# TSL1020

## 20 + 1 channel buffer for TFT-LCD panels

## Features

- Wide supply voltage: 5.5V to 16.8V
- Low operating current: 8.5mA typ. at 25°C
- Bandwidth at -3dB: 5MHz
- High output current COM amplifier: ±150mA
- Industrial temperature range: -40°C to +95°C
- Small package: TQFP48 ePad

## Application

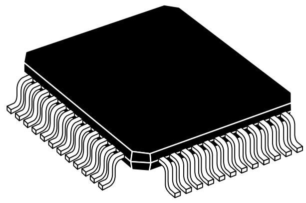
- TFT liquid crystal display (LCD)

## Description

The TSL1020 is composed of 20 + 1 channel buffers which are used to buffer the reference voltage for gamma correction in thin film transistor (TFT) liquid crystal displays (LCD).

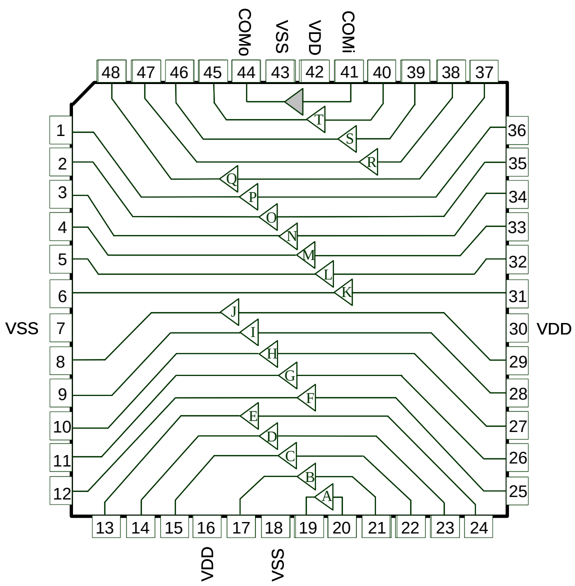
One COM amplifier is able to deliver high output current, up to ±150mA. Amplifiers A and B feature positive single supply inputs for common mode voltage, thus can be used for the highest gamma voltages. The amplifiers C to T inclusive, and the COM amplifier, feature negative single supply inputs and are dedicated to the lowest gamma voltages.

The TSL1020 is fully characterized and guaranteed over a wide industrial temperature range (-40 to +95°C).



**7 x 7mm TQFP48 ePad**

**Pin connections (top view)**



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage ($V_{DD}$ - $V_{SS}$) | 18 | V |
| $V_{in}$ | Input voltage | $V_{SS}$ -0.5 to $V_{DD}$ +0.5 | V |
| $R_{thja}$ | Thermal resistance junction to ambient for TQFP48<br>ePad not thermally connected to PCB<br>ePad thermally connected to PCB | <br>85<br>36 | °C/W |
| $T_{lead}$ | Lead temperature (soldering 10 seconds) | 260 | °C |
| $T_{stg}$ | Storage temperature | -65 to +150 | °C |
| $T_j$ | Junction temperature | 150 | °C |
| ESD | Human body model (HBM)[1] | 2000 | V |
| | Machine model (MM)[2] | 200 | V |

1. Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.

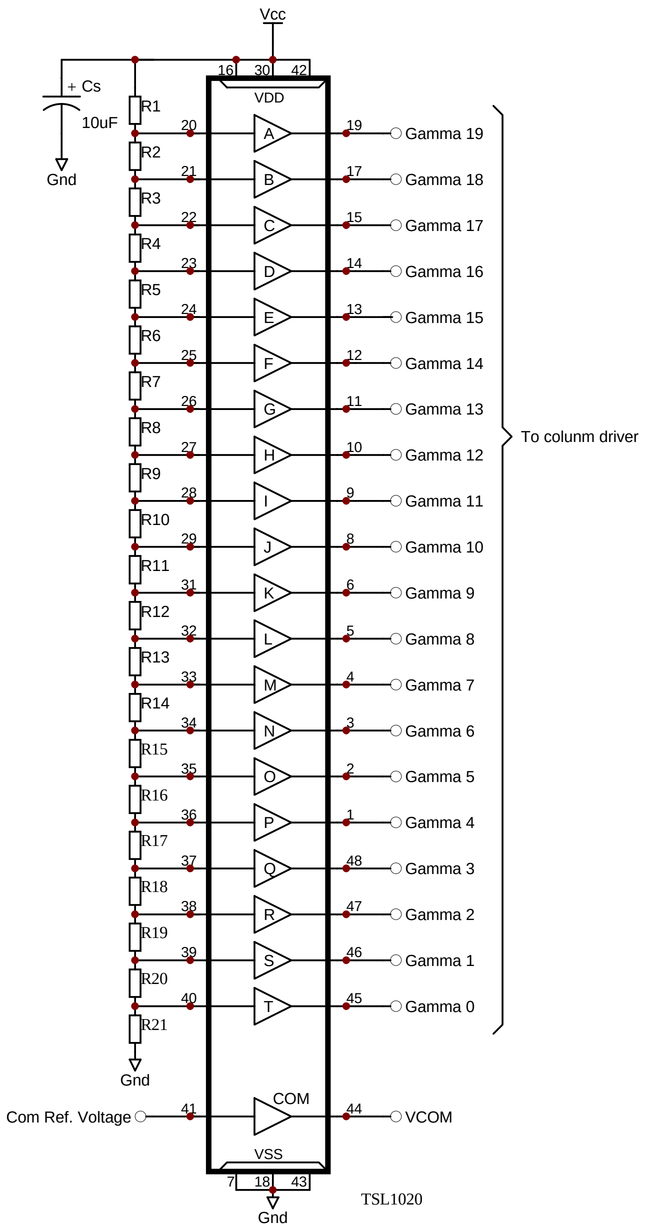
2. Machine model: A 200pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5Ω). This is done for all couples of connected pin combinations while the other pins are floating.

**Table 2. Operating conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage ($V_{DD}$ - $V_{SS}$) | 5.5 to 16.8 | V |
| $T_{amb}$ | Ambient temperature | -40 to +95 | °C |
| $V_{in}$ | Input voltages for buffers A & B | $V_{SS}$ + 1.5V to $V_{DD}$ | V |
| | Input voltages for buffers C to T & COM | $V_{SS}$ to $V_{DD}$ - 1.5V | |

# 2 Typical application schematics

**Figure 1. A typical application schematic for the TSL1020**




Note that:

- Amplifiers **A** & **B** have their input voltages in the range $V_{SS}$+1.5V to $V_{DD}$. This is why they must be used for high level gamma correction voltages.
- Amplifiers **C to T** have their input voltages in the range $V_{SS}$ to $V_{DD}$-1.5V. This is why they must be used for medium-to-low level gamma correction voltages.
- Amplifier **COM** has its input voltage range from $V_{SS}$ to $V_{DD}$-1.5V.

# 3 Electrical characteristics

**Table 3. Electrical characteristics for $T_{amb}$ = 25°C , $V_{DD}$ = +5V, $V_{SS}$ = -5V, $R_L$ = 10kΩ, $C_L$ = 10pF (unless otherwise specified)**

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{io}$ | Input offset voltage | $V_{icm}$ = 0V | | | 12 | mV |
| $\Delta V_{io}$ | Input offset voltage drift | -40°C < $T_{amb}$ < +95°C | | 5 | | µV/°C |
| $I_{ib}$ | Input bias current | $V_{icm}$ = 0V, buffers A & B<br>$V_{icm}$ = 0V, buffers C to T & COM | | | 140<br>70 | nA |
| $R_{in}$ | Input impedance | | | 1 | | GΩ |
| $C_{in}$ | Input capacitance | | | 1.35 | | pF |
| $V_{OL}$ | Output voltage low | $I_{out}$ = -5mA<br>Buffers C to R<br>Buffers S, T & COM | | -4.88<br>-4.92 | -4.80<br>-4.85 | V |
| $V_{OH}$ | Output voltage high | $I_{out}$ = 5mA for buffers A & B | 4.82 | 4.87 | | V |
| $I_{out}$ | Short circuit output current | (A to T buffers) | | ±40 | | mA |
| | | COM buffer | | ±150 | | |
| PSRR | Power supply rejection ratio | $V_{CC}$= 6.5 to 15.5V | 80 | 100 | | dB |
| $I_{CC}$ | Supply current | No load | | 8.5 | 12 | mA |
| SR | Slew rate<br>(rising & falling edge) | -3.5V < $V_{out}$ < +3.5V<br>10% to 90% | | 1.1 | | V/µs |
| $t_s$ | Settling time | Settling to 0.1%, $V_{out}$= 2V step | | 5 | | µs |
| BW | Bandwidth at -3dB | $R_L$=10kΩ, $C_L$=10pF | | 5 | | MHz |
| $G_m$ | Phase margin | $R_L$=10kΩ, $C_L$=10pF | | 70 | | degrees |
| $C_s$ | Channel separation | f=1MHz | | 75 | | dB |

*Note: Limits are 100% production tested at 25°C. Behavior at the temperature range limits is guaranteed through correlation and by design.*

**Figure 2. Supply current vs. supply voltage for various temperatures**

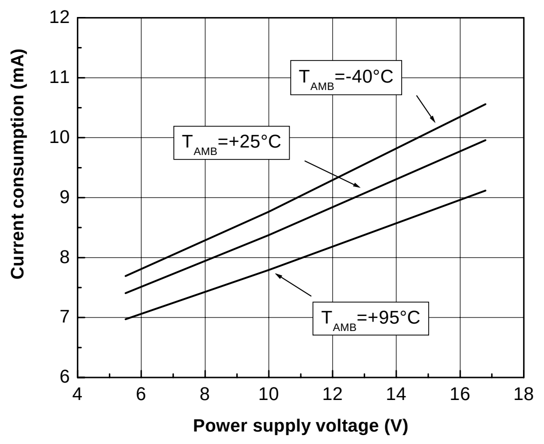



**Figure 3. Output offset voltage (eq. $V_{io}$) vs. temperature**

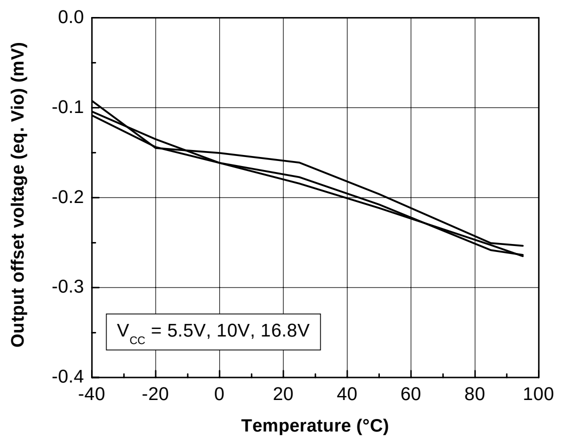



**Figure 4. Input current ($I_{ib}$) vs. temperature**

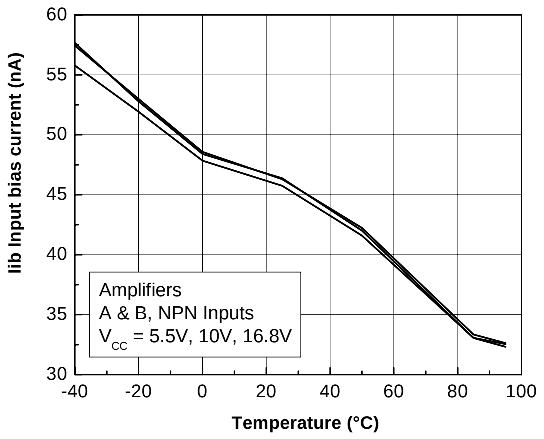



**Figure 5. Input current ($I_{ib}$) vs. temperature**

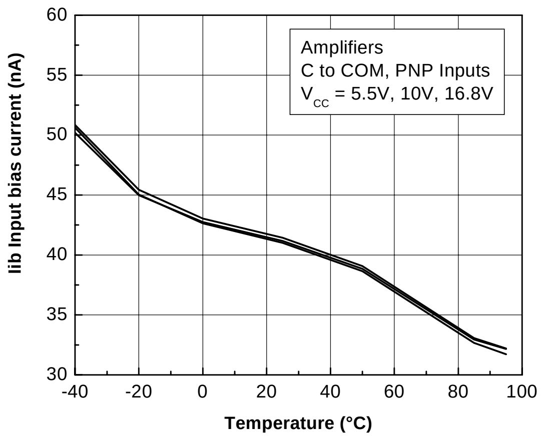



**Figure 6. Output current capability vs. temperature**

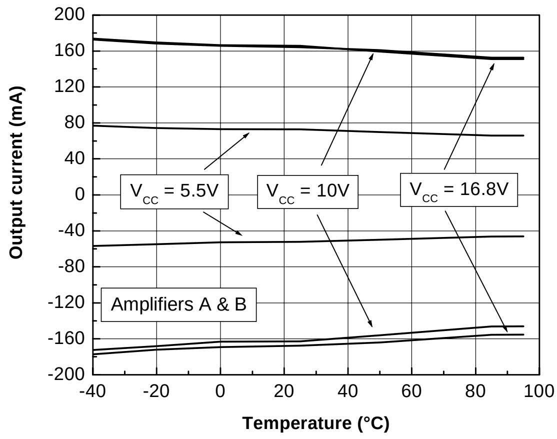



**Figure 7. Output current capability vs. temperature**

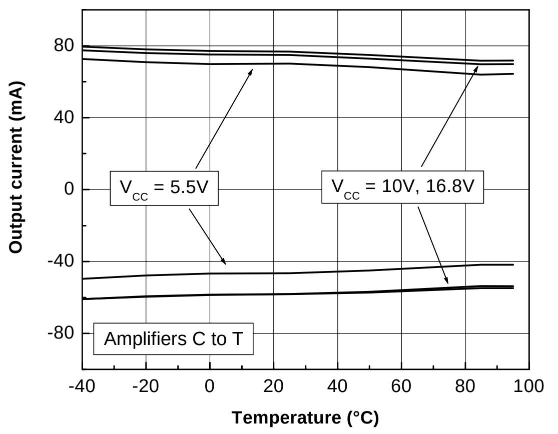


**Figure 8. Output current capability vs. temperature**

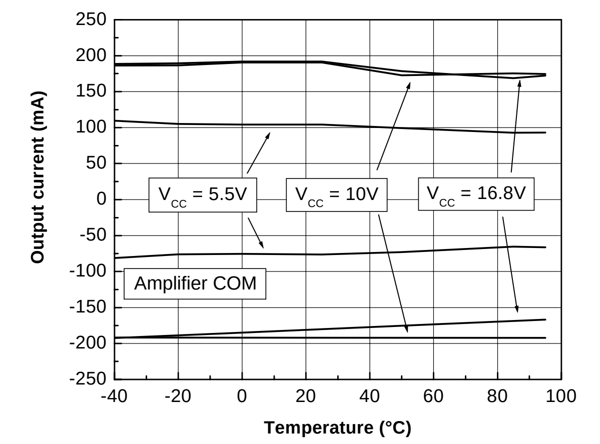



**Figure 9. High level voltage drop vs. temperature**

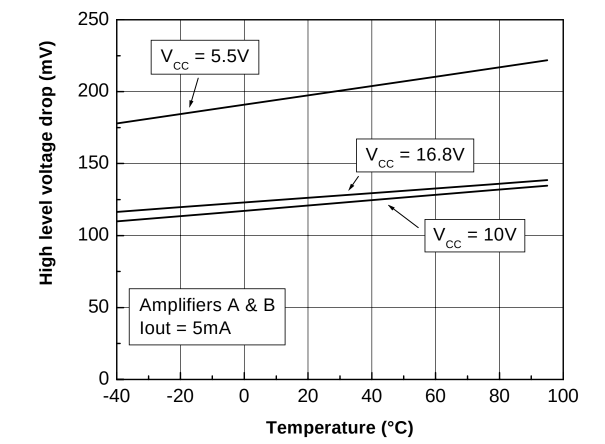



**Figure 10. Low level voltage drop vs. temperature**

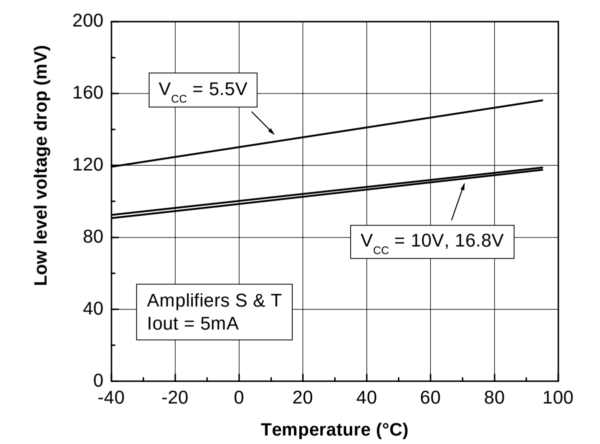



**Figure 11. Low level voltage drop vs. temperature**

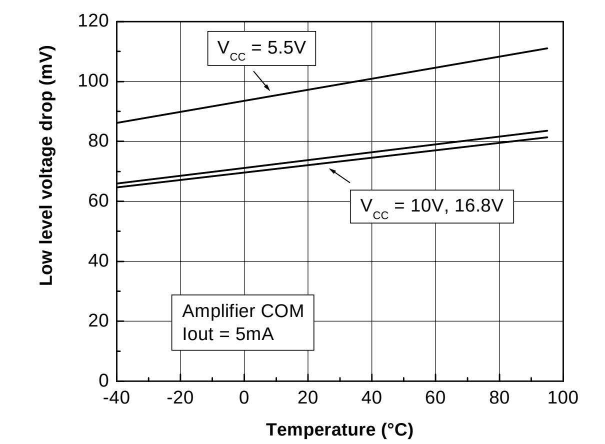



**Figure 12. Voltage output high ($V_{OH}$) vs. output current - Amplifiers A & B**

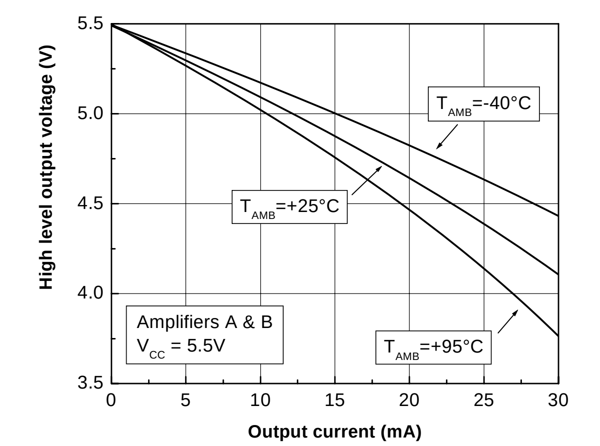



**Figure 13. Voltage output high ($V_{OH}$) vs. output current - Amplifiers A & B**

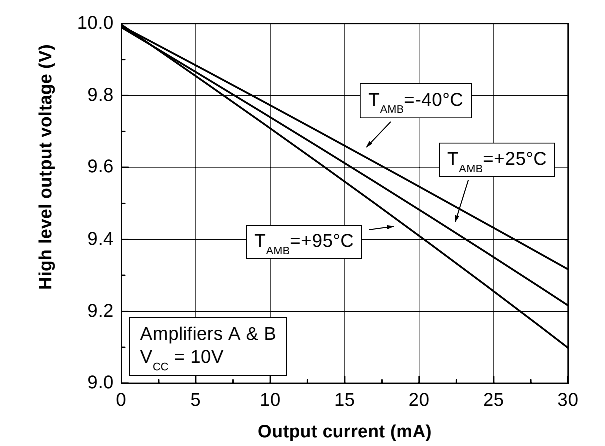


**Figure 14. Voltage output high ($V_{OH}$) vs. output current - Amplifiers A & B**

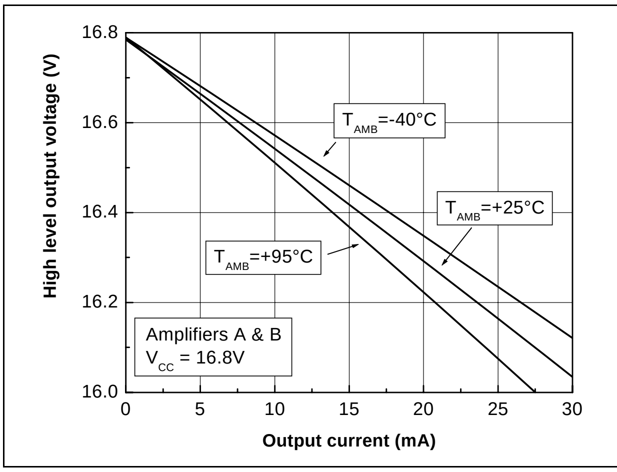



**Figure 15. Voltage output low ($V_{OL}$) vs. output current - Amplifiers C to R**

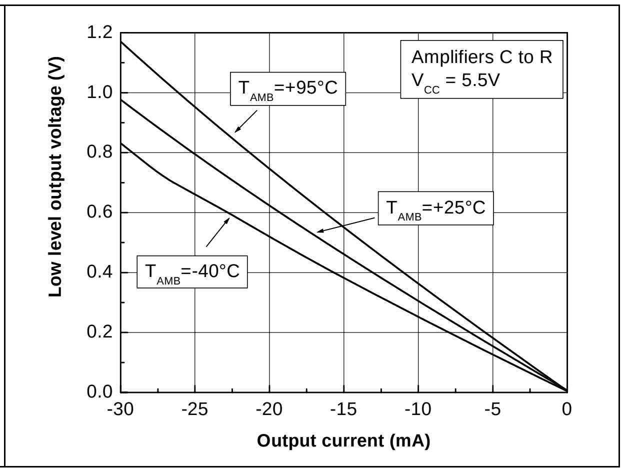



**Figure 16. Voltage output low ($V_{OL}$) vs. output current - Amplifiers C to R**

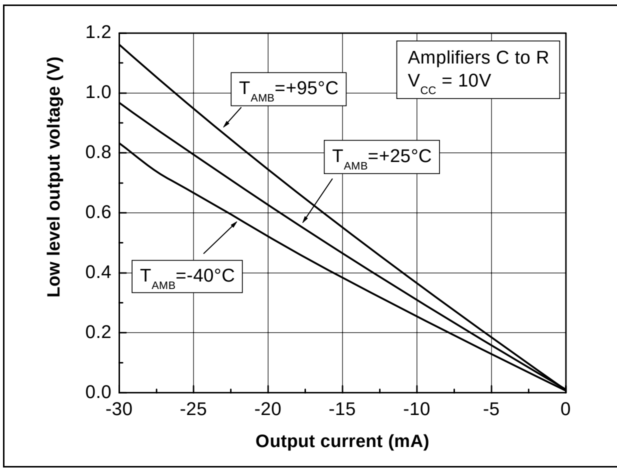



**Figure 17. Voltage output low ($V_{OL}$) vs. output current - Amplifiers C to R**

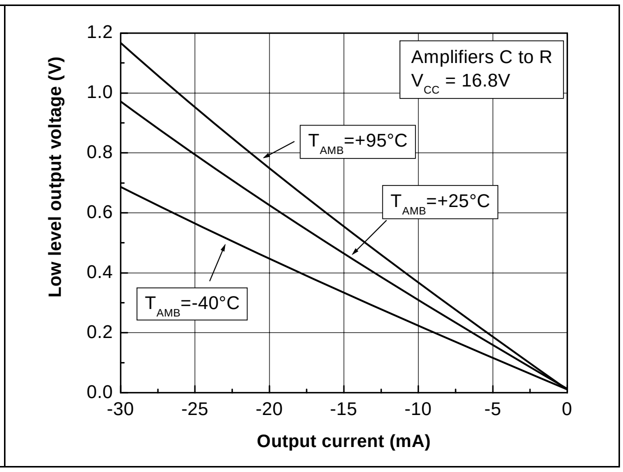



**Figure 18. Voltage output low ($V_{OL}$) vs. output current - Amplifiers S & T**

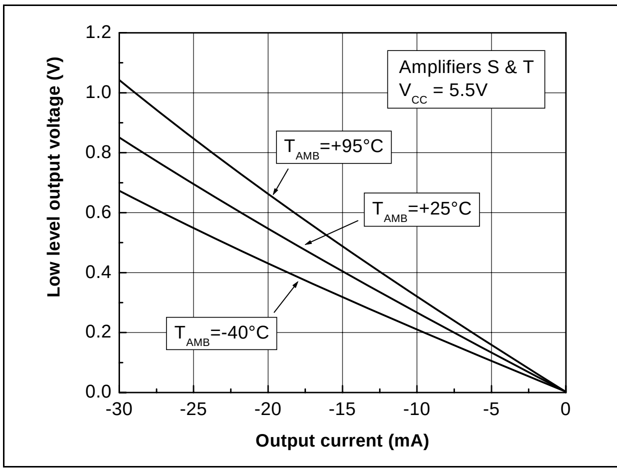



**Figure 19. Voltage output low ($V_{OL}$) vs. output current - Amplifiers S & T**

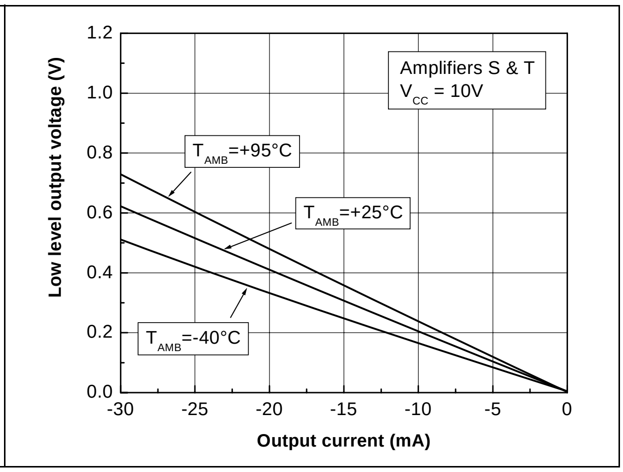


**Figure 20. Voltage output low ($V_{OL}$) vs. output current - Amplifiers S & T**

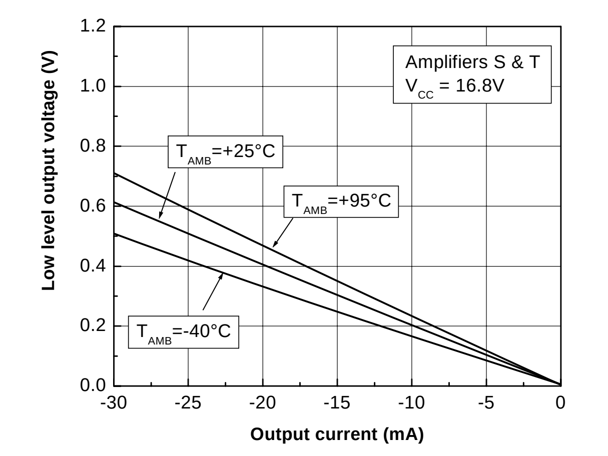



**Figure 21. Voltage output low ($V_{OL}$) vs. output current - Amplifier COM**

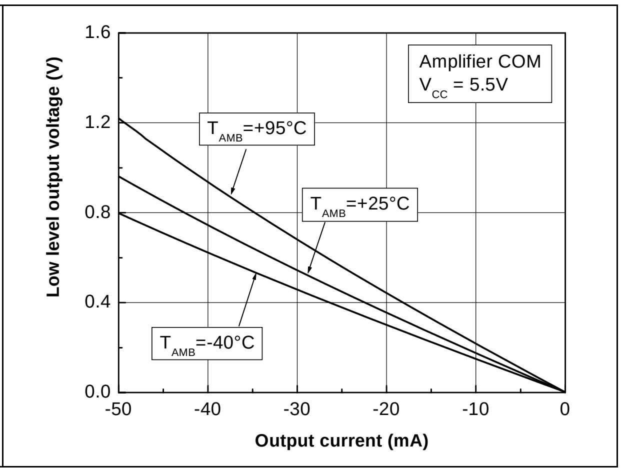



**Figure 22. Voltage output low ($V_{OL}$) vs. output current - Amplifier COM**

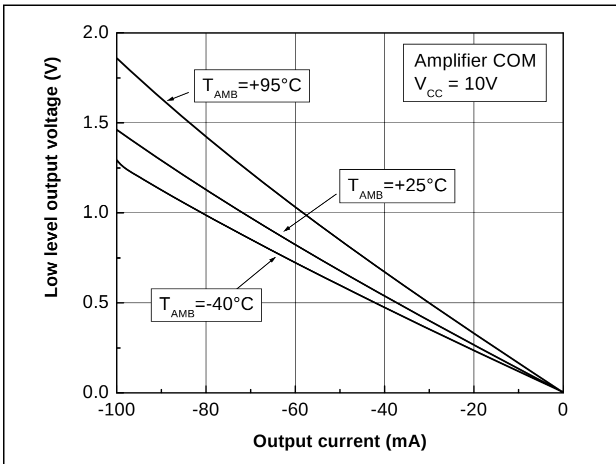



**Figure 23. Voltage output low ($V_{OL}$) vs. output current - Amplifier COM**

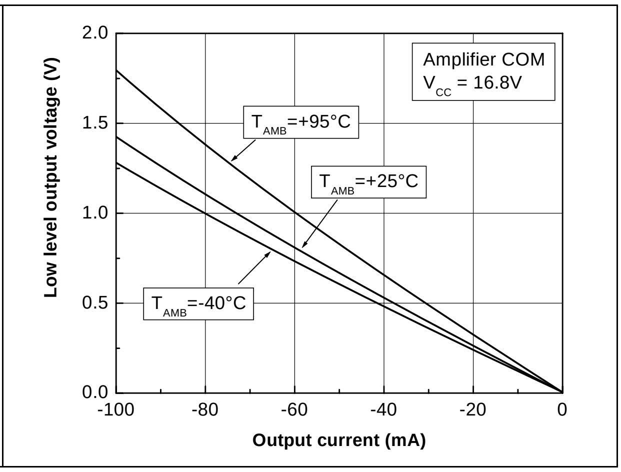



**Figure 24. Positive slew rate vs. temperature**

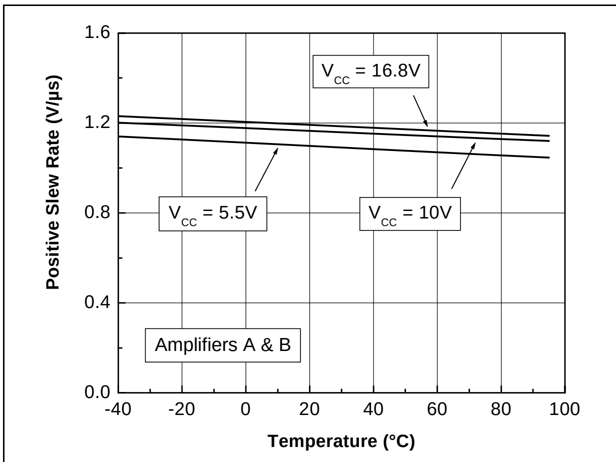



**Figure 25. Positive slew rate vs. temperature**

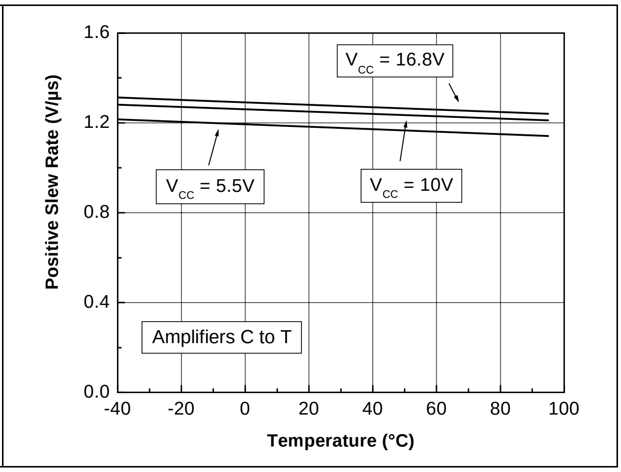


Figure 26. Positive slew rate vs. temperature

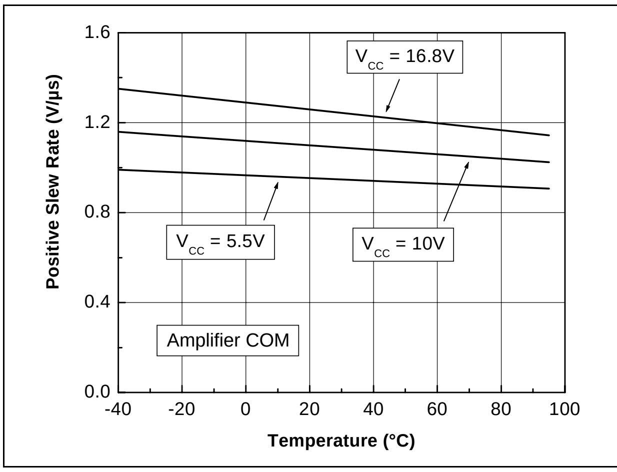



Figure 27. Negative slew rate vs. temperature

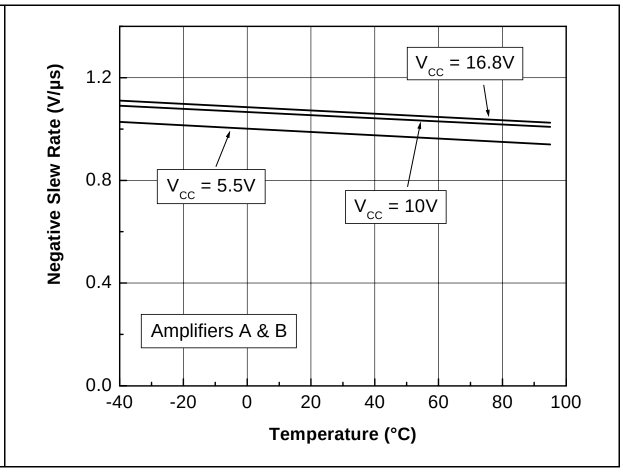



Figure 28. Negative slew rate vs. temperature

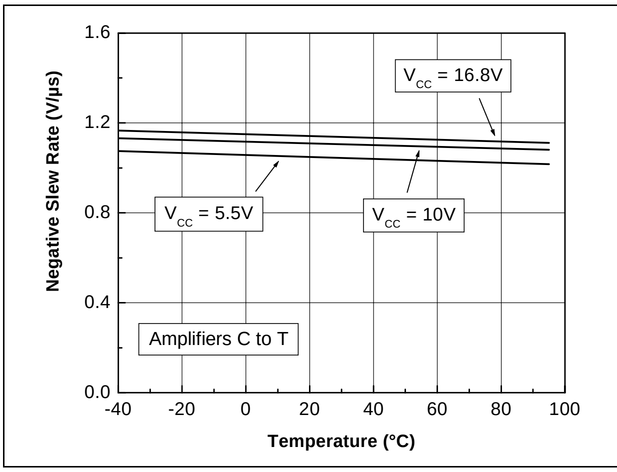



Figure 29. Negative slew rate vs. temperature

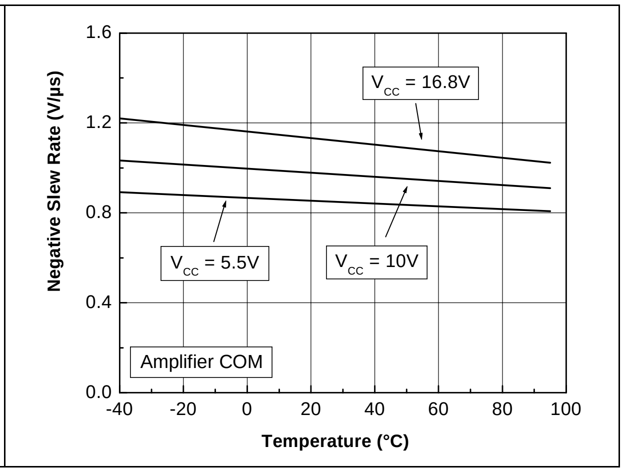



Figure 30. Large signal response - Amplifiers A & B

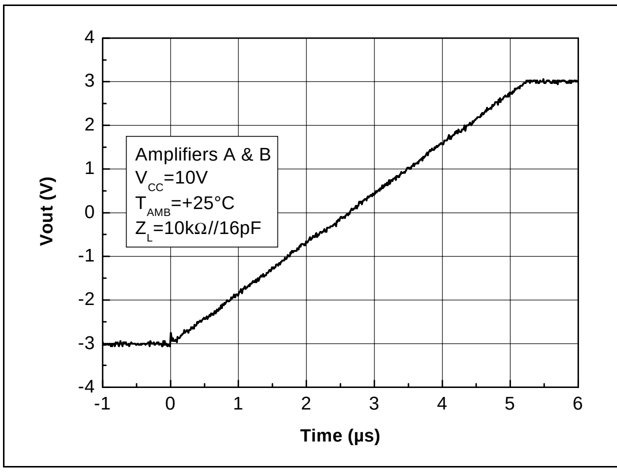



Figure 31. Large signal response - Amplifiers A & B

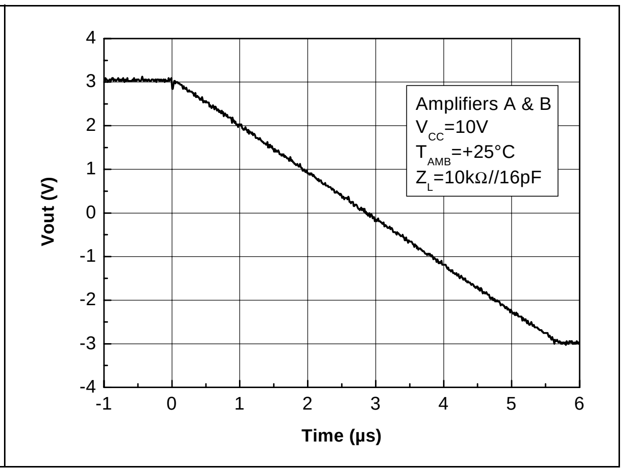


**Figure 32. Large signal response - Amplifiers C to T**

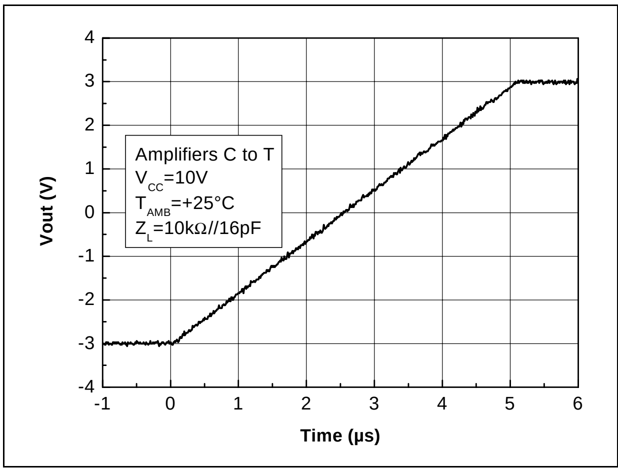



**Figure 33. Large signal response - Amplifiers C to T**

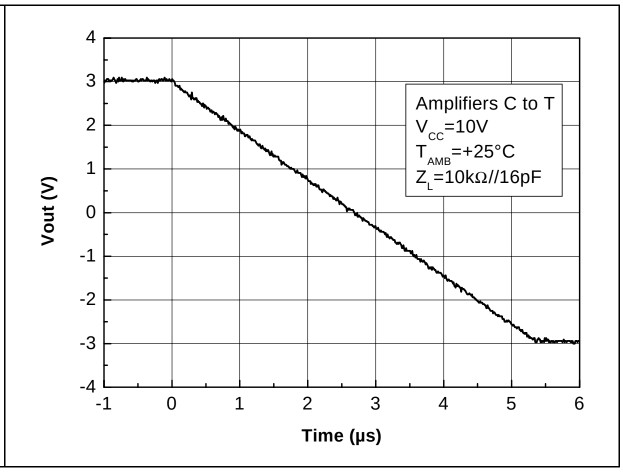



**Figure 34. Large signal response - Amplifier COM**

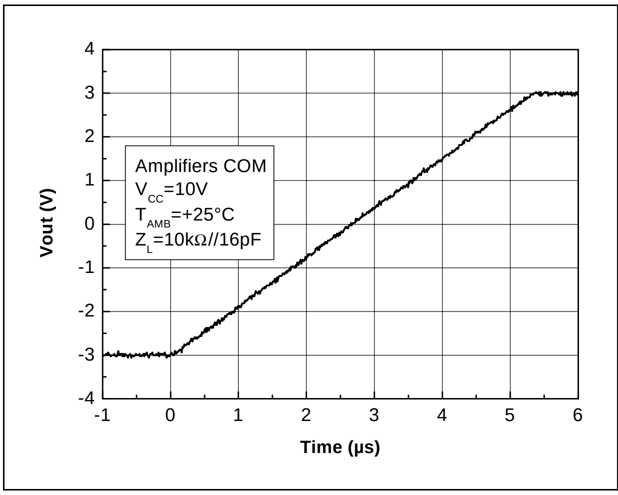



**Figure 35. Large signal response - Amplifier COM**

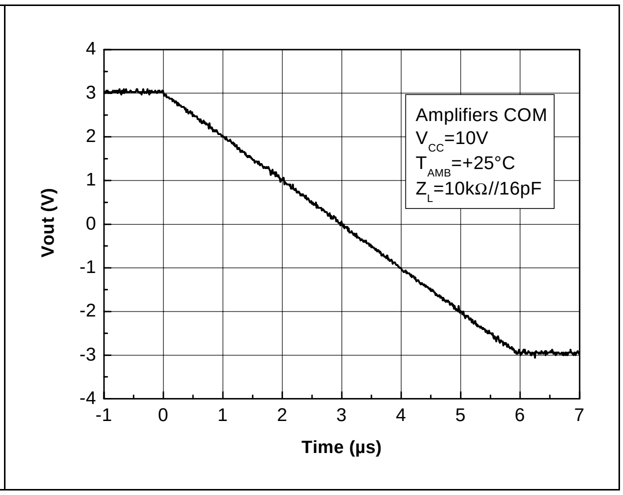



**Figure 36. Small signal response - Amplifiers A & B**

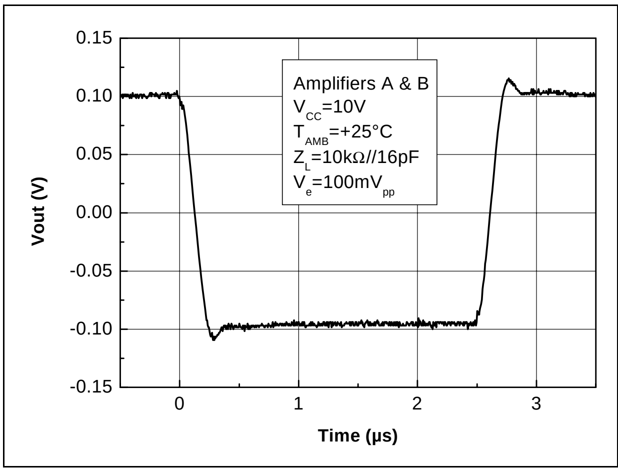



**Figure 37. Small signal response - Amplifiers C to T**

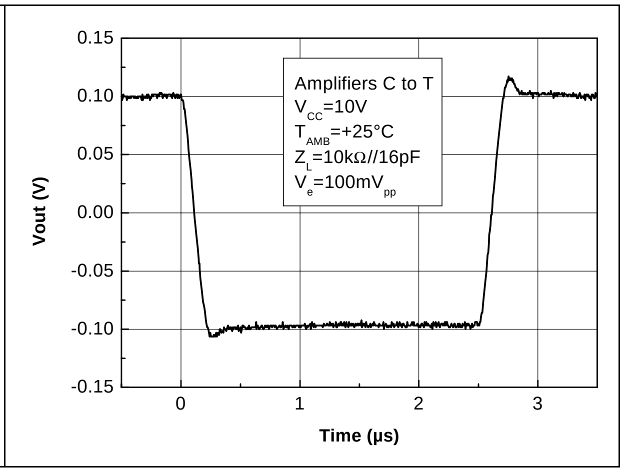


**Figure 38. Small signal response - Amplifier COM**

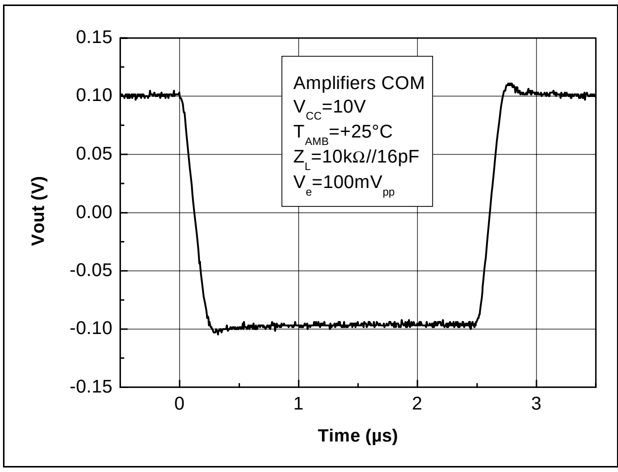



**Figure 39. Output voltage response to current transient - Amplifiers A & B**

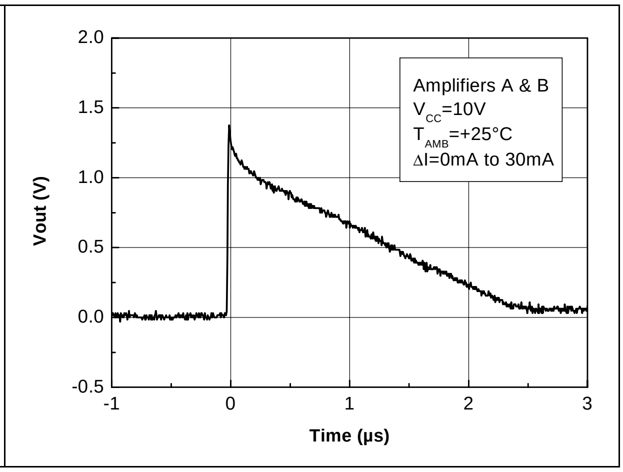



**Figure 40. Output voltage response to current transient - Amplifiers A & B**

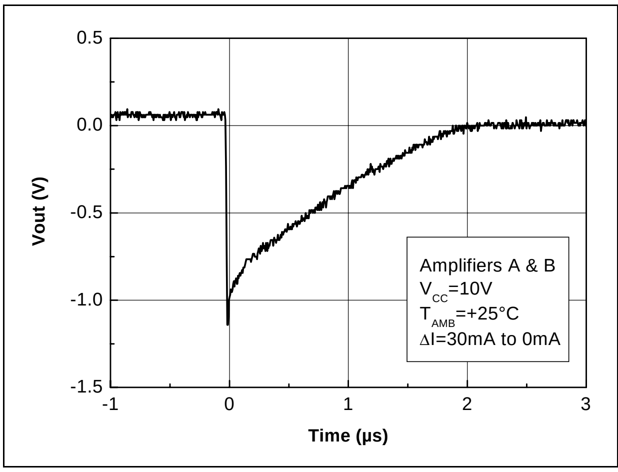



**Figure 41. Output voltage response to current transient - Amplifiers C to T**

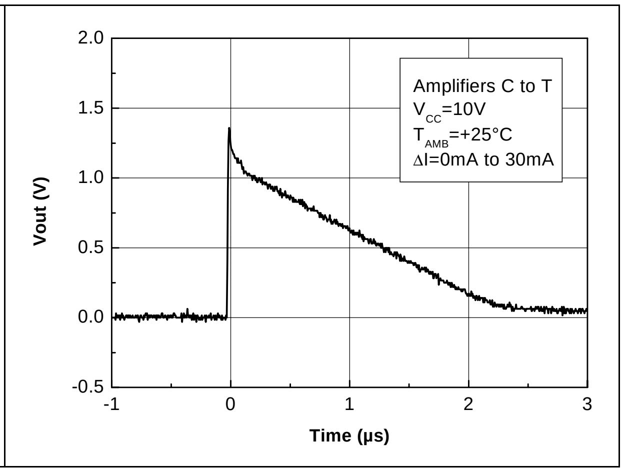



**Figure 42. Output voltage response to current transient - Amplifiers C to T**

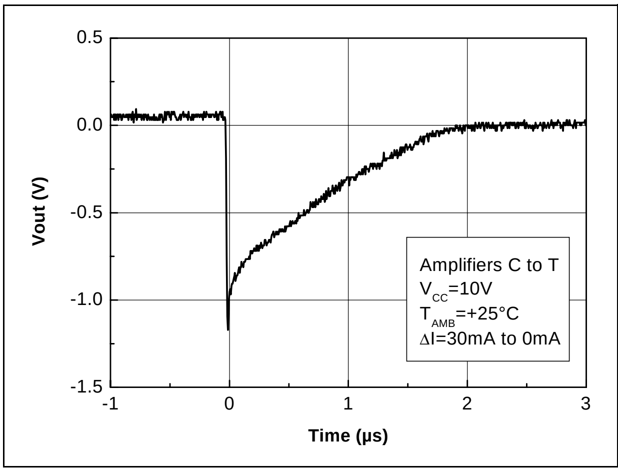



**Figure 43. Output voltage response to current transient - Amplifier COM**

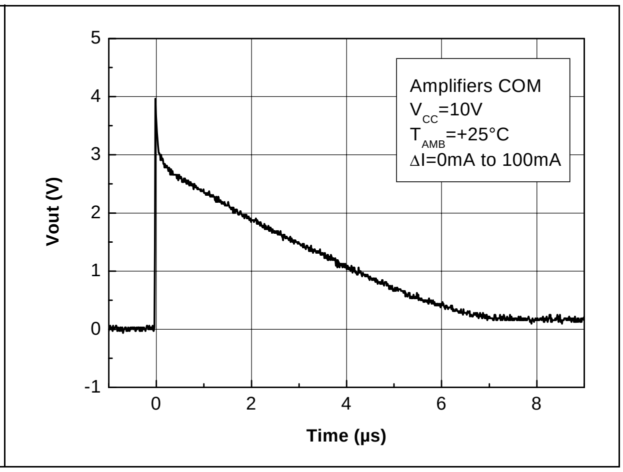


**Figure 44. Output voltage response to current transient - Amplifier COM**

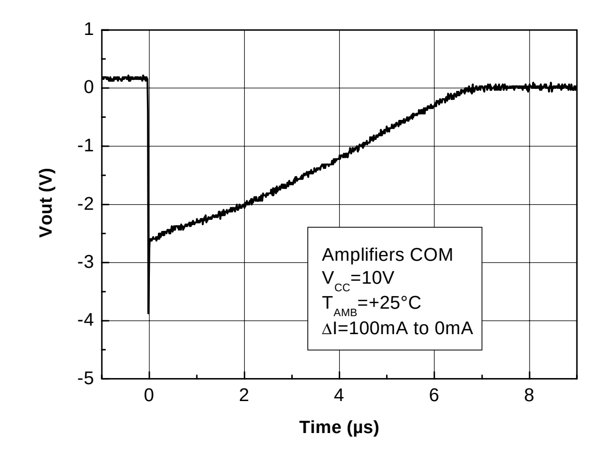



**Figure 45. Output voltage response to current transient - Amplifier COM**

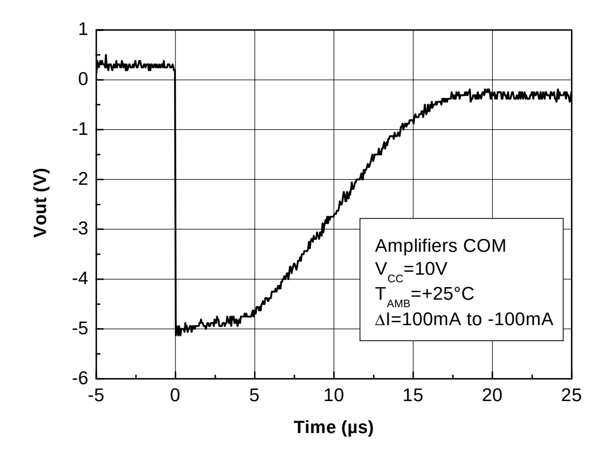
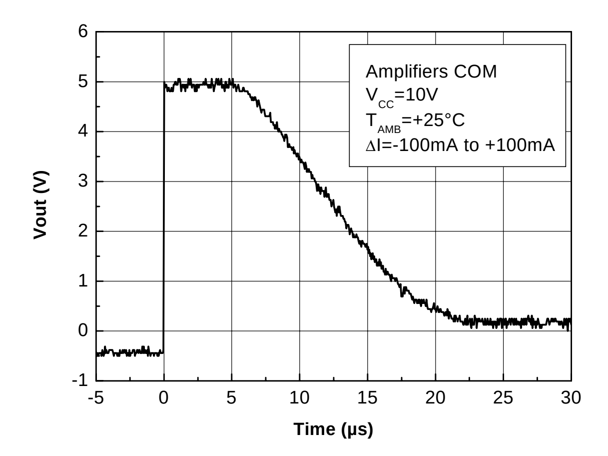



**Figure 46. Output voltage response to current transient - Amplifier COM**



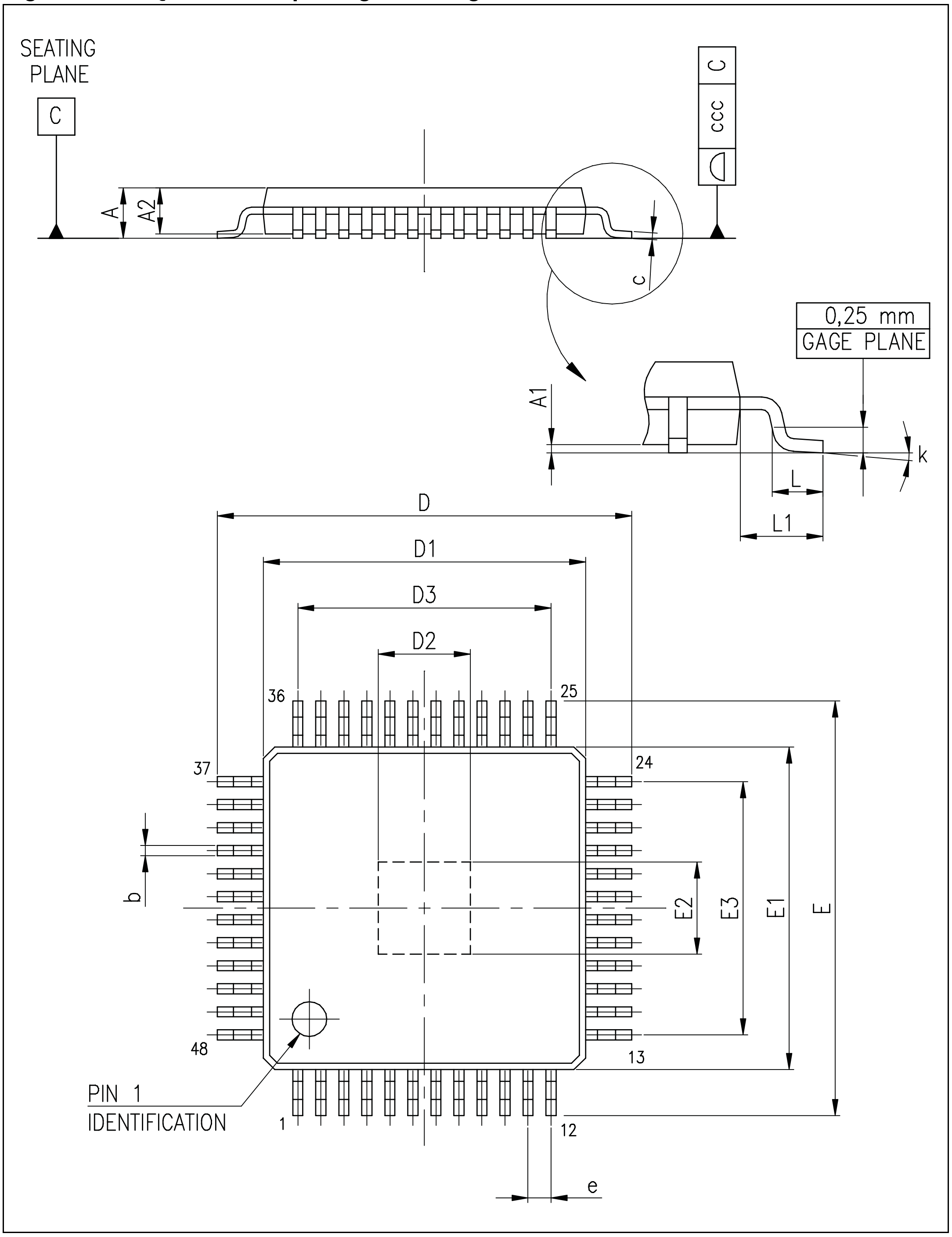
# 4 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

**Table 4. TQFP48 ePad package mechanical data**

| Ref. | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.20 | | | 0.047 |
| A1 | 0.05 | | 0.15 | 0.002 | | 0.006 |
| A2 | 0.95 | 1.00 | 1.05 | 0.037 | 0.039 | 0.041 |
| b | 0.17 | 0.22 | 0.27 | 0.007 | 0.009 | 0.011 |
| c | 0.09 | | 0.20 | 0.004 | | 0.008 |
| D | 8.80 | 9.00 | 9.20 | 0.346 | 0.354 | 0.362 |
| D1 | 6.80 | 7.00 | 7.20 | 0.268 | 0.276 | 0.283 |
| D2 | 2.00 | | | 0.079 | | |
| D3 | | 5.50 | | | 0.217 | |
| E | 8.80 | 9.00 | 9.20 | 0.346 | 0.354 | 0.362 |
| E1 | 6.80 | 7.00 | 7.20 | 0.268 | 0.276 | 0.283 |
| E2 | 2.00 | | | 0.079 | | |
| E3 | | 5.50 | | | 0.217 | |
| e | | 0.50 | | | 0.020 | |
| L | 0.45 | 0.60 | 0.75 | 0.018 | 0.024 | 0.030 |
| L1 | | 1.00 | | | 0.039 | |
| k | 0° | 3.5° | 7° | 0° | 3.5° | 7° |
| ccc | | | 0.08 | | | 0.003 |

**Figure 47. TQFP48 ePad package drawing**



# 5 Ordering information

**Table 5. Order codes**

| Order code | Temperature range | Package | Packing | Marking |
|---|---|---|---|---|
| TSL1020IF | -40°C to +95°C | TQFP48 ePad | Tray | SL1020I |
| TSL1020IFT | | | Tape & reel | |

# 6 Revision history

**Table 6. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 28-Jan-2008 | 1 | Initial release. |