DC Parameters

National Semiconductor
Application Note 1873
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V_{OS} (Input Offset Voltage)

In an ideal case, in any op-amp circuit, when 0V is applied to the input, 0V should be expected at the output. In actuality, there is a voltage present at the output. This voltage is due to the number of mismatches of the op-amp's internal transistors and resistance. The value of V_{os} is determined by the voltage required to make the output voltage 0V.

TABLE 1. Offset Voltage for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **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 (Note 7)	V_{CM} = 4.5V		±6	±50 ±120	µV
		V_{CM} = 0.5V		±6	±40 ±100	

When looking at a datasheet, it is important to see at what voltage and conditions the part is specified at. The part in *Figure 1*, the LMP7731, is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. The first column is the abbreviated symbol of the parameter. The second column is the name and description of the parameter. In addition, there might be some added conditions to a particular parameter located in the third column. The offset voltage to the LMP7731 is specified at V_{CM} = 4.5V and 0.5V instead of the usual 2.5V. There are three test conditions, a Minimum, Typical and Maximum values. These are guaranteed values for the performance of this part. Also, for this parameter there are bolded maximum values, which indicate the condition at temperature extremes. The last column states the unit of the parameter.

In the "Typical Characteristics" section of this datasheet, there are various curves displaying different parameters. These curves are used to help understand the specified values of the datasheet.

In *Figure 2*, the offset voltage is -6µV at 5V and 25°C.

Offset Voltage vs. Supply Voltage

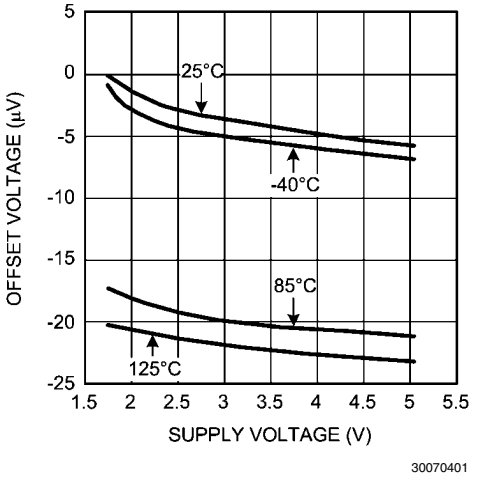

FIGURE 1. Offset Voltage vs. V_{CM} for LMP7731 (Typical Characteristics)

TCV_{OS} (Input Offset Voltage Drift)

TCV_{os} is defined as the temperature coefficient of the offset voltage. The value of TCV_{os} is determined by the amount of change in input offset voltage per degree Celsius.

TABLE 2. Offset Voltage Drift for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
TCV_{OS}	Input Offset Voltage Drift	V_{CM} = 4.5V		±0.5	±1.0	µV/°C
		V_{CM} = 0.5V		±0.2	±0.8	

Like the offset voltage, the offset voltage drift has the conditions of V_{CM} = 4.5V and 0.5V instead of the usual 2.5V.

In the upper left corner of *Figure 4*, the parameters of the graph are shown, with the supply voltage at 3.3 and 5V, common mode voltage at 0.5V and the temperature range from -40 °C to 125 °C.

The TCV_{OS} typical value for the LMP7731 according to *Figure 4* is -0.2µV/°C.

TCV_{OS} Distribution

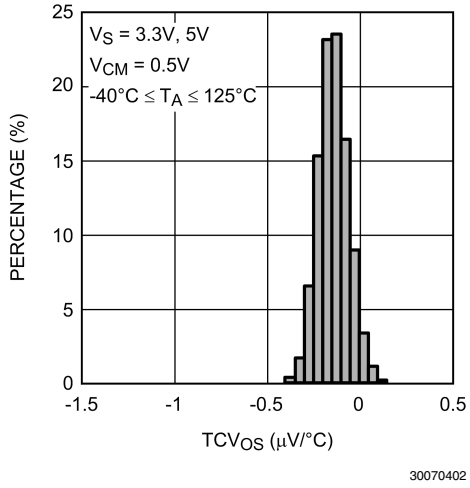

FIGURE 2. Percentage vs. TCV_{os} Distribution for LMP7731 (Typical Characteristics)

I_{IN} (Input Current)

An ideal op-amp has no current flowing in the input terminals. In actuality, there are small currents that flow through both input terminals. The input current is defined as the sum of the currents that flow into the op-amp.

TABLE 3. Input Current for LMP2011 (Electrical Characteristics)

5V DC Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_J = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = 2.5V and R_L > 1MΩ. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 3)	Typ (Note 2)	Max (Note 3)	Units
I_{IN}	Input Current			-3		pA

Looking at the top of the datasheet, *Figure 5*, the LMP2011 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_O = 2.5V, R_L >1MΩ. There are no additional conditions associated with this parameter.

I_{OS} (Input Offset Current)

The difference between the currents flowing into the input terminals.

TABLE 4. Input Offset Current for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
I_{OS}	Input Offset Current	V_{CM} = 4.5V		±1	±50 **±70**	nA
		V_{CM} = 0.5V		±11	±65 **±80**	

Looking at the top of the datasheet, Figure 6, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the conditions of V_{CM} = 4.5V and V_{CM} = 0.5V.

TCI_{OS} (Input Offset Current Drift)

The change in input offset current due to the change in temperature.

TABLE 5. Input Offset Current Drift for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
TCI_{OS}	Input Offset Current Drift	V_{CM} = 0.5V and V_{CM} = 4.5V		0.0482		nA/°C

Looking at the top of the datasheet, Figure 7, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the conditions of V_{CM} = 0.5V and V_{CM} = 4.5V.

I_B (Bias Current)

In an ideal op-amp circuit, there should be no current flowing in or out of the input terminals. But in actuality, there is a small current that flows into both terminals. The bias current is calculated as the average of the two input currents.

TABLE 6. Bias Current for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
I_B	Input Bias Current	V_{CM} = 4.5V		±1.5	±30 **±50**	nA
		V_{CM} = 0.5V		±14	±50 **±85**	

Looking at the top of the datasheet, Figure 7, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the conditions of V_{CM} = 0.5V and V_{CM} = 4.5V.

In the upper right corner of Figure 8, the conditions of this graph are shown with the supply voltage at 5V.

The input bias current value at V_{CM} = 0.5V at 25°C is at 14nA

The input bias current value at V_{CM} = 4.5V at 25°C is at 1.5nA

Input Bias Current vs. V_{CM}

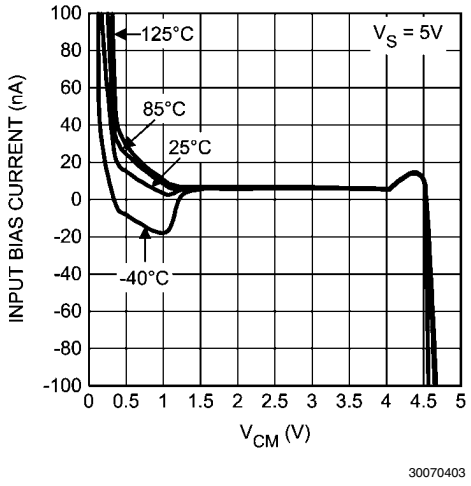

FIGURE 3. Input Bias Current vs. VCM For LMP7731 (Typical Characteristics)

CMRR (Common Mode Rejection Ratio)

This parameter is calculated as the change in input offset voltage with respect to the change in the common mode voltage. CMRR is defined as $20*\log(\Delta V_{CM}/\Delta V_{OS})$, in decibels (dB).

TABLE 7. Common Mode Rejection Ratio for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
CMRR	Common Mode Rejection Ratio	0.15V ≤ V_{CM} ≤ 0.7V	101	120		dB
		0.23 ≤ V_{CM} ≤ 0.7V	89			
		1.5V ≤ V_{CM} ≤ 4.85V	105	130		
		1.5V ≤ V_{CM} ≤ 4.77V	99			

Looking at the top of the datasheet, Figure 10, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the V_{CM} conditions ranging between 0.15 and 0.7, 0.23 and 0.7, 1.5 and 4.85, and 1.5 and 4.77 volts.

In the upper right corner of Figure 11, the conditions of this parameter are given as the supply voltage at 2.5, 3.3, and 5 volts.

The CMRR for the LMP7731 at 5V is measured to be 130dB.

CMRR vs. Frequency

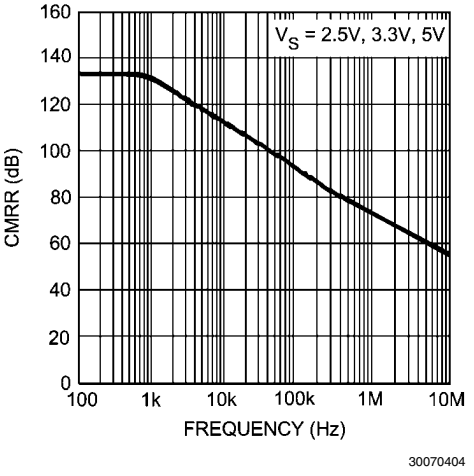

FIGURE 4. Common Mode Rejection Ratio vs. Frequency For LMP7731 (Typical Characteristics)

PSRR (Power Supply Rejection Ratio)

This parameter is calculated as the change in input offset voltage with respect to the change in power supply voltage. PSRR is defined as $20*\log(\Delta V_{OS}/\Delta V_{SUPPLY})$, in decibels (dB).

TABLE 8. Power Supply Rejection Ratio for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
PSRR	Power Supply Rejection Ratio	2.5V ≤ V+ ≤ 5V	111 105	129		dB
		1.8V ≤ V+ ≤ 5.5V		117		

Looking at the top of the datasheet, Figure 12, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the V^+ conditions in the range of 2.5 to 5, and 1.8 to 5.5 volts.

The PSRR for the LMP7731 at 5V is measured to be 129dB

PSRR vs. Frequency

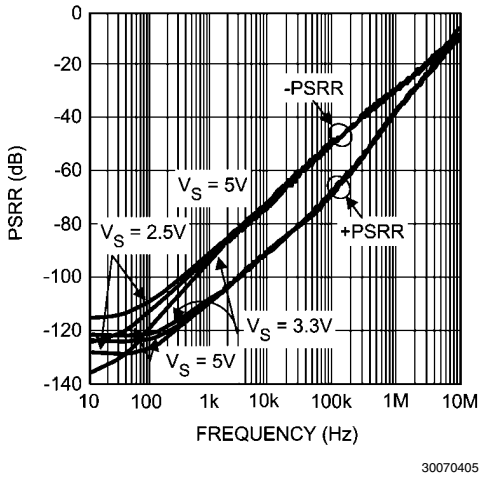

FIGURE 5. Power Supply Rejection Ratio vs. Frequency For LMP7731 (Typical Characteristics)

A_{VOL} (Open Loop/Large Signal Voltage Gain)

The ratio of the output signal to the input signal (the gain) of the amplifier without external feedback, in decibels (dB).

TABLE 9. Large Signal Voltage Gain for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
A_{VOL}	Large Signal Voltage Gain	R_L = 10 kΩ to V+/2 V_O = 0.5V to 4.5V	112 104	130		dB
		R_L = 2 kΩ to V+/2 V_O = 0.5V to 4.5V	110 94	119		

Looking at the top of the datasheet, Figure 14, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L >10kΩ to $V^+/2$. This particular parameter has the R_L = 10kΩ to $V^+/2$ with V_O from 0.5 to 4.5V and R_L = 2kΩ to $V^+/2$ with V_O from 0.5 to 4.5V.

V_O (Voltage Swing)

This is the maximum peak-to-peak voltage swing that can be inputted to the circuit without clipping the signal.

Table 10. Output Swing High and Low for LMP7731 (Electrical Characteristics)

TABLE 10. Offset Voltage for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
V_O	Output Swing High	R_L = 10 kΩ to V+/2		8	50 75	mV from either rail
		R_L = 2 kΩ to V+/2		24	50 75	
	Output Swing Low	R_L = 10 kΩ to V+/2		9	50 75	
		R_L = 2 kΩ to V+/2		23	50 75	

Looking at the top of the datasheet, Figure 15, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L >10kΩ to $V^+/2$. This particular parameter has the R_L = 10kΩ to $V^+/2$ and R_L = 2kΩ to $V^+/2$.

I_O (Output Short Circuit Current)

The amount of current that is drawn from the output.

TABLE 11. Output Short Circuit Current for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
I_O	Output Short Circuit Current	Sourcing, V_O = V+/2	33 27	47		mA
		Sinking, V_O = V+/2 V_{IN} (diff) = −100 mV	30 25	49		

Looking at the top of the datasheet, Figure 15, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the V_O = V^+/2 with V_{IN} (diff) = 100mV for sourcing and V_O = V^+/2 with V_{IN} (diff) = -100mV for sinking.

I_S (Supply Current)

The current into the Vcc+ and Vcc- inputs required to operate the op amp.

TABLE 12. Supply Current for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L > 10 kΩ to V^+/2. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
I_S	Supply current (Per Channel)	V_{CM} = 4.5V		2.2	3.0 3.7	mA
		V_{CM} = 0.5V		2.5	3.4 4.2	

Looking at the top of the datasheet, Figure 15, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = V^+/2, R_L >10kΩ to V^+/2. This particular parameter has the V_{CM}=4.5 and 0.5V.

CMVR (Common Mode Voltage Range)

(Also called Input Voltage Range) The amplifier's common mode voltage operation range. If the common mode voltage has exceeded the limits, the op amp will not function as stated in the datasheet.

TABLE 13. Input Common-Mode Voltage Range for LMP7731 (Electrical Characteristics)

5V Electrical Characteristics

Unless otherwise specified, all limits are guaranteed for T_A = 25°C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L > 10 kΩ to $V^+/2$. **Boldface** limits apply at the temperature extremes.

Symbol	Parameter	Conditions	Min (Note 6)	Typ (Note 5)	Max (Note 6)	Units
CMVR	Input Common-Mode Voltage Range	Large Signal CMRR ≥ 80 dB	0		5	V

Looking at the top of the datasheet, Figure 12, the LMP7731 is specified at 5V, at 25 °C, V^+ = 5V, V^- = 0V, V_{CM} = $V^+/2$, R_L >10kΩ to $V^+/2$. This particular parameter has the Large Signal CMRR ≥ 80dB.

Notes

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