Low Noise, Low Drift FET Op Amp

AD645

FEATURES
Improved Replacement for Burr-Brown OPA-111 and OPA-121 Op Amp

LOW NOISE
2 μV p-p max, 0.1 Hz to 10 Hz
10 nV/√Hz max at 10 kHz
11 fA p-p Current Noise 0.1 Hz to 10 Hz

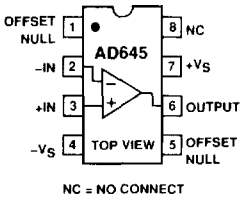
IMPROVED DRIFT

HIGH DC ACCURACY
250 μV max Offset Voltage
1 μV/°C max Drift
1.5 pA max Input Bias Current
114 dB Open-Loop Gain
Available in Plastic Mini-DIP, 8-Pin Header Packages, or Chip Form

APPLICATIONS
Low Noise Photodiode Preamps
CT Scanners
Precision I-V Converters

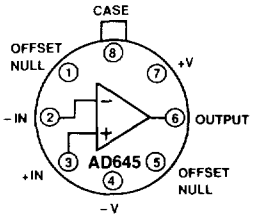
CONNECTION DIAGRAMS

8-Pin Plastic Mini-DIP (N) Package



NC = NO CONNECT

TO-99 (H) Package



NOTE: CASE IS CONNECTED TO PIN 8

PRODUCT DESCRIPTION

The AD645 is a low noise, precision FET input op amp. It offers the pico amp level input currents of a FET input device coupled with offset drift and input voltage noise comparable to a high performance bipolar input amplifier.

The AD645 has been improved to offer the lowest offset drift in a FET op amp, 1 μV/°C. Offset voltage drift is measured and trimmed at wafer level for the lowest cost possible. An inherently low noise architecture and advanced manufacturing techniques result in a device with a guaranteed low input voltage noise of 2 μV p-p, 0.1 Hz to 10 Hz. This level of dc performance along with low input currents make the AD645 an excellent choice for high impedance applications where stability is of prime concern.

The AD645 is available in six performance grades. The AD645J and AD645K are rated over the commercial temperature range of 0°C to +70°C. The AD645A, AD645B, and the ultra-precision AD645C are rated over the industrial temperature range of -40°C to +85°C. The AD645S is rated over the military temperature range of -55°C to +125°C and is available processed to MIL-STD-883B.

The AD645 is available in an 8-pin plastic mini-DIP, 8-pin header, or in die form.

PRODUCT HIGHLIGHTS

1. Guaranteed and tested low frequency noise of 2 μV p-p max and 20 nV/√Hz at 100 Hz makes the AD645C ideal for low noise applications where a FET input op amp is needed.
2. Low V_{OS} drift of 1 μV/°C max makes the AD645C an excellent choice for applications requiring ultimate stability.
3. Low input bias current and current noise (11 fA p-p 0.1 Hz to 10 Hz) allow the AD645 to be used as a high precision preamp for current output sensors such as photodiodes, or as a buffer for high source impedance voltage output sensors.

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ORDERING GUIDE

Model[1]	Temperature Range	Package Option[2]
AD645JN	0°C to +70°C	N-8
AD645KN	0°C to +70°C	N-8
AD645AH	-40°C to +85°C	H-08A
AD645BH	-40°C to +85°C	H-08A
AD645CH	-40°C to +85°C	H-08A
AD645SH/883B	-55°C to +125°C	H-08A

NOTES
[1]Chips are also available.
[2]N = Plastic Mini-DIP; H = Metal Can. For outline information see Package Information section.

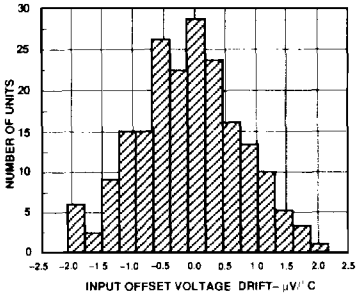

Figure 2. Typical Distribution of Average Input Offset Voltage Drift (196 Units)

AD645—SPECIFICATIONS (@ +25°C, and ±15 V dc, unless otherwise noted)

Model	Conditions	AD645J/A			AD645K/B			AD645C			AD645S			Units
		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
INPUT OFFSET VOLTAGE[1]														
Initial Offset			100	500		50	250		50	250		100	500	μV
Offset	T_{MIN}, T_{MAX}		300	1000		100	400		75	300		500	1500	μV
Drift (Average)			3	10/5		1	5/2		0.5	1		4	10	μV/°C
vs. Supply (PSRR)		90	110		94	110		94	110		90	110		dB
vs. Supply	T_{MIN}, T_{MAX}		100		90	100		90	100		86	95		dB
INPUT BIAS CURRENT[2]														
Either Input	V_{CM} = 0 V		0.7/1.8	3/5		0.7/1.8	1.5/3		1.8	3		1.8	5	pA
Either Input @ T_{MAX}	V_{CM} = 0 V		16/115			16/115			115			1800		pA
Either Input	V_{CM} = +10 V		0.8/1.9			0.8/1.9			1.9			1.9		pA
Offset Current	V_{CM} = 0 V		0.1	1.0		0.1	0.5		0.1	0.5		0.1	1.0	pA
Offset Current @ T_{MAX}	V_{CM} = 0 V		2/6			2/6			6			100		pA
INPUT VOLTAGE NOISE	0.1 to 10 Hz		1.0	3.0		1.0	2.5		1	2		1.0	3.3	μV p-p
	f = 10 Hz		20	50		20	40		20	40		20	50	nV/√Hz
	f = 100 Hz		10	30		10	20		10	20		10	30	nV/√Hz
	f = 1 kHz		9	15		9	12		9	12		9	15	nV/√Hz
	f = 10 kHz		8	10		8	10		8	10		8	10	nV/√Hz
INPUT CURRENT NOISE	f = 0.1 to 10 Hz		11	20		11	15		11	15		11	20	fA p-p
	f = 0.1 thru 20 kHz		0.6	1.1		0.6	0.8		0.6	0.8		0.6	1.1	fA/√Hz
FREQUENCY RESPONSE														
Unity Gain, Small Signal			2			2			2			2		MHz
Full Power Response	V_O = 20 V p-p													
	R_{LOAD} = 2 kΩ	16	32		16	32		16	32		16	32		kHz
Slew Rate, Unity Gain	V_{OUT} = 20 V p-p													
	R_{LOAD} = 2 kΩ	1	2		1	2		1	2		1	2		V/μs
SETTLING TIME[3]														
To 0.1%			6			6			6			6		μs
To 0.01%			8			8			8			8		μs
Overload Recovery[4]	50% Overdrive		5			5			5			5		μs
Total Harmonic Distortion	f = 1 kHz													
	R_{LOAD} ≥ 2 kΩ													
	V_O = 3 V rms		0.0006			0.0006			0.0006			0.0006		%
INPUT IMPEDANCE														
Differential	V_{DIFF} = ±1 V		10^{12}‖1			10^{12}‖1			10^{12}‖1			10^{12}‖1		Ω‖pF
Common-Mode			10^{14}‖2.2			10^{14}‖2.2			10^{14}‖2.2			10^{14}‖2.2		Ω‖pF
INPUT VOLTAGE RANGE														
Differential[5]			±20			±20			±20			±20		V
Common-Mode Voltage		±10	+11, −10.4		±10	+11, −10.4		±10	+11, −10.4		±10	+11, −10.4		V
Over Max Oper. Range		±10			±10			±10			±10			V
Common-Mode Rejection Ratio	V_{CM} = ±10 V	90	110		94	110		94	110		90	110		dB
	T_{MIN}, T_{MAX}		100		90	100		90	100		86	100		dB
OPEN-LOOP GAIN	V_O = ±10 V													
	R_{LOAD} ≥ 2 kΩ	114	130		120	130		120	130		114	130		dB
	T_{MIN}, T_{MAX}				114			114			110			dB
OUTPUT CHARACTERISTICS														
Voltage	R_{LOAD} ≥ 2 kΩ	±10	±11		±10	±11		±10	±11		±10	±11		V
	T_{MIN}, T_{MAX}	±10			±10			±10			±10			V
Current	V_{OUT} = ±10 V	±5	±10		±5	±10		±5	±10		±5	±10		mA
	Short Circuit		±15			±15			±15			±15		mA
POWER SUPPLY														
Rated Performance			±15			±15			±15			±15		V
Operating Range		±5		±18	±5		±18	±5		±18	±5		±18	V
Quiescent Current			3.0	3.5		3.0	3.5		3.0	3.5		3.0	3.5	mA
Transistor Count	# of Transistors		62			62			62			62		

NOTES

[1]Input offset voltage specifications are guaranteed after 5 minutes of operation at T_A = +25°C.

[2]Bias current specifications are guaranteed maximum at either input after 5 minutes of operation at T_A = +25°C. For higher temperature, the current doubles every 10°C.

[3]Gain = −1, R_{LOAD} = 2 kΩ.

[4]Defined as the time required for the amplifier's output to return to normal operation after removal of a 50% overload from the amplifier input.

[5]Defined as the maximum continuous voltage between the inputs such that neither input exceeds ±10 V from ground.

All min and max specifications are guaranteed.

Specifications subject to change without notice.