36V, Single-Supply, General-Purpose Operational Amplifiers

General Description

The ET85904 is a 36V, single-supply, low-noise operational amplifiers with the ability to operate on supplies ranging from 2.7 V (±1.35 V) to 36 V (±18 V). These devices are available in micro-packages and offer low offset, drift, and bandwidth with low quiescent current.

Unlike most operational amplifiers, which are specified at only one supply voltage, the ET85904 is specified from 2.7 to 36 V. Input signals beyond the supply rails do not cause phase reversal. The ET85904 is stable with capacitive loads up to 300 pF. The input can operate 100 mV below the negative rail and within 2 V of the top rail during normal operation. These devices can operate with full rail-to-rail input 100 mV beyond the top rail, but with reduced performance within 2 V of the top rail.

ET85904 is specified for the extended industrial / automotive temperature range (-40°C to +125°C). They are available in SOP14 and TSSOP14 packages.

Features

- Scalable CMOS amplifier for low-cost applications
- Supply range: 2.7 to 36 V, ±1.35 V to ±18 V
- Low noise: 14 nV/√Hz
- Low offset drift: ±0.3 μV/°C (typical)
- RFI filtered inputs
- Input range includes the negative supply
- Input range operates to positive supply
- Rail-to-rail output
- Gain bandwidth: 3 MHz
- Low quiescent current: 475 μA per amplifier
- High common-mode rejection: 120 dB (typical)
- Low-input bias current: 8 pA
- SOP14 or TSSOP14 Package

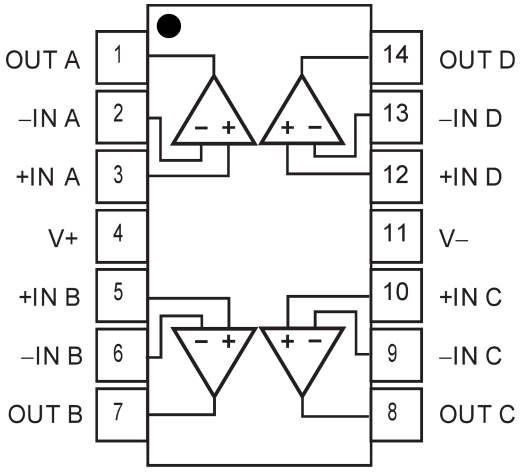
Applications

- Tracking amplifier in power modules
- Temperature measurements
- Transducer amplifiers
- Transducer amplifiers
- Bridge amplifiers

Device information

Part No.	Package	Tape / Reel
ET85904M	SOP14	Tape and Reel
ET85904V	TSSOP14	Tape and Reel

Pin Configuration

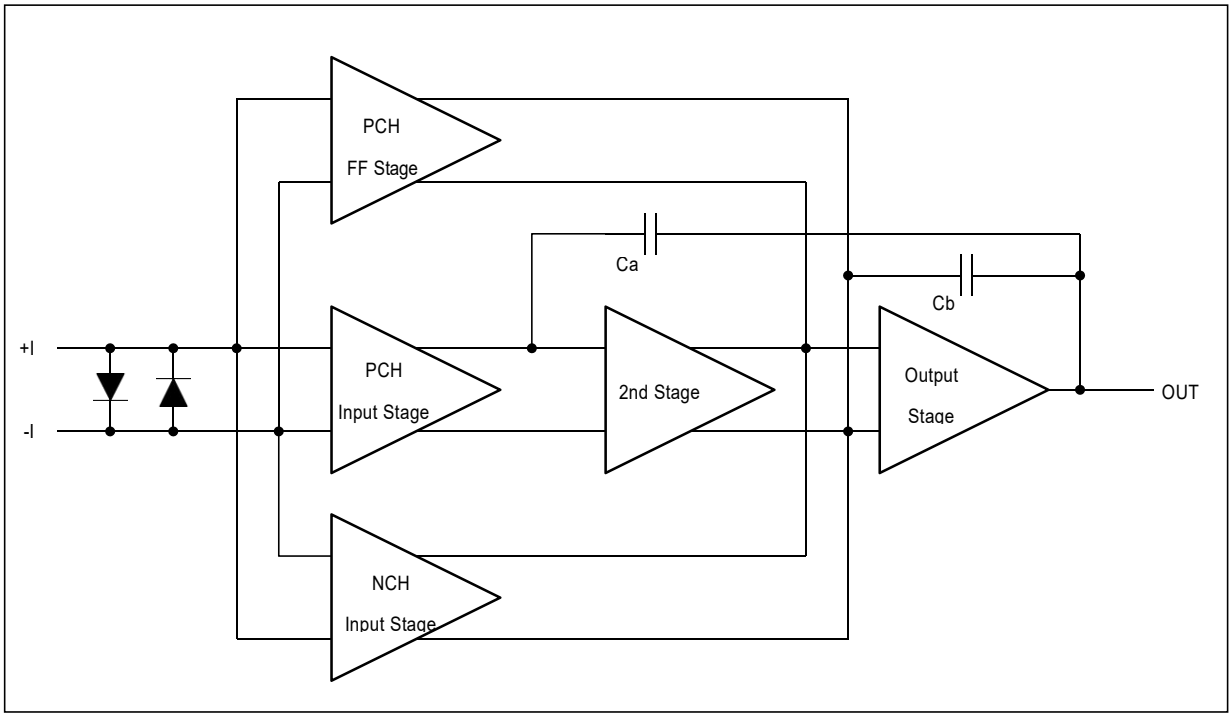


Top View

Pin Function

Pin Number	Symbol	Descriptions
1,7,8,14	OUT	Output
11	V-	Negative supply
3,5,10,12	+IN	Non-inverting input
2,6,9,13	-IN	Inverting input
4	V+	Positive supply

Functional Block Diagram



Functional Description

Over View

The ET85904 operational amplifiers provide high overall performance, and are designed for many general purpose applications. The excellent offset drift of only 2 μV/°C provides excellent stability over the entire temperature range. In addition, the series offers good overall performance with high CMRR, PSRR, and AOL. As with all amplifiers, applications with noisy or high-impedance power supplies require decoupling capacitors close to the device pins. In most cases, 0.1 μF capacitors are adequate.

Common-Mode Voltage Range

The input common-mode voltage range extends 100 mV below the negative rail and within 2V of the top rail for normal operation. ET85904 can operate with full rail-to-rail input 100 mV beyond the top rail, but with reduced performance within 2V of the top rail. The typical performance in this range is summarized in Below Table:

Parameter	Min	Typ	Max	Unit
Input common-mode voltage	(V+) – 2		(V+) + 0.1	V
Offset voltage		7		mV
vs temperature		12		μV/°C
Common-mode rejection		65		dB
Open-loop gain		60		dB
GBW		0.7		MHz
Slew rate		0.7		V/μs
Noise at f = 1 kHz		30		nV/√Hz

Phase-Reversal Protection

ET85904 has an internal phase-reversal protection. Many operational amplifiers exhibit a phase reversal when the input is driven beyond its linear common-mode range. This condition is most often encountered in noninverting circuits when the input is driven beyond the specified common-mode voltage range, causing the output to reverse into the opposite rail. The input prevents phase reversal with excessive common-mode voltage. Instead, the output limits into the appropriate rail. This performance is shown in Figure 37.

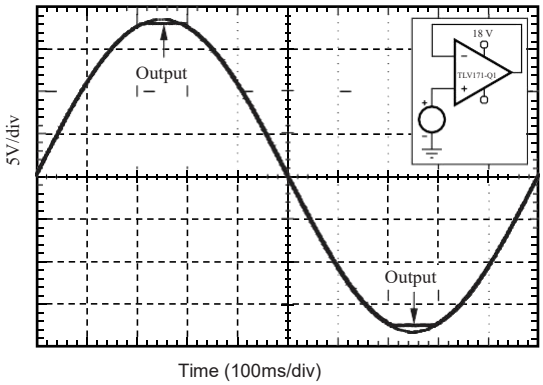


Figure 37. No Phase Reversal

Capacitive Load and Stability

The dynamic characteristics have been optimized for commonly encountered operating conditions. The combination of low closed-loop gain and high capacitive loads decreases the phase margin of the amplifier and can lead to gain peaking or oscillations. As a result, heavier capacitive loads must be isolated from the output. The simplest way to achieve this isolation is to add a small resistor (for example, R_{OUT} equal to 50 Ω) in series with the output.

Operating Voltage

ET85904 is specified for operation from 4.5 V to 36 V (±2.25 V to ±18 V); many specifications apply from -40°C to +125°C.

Place 0.1uF bypass capacitors close to the power-supply pins to reduce errors coupling in from noisy or high-impedance power supplies.

Absolute Maximum Ratings

Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. These are only stress ratings, and functional operation of the device at these or any other conditions beyond those indicated under recommended operating conditions are not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

Parameter	Rating	Unit
Supply Voltage(1)	0 to 40	V
Signal input terminals Voltage	(V-)-0.3V to (V+)+0.5	V
Signal input terminals Current	-10 to +10	mA
ESD (Human Body Model)	±4000	V
Storage Temperature Range	-65 to +150	°C
Max Junction Temperature Range	-65 to +150	°C
Lead Temperature Range（Soldering, 60 sec）	300	°C

Note1: All voltage values, except differential voltage are with respect to network terminal.

Thermal Characteristics

Symbol	Package	Ratings	Value	Unit
$R_{\theta JA}$	SOP14	Thermal Characteristics, Thermal Resistance, Junction-to-Air	105	°C/W
	TSSOP14		95	°C/W

Recommended Operating Conditions

Characteristic	Symbol	Min	Max	Unit
DC Supply Voltage	(V+ – V-)	4.5 (±2.25)	36 (±18)	V
Operating Temperature Range	T_A	-40	+125	°C

Electrical Characteristics

T_A = 25°C, V_S = 2.7 to 36V, V_{CM} = V_{OUT} = V_S/2, and R_{LOAD} = 10kΩ connected to V_S/2, (unless otherwise noted)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
OFFSET VOLTAGE						
V_{OS}	Input offset voltage			0.25	±1.8	mV
	Over temperature	T_A = –40°C to +125°C		0.3	±2	mV
dV_{OS}/dT	Drift	T_A = –40°C to +125°C		0.3	±2	µV/°C
	vs power supply	V_S = 4 to 36 V T_A = –40°C to +125°C		1	±3	µV/V
	Channel separation, DC	DC		5		µV/V
INPUT BIAS CURRENT						
I_B	Input bias current			±8	±15	pA
	Over temperature	T_A = –40°C to +125°C		±3.5		nA
I_{OS}	Input offset current			±4		pA
	Over temperature	T_A = –40°C to +125°C		±3.5		nA
NOISE						
	Input voltage noise	f = 0.1 Hz to 10 Hz		3		μV_{PP}
e_n	Input voltage noise density	f = 100 Hz		25		nV/√Hz
		f = 1 kHz		14		nV/√Hz
INPUT VOLTAGE						
V_{CM}	Common-mode voltage range[(1)]		(V-) – 0.1		(V+) – 2	V
CMRR	Common-mode rejection ratio	V_S = ±2 V (V-) – 0.1 V < V_{CM} < (V+) – 2 V T_A = -40°C to +125°C	90	104		dB
		V_S = ±18 V (V-) – 0.1 V < V_{CM} < (V+) – 2 V T_A = -40°C to +125°C	104	120		dB
INPUT IMPEDANCE						
	Differential			100 || 3		MΩ || pF
	Common-mode			6 || 3		GΩ || pF
OPEN-LOOP GAIN						
A_{OL}	Open-loop voltage gain	V_S = 4 V to 36 V (V-) + 0.35V < V_O < (V+) - 0.35V T_A = -40°C to +125°C	110	130		dB

Electrical Characteristics (Continued)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
FREQUENCY RESPONSE						
GBP	Gain bandwidth product			3		MHz
SR	Slew rate	G = 1		1.5		V/μs
t_S	Settling time	To 0.1%, V_S = ±18 V, G = 1 ,10 V step		6		μs
		To 0.01% (12 bit) ,V_S = ±18 V, G = 1,10V step		10		μs
	Overload recovery time	V_{IN} × gain > V_S		2		μs
THD+N	Total harmonic distortion + noise	G = 1, f = 1 kHz V_O = 3 V_{RMS}		0.0002		%
OUTPUT						
V_O	Voltage output swing from rail	V_S = 5 V R_L = 10 kΩ		30		mV
	Over temperature	R_L = 10 kΩ A_{OL} ≥ 110 dB T_A = –40°C to +125°C	(V-) + 0.35		(V+) – 0.35	V
I_{SC}	Short-circuit current			+25/–35		mA
C_{LOAD}	Capacitive load drive					pF
R_O	Open-loop output resistance	f = 1 MHz I_O = 0 A		150		Ω
POWER SUPPLY						
V_S	Specified voltage range		2.7		36	V
I_Q	Quiescent current per amplifier	I_O = 0 A		475	595	μA
	Over temperature	I_O = 0 A T_A = –40°C to +125°C		650		μA
TEMPERATURE						
	Specified range		–40		125	°C
	Operating range		–55		150	°C

Note1: The input range can be extended beyond (V+) - 2 V up to V+.

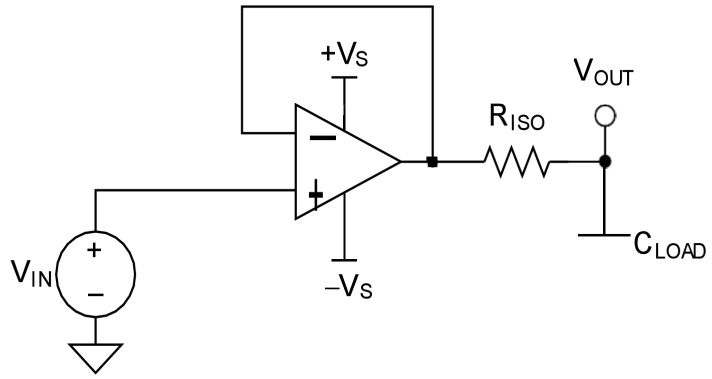
Application Notes

The OPAx171 operational amplifiers provide high overall performance, and are designed for many general-purpose applications. The excellent offset drift of only 2 μV/°C provides excellent stability over the entire temperature range. In addition, the series offers good overall performance with high CMRR, PSRR, and A_{OL}. As with all amplifiers, applications with noisy or high-impedance power supplies require decoupling capacitors close to the device pins. In most cases, 0.1-μF capacitors are adequate.

Layout Guidelines

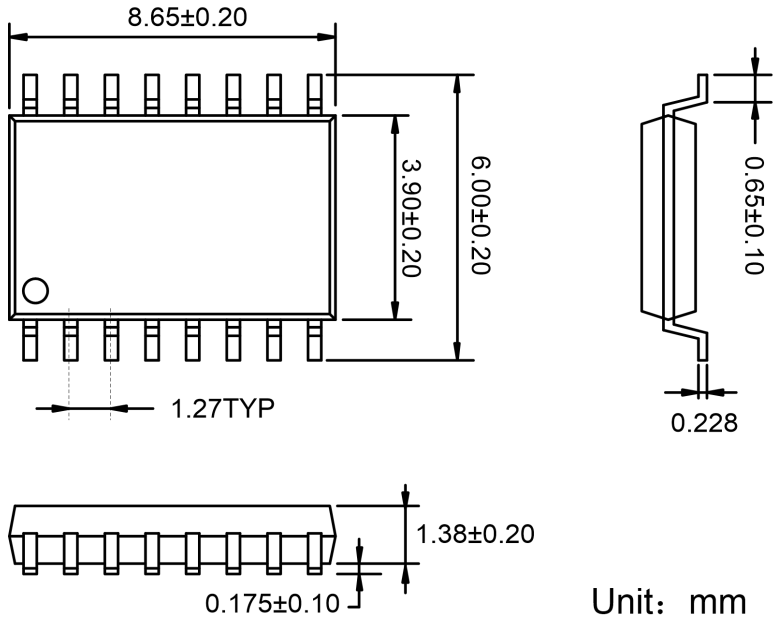
For best operational performance of the devices, good printed circuit board (PCB) layout practices are recommended. Low-loss, 0.1-μF bypass capacitors must be connected between each supply pin and ground, placed as close to the devices as possible. A single bypass capacitor from V+ to ground is applicable to single- supply applications.

Typical Application

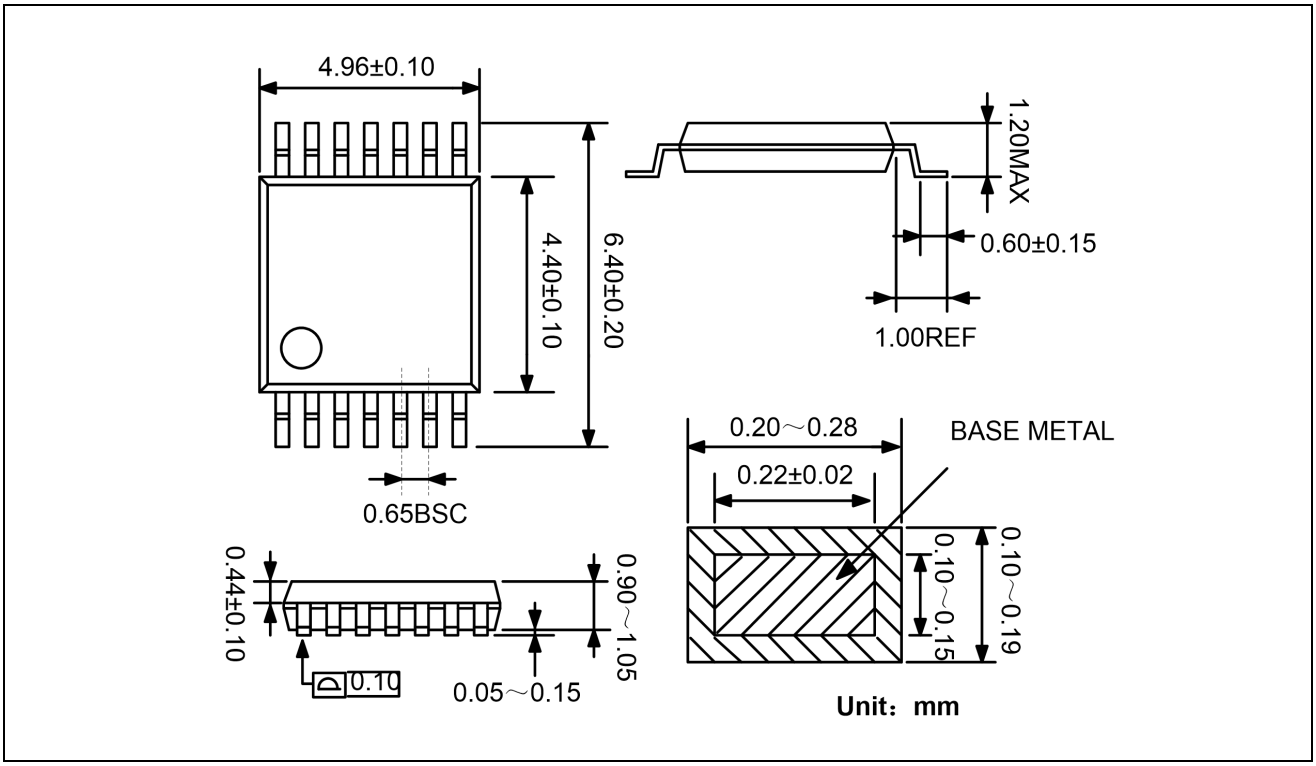


Package Dimension

SOP14



TSSOP14



Revision History and Checking Table

Version	Date	Revision Item	Modifier	Function & Spec Checking	Package & Tape Checking
0	2022-9-21	Preliminary Version	Shibo	Wanggp	Liujy