−5.3	**−5.0**	V
			5.0	5.3		
A_{VOL}	Open Loop Voltage Gain	−4V ≤ V_O ≤ 4V R_L = 10 kΩ to 0V	20 **12**	110		V/mV
V_{OUT}	Output Swing High	R_L = 10 kΩ to 0V, V_{ID} = 100 mV		80	150 **200**	mV from either rail
		R_L = 2 kΩ to 0V, V_{ID} = 100 mV		170	300 **400**	
	Output Swing Low	R_L = 10 kΩ to 0V V_{ID} = −100 mV		90	150 **200**	
		R_L = 2 kΩ to 0V V_{ID} = −100 mV		210	300 **400**	
I_{OUT}	Output Current	Sourcing, V_{OUT} = −5V V_{ID} = 200 mV	6 **4**	11		mA
		Sinking, V_{OUT} = 5V V_{ID} = −200 mV	6 **4**	12		
I_S	Supply Current	V_{CM} = −4.5V and V_{CM} = 4.5V		0.65	1.0 **1.1**	mA
SR	Slew Rate	±4V Step		1.7		V/μs
GBW	Gain Bandwidth	f = 100 kHz, R_L = 100 kΩ		4.0		MHz
e_n	Input Referred Voltage Noise Density	f = 1 kHz		33		$nV/\sqrt{Hz}$
i_n	Input Referred Voltage Noise Density	f = 1 kHz		0.26		$pA/\sqrt{Hz}$
THD+N	Total Harmonic Distortion + Noise	f = 10 kHz		−66		dB

±15V Electrical Characteristics

Unless otherwise specified, all limits guaranteed for T_A = 25°C, V^+ = 15V, V^- = −15V, V_{CM} = V_{OUT} = 0V and R_L > 1 MΩ to 0V. **Boldface** limits apply at the temperature extremes

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_{OS}	Input Offset Voltage	V_{CM} = −14.5V and V_{CM} = 14.5V	−4 **−5**	±0.2	+4 **+5**	mV
TCV_{OS}	Input Offset Voltage Temperature Drift			±2		µV/°C
I_B	Input Bias Current	V_{CM} = −14.5V	−250 **−300**	−110		nA
		V_{CM} = 14.5V		40	80 **90**	
I_{OS}	Input Offset Current	V_{CM} = −14.5V and V_{CM} = 14.5V		1	40 **50**	nA
CMRR	Common Mode Rejection Ratio	−15V ≤ V_{CM} ≤12V	84 **82**	115		dB
		−15V ≤ V_{CM} ≤ 15V	78 **76**	100		
PSRR	Power Supply Rejection Ratio	2.7V ≤ V_S ≤ 30V, V_{CM} = −14.5V	86 **84**	106		dB
CMVR	Common Mode Voltage Range	CMRR > 80 dB		−15.3	**−15.0**	V
			15.0	15.3		
A_{VOL}	Open Loop Voltage Gain	−13V ≤ V_O ≤ 13V R_L = 10 kΩ to 0V	25 **15**	200		V/mV
V_{OUT}	Output Swing High	R_L = 10 kΩ to 0V V_{ID} = 100 mV		135	300 **400**	mV from either rail
	Output Swing Low	R_L = 10 kΩ to 0V V_{ID} = −100 mV		160	300 **400**	
I_{OUT}	Output Current (Note 4)	Sourcing, V_{OUT} = −15V V_{ID} = 200 mV	5 **3**	10		mA
		Sinking, V_{OUT} = 15V V_{ID} = −200 mV	8 **5**	13		
I_S	Supply Current	V_{CM} = −14.5V and V_{CM} = 14.5V		0.7	1.2 **1.3**	mA
SR	Slew Rate	±12V Step		1.9		V/µs
GBW	Gain Bandwidth	f = 100 kHz, R_L = 100 kΩ		4.6		MHz
e_n	Input Referred Voltage Noise Density	f = 1 kHz		31		$nV/\sqrt{Hz}$
i_n	Input Referred Voltage Noise Density	f = 1 kHz		0.27		$pA/\sqrt{Hz}$
THD+N	Total Harmonic Distortion + Noise	f = 10 kHz		−65		dB

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Operating Ratings indicate conditions for which the device is intended to be functional, but specific performance is not guaranteed. For guaranteed specifications and the test conditions, see the Electrical Characteristics.

Note 2: Human Body Model, applicable std. MIL-STD-883, Method 3015.7. Machine Model, applicable std. JESD22-A115-A (ESD MM std. of JEDEC)

Field-Induced Charge-Device Model, applicable std. JESD22-C101-C (ESD FICDM std. of JEDEC).

Note 3: Applies to both single-supply and split-supply operation. Continuous short circuit operation at elevated ambient temperature can result in exceeding the maximum allowed junction temperature of 150°C.

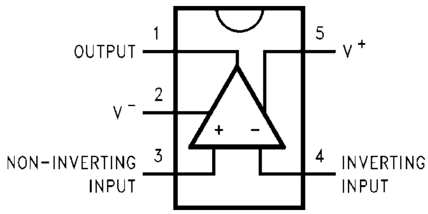
Note 4: The maximum power dissipation is a function of $T_{J(MAX)}$, θ_{JA}. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{J(MAX)} - T_A)/\theta_{JA}$. All numbers apply for packages soldered directly unto a PC board.

Note 5: Typical values represent the most likely parametric norm as determined at the time of characterization. Actual typical values may vary over time and will also depend on the application and configuration. The typical values are not tested and are not guaranteed on shipped production material.

Note 6: All limits are guaranteed by testing or statistical analysis.

Connection Diagram

5-Pin SOT-23



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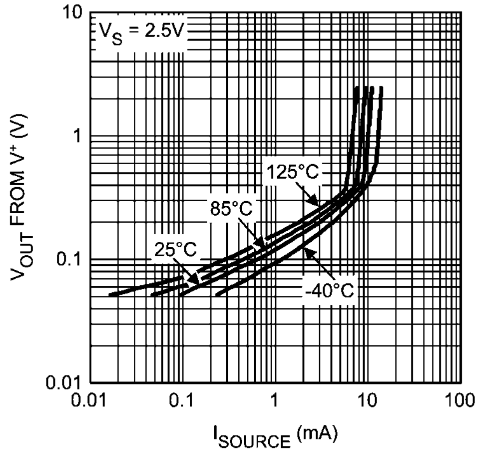
Top View

Ordering Information

Package	Part Number	Package Marking	Transport Media	NSC Drawing
5-Pin SOT-23	LM7341MF	AV4A	1k Units Tape and Reel	MF05A
	LM7341MFE		250 Units Tape and Reel	
	LM7341MFX		3k Units Tape and Reel	

Typical Performance Characteristics

Output Swing vs. Sourcing Current



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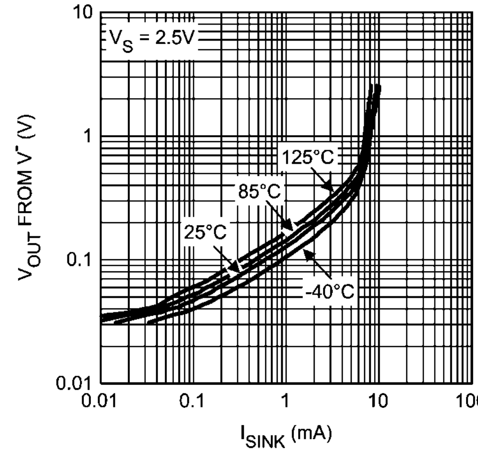
Output Swing vs. Sinking Current



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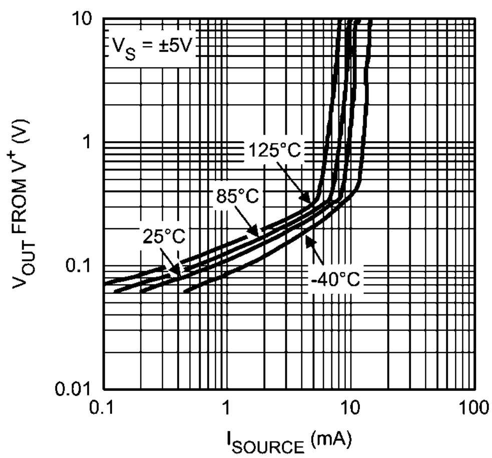
Output Swing vs. Sourcing Current



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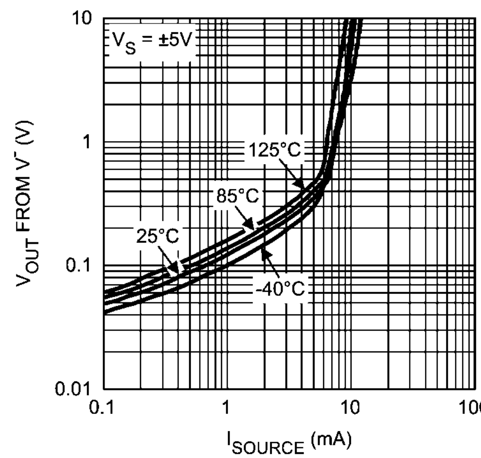
Output Swing vs. Sinking Current



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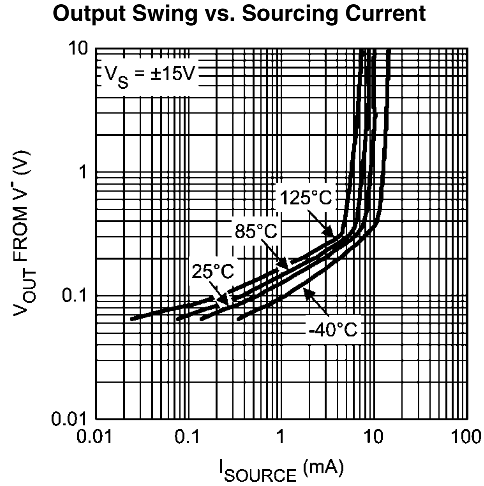
Output Swing vs. Sourcing Current



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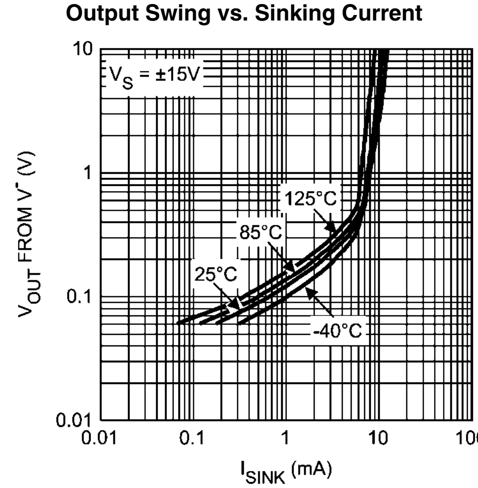
Output Swing vs. Sinking Current



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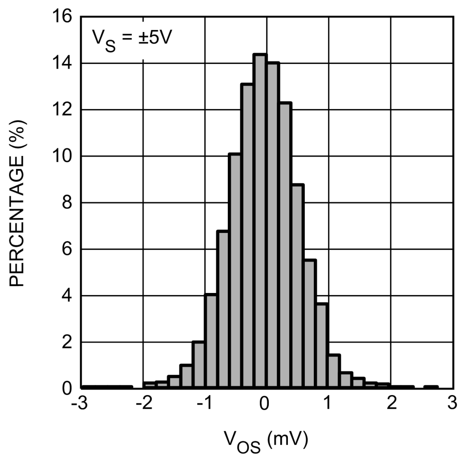
V_{OS} Distribution



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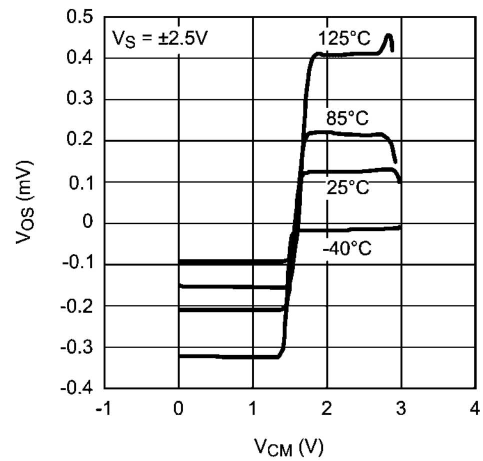
V_{OS} vs. V_{CM} (Unit 1)



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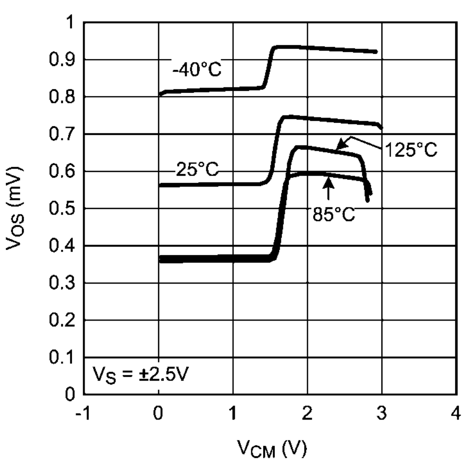
V_{OS} vs. V_{CM} (Unit 2)



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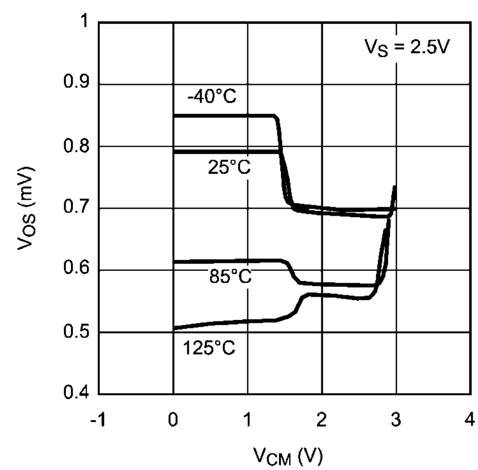
V_{OS} vs. V_{CM} (Unit 3)



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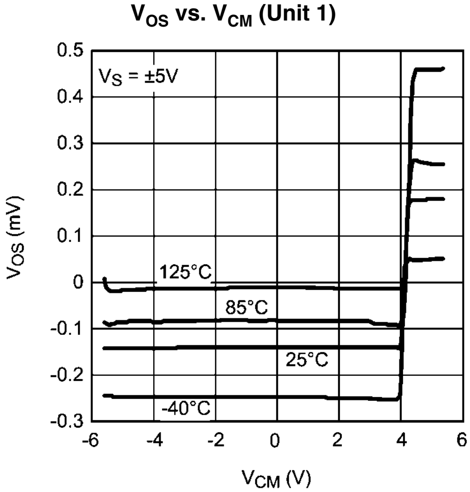
V_{OS} vs. V_{CM} (Unit 1)



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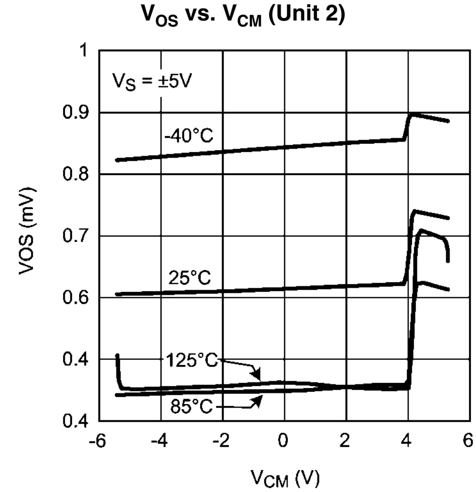
V_{OS} vs. V_{CM} (Unit 2)



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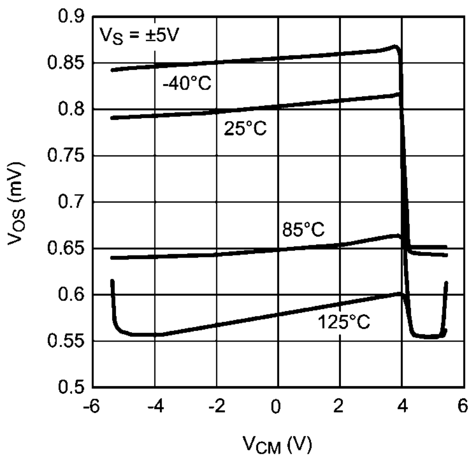
V_{OS} vs. V_{CM} (Unit 3)



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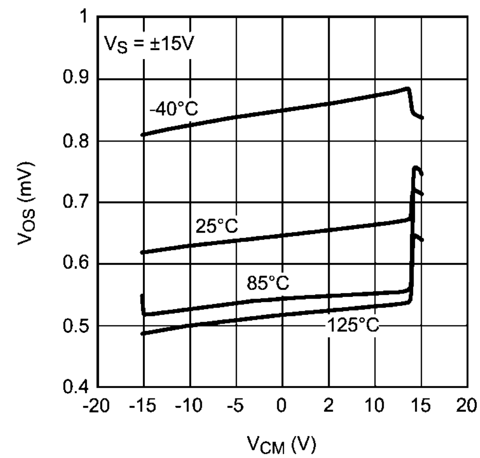
V_{OS} vs. V_{CM} (Unit 1)



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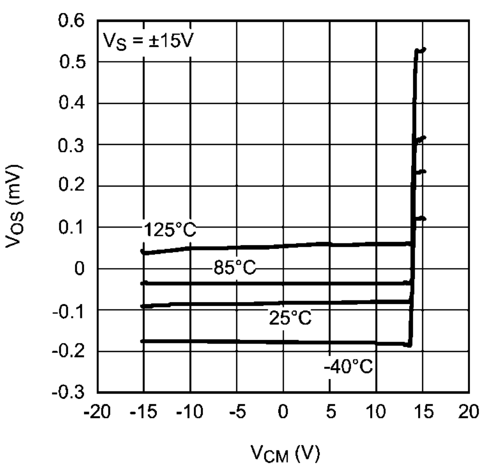
V_{OS} vs. V_{CM} (Unit 2)



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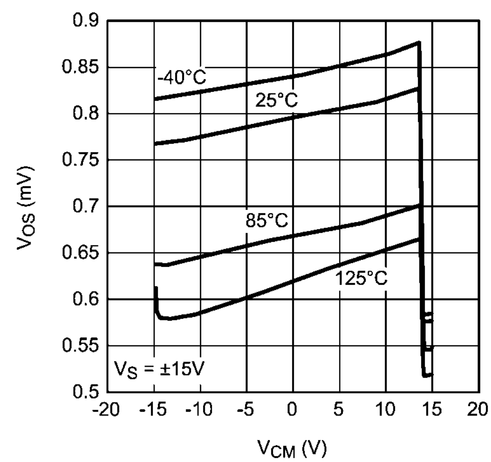
V_{OS} vs. V_{CM} (Unit 3)



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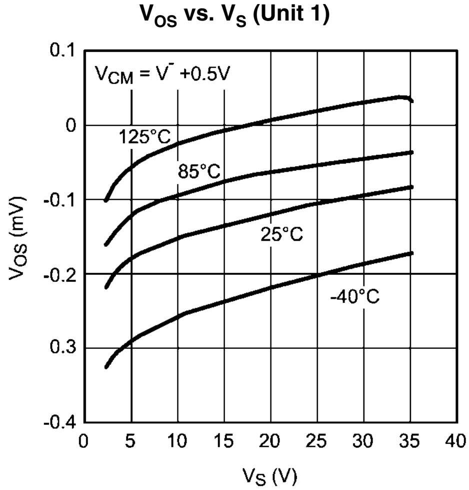
V_{OS} vs. V_S (Unit 1)



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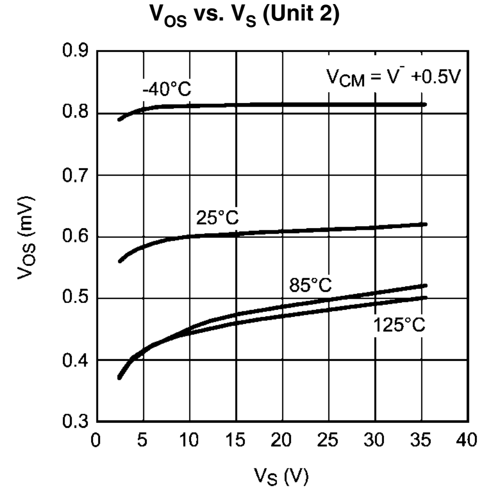
V_{OS} vs. V_S (Unit 2)



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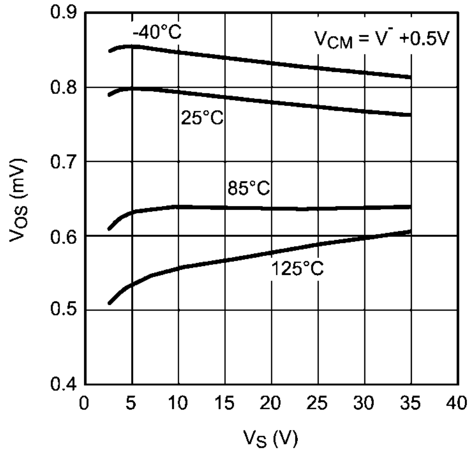
V_{OS} vs. V_S (Unit 3)



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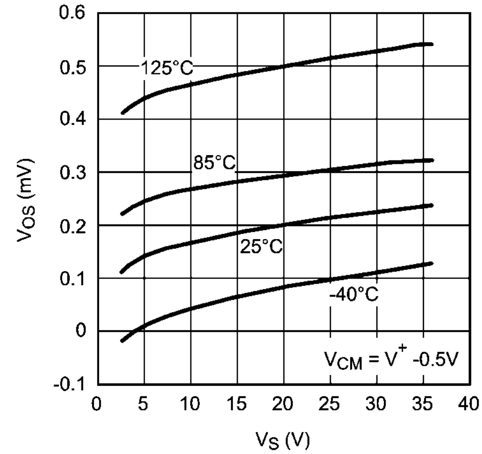
V_{OS} vs. V_S (Unit 1)



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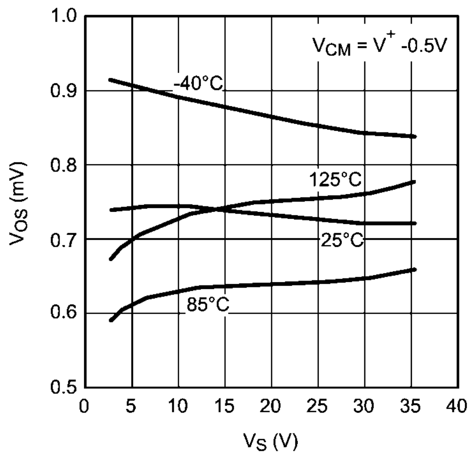
V_{OS} vs. V_S (Unit 2)



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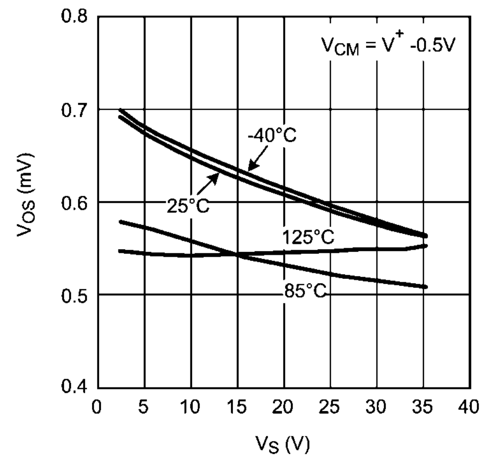
V_{OS} vs. V_S (Unit 3)



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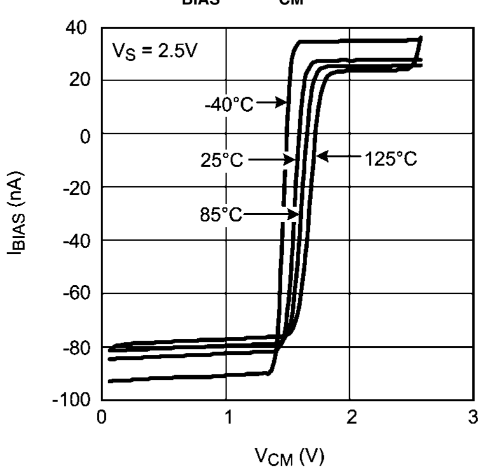
I_{BIAS} vs. V_{CM}



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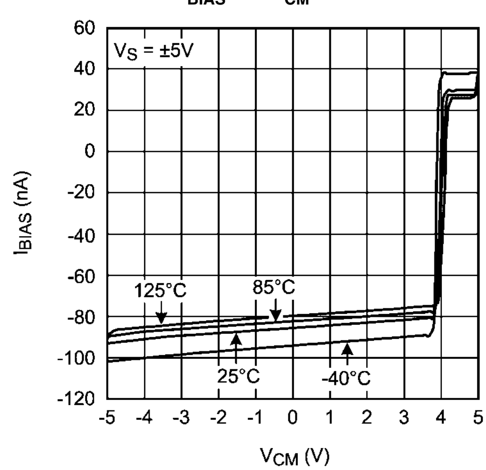
I_{BIAS} vs. V_{CM}



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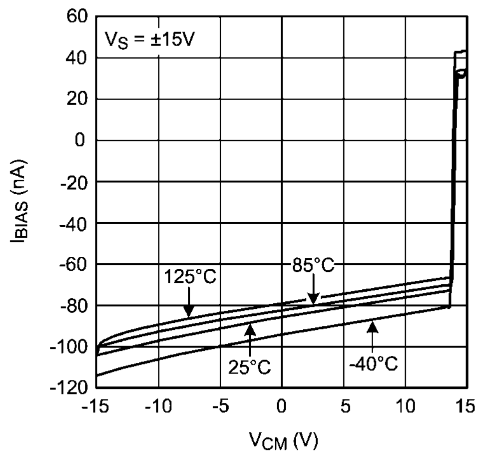
I_{BIAS} vs. V_{CM}



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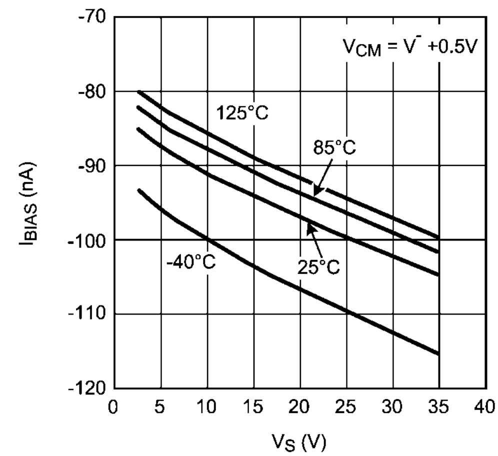
I_{BIAS} vs. V_S



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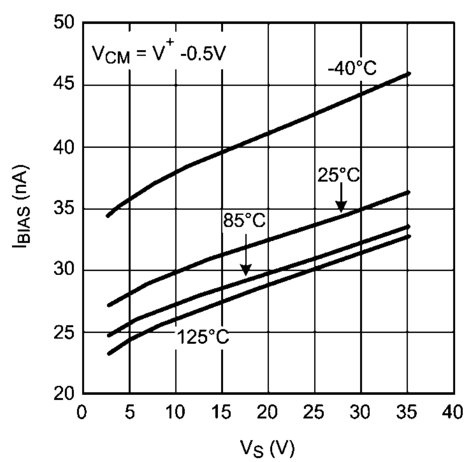
I_{BIAS} vs. V_S



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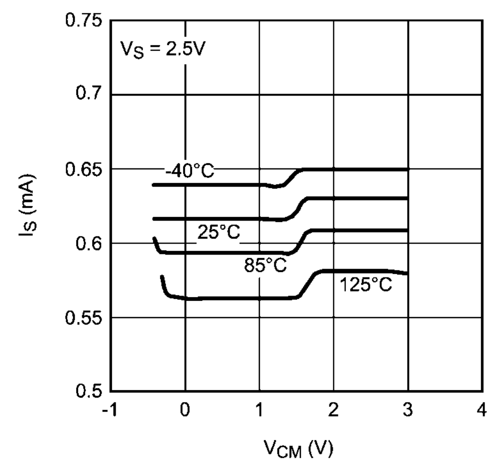
I_S vs. V_{CM}



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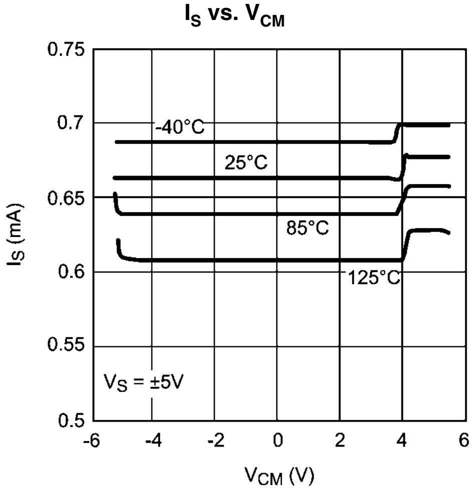
I_S vs. V_{CM}



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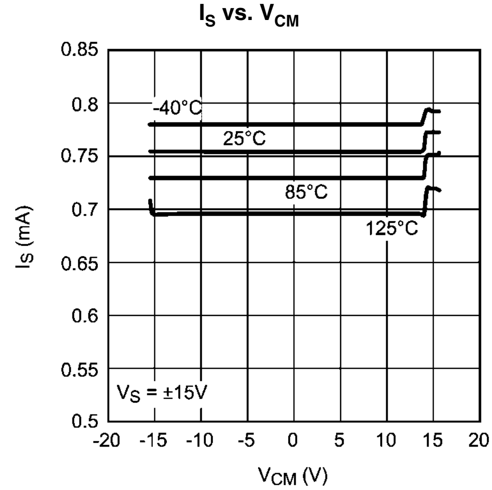
I_S vs. V_{CM}



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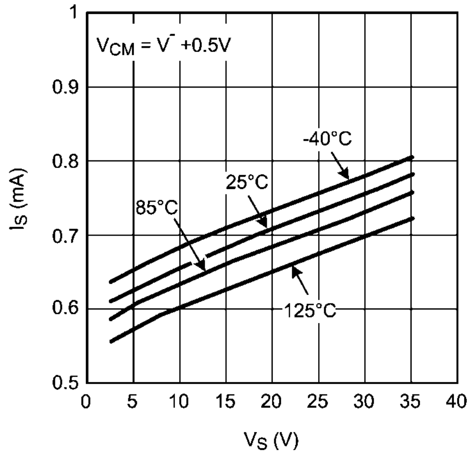
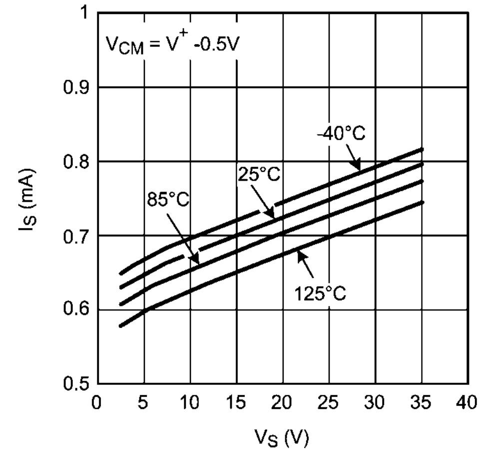
I_S vs. V_{CM}



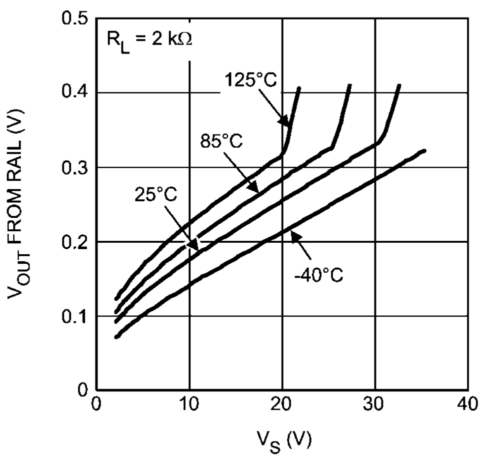
20206028

I_S vs. V_{CM}



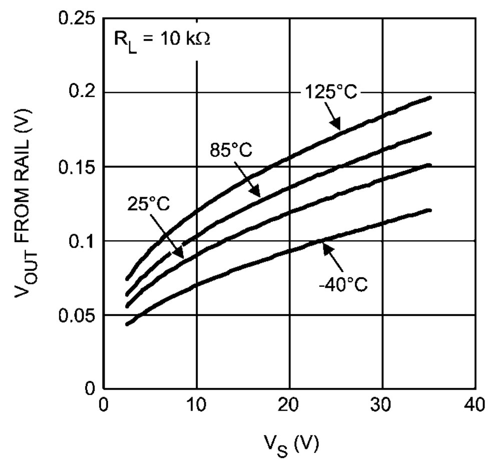
20206029

Positive Output Swing vs. Supply Voltage



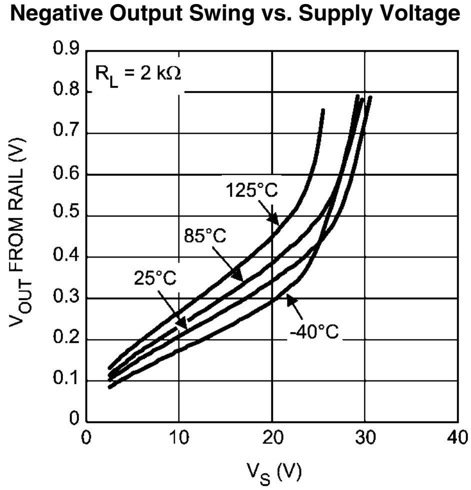
20206036

Positive Output Swing vs. Supply Voltage



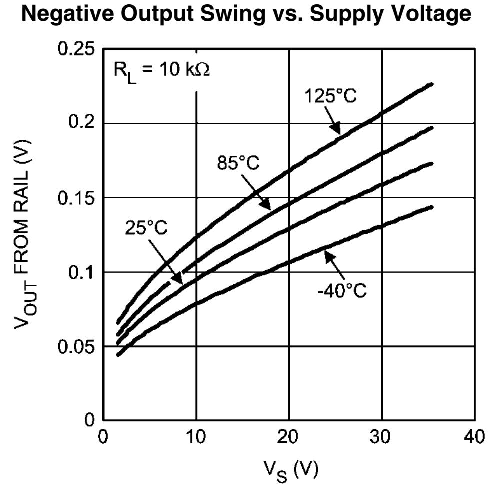
20206037

Negative Output Swing vs. Supply Voltage



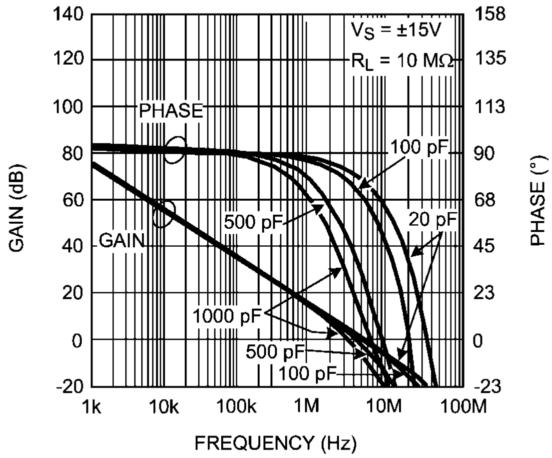
20206038

Negative Output Swing vs. Supply Voltage



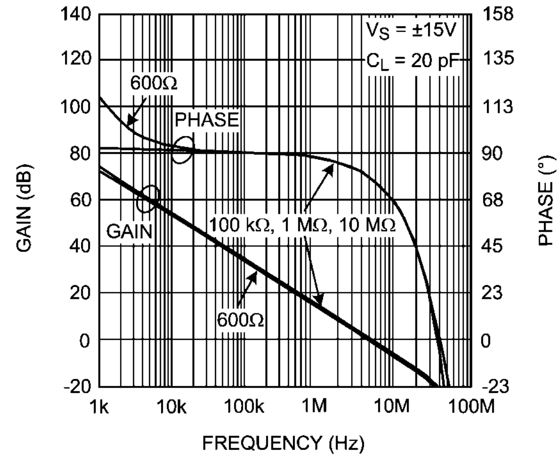
20206039

Open Loop Frequency with Various Capacitive Load



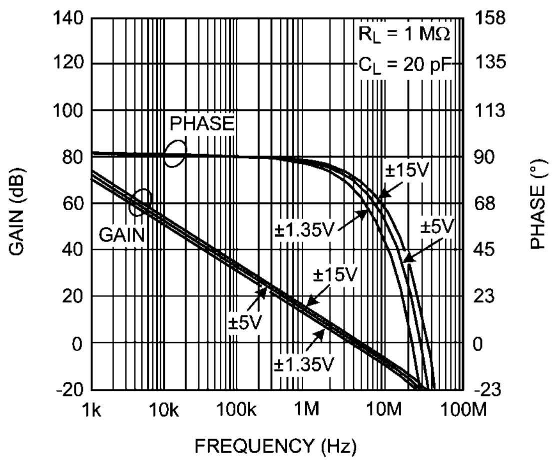
20206044

Open Loop Frequency with Various Resistive Load



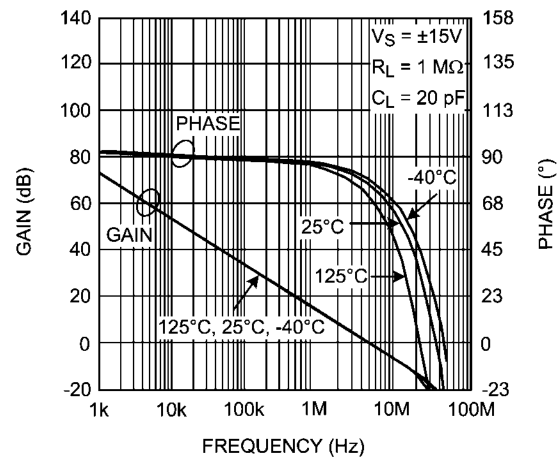
20206045

Open Loop Frequency with Various Supply Voltage



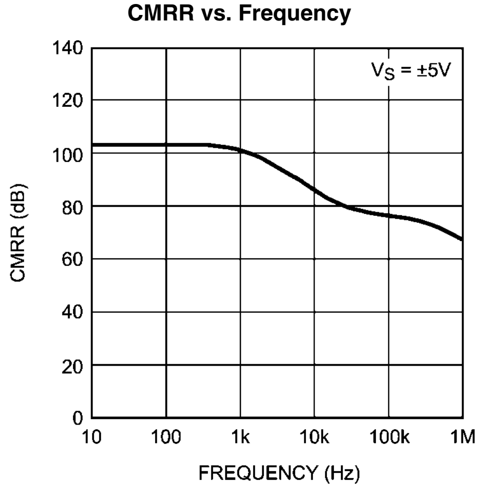
20206046

Open Loop Frequency Response with Various Temperatures



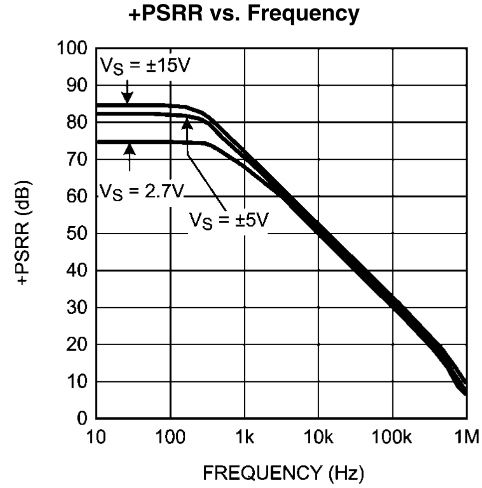
20206047

CMRR vs. Frequency



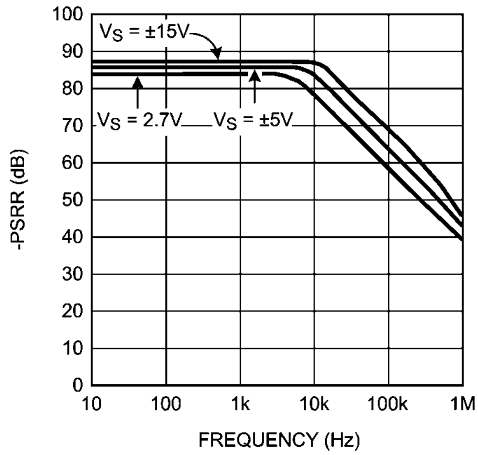
20206043

+PSRR vs. Frequency



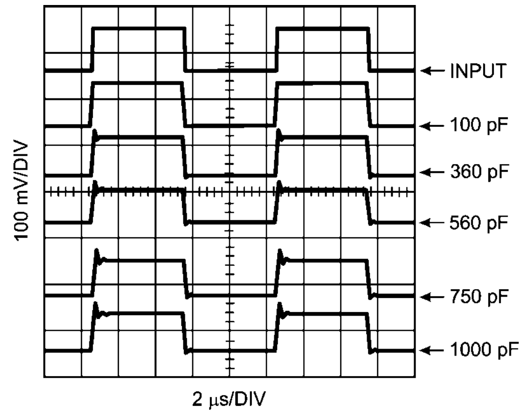
20206041

-PSRR vs. Frequency



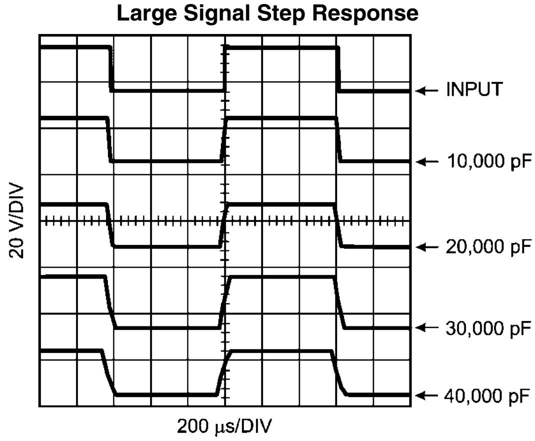
20206042

Small Signal Step Response



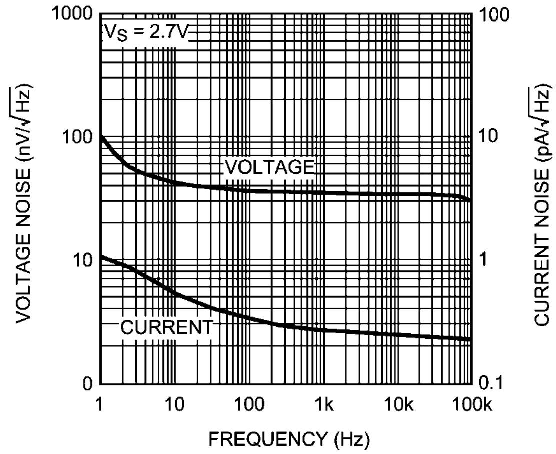
20206051

Large Signal Step Response



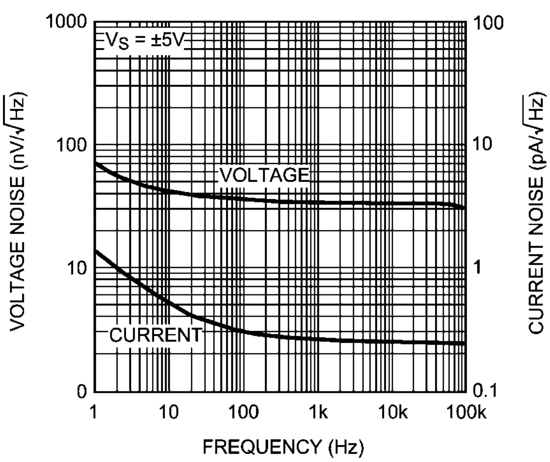
20206052

Input Referred Noise Density vs. Frequency



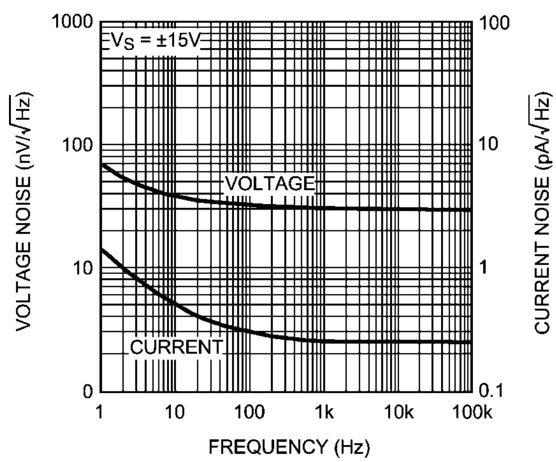
20206048

Input Referred Noise Density vs. Frequency



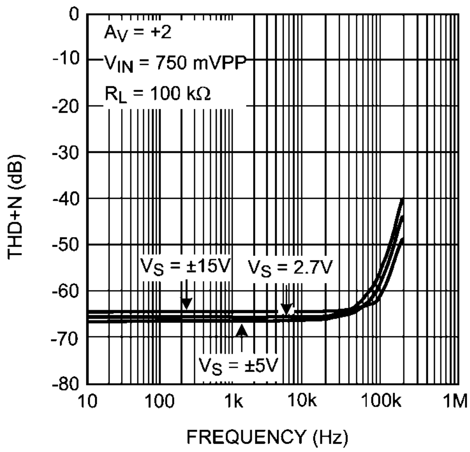
20206049

Input Referred Noise Density vs. Frequency



20206050

THD+N vs. Frequency



20206053

Application Information

GENERAL INFORMATION

Low supply current and wide bandwidth, greater than rail-to-rail input range, full rail-to-rail output, good capacitive load driving ability, wide supply voltage and low distortion all make the LM7341 ideal for many diverse applications.

The high common-mode rejection ratio and full rail-to-rail input range provides precision performance when operated in non-inverting applications where the common-mode error is added directly to the other system errors.

CAPACITIVE LOAD DRIVING

The LM7341 has the ability to drive large capacitive loads. For example, 1000 pF only reduces the phase margin to about 30 degrees.

POWER DISSIPATION

Although the LM7341 has internal output current limiting, shorting the output to ground when operating on a +30V power supply will cause the op amp to dissipate about 350 mW. This is a worst-case example. In the 5-pin SOT-23 package, the higher thermal resistance will cause a calculated rise of 113°C. This can raise the junction temperature to above the absolute maximum temperature of 150°C.

Operating from split supplies greatly reduces the power dissipated when the output is shorted. Operating on ±15V supplies can only cause a temperature rise of 57°C in the 5-pin SOT-23 package, assuming the short is to ground.

WIDE SUPPLY RANGE

The high power-supply rejection ratio (PSRR) and common mode rejection ratio (CMRR) provide precision performance when operated on battery or other unregulated supplies. This advantage is further enhanced by the very wide supply range (2.5V–32V) offered by the LM7341. In situations where highly variable or unregulated supplies are present, the excellent PSRR and wide supply range of the LM7341 benefit the system designer with continued precision performance, even in such adverse supply conditions.

SPECIFIC ADVANTAGES OF 5-Pin SOT-23 (TinyPak)

The obvious advantage of the 5-pin SOT-23, TinyPak, is that it can save board space, a critical aspect of any portable or miniaturized system design. The need to decrease overall system size is inherent in any handheld, portable, or lightweight system application.

Furthermore, the low profile can help in height limited designs, such as consumer hand-held remote controls, sub-notebook computers, and PCMCIA cards.

An additional advantage of the tiny package is that it allows better system performance due to ease of package placement. Because the tiny package is so small, it can fit on the board right where the op amp needs to be placed for optimal performance, unconstrained by the usual space limitations. This optimal placement of the tiny package allows for many system enhancements, not easily achieved with the constraints of a larger package. For example, problems such as system noise due to undesired pickup of digital signals can be easily reduced or mitigated. This pick-up problem is often caused by long wires in the board layout going to or from an op amp. By placing the tiny package closer to the signal source and allowing the LM7341 output to drive the long wire, the signal becomes less sensitive to such pick-up. An overall reduction of system noise results.

Often times system designers try to save space by using dual or quad op amps in their board layouts. This causes a complicated board layout due to the requirement of routing several signals to and from the same place on the board. Using the tiny op amp eliminates this problem.

Additional space savings parts are available in tiny packages from National Semiconductor, including low power amplifiers, precision voltage references, and voltage regulators.

LOW DISTORTION, HIGH OUTPUT DRIVE CAPABILITY

The LM7341 offers superior low-distortion performance, with a total-harmonic-distortion-plus-noise of −66 dB at f = 10 kHz. The advantage offered by the LM7341 is its low distortion levels, even at high output current and low load resistance.

Typical Applications

HANDHELD REMOTE CONTROLS

The LM7341 offers outstanding specifications for applications requiring good speed/power trade-off. In applications such as remote control operation, where high bandwidth and low power consumption are needed. The LM7341 performance can easily meet these requirements.

OPTICAL LINE ISOLATION FOR MODEMS

The combination of the low distortion and good load driving capabilities of the LM7341 make it an excellent choice for driving opto-coupler circuits to achieve line isolation for modems. This technique prevents telephone line noise from coupling onto the modem signal. Superior isolation is achieved by coupling the signal optically from the computer modem to the telephone lines; however, this also requires a low distortion at relatively high currents. Due to its low distortion at high output drive currents, the LM7341 fulfills this need, in this and in other telecom applications.

REMOTE MICROPHONE IN PERSONAL COMPUTERS

Remote microphones in Personal Computers often utilize a microphone at the top of the monitor which must drive a long cable in a high noise environment. One method often used to reduce the nose is to lower the signal impedance, which reduces the noise pickup. In this configuration, the amplifier usually requires 30 dB–40 dB of gain, at bandwidths higher than most low-power CMOS parts can achieve. The LM7341 offers the tiny package, higher bandwidths, and greater output drive capability than other rail-to-rail input/output parts can provide for this application.

OTHER SOT-23 AMPLIFIERS

The **LM7321** is a rail-to-rail input and output amplifier that can tolerate unlimited capacitive load. It works from 2.7V to ±15V and across the −40°C to +125°C temperature range. It has 20 MHz gain-bandwidth, and is available in both 5-Pin SOT-23 and 8-Pin SOIC packages.

The **LM6211** is a 20 MHz part with CMOS input, which runs on 5V to 24V single supplies. It has rail-to-rail output and low noise.

The **LMP7701** is a rail-to-rail input and output precision part with an input voltage offset under 220 microvolts and low noise. It has 2.5 MHz bandwidth and works on 2.7V to 12V supplies.

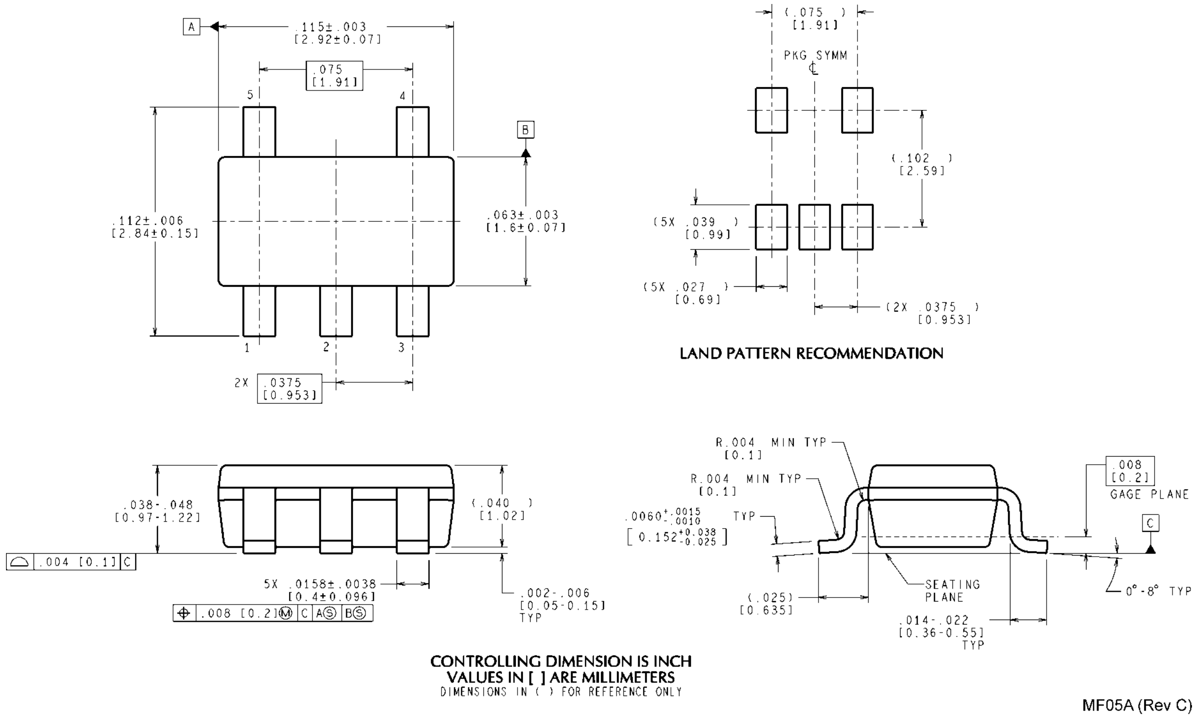
SMALLER SC70 AMPLIFIERS

The **LMV641** is a 10 MHz amplifier which uses only 140 micro amps of supply current. The input voltage offset is less than 0.5 mV.

The **LMV851** is an 8 MHz amplifier which uses only 0.4 mA supply current, and is available in the smaller SC70 package. The LMV851 also resists Electro Magnetic Interference (EMI) from mobile phones and similar high frequency sources. It works on 2.7V to 5.5 V supplies.

Detailed information on these and a wide range of other parts can be found at www.national.com.

Physical Dimensions inches (millimeters) unless otherwise noted



5-Pin SOT-23 Package
NS Package Number MF05A

Notes

Notes

National Semiconductor Americas Technical Support Center
Email: support@nsc.com
Tel: 1-800-272-9959

National Semiconductor Europe Technical Support Center
Email: europe.support@nsc.com
German Tel: +49 (0) 180 5010 771
English Tel: +44 (0) 870 850 4288

National Semiconductor Asia Pacific Technical Support Center
Email: ap.support@nsc.com

National Semiconductor Japan Technical Support Center
Email: jpn.feedback@nsc.com