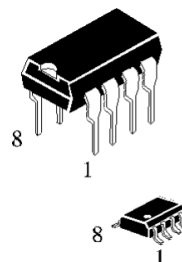


## Low Power Dual Operational Amplifier

(compatible to LM2904 )

The HT2904A contains two independent high gain operational amplifiers with internal frequency compensation. The op-amps operate over a wide voltage range. The low power drain makes the HT2904A a good choice for battery operation.

- ☐ Internally frequency compensated for unity gain
- ☐ Large DC voltage gain
- ☐ Single or Split Supply Operation
- ☐ Input common-mode voltage range to ground
- ☐ Large output voltage swing: 0V DC to  $V_{CC}-1.5V$  DC
- ☐ Power drain suitable for battery operation
- ☐ Low input offset voltage and offset current
- ☐ Differential input voltage range equal to the power supply voltage



### ORDERING INFORMATION

HT2904ANZ Plastic

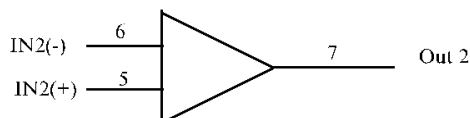
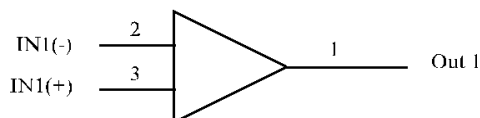
HT2904ARZ SOP

HT2904ARMZ MSOP8

HT2904AG Chip

$T_A = -40^\circ$  to  $125^\circ$  C for all packages

### BLOCK DIAGRAM



PIN 4 = GND

PIN 8 =  $V_{CC}$

**MAXIMUM RATINGS \***

| Symbol           | Parameter                                      | Value       | Unit |
|------------------|------------------------------------------------|-------------|------|
| V <sub>CC</sub>  | Power Supply Voltages                          |             |      |
|                  | Single Supply                                  | 32          | V    |
|                  | Split Supplies                                 | ±16         |      |
| V <sub>IDR</sub> | Input Differential Voltage Range (1)           | ±32         | V    |
| V <sub>ICR</sub> | Input Common Mode Voltage Range                | -0.3 to 32  | V    |
| t <sub>S</sub>   | Short-Circuit duration of Output               | 100         | ms   |
| I <sub>IN</sub>  | Input Current, per pin (2)                     | 50          | mA   |
| T <sub>J</sub>   | Junction Temperature<br>Plastic Packages       | 150         | °C   |
| T <sub>stg</sub> | Storage Temperature<br>Plastic Packages        | -55 to +125 | °C   |
| T <sub>L</sub>   | Lead Temperature, 1mm from Case for 10 Seconds | 260         | °C   |

\* Maximum Ratings are those values beyond which damage to the device may occur. Functional operation should be restricted to the Recommended Operating Conditions.

Notes:

1. Split Power Supplies.
2. V<sub>IN</sub> < -0.3V

**RECOMMENDED OPERATING CONDITIONS**

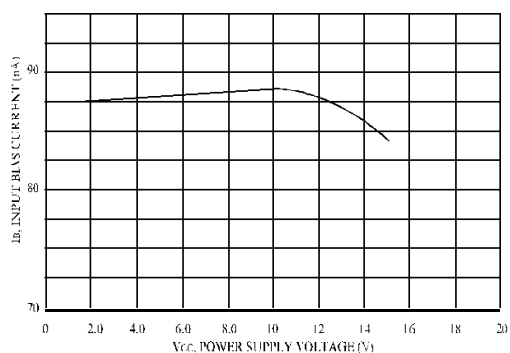
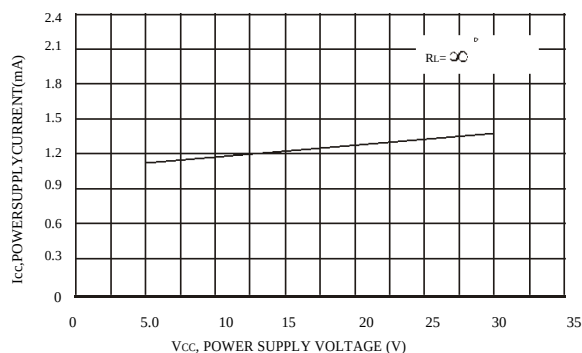
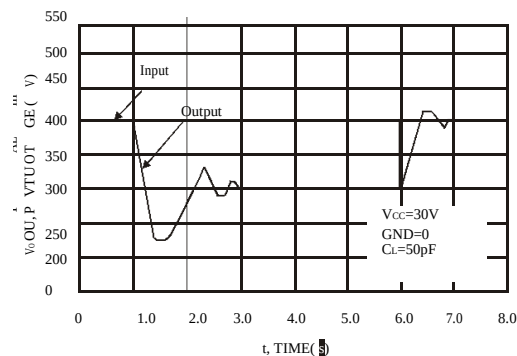
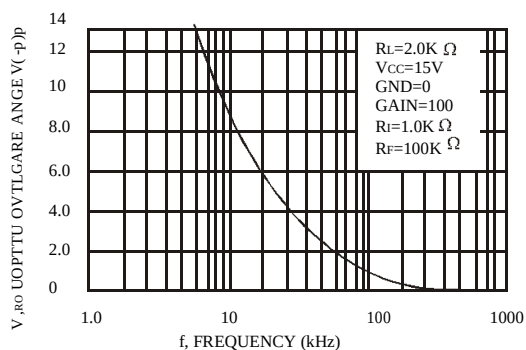
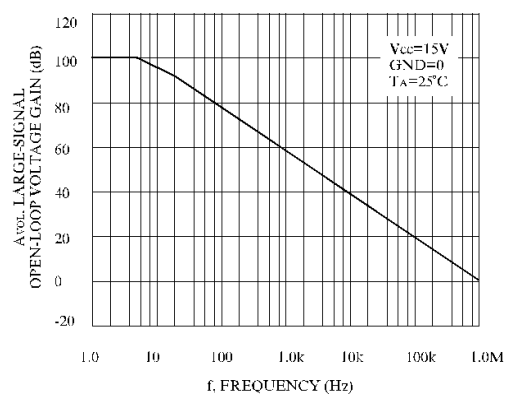
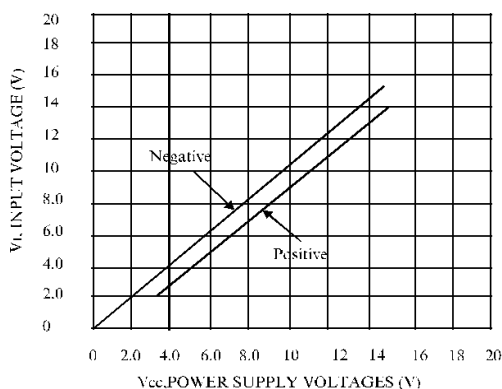
| Symbol          | Parameter                               | Min            | Max          | Unit |
|-----------------|-----------------------------------------|----------------|--------------|------|
| V <sub>CC</sub> | DC Supply Voltage                       | ±2.5 or<br>5.0 | ±15 or<br>30 | V    |
| T <sub>A</sub>  | Operating Temperature, All Packag Types | -40            | +125         | °C   |

**DC ELECTRICAL CHARACTERISTICS** ( $T_A=0 \div +70^{\circ}\text{C}$ )

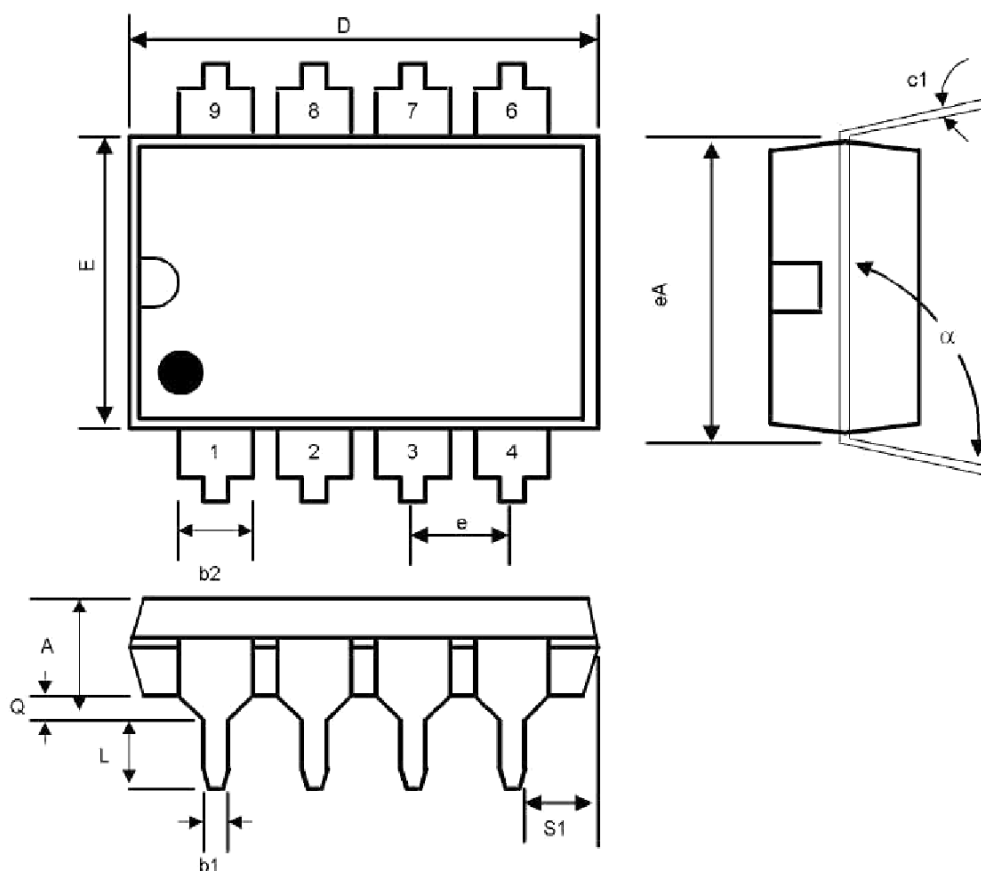
| Symbol    | Parameter                                   | Test Conditions                                                                                                                                                 | Guaranteed Limit |                                                | Unit                   |
|-----------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|------------------------------------------------|------------------------|
|           |                                             |                                                                                                                                                                 | Min              | Max                                            |                        |
| $V_{IO}$  | Maximum Input Offset Voltage                | $V_{CC}=5.0\text{-}30\text{V}$ , $R_S=0\Omega$ ,<br>$V_O=1.4\text{V}$<br>$V_{ICR}=0\text{V}-(V_{CC}-1.5\text{V})^*$<br>$V_{ICR}=0\text{V}-(V_{CC}-2.0\text{V})$ |                  | 2.0*<br>3.0                                    | mV                     |
| $I_{IO}$  | Maximum Input Offset Current                | $V_{CC}=5.0\text{-}30\text{V}$ , $V_O=1.4\text{V}$                                                                                                              |                  | $\pm 50^*$<br>$\pm 150$                        | nA                     |
| $I_{IB}$  | Maximum Input Bias Current                  | $V_{CC}=5.0\text{-}30\text{V}$ , $V_O=1.4\text{V}$                                                                                                              |                  | -250*<br>-500                                  | nA                     |
| $V_{ICR}$ | Input Common Mode Voltage Range             | $V_{CC}=30\text{V}$                                                                                                                                             | 0<br>0           | $V_{CC}-1.5\text{V}^*$<br>$V_{CC}-2.0\text{V}$ | V                      |
| $I_{CC}$  | Maximum Power Supply Current                | $R_L=\infty$ , $V_{CC}=30\text{V}$ , $V_O=15\text{V}$<br>$R_L=\infty$ , $V_{CC}=5\text{V}$ , $V_O=2.5\text{V}$                                                  |                  | 2<br>1.2                                       | mA                     |
| $A_{VOL}$ | Minimum Large Signal Open-Loop Voltage Gain | $V_{CC}=15\text{V}$ , $R_L=2\text{K}\Omega$                                                                                                                     | 25*<br>15        |                                                | V/mV                   |
| $V_{OH}$  | Minimum Output High-Level Voltage Swing     | $V_{CC}=5\text{V}$ , $R_L=2\text{K}\Omega^*$<br>$V_{CC}=30\text{V}$ , $R_L=2\text{K}\Omega$<br>$V_{CC}=30\text{V}$ , $R_L=10\text{K}\Omega$                     | 3.3*<br>26<br>27 |                                                | V                      |
| $V_{OL}$  | Maximum Output Low-Level Voltage Swing      | $V_{CC}=5\text{V}$ , $R_L=10\text{K}\Omega$                                                                                                                     |                  | 20                                             | mV                     |
| CMR       | Common Mode Rejection                       | $V_{CC}=5\text{-}30\text{V}$ , $R_S=10\text{K}\Omega$                                                                                                           | 65*              |                                                | dB                     |
| PSR       | Power Supply Rejection                      | $V_{CC}=5\text{-}30\text{V}$                                                                                                                                    | 65*              |                                                | dB                     |
| $I_{SC}$  | Maximum Output Short Circuit to GND         | $V_{CC}=5.0\text{V}$ , $V_O=0\text{V}$                                                                                                                          |                  | 60*                                            | mA                     |
| $I_{O+}$  | Minimum Source Output Current               | $V_{CC}=15\text{V}$ , $V_{ID}=1.0\text{V}$                                                                                                                      | 20*              |                                                | mA                     |
| $I_{O-}$  | Minimum Output Sink Current                 | $V_{CC}=15\text{V}$ , $V_O=15\text{V}$ , $V_{ID}=-1.0\text{V}$<br>$V_{CC}=15\text{V}$ , $V_O=0.2\text{V}$ , $V_{ID}=-1.0\text{V}$                               | 10*<br>12*       |                                                | mA<br>$\infty\text{A}$ |
| $V_{IDR}$ | Differential Input Voltage Range            | All $V_{IN} \geq \text{GND}$ or V-Supply (if used)                                                                                                              |                  | $V_{CC}^*$                                     | V                      |

\*  $T_A = +25^{\circ}\text{C}$

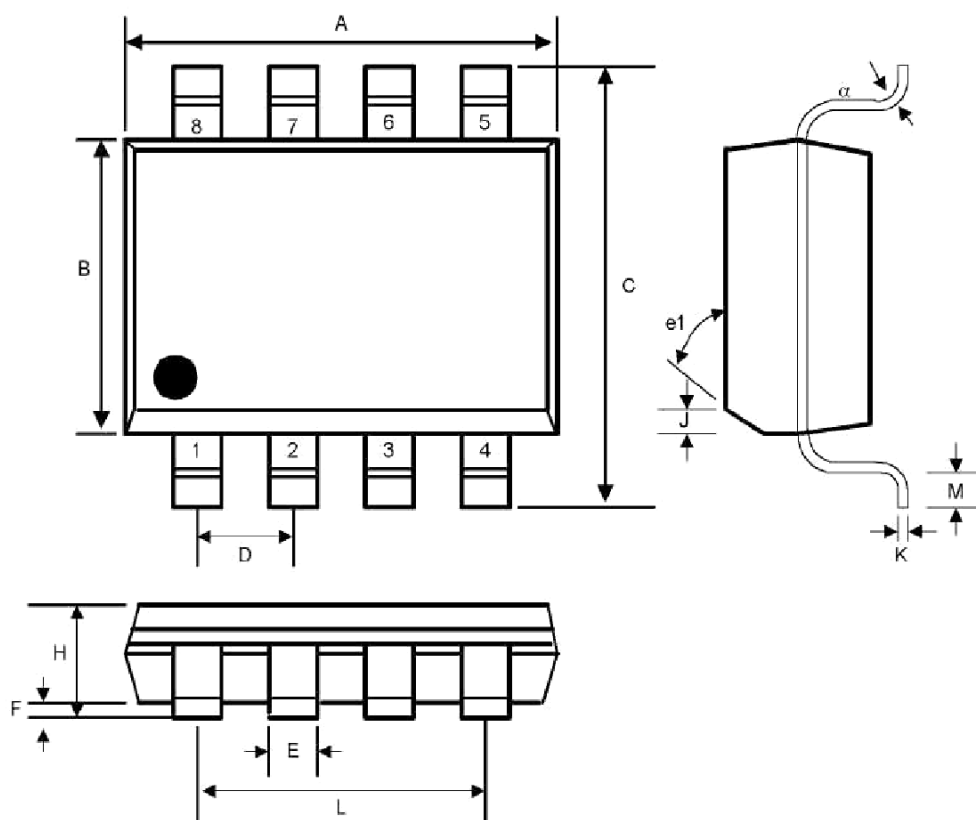
**NOTE:** Guaranteed Limits of DC Electrical Characteristics are given for  $T_A=-40$ ,  $+125^{\circ}\text{C}$  as the information for chips

**TYPICAL PERFORMANCE CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ )**


Package Outlines: DIP-8



| SYMBOL   | INCHES          |                  | MILLIMETERS     |                  | NOTES |
|----------|-----------------|------------------|-----------------|------------------|-------|
|          | MIN             | MAX              | MIN             | MAX              |       |
| A        | -               | 0.200            | -               | 5.08             | -     |
| b1       | 0.014           | 0.023            | 0.36            | 0.58             | -     |
| b2       | 0.045           | 0.065            | 1.14            | 1.65             | -     |
| c1       | 0.008           | 0.015            | 0.20            | 0.38             | -     |
| D        | 0.355           | 0.400            | 9.02            | 10.16            | -     |
| E        | 0.220           | 0.310            | 5.59            | 7.87             | -     |
| e        | 0.100 BSC       |                  | 2.54 BSC        |                  | -     |
| eA       | 0.300 BSC       |                  | 7.62 BSC        |                  | -     |
| L        | 0.125           | 0.200            | 3.18            | 5.08             | -     |
| Q        | 0.015           | 0.060            | 0.38            | 1.52             | -     |
| s1       | 0.005           | -                | 0.13            | -                | -     |
| $\alpha$ | 90 <sup>0</sup> | 105 <sup>0</sup> | 90 <sup>0</sup> | 105 <sup>0</sup> | -     |

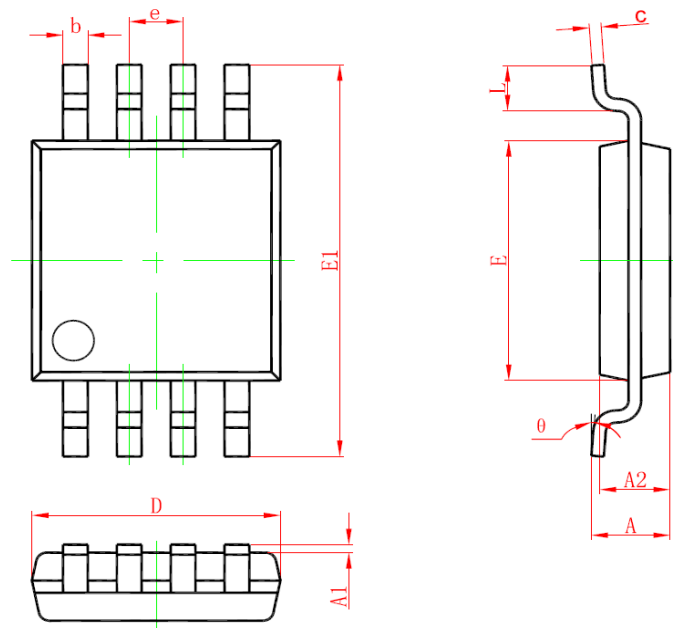
**Small Outline SOP-8**


| SYMBOL | INCHES |       | MILLIMETERS |      | NOTES |
|--------|--------|-------|-------------|------|-------|
|        | MIN    | MAX   | MIN         | MAX  |       |
| A      | 0.188  | 0.197 | 4.80        | 5.00 | -     |
| B      | 0.149  | 0.158 | 3.80        | 4.00 | -     |
| C      | 0.228  | 0.244 | 5.80        | 6.20 | -     |
| D      | 0.050  | BSC   | 1.27        | BSC  | -     |
| E      | 0.013  | 0.020 | 0.33        | 0.51 | -     |
| F      | 0.004  | 0.010 | 0.10        | 0.25 | -     |
| H      | 0.053  | 0.069 | 1.35        | 1.75 | -     |
| J      | 0.011  | 0.019 | 0.28        | 0.48 | -     |
| K      | 0.007  | 0.010 | 0.19        | 0.25 | -     |
| M      | 0.016  | 0.050 | 0.40        | 1.27 | -     |
| L      | 0.150  | REF   | 3.81        | REF  | -     |
| e1     | 45°    |       | 45°         |      | -     |
| α      | 0°     | 8°    | 0°          | 8°   | -     |

\*All specs and applications shown above subject to change without prior notice.

## Package Outline Dimensions

MSOP-8



| Symbol | Dimensions In Millimeters |       | Dimensions In Inches |       |
|--------|---------------------------|-------|----------------------|-------|
|        | Min                       | Max   | Min                  | Max   |
| A      | 0.820                     | 1.100 | 0.032                | 0.043 |
| A1     | 0.020                     | 0.150 | 0.001                | 0.006 |
| A2     | 0.750                     | 0.950 | 0.030                | 0.037 |
| b      | 0.250                     | 0.380 | 0.010                | 0.015 |
| c      | 0.090                     | 0.230 | 0.004                | 0.009 |
| D      | 2.900                     | 3.100 | 0.114                | 0.122 |
| e      | 0.650(BSC)                |       | 0.026(BSC)           |       |
| E      | 2.900                     | 3.100 | 0.114                | 0.122 |
| E1     | 4.750                     | 5.050 | 0.187                | 0.199 |
| L      | 0.400                     | 0.800 | 0.016                | 0.031 |
| θ      | 0°                        | 6°    | 0°                   | 6°    |