

Description

The TLV521 350 nA nanopower op amp offers optimum price performance in TI's nanopower family of operational amplifiers. The TLV521 has a carefully designed CMOS input stage enabling very low I_{bias} of 1 pA, thereby reducing I_{BIAS} and I_{OS} errors that would otherwise impact sensitive applications like Megaohm resistance, high-impedance photodiode and charge sense situations. Additionally, built-in EMI protection reduces sensitivity to unwanted RF signals from sources like mobile phones and RFID readers.

The TLV521 is offered in the 5-pin SC70 package, and operates from -40°C to 125°C .

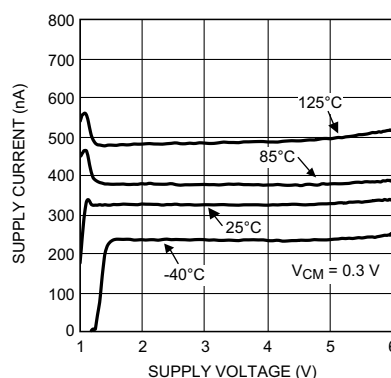
Features

- Unmatched Price Performance
- For $V_S = 3.3\text{ V}$, Typical Unless Otherwise Noted
 - Ultra-low Supply Current
 - 350 nA Typical, 500 nA Maximum
 - Wide Operating Voltage Range 1.7 V to 5.5 V
 - Low TCV_{OS} $1.5\text{ }\mu\text{V}/^{\circ}\text{C}$
 - V_{OS} 3 mV (Max)
 - Input Bias Current 1 pA
 - PSRR 100 dB
 - CMRR 90 dB
 - Open-Loop Gain 110 dB
 - Gain Bandwidth Product 6 kHz
 - Slew Rate 2.5 V/ms
 - Input Voltage Noise at $f = 100\text{ Hz}$ $300\text{ nV}/\sqrt{\text{Hz}}$
 - Temperature Range -40°C to 125°C
 - Rail to Rail Input and Output (RRIO)

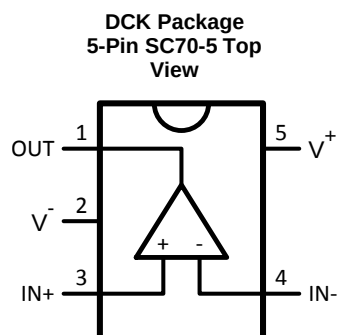
Applications

- Wireless Remote Sensors
- Powerline Monitoring
- Power Meters
- Battery Powered Industrial Sensors
- Micropower Oxygen Sensor and Toxic Gas Sensor
- Active RFID Readers
- Zigbee Based Sensors for HVAC Control
- Sensor Network Powered by Energy Scavenging
- Current Sensing
- Glucose Monitoring

Nanopower Supply Current



Pin Configuration and Functions



Pin Functions

PIN		TYPE	DESCRIPTION
NO.	NAME		
1	OUT	O	Output
2	V ⁻	P	Negative Power Supply
3	IN ⁺	I	Noninverting Input
4	IN ⁻	I	Inverting Input
5	V ⁺	P	Positive Power Supply

Absolute Maximum Ratings⁽¹⁾

over operating free-air temperature range (unless otherwise noted)⁽¹⁾

	MIN	MAX	UNIT
Any pin relative to V^-	-0.3	6	V
$IN+$, $IN-$, OUT Pins	$V^- - 0.3\text{ V}$	$V^+ + 0.3\text{ V}$	V
V^+ , V^- , OUT Pins		40	mA
Differential Input Voltage ($V_{IN+} - V_{IN-}$)	-300	300	mV
Junction Temperature	-40	150	°C
Mounting Temperature	Infrared or Convection (30 sec.)	260	°C
	Wave Soldering Lead Temp. (4 sec.)	260	°C
Storage temperature, T_{stg}	-65	150	°C

- (1) Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under Recommended Operating Conditions. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±2000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000	
	Machine Model	±200	

- (1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

Recommended Operating Conditions⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

	MIN	MAX	UNIT
Temperature Range	-40	125	°C
Supply Voltage ($V_S = V^+ - V^-$)	1.7	5.5	V

- (1) Absolute Maximum Ratings indicate limits beyond which damage may occur. Recommended Operating Conditions indicate conditions for which the device is intended to be functional, but specific performance is not ensured. For ensured specifications and test conditions, see Electrical Characteristics.

Thermal Information

THERMAL METRIC ⁽¹⁾		TLV521	UNIT
		DCK (SC70)	
		5 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	269.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	93.7	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	48.8	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	2	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	47.9	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	N/A	°C/W

Electrical Characteristics

Unless otherwise specified, all limits for $T_A = 25^\circ\text{C}$, $V^+ = 3.3\text{ V}$, $V^- = 0\text{ V}$, $V_{CM} = V_O = V^+/2$, and $R_L > 1\text{ M}\Omega$.⁽¹⁾

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{OS} Input Offset Voltage	$V_{CM} = 0.3\text{ V}$	-3	0.1	3	mV
	$V_{CM} = 3\text{ V}$	-3	0.1	3	
TCV_{OS} Input Offset Voltage Drift			± 1.5		$\mu\text{V}/^\circ\text{C}$
I_{BIAS} Input Bias Current			1		pA
I_{OS} Input Offset Current			50		fA
$CMRR$ Common Mode Rejection Ratio	$0\text{ V} \leq V_{CM} \leq 3.3\text{ V}$	70	90		dB
	$0\text{ V} \leq V_{CM} \leq 2.2\text{ V}$		100		
$PSRR$ Power Supply Rejection Ratio	$V^+ = 1.8\text{ V}$ to 3.3 V ; $V_{CM} = 0.3\text{ V}$	80	100		dB
$CMVR$ Common Mode Voltage Range	$CMRR \geq 70\text{ dB}$	0		3.3	V
A_{VOL} Large Signal Voltage Gain	$V_O = 0.5\text{ V}$ to 2.8 V $R_L = 100\text{ k}\Omega$ to $V^+/2$	80	110		dB
V_O Output Swing	High $R_L = 100\text{ k}\Omega$ to $V^+/2$ $V_{IN}(\text{diff}) = 100\text{ mV}$		3	50	mV from either rail
	Low $R_L = 100\text{ k}\Omega$ to $V^+/2$ $V_{IN}(\text{diff}) = -100\text{ mV}$		2	50	
I_O Output Current	Sourcing, V_O to V^- $V_{IN}(\text{diff}) = 100\text{ mV}$		11		mA
	Sinking, V_O to V^+ $V_{IN}(\text{diff}) = -100\text{ mV}$		12		
I_S Supply Current	$V_{CM} = 0.3\text{ V}$		350	500	nA

AC Electrical Characteristics ⁽¹⁾

Unless otherwise specified, all limits for $T_A = 25^\circ\text{C}$, $V^+ = 3.3\text{ V}$, $V^- = 0\text{ V}$, $V_{CM} = V_O = V^+/2$, and $R_L > 1\text{ M}\Omega$.

PARAMETER		TEST CONDITIONS	MIN (2)	TYP (3)	MAX (2)	UNIT
GBW	Gain-Bandwidth Product	$C_L = 20\text{ pF}$, $R_L = 100\text{ k}\Omega$		6		kHz
SR	Slew Rate	$A_V = +1$, $V_{IN} = 0\text{ V}$ to 3.3 V	Falling Edge	2.9		V/ms
			Rising Edge	2.5		
θ_m	Phase Margin	$C_L = 20\text{ pF}$, $R_L = 100\text{ k}\Omega$		73		deg
G_m	Gain Margin	$C_L = 20\text{ pF}$, $R_L = 100\text{ k}\Omega$		19		dB
e_n	Input-Referred Voltage Noise Density	$f = 100\text{ Hz}$		300		$\text{nV}/\sqrt{\text{Hz}}$
	Input-Referred Voltage Noise	0.1 Hz to 10 Hz		22		μV_{PP}
I_n	Input-Referred Current Noise	$f = 100\text{ Hz}$		100		$\text{fA}/\sqrt{\text{Hz}}$
EMIRR	EMI Rejection Ratio, IN^+ and IN^- ⁽⁴⁾	$V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB_P), $f = 400\text{ MHz}$		121		dB
		$V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB_P), $f = 900\text{ MHz}$		121		
		$V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB_P), $f = 1800\text{ MHz}$		124		
		$V_{RF_PEAK} = 100\text{ mV}_P$ (-20 dB_P), $f = 2400\text{ MHz}$		142		

- (1) Electrical Characteristics values apply only for factory testing conditions at the temperature indicated. Factory testing conditions result in very limited self-heating of the device such that $T_J = T_A$. Parametric performance, as indicated in the electrical tables, is not ensured under conditions of self heating where $T_J > T_A$. Absolute Maximum Ratings indicate junction temperature limits beyond which the device may be permanently degraded, either mechanically or electrically.
- (2) All limits are ensured by testing, statistical analysis or design.
- (3) Typical values represent the most likely parametric norm 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 ensured on shipped production material.
- (4) The EMI Rejection Ratio is defined as $EMIRR = 20\log(V_{RF_PEAK}/\Delta V_{OS})$.

Typical Characteristics

At $T_J = 25^\circ\text{C}$, unless otherwise specified.

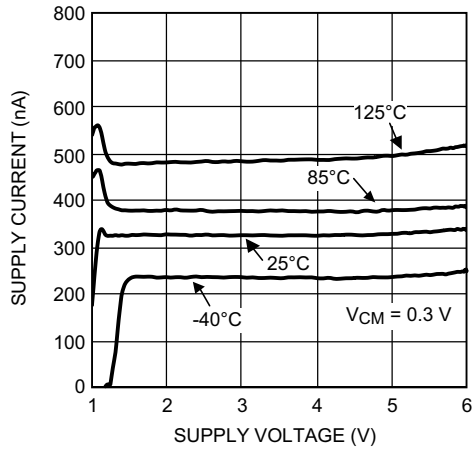


Figure 1. Supply Current vs. Supply Voltage

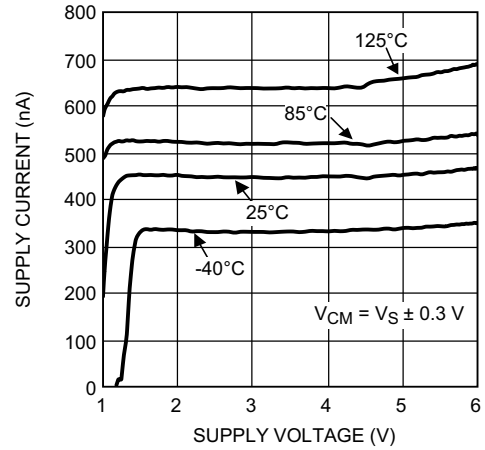


Figure 2. Supply Current vs. Supply Voltage

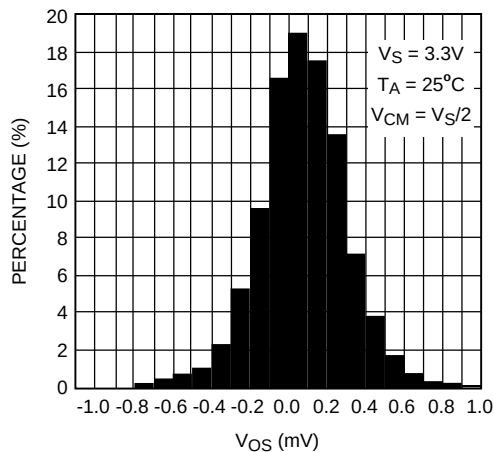


Figure 3. Offset Voltage Distribution

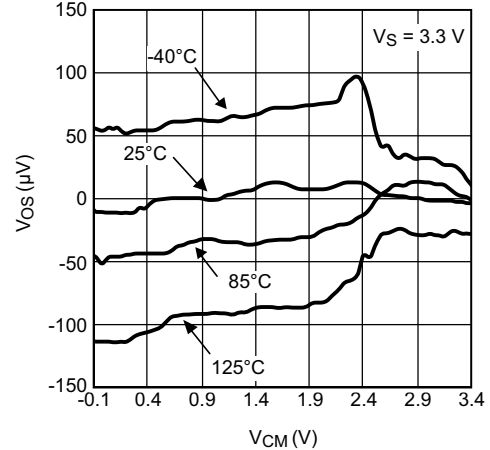


Figure 4. Input Offset Voltage vs. Input Common Mode

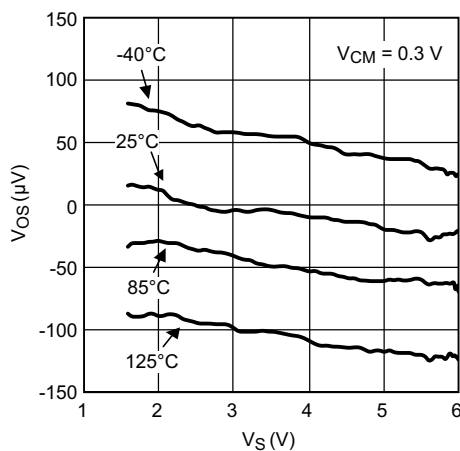


Figure 5. Input Offset Voltage vs. Supply Voltage

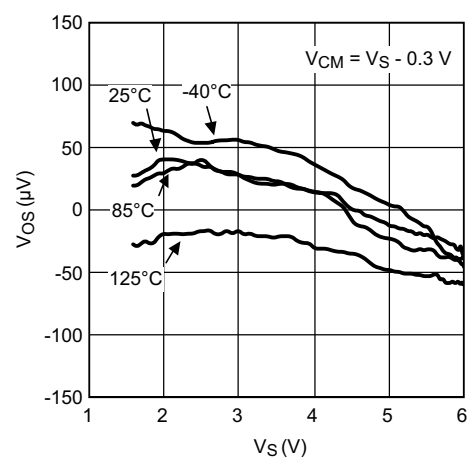


Figure 6. Input Offset Voltage vs. Supply Voltage

Typical Characteristics

At $T_J = 25^\circ\text{C}$, unless otherwise specified.

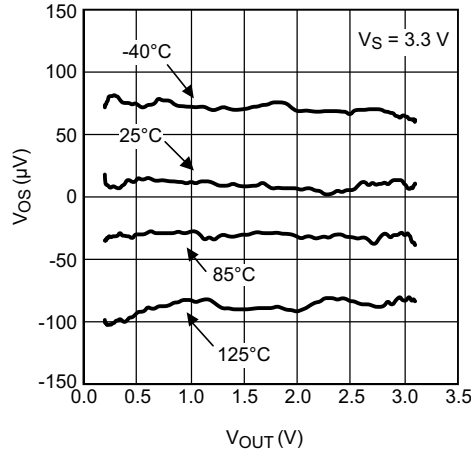


Figure 7. Input Offset Voltage vs. Output Voltage

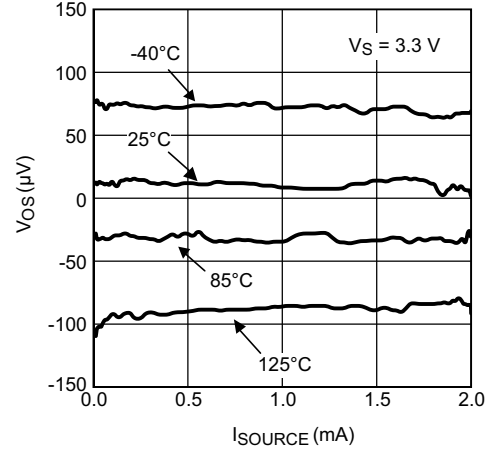


Figure 8. Input Offset Voltage vs. Sourcing Current

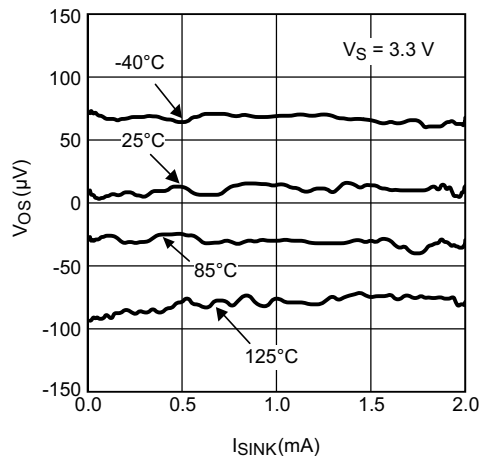


Figure 9. Input Offset Voltage vs. Sinking Current

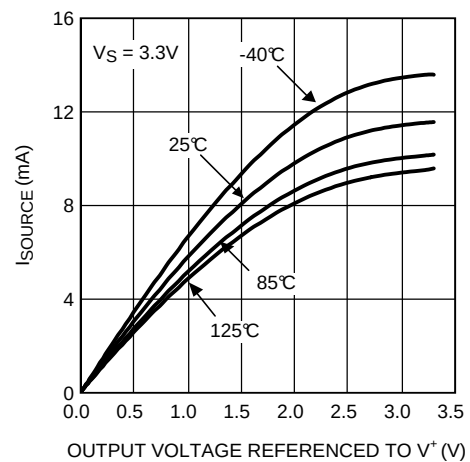


Figure 10. Sourcing Current vs. Output Voltage

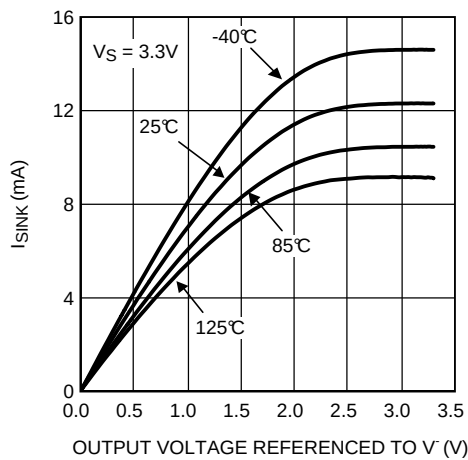


Figure 11. Sinking Current vs. Output Voltage

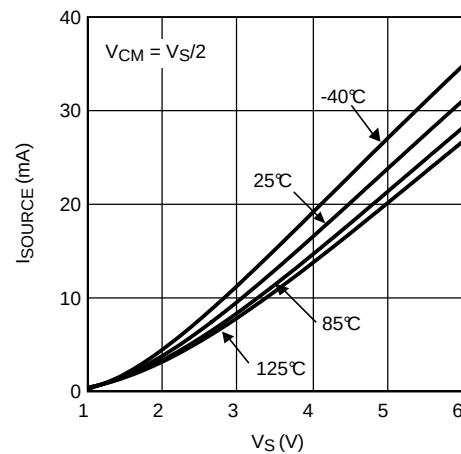


Figure 12. Sourcing Current vs. Supply Voltage

Typical Characteristics

At $T_J = 25^\circ\text{C}$, unless otherwise specified.

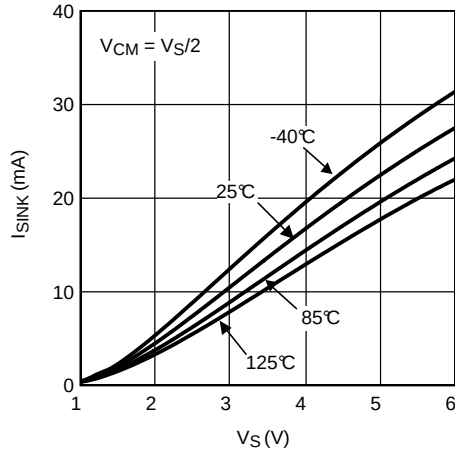


Figure 13. Sinking Current vs. Supply Voltage

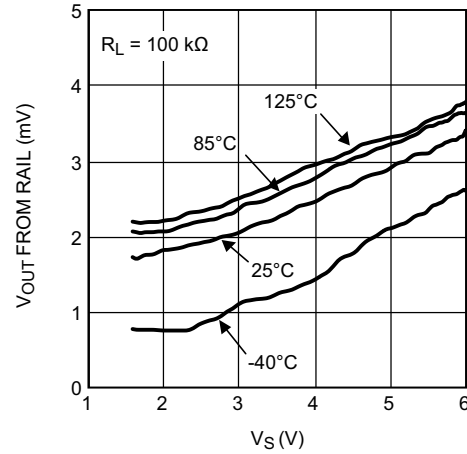


Figure 14. Output Swing High vs. Supply Voltage

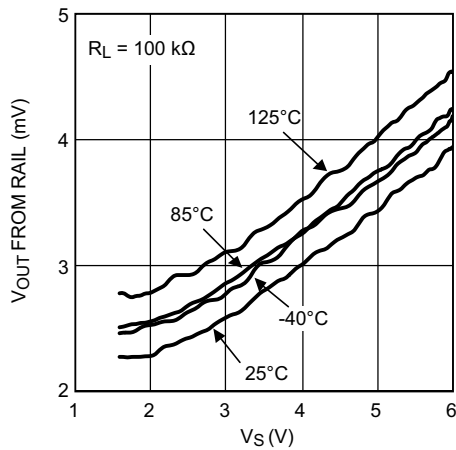


Figure 15. Output Swing Low vs. Supply Voltage

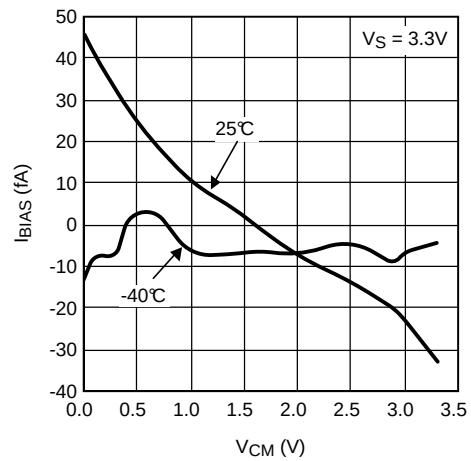


Figure 16. Input Bias Current vs. Common Mode Voltage

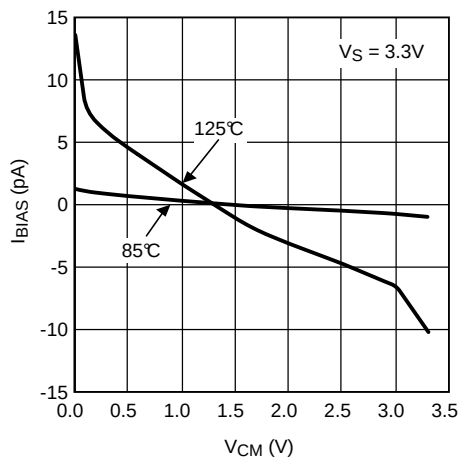


Figure 17. Input Bias Current vs. Common Mode Voltage

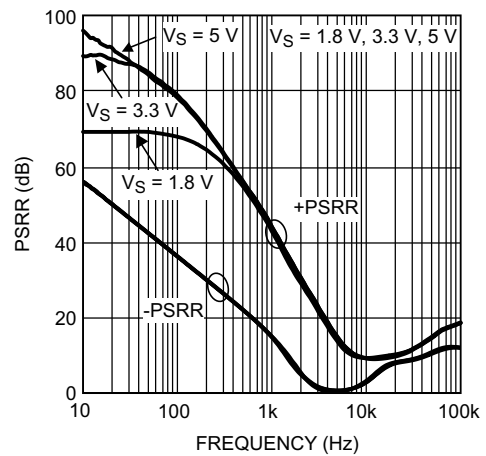


Figure 18. PSRR vs. Frequency

Typical Characteristics

At $T_J = 25^\circ\text{C}$, unless otherwise specified.

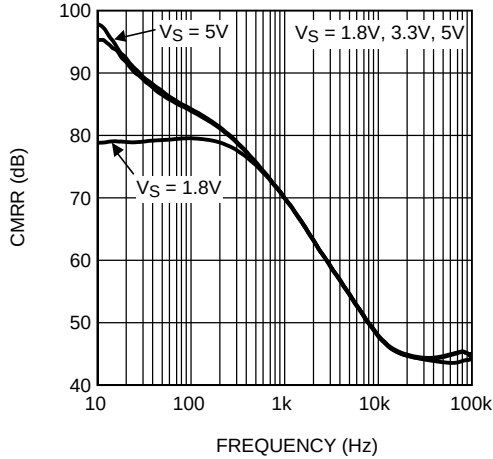


Figure 19. CMRR vs. Frequency

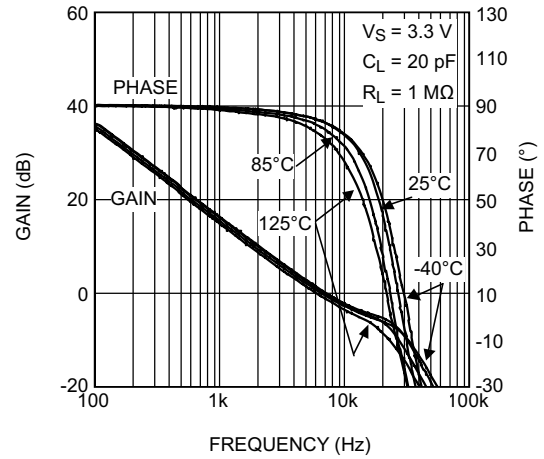


Figure 20. Frequency Response vs. Temperature

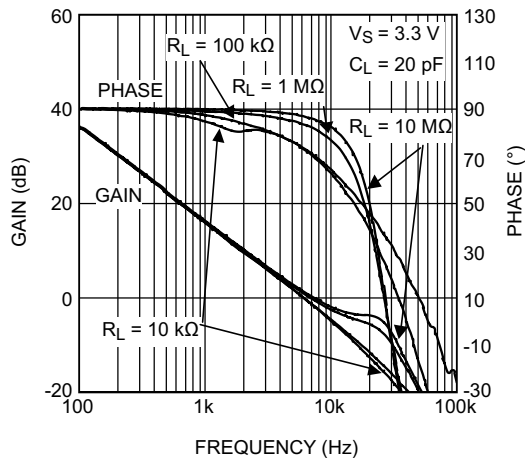


Figure 21. Frequency Response vs. R_L

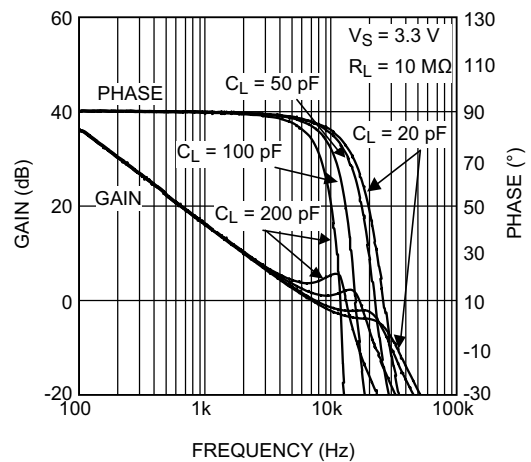


Figure 22. Frequency Response vs. C_L

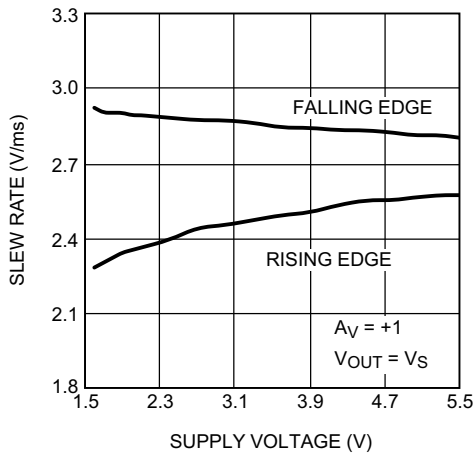


Figure 23. Slew Rate vs. Supply Voltage

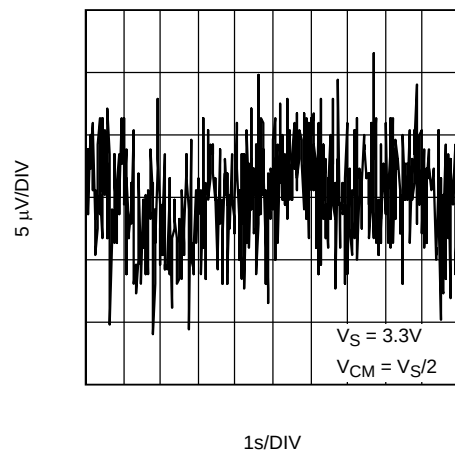


Figure 24. 0.1 to 10 Hz Time Domain Voltage Noise

Typical Characteristics

At $T_j = 25^\circ\text{C}$, unless otherwise specified.

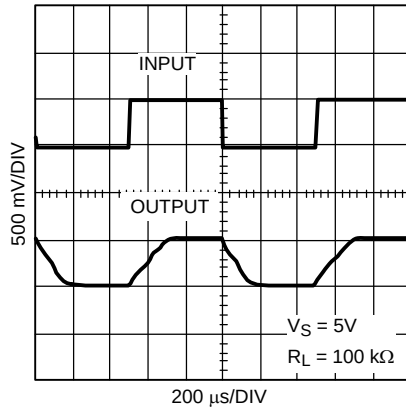


Figure 25. Large Signal Pulse Response

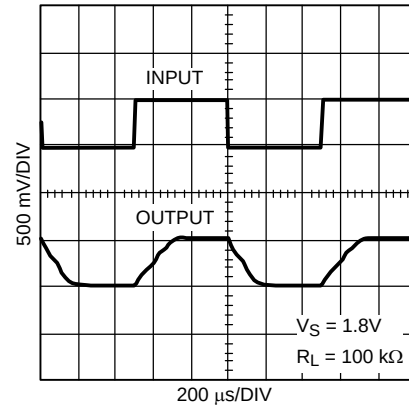


Figure 26. Large Signal Pulse Response

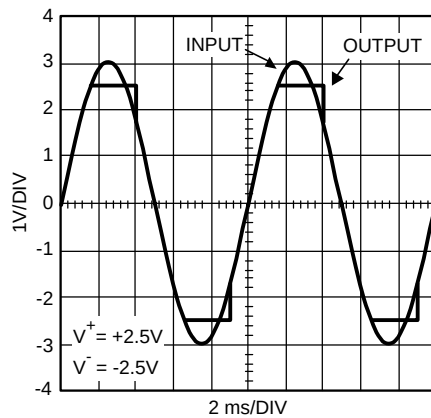


Figure 27. Overload Recovery Waveform

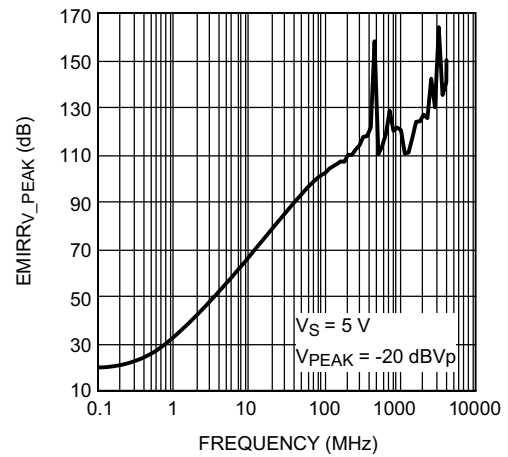
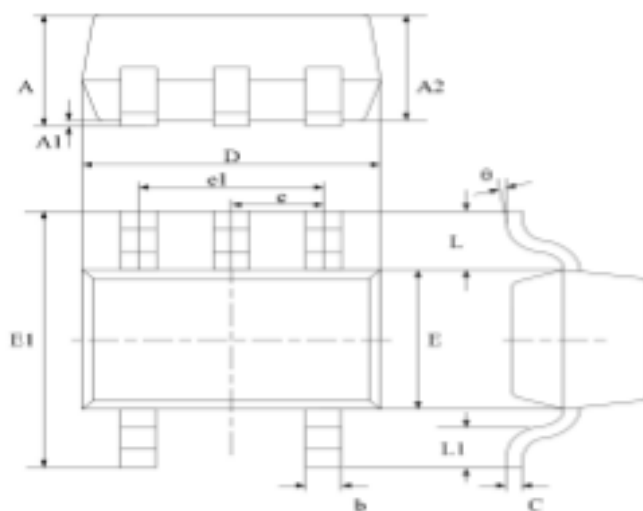


Figure 28. EMIRR vs. Frequency

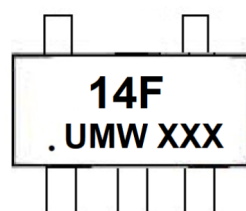
Package Dimension

SC70-5 (SOT353)



Symbol	Dimensions In Millimeters		Dimensions In Inches	
	Min	Max	Min	Max
A	0.800	1.100	0.035	0.043
A1	0.000	0.100	0.000	0.004
A2	0.800	0.900	0.035	0.039
b	0.150	0.350	0.006	0.014
C	0.080	0.150	0.003	0.006
D	1.8500	2.150	0.079	0.087
E	1.100	1.400	0.045	0.053
E1	1.950	2.200	0.085	0.096
e	0.850 typ.		0.026 typ.	
e1	1.200	1.400	0.047	0.055
L	0.42 ref.		0.021 ref.	
L1	0.260	0.460	0.010	0.018
θ	0°	8°	0°	8°

Marking



Ordering information

Order code	Package	Baseqty	Deliverymode
UMW TLV521DCKR	SC70-5	3000	Tape and reel