

## 1.Description

The TP10 series are CMOS dual, and quad RRIO opamps with low offset, low power and stable high frequency response. with 6MHz bandwidth, 4.5V/μs slew rate and low distortion while drawing only 600 μA of quiescent current per amplifier. The input common-mode voltage range extends 300mV beyond V<sub>-</sub> and V<sub>+</sub>, and the outputs swing rail-to-rail. The TP10 family can be used as plug-in replacements for many commercially available op-amps to reduce power and improve input/output range and performance. The combination of features makes the TP10 ideal choices for motor control and portable audio amplification, sound ports, and other consumer Audio. The TP10 Op-amp is very stable, and it is capable of driving heavy capacitive loads such as those found in LCDs. The ability to swing rail-to-rail at the inputs and outputs enables designers to buffer CMOS DACs, ASICs, or other wide output swing devices in single supply systems

## 2.Features

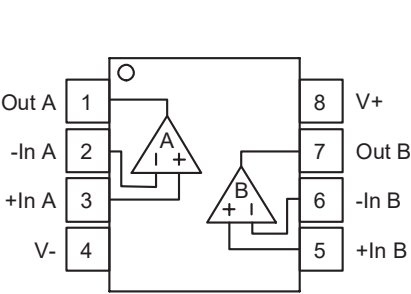
- Supply Voltage: 2.7V to 5.5V
- Low Supply Current: 600μA per channel
- Rail to Rail Input and Output
- Bandwidth: 6 MHz
- Slew Rate: 4.5V/μs
- Excellent EMI Suppress Performance
- Offset Voltage: ±3mV Maximum
- Offset Voltage Temperature Drift: 1μV/°C
- Low Noise: 19 nV/√Hz at 1kHz
- High Output Capability: 100mA
- -40°C to 125°C Operation Temperature Range

## 3.Applications

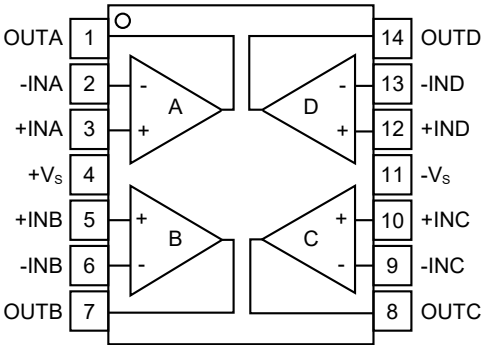
- E-Bike
- Motor Control
- Portable Audio



4.Pinning Information



TP10-2  
SOP-8



TP10-4  
TSSOP-14/SOP-14



## 5. Absolute Maximum Ratings

| Parameter                                             | Rating                                               |
|-------------------------------------------------------|------------------------------------------------------|
| Supply Voltage, (+V <sub>S</sub> )-(-V <sub>S</sub> ) | 7V                                                   |
| Input Voltage                                         | (-V <sub>S</sub> ) - 0.3 to (+V <sub>S</sub> ) + 0.3 |
| Differential input Voltage                            | ±7V                                                  |
| Input Current: +IN, -IN <sup>Note 2</sup>             | ±10mA                                                |
| Output Short-Circuit Duration <sup>Note 3</sup>       | Infinite                                             |
| Maximum Junction Temperature                          | 150°C                                                |
| Operating Temperature Range                           | -40 to 125°C                                         |
| Storage Temperature Range                             | -65 to 150°C                                         |
| Lead Temperature (Soldering, 10 sec)                  | 260°C                                                |

Note 1: Stresses beyond those listed under Absolute Maximum Ratings may cause permanent damage to the device. Exposure to any Absolute Maximum Rating condition for extended periods may affect device reliability and lifetime.

Note 2: The inputs are protected by ESD protection diodes to each power supply. If the input extends more than 300mV beyond the power supply, the input current should be limited to less than 10mA.

Note 3: A heat sink may be required to keep the junction temperature below the absolute maximum. This depends on the power supply voltage and how many amplifiers are shorted. Thermal resistance varies with the amount of PC board metal connected to the package. The specified values are for short traces connected to the leads.

## 6. ESD Ratings

| Parameter                | Condition                  | Symbol | Value | Units |
|--------------------------|----------------------------|--------|-------|-------|
| Human Body Model ESD     | MIL-STD-883H Method 3015.8 | HBM    | 8     | kV    |
| Charged Device Model ESD | JEDEC-EIA/JESD22-C101E     | CDM    | 2     | kV    |



## 7. Electrical Characteristics

All test condition is  $V_S=5V$ ,  $T_A=25^{\circ}C$ ,  $R_L=2k\Omega$ ,  $C_L=100pF$ , unless otherwise noted.

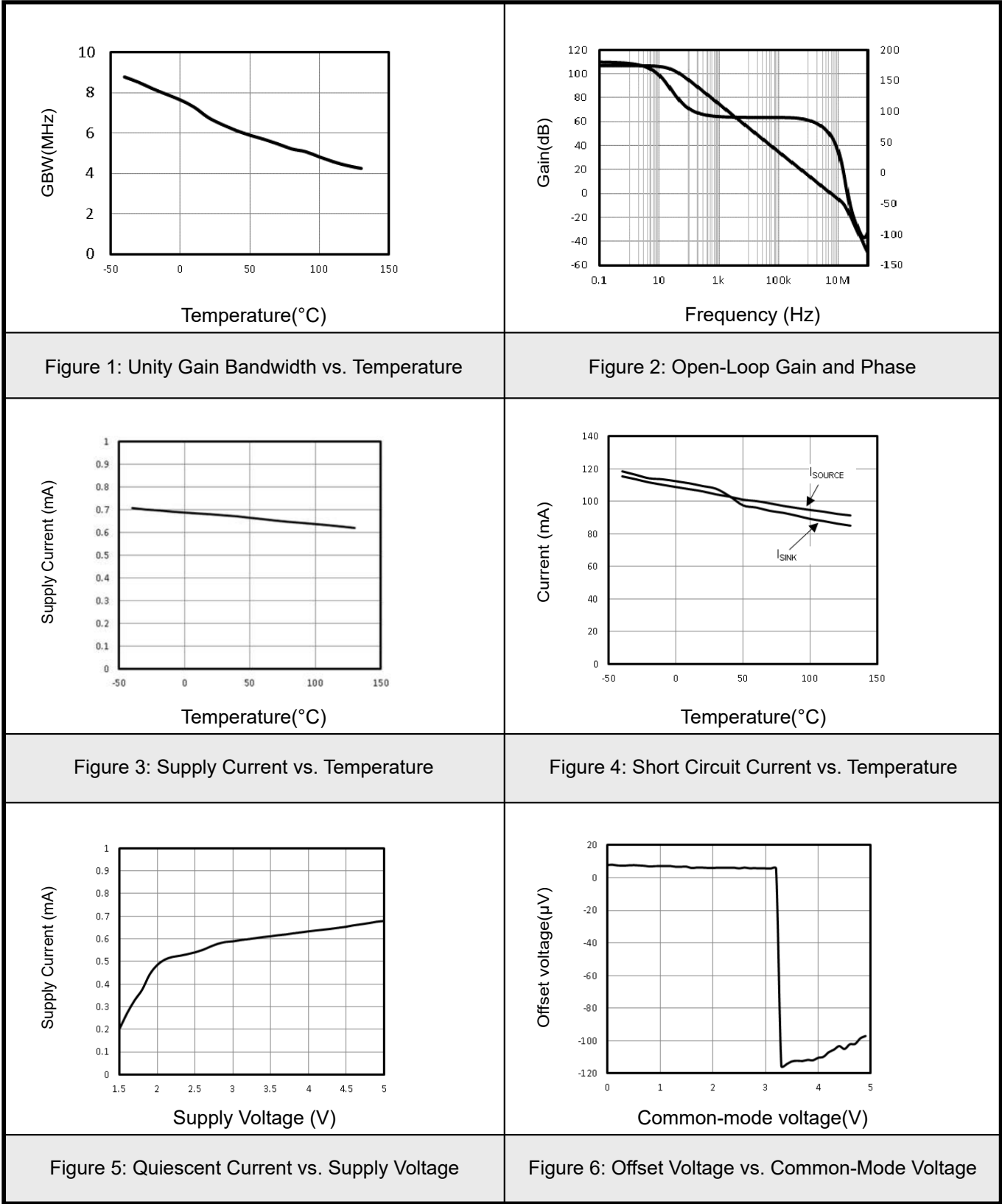
| Parameter                       | Symbol              | Conditions                                                                  | Min        | Typ | Max      | Units            |
|---------------------------------|---------------------|-----------------------------------------------------------------------------|------------|-----|----------|------------------|
| Supply Voltage Range            | $V_S$               |                                                                             | 2.7        |     | 5.5      | V                |
| Quiescent Current per Amplifier | $I_Q$               |                                                                             |            | 600 | 900      | μA               |
| Power Supply Rejection Ratio    | PSRR                | $V_S=2.7V$ to $5.5V$                                                        | 70         | 95  |          | dB               |
| Input Offset Voltage            | $V_{OS}$            | $V_{CM}=0V$ to $3V$                                                         | -3         |     | 3        | mV               |
| Input Offset Voltage Drift      | $V_{OS TC}$         | $T_A=-40^{\circ}C$ to $125^{\circ}C$                                        |            | 2   |          | μV/ $^{\circ}C$  |
| Input Bias Current              | $I_B$               | $T_A=25^{\circ}C$                                                           |            | 1   |          | pA               |
|                                 |                     | $T_A=85^{\circ}C$                                                           |            | 25  |          | pA               |
| Input Offset Current            | $I_{OS}$            |                                                                             |            | 1   |          | pA               |
| Input Capacitance               | $C_{IN}$            | Differential Mode                                                           |            | 10  |          | pF               |
|                                 |                     | Common Mode                                                                 |            | 10  |          | pF               |
| Open-loop Voltage Gain          | $A_V$               | $R_{LOAD}=10k\Omega$                                                        | 80         | 100 |          | dB               |
| Common-mode input Voltage Range | $V_{CMR}$           |                                                                             | (V-) - 0.1 |     | (V+)+0.1 | V                |
| Common Mode Rejection Ratio     | CMRR                | $V_{CM}=0V$ to $3V$                                                         | 70         | 100 |          | dB               |
| Channel Separation              | Xtalk               | $f=1kHz$ , $R_L=2k\Omega$                                                   |            | 110 |          | dB               |
| Maximum Output Voltage Swing    | $V_{OH}$ , $V_{OL}$ | $R_{LOAD}=10k\Omega$                                                        |            | 5   | 15       | mV               |
| Output Short-Circuit Current    | $I_{SC}$            |                                                                             |            | 100 |          | mA               |
| Output Current                  | $I_O$               | 1V Output Drop Voltage                                                      |            | 50  |          | mA               |
| Gain-Bandwidth Product          | GBW                 |                                                                             |            | 6   |          | MHz              |
| Slew Rate                       | SR                  | $A_V=1$ , $V_{OUT}=1.5V$ to $3.5V$<br>$C_{LOAD}=60pF$ , $R_{LOAD}=1k\Omega$ |            | 4.5 |          | V/μs             |
| Settling Time, 0.1%             | $t_s$               | $A_V=1$ , 2V Step                                                           |            | 0.8 |          | μs               |
| Settling Time, 0.01%            |                     | $C_{LOAD}=60pF$ , $R_{LOAD}=1k\Omega$                                       |            | 1   |          | μs               |
| Phase Margin                    | PM                  | $R_{LOAD}=1k\Omega$ , $C_{LOAD}=60pF$                                       |            | 60  |          | °                |
| Gain Margin                     | GM                  | $R_{LOAD}=1k\Omega$ , $C_{LOAD}=60pF$                                       |            | 15  |          | dB               |
| Input Voltage Noise             | $E_N$               | $f=0.1Hz$ to $10Hz$                                                         |            | 8   |          | μV <sub>PP</sub> |



| Parameter                         | Symbol | Conditions                                                   | Min | Typ   | Max | Units                  |
|-----------------------------------|--------|--------------------------------------------------------------|-----|-------|-----|------------------------|
| Input Voltage Noise Density       | $e_N$  | f=1kHz                                                       |     | 19    |     | nV/ $\sqrt{\text{Hz}}$ |
| Input Current Noise               | $i_N$  | f=1kHz                                                       |     | 2     |     | fA/ $\sqrt{\text{Hz}}$ |
| TotalHarmonicDistortion and Noise | THD+N  | f=1kHz, $A_v=1$ , $R_L=2\text{k}\Omega$ , $V_{OUT}=1V_{p-p}$ |     | 0.003 |     | %                      |

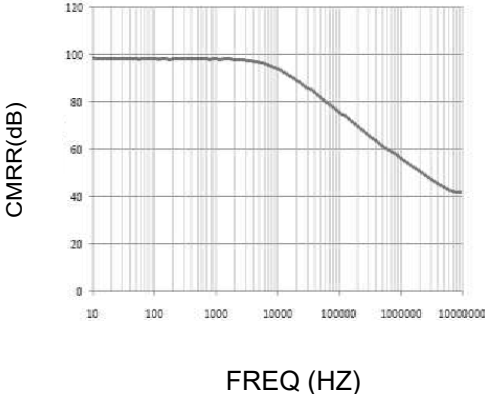
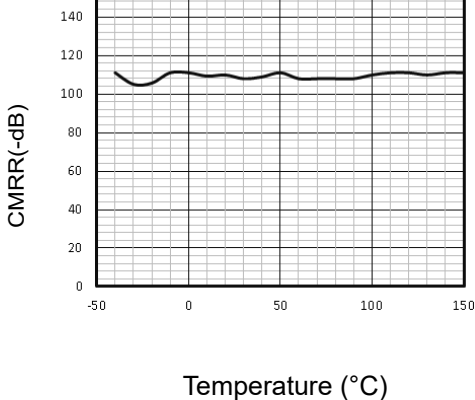
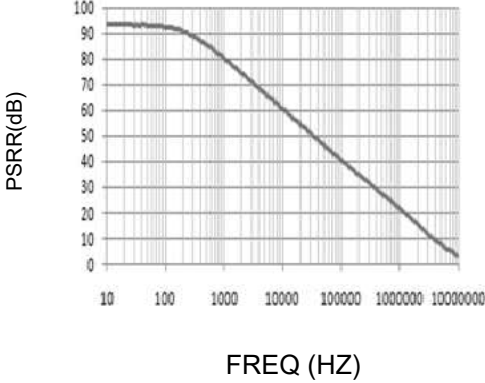
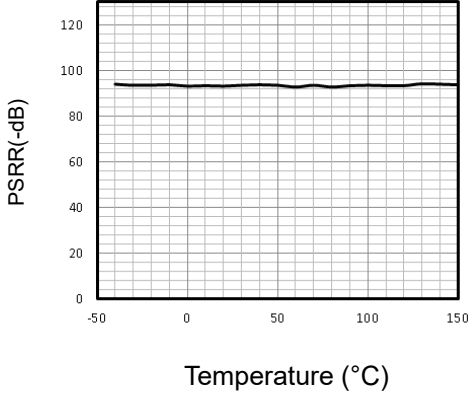
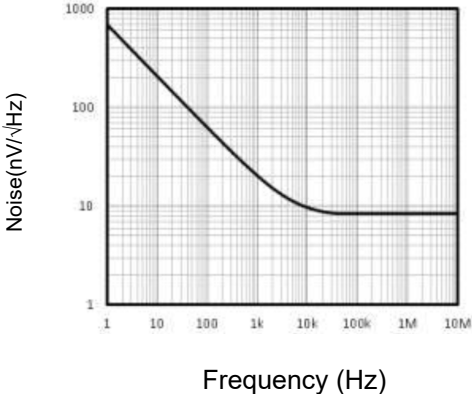
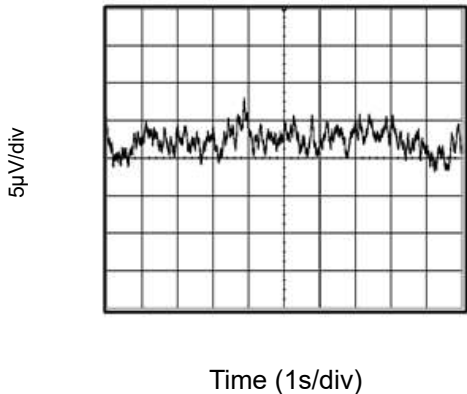


8.1 Typical characteristic





8.2 Typical characteristic

|                                                                                                           |                                                                                                              |
|-----------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|
|  <p>FREQ (HZ)</p>        |  <p>Temperature (°C)</p>   |
| Figure 7: CMRR vs. Frequency                                                                              | Figure 8: CMRR vs. Temperature                                                                               |
|  <p>FREQ (HZ)</p>      |  <p>Temperature (°C)</p> |
| Figure 9: Power-Supply Rejection Ratio                                                                    | Figure 10: PSRR vs. Temperature                                                                              |
|  <p>Frequency (Hz)</p> |  <p>Time (1s/div)</p>    |
| Figure 11: Input Voltage Noise Spectral Density                                                           | Figure 12: 0.1 Hz to 10 Hz Input Voltage Noise                                                               |



### 8.3 Typical characteristic

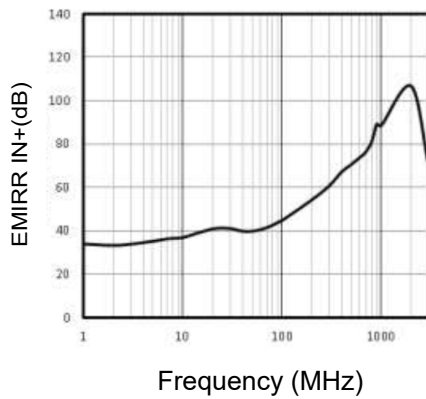


Figure 13: EMIRR IN+ vs. Frequency

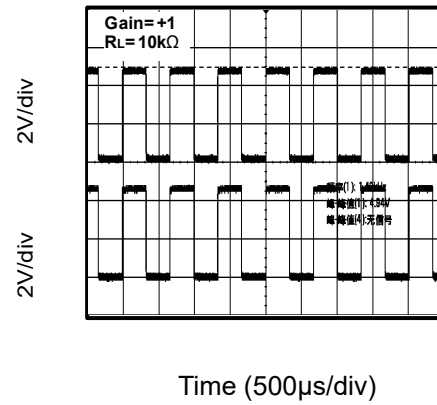


Figure 14: Large-Scale Step Response

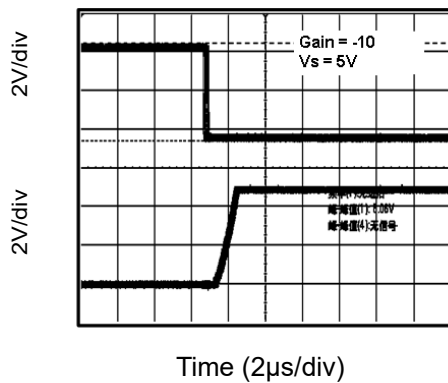


Figure 15: Negative Over-Voltage Recovery

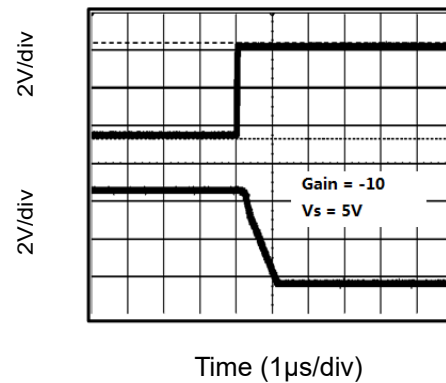


Figure 16: Positive Over-Voltage Recovery

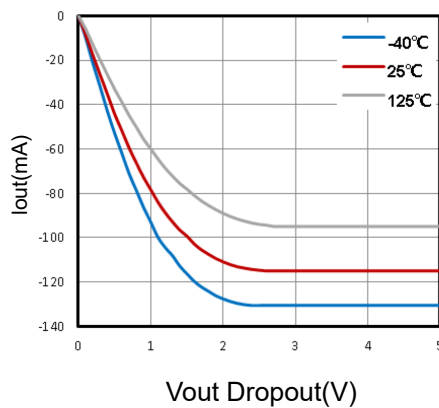


Figure 17: Negative Output Swing vs. Load Current

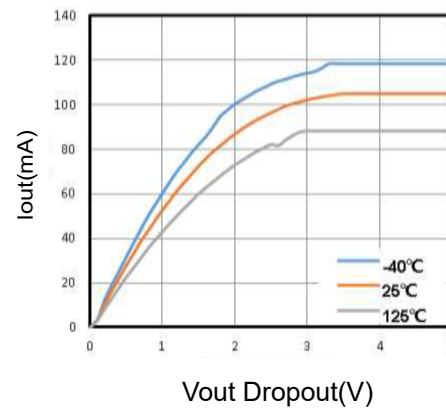
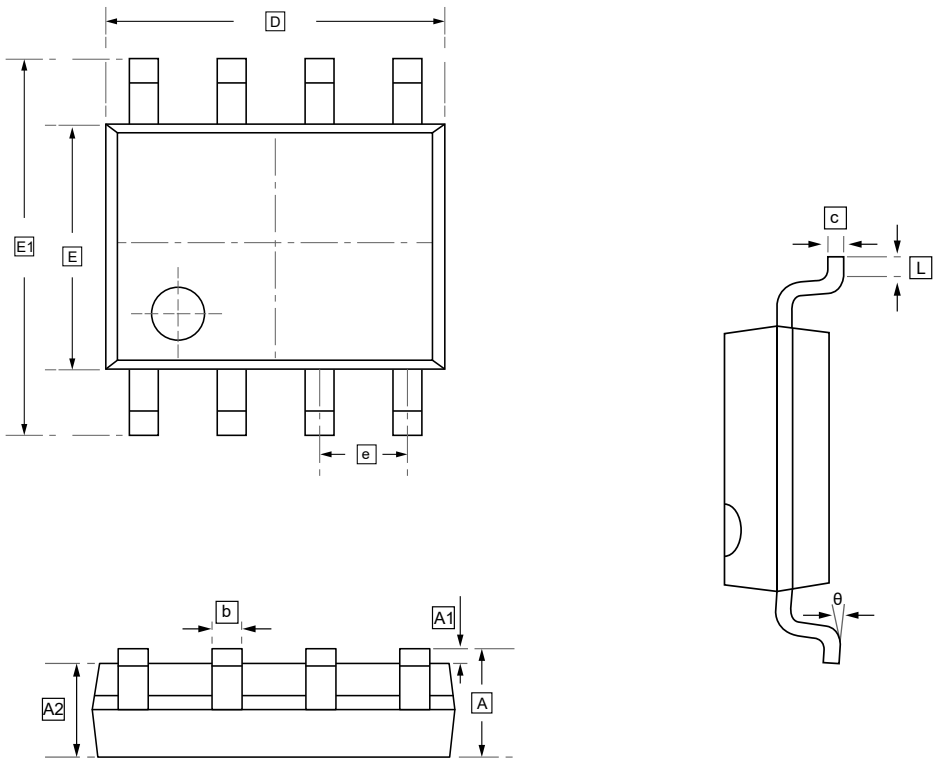


Figure 18: Positive Output Swing vs. Load Current



9.1 SOP-8 Package Outline Dimensions

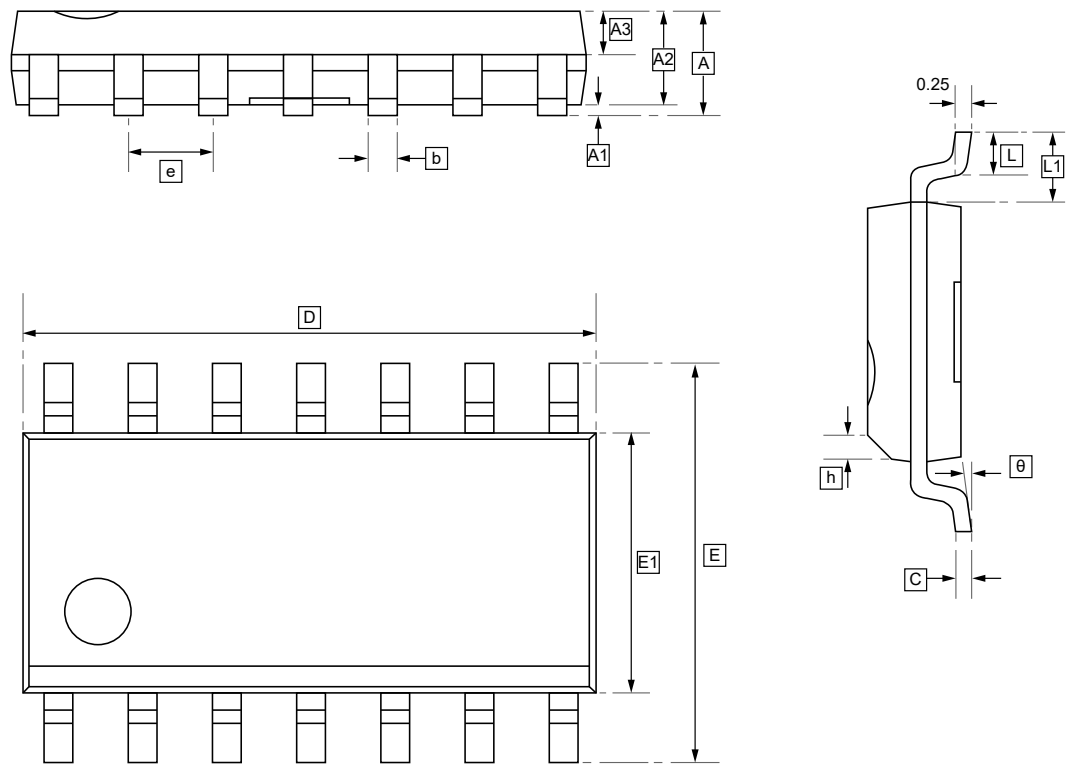


DIMENSIONS (mm are the original dimensions)

| Symbol | A     | A1    | A2    | b     | c     | D     | E     | E1    | e     | L     | θ  |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|----|
| Min    | 1.350 | 0.000 | 1.350 | 0.330 | 0.170 | 4.700 | 3.800 | 5.800 | 1.270 | 0.400 | 0° |
| Max    | 1.750 | 0.100 | 1.550 | 0.510 | 0.250 | 5.100 | 4.000 | 6.200 | BSC   | 1.270 | 8° |



9.2 SOP-14 Package Outline Dimensions



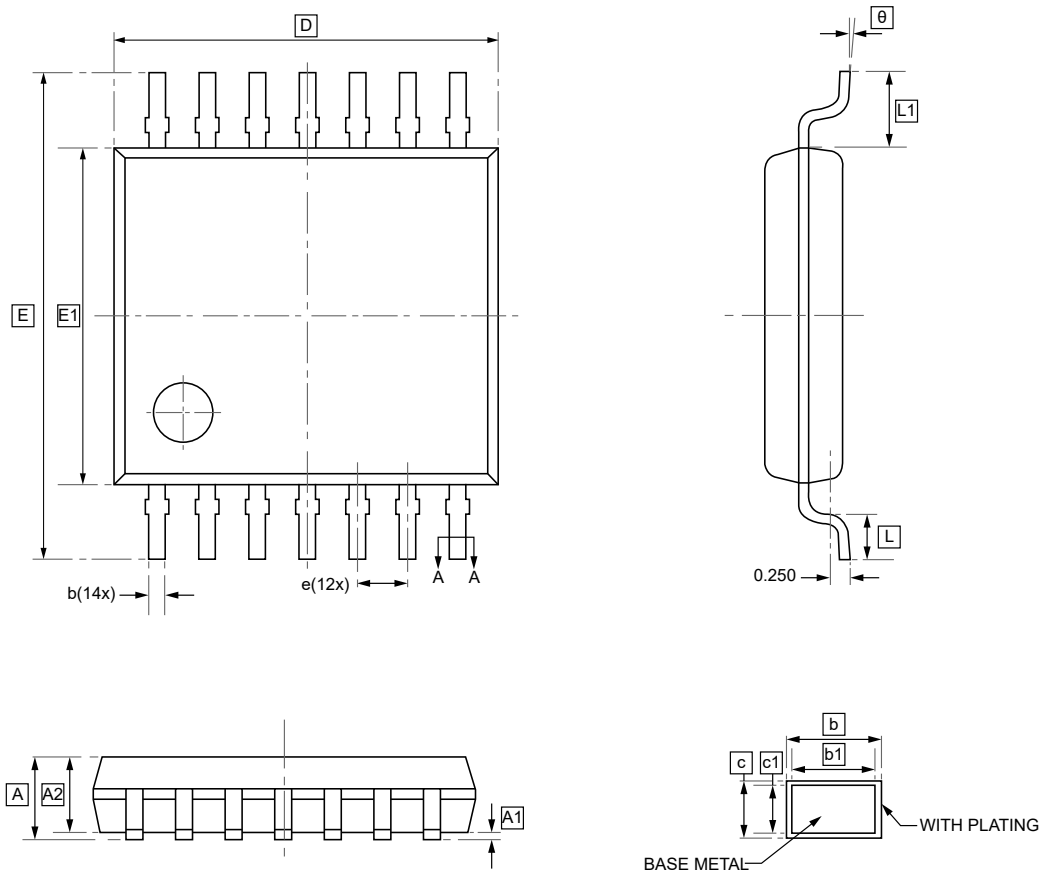
DIMENSIONS (mm are the original dimensions)

| Symbol | A    | A1   | A2   | A3   | b     | C    | D    | E    | E1   | e    | h    | L    |
|--------|------|------|------|------|-------|------|------|------|------|------|------|------|
| Min    | -    | 0.05 | 1.35 | 0.65 | 0.203 | 0.17 | 8.45 | 5.80 | 3.80 | 1.24 | 0.25 | 0.40 |
| Max    | 1.75 | 0.25 | 1.55 | 0.75 | 0.305 | 0.25 | 8.85 | 6.20 | 4.00 | 1.30 | 0.50 | 0.80 |

| Symbol | L1   | θ  |
|--------|------|----|
| Min    | 1.00 | 0° |
| Max    | 1.10 | 8° |



9.3 TSSOP-14 Package Outline Dimensions



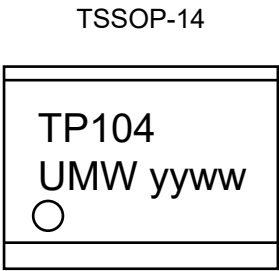
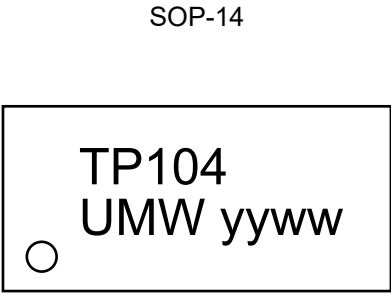
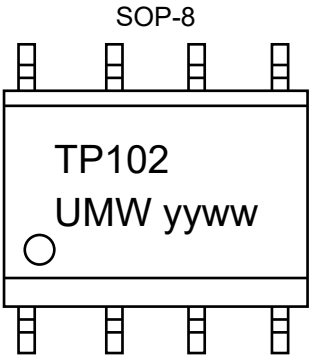
DIMENSIONS (mm are the original dimensions)

| Symbol | A    | A1   | A2   | b    | b1   | c    | c1    | D    | E    | E1   | e    | L1   |
|--------|------|------|------|------|------|------|-------|------|------|------|------|------|
| Min    | -    | 0.05 | 0.90 | 0.20 | 0.19 | 0.13 | 0.120 | 4.90 | 6.20 | 4.30 | 0.65 | 0.85 |
| Max    | 1.20 | 0.15 | 1.05 | 0.28 | 0.25 | 0.17 | 0.14  | 5.10 | 6.60 | 4.50 | BSC  | 1.15 |

| Symbol | L    | $\theta$ |
|--------|------|----------|
| Min    | 0.45 | 0°       |
| Max    | 0.75 | 8°       |



10.Ordering information



yy: Year Code  
ww: Week Code

| Order Code    | Marking | Package  | Base QTY | Delivery Mode |
|---------------|---------|----------|----------|---------------|
| UMW TP10-2-SR | T102    | SOP-8    | 2500     | Tape and reel |
| UMW TP10-4-SR | T104    | SOP-14   | 2500     | Tape and reel |
| UMW TP10-4-TR | T104    | TSSOP-14 | 4000     | Tape and reel |



## **11.Disclaimer**

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