# ZXCT1082/83/84/85/86/87

## PRECISION HIGH VOLTAGE HIGH-SIDE CURRENT MONITORS

## Description

The ZXCT1082 and ZXCT1083 are high side unipolar current sense monitors. These devices eliminate the need to disrupt the ground plane when sensing a load current.

The ZXCT1082/1084/1086 have 60V maximum operating voltage and ZXCT1083/1085/1087 have 40V maximum operating voltage.

The wide common-mode input voltage range and low quiescent currents coupled with SOT25 packages make them suitable for a range of applications; including automotive and systems operating from industrial 24-28V rails.

Their quiescent current is only 0.6µA thereby minimizing current sensing error.

The ZXCT1082 and ZXCT1083 use three external transconductance/gain setting resistors which increase versatility by permitting wide gain ranges and optimization of bandwidths.

The ZXCT1084/5/6/7 are fixed gain voltage output counterparts of the ZXCT1082/3.

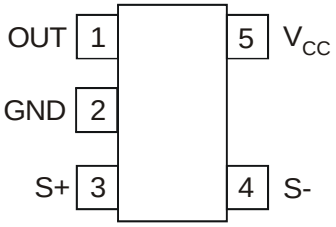
## Features

- Wide supply and common-mode voltage range
  - o 2.7V to 60V ZXCT1082/84/86
  - o 2.7V to 40V ZXCT1083/85/87
- Independent supply and input common-mode voltage
- Low quiescent current (0.6µA).
- AEC-Q100 Grade 1 qualified
- Extended industrial temperate range -40 to 125°C
- Package SOT25

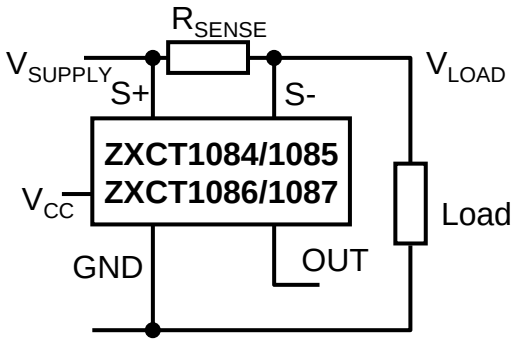
## Applications

- Automotive current measurement
- Industrial applications current measurement
- Battery management
- Over current monitor
- Power Management
- Current sources

## Pin Assignments

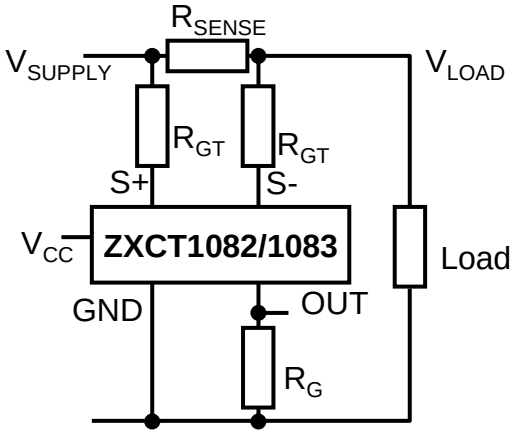



## Typical Application Circuits




ZXCT1084/85: $V_{OUT} = 25 \times V_{SENSE}$

ZXCT1086/87: $V_{OUT} = 50 \times V_{SENSE}$




ZXCT1082/83: $V_{OUT} = V_{SENSE} \frac{* R_G}{R_{GT}}$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## Pin Description

| PIN | Name | Description | | |
|---|---|---|---|---|
| | | Common | ZXCT1082/3 | ZXCT1084/5/6/7 |
| 1 | OUT | Output pin. | Current output. | Voltage output |
| 2 | GND | Ground pin. | | |
| 3 | S+ | This is the positive input of the current monitor. It has a wide common-mode input range. The current through this pin varies with differential sense voltage. | An external resistor, $R_{GT}$, should be connected from S+ to the input side ($V_{SUPPLY}$) of the sense resistor | Should be directly connected to the input side ($V_{SUPPLY}$) of the sense resistor. |
| 4 | S- | This is the negative input of the current monitor. It has a wide common-mode input range. | An external resistor, $R_{GT}$, should be connected from S- to the load side ($V_{LOAD}$) of the sense resistor. | Should be directly connected to the load side ($V_{LOAD}$) of the sense resistor. |
| 5 | $V_{CC}$ | This is the analogue supply and provides power to internal circuitry. | | |

## Absolute Maximum Ratings

| Parameter | Rating | Unit |
|---|---|---|
| Voltage on S- and S+<br>ZXCT1082, ZXCT1084, ZXCT1086<br>ZXCT1083, ZXCT1085, ZXCT1087 | <br>-0.3 to 65<br>-0.3 to 45 | V |
| Voltage on $V_{CC}$<br>ZXCT1082, ZXCT1084, ZXCT1086<br>ZXCT1083, ZXCT1085, ZXCT1087 | <br>-0.3 to 65<br>-0.3 to 45 | V |
| Voltage on OUT | -0.3 to $V_{S-}$ | V |
| Differential Input Voltage, $V_{S+}$ - $V_{S-}$ | ±800 | mV |
| Input current into S+ or S- (†) | ±12 | mA |
| Storage Temperature | -55 to 150 | °C |
| Maximum Junction Temperature | 150 | °C |
| Package Power Dissipation | 300 at $T_A$ = 25°C<br>(De-rate to zero at 150°C) | mW |
| **ESD Rating** | | |
| Human Body Model | 2 | kV |
| Machine Model | 200 | V |

Operation above the absolute maximum rating may cause device failure. Operation at the absolute maximum ratings, for extended periods, may reduce device reliability.

(†) The differential input voltage limit, $V_{S+}$ - $V_{S-}$ may be exceeded provided that the input current limit into S+ or S- is not exceeded

## Recommended Operating Conditions

| Symbol | Parameter | Min | Max | Units |
|---|---|---|---|---|
| $V_{IN}$ | ZXCT1083/1085/1087 Common-Mode Input Range<br>ZXCT1082/1084/1086 Common-Mode Input Range | 2.7<br>2.7 | 40<br>60 | V |
| $V_{CC}$ | ZXCT1083/1085/1087 Supply Voltage Range<br>ZXCT1082/1084/1086 Supply Voltage Range | 2.7<br>2.7 | 40<br>60 | V |
| $V_{SENSE}$ | Differential Sense Input Voltage Range | 0 | 0.5 | V |
| $V_{OUT}$ | Output Voltage Range | 0 | $V_{S-}$ -1 | V |
| $T_A$ | Ambient Temperature Range | -40 | 125 | °C |


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## Electrical Characteristics

Test Conditions $T_A$ = 25°C, $V_{S+}$ = 12V, $V_{CC}$ = 5 V, $V_{SENSE}$[1] = 100mV, ZXCT1082/3 $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ; unless otherwise stated. (FT = -40°C to +125°C)

| Symbol | Parameter | Conditions | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| **Input** | | | | | | | |
| $I_{S+}$ | S+ input current | $V_{SENSE}$ = 0mV (Note 1) | | | 1.7 | | µA |
| | | | $T_A$ = FT | | | 5 | |
| $I_{S-}$ | S- input current | | | | 1.7 | | µA |
| | | | $T_A$ = FT | | | 5 | |
| $V_{IO}$ | Input Offset Voltage (Note 2) | $V_{SENSE}$ = 0mV | | | ±0.2 | ±1 | mV |
| | | ZXCT1082/3/4/5 | $T_A$ = FT | | | ±2.5 | |
| | | ZXCT1086/87 | $T_A$ = FT | | | ±3 | |
| | | Temperature co-efficient | | | ±4 | | µV/K |
| **Output** | | | | | | | |
| $G_T$ | Transconductance | ZXCT1082/3 $V_{SENSE}$ = 10mV to 150mV (Note 1, 3) | | | 200 | | µA/V |
| $G_{T-ERR}$ | Transconductance error (Note 4) | | | -1 | | +1 | % |
| | | | $T_A$ = FT | -2 | | +2 | |
| $G_{T-TC}$ | Transconductance temperature co-efficient | | $T_A$ = FT | | 10 | | nA/K |
| $Z_{OUT}$ | Output impedance | ZXCT1082/3 | | | 1¦¦5 | | GΩ¦¦pF |
| $G_V$ | Gain | ZXCT1084/5/6/7 $V_{SENSE}$ = 10mV to 150mV (Note 1) | 1084/5 | | 25 | | V/V |
| | | | 1086/7 | | 50 | | |
| $G_{V-ERR}$ | Gain error (Note 4) | | | -1 | | +1 | % |
| | | | $T_A$ = FT | -2 | | +2 | |
| $G_{V-TC}$ | Voltage gain temperature co-efficient | | $T_A$ = FT | | 100 | | ppm/K |
| $Z_{OUT}$ | Output impedance | ZXCT1084/5/6/7 | | | 125 | | kΩ |
| $V_{OUTH}$ | Output relative to common mode, $V_{S-}$ | ZXCT1082/3 | | $V_{LOAD}$ - 1 | $V_{LOAD}$ - 0.8 | | V |
| | | ZXCT1084/5/6/7 | | $V_{S-}$ - 1 | $V_{S-}$ - 0.8 | | |

Notes:
1. For the ZXCT1082/83 $V_{SENSE}$ = "$V_{SUPPLY}$" – "$V_{LOAD}$" where $V_{LOAD}$ is the load voltage or the lower potential side of the sense resistor. For the ZXCT1083/84/85/86 $V_{SENSE}$ = "$V_{S+}$" – "$V_{S-}$"
2. $V_{IO}$ is extrapolated from measurements for the gain-error test.
3. For $V_{SENSE}$ > 10mV, the internal voltage-current converter is fully linear. This enables a true offset to be defined and used.
4. Gain or transconductance error is calculated by applying two values of $V_{SENSE}$ and calculating the error of the slope vs. the ideal.


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## Electrical Characteristics (cont.)

Test Conditions $T_A$ = 25°C, $V_{S+}$ = 12V, $V_{CC}$ = 5 V, $V_{SENSE}$[1] = 100mV, ZXCT1082/3 $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ; unless otherwise stated. (FT = -40°C to +125°C)

| Symbol | Parameter | Conditions | | Min. | Typ. | Max. | Units |
|---|---|---|---|---|---|---|---|
| **AC characteristics** | | | | | | | |
| BW | -3dB Small Signal Bandwidth | $V_{SENSE\ (AC)}$ = 10mV$_{PP}$ (Note 1) | G = 25 | | 500 | | kHz |
| | | | G = 50 | | 200 | | |
| $t_{s(0.1\%)}$ | Settling time (0.1%) | $V_{SENSE}$ = 50mV to 300mV step | G = 25 | | 5 | | µs |
| | | $V_{SENSE}$ = 50mV to 200mV step | G = 50 | | 7 | | |
| $i_{N-OUT}$ | Output noise current density | f = 1kHz | ZXCT1082/3 | | 12 | | pA/√Hz |
| | | f = 10kHz | | | 10 | | |
| | Total output noise current | f = 0.1Hz to 100kHz | | | 3 | | nA$_{RMS}$ |
| $v_{N-OUT}$ | Output noise voltage density | f = 1kHz | ZXCT1084/5 | | 1.5 | | µV/√Hz |
| | | | ZXCT1086/7 | | 2.9 | | |
| | | f = 10kHz | ZXCT1084/5 | | 1.2 | | |
| | | | ZXCT1086/7 | | 2.3 | | |
| | Total output noise voltage | f = 0.1Hz to 100kHz | ZXCT1084/5 | | 390 | | µV$_{RMS}$ |
| | | | ZXCT1086/7 | | 730 | | |
| **Power Supply** | | | | | | | |
| $I_{CC}$ | $V_{CC}$ Supply current | $V_{SENSE}$ = 0V | | | 0.6 | | µA |
| | | | $T_A$ = FT | | | 2 | |
| PSRR (Note 5) | $V_{CC}$ Supply rejection ratio | ZXCT1083/5: $V_{SENSE}$ = 60mV; $V_{CC}$ = 2.7V to 40V | | 80 | 100 | | dB |
| | | | $T_A$ = FT | 75 | | | |
| | | ZXCT1087: $V_{SENSE}$ = 30mV; $V_{CC}$ = 2.7V to 40V | | 80 | 100 | | |
| | | | $T_A$ = FT | 75 | | | |
| | | ZXCT1082/4: $V_{SENSE}$ = 60mV; $V_{CC}$ = 2.7V to 60V | | 80 | 100 | | |
| | | | $T_A$ = FT | 75 | | | |
| | | ZXCT1086: $V_{SENSE}$ = 30mV; $V_{CC}$ = 2.7V to 60V | | 80 | 100 | | |
| | | | $T_A$ = FT | 75 | | | |
| CMRR (Note 5) | Common-mode sense rejection ratio | ZXCT1083/5: $V_{SENSE}$ = 60mV; $V_{S+}$ = 2.7V to 40V | | 80 | 100 | | dB |
| | | | $T_A$ = FT | 80 | | | |
| | | ZXCT1087: $V_{SENSE}$ = 30mV; $V_{S+}$ = 2.7V to 40V | | 80 | 100 | | |
| | | | $T_A$ = FT | 80 | | | |
| | | ZXCT1082/4: $V_{SENSE}$ = 60mV; $V_{S+}$ = 2.7V to 60V | | 80 | 100 | | |
| | | | $T_A$ = FT | 80 | | | |
| | | ZXCT1086: $V_{SENSE}$ = 30mV; $V_{S+}$ = 2.7V to 60V | | 80 | 100 | | |
| | | | $T_A$ = FT | 80 | | | |

Notes: 5. Measured relative to input


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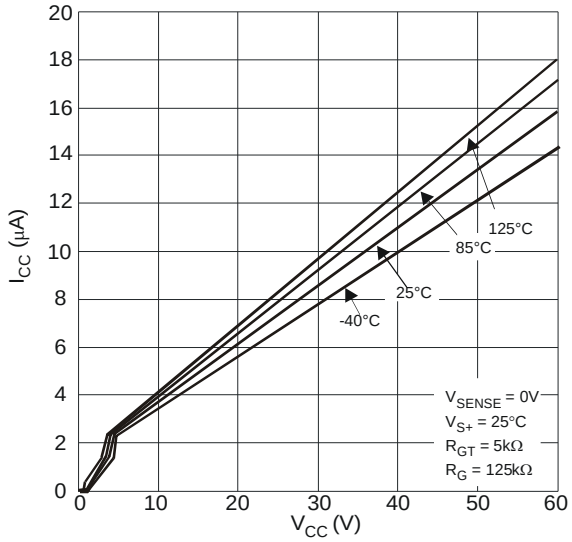
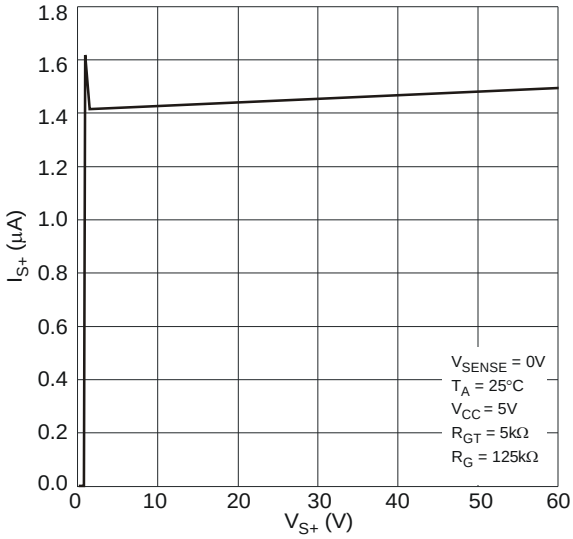
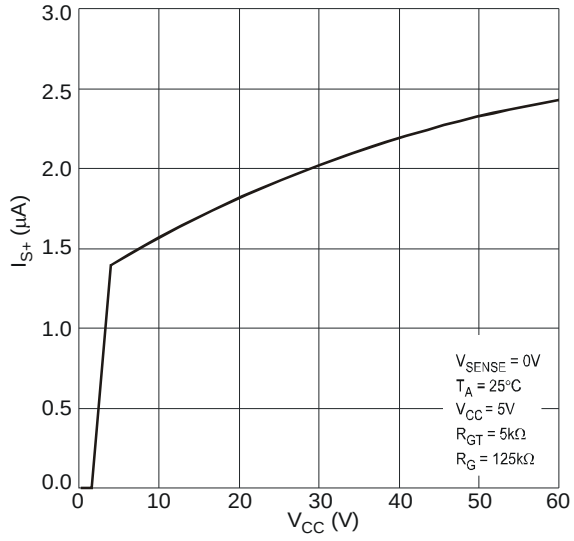
## Typical Characteristics $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ, $T_A$ = 25°C unless otherwise stated



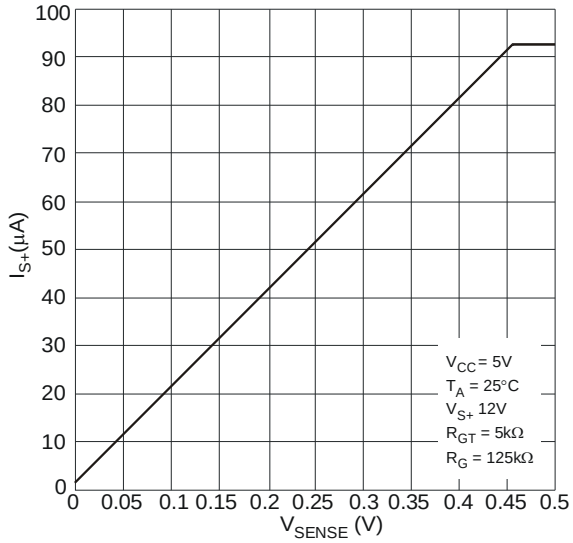

Supply Current vs. Supply Voltage



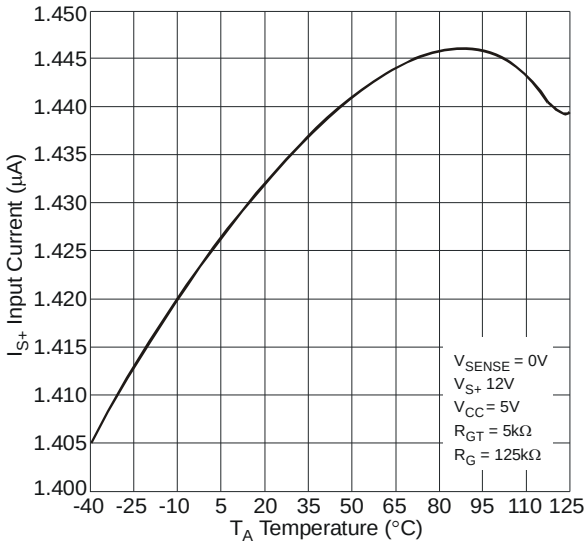

S+ Input Current vs. S+ Voltage



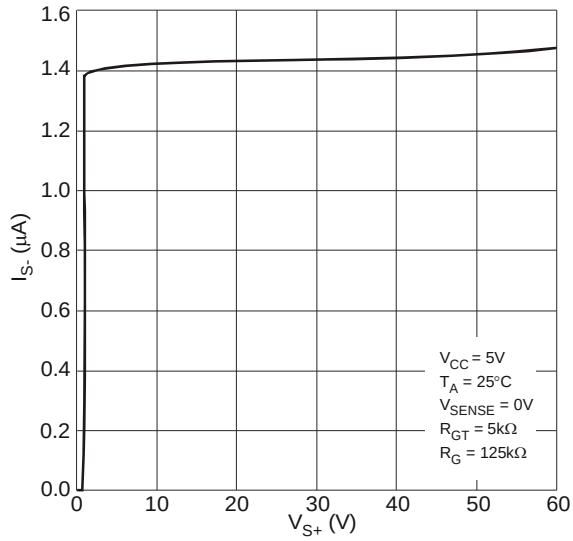

$I_{S+}$ Input Current vs. $V_{CC}$




$I_{S+}$ Input Current vs. $V_{SENSE}$




$I_{S+}$ Input Current vs. Ambient Temperature




$I_{S-}$ Input Current vs. S+ Voltage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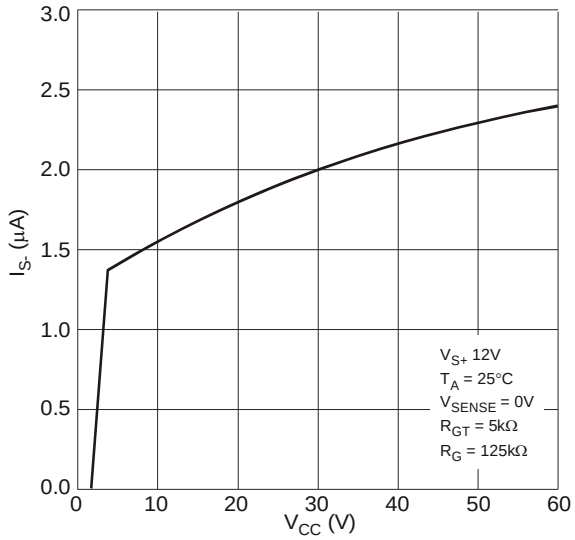
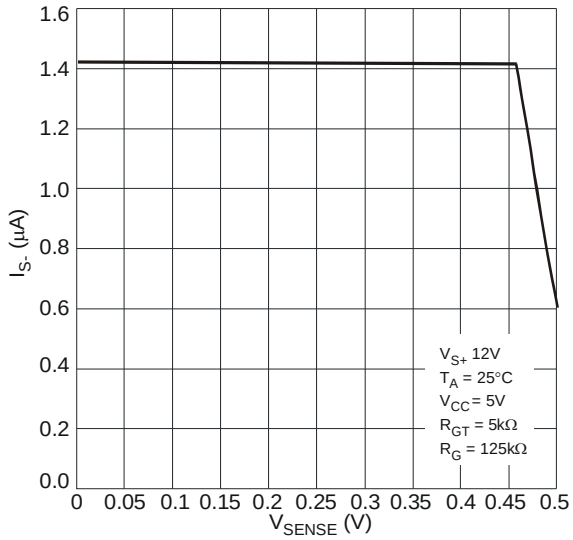
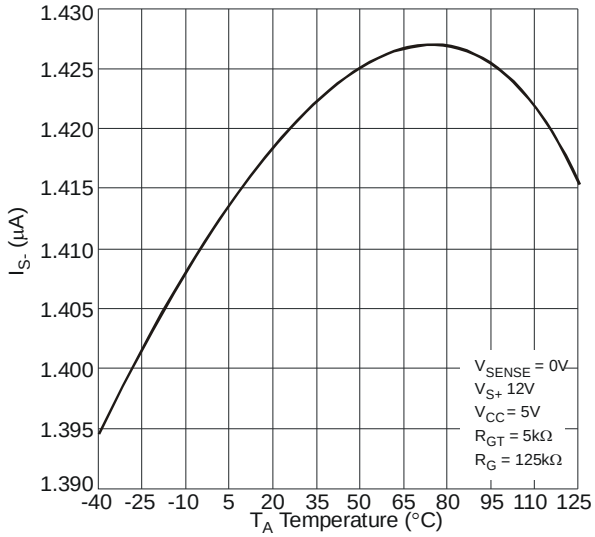
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ, $T_A$ = 25°C



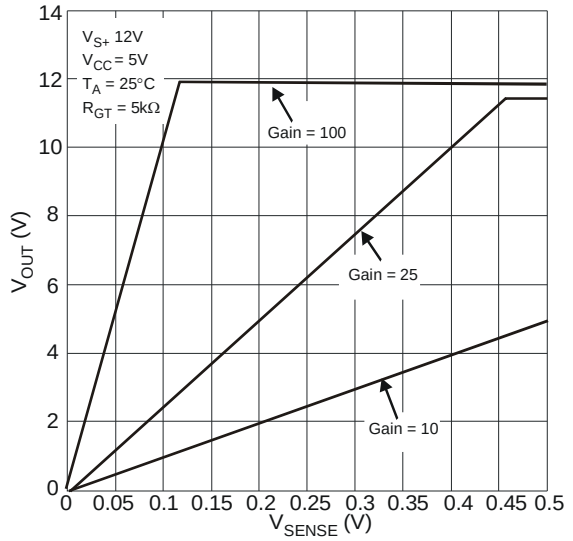

$I_{S-}$ Input Current vs. Supply Voltage



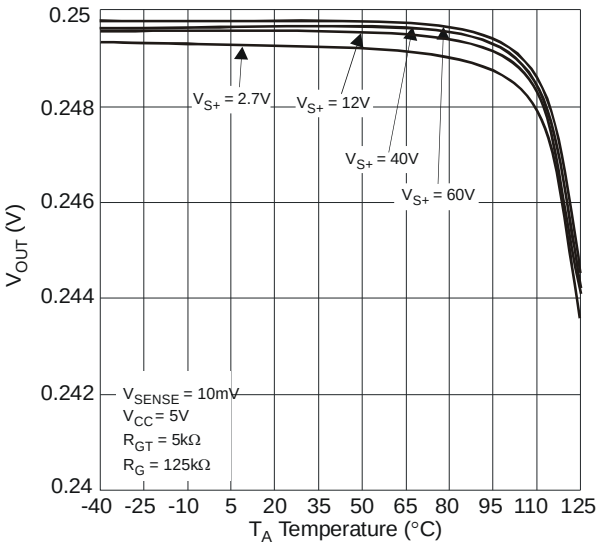

$I_{S-}$ Input Current vs. $V_{SENSE}$ Different Voltage



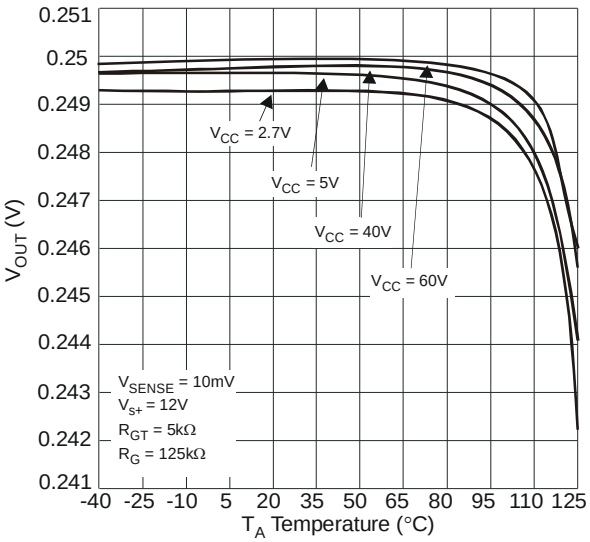

$I_{S-}$ Input Current vs. Ambient Temperature




Output Voltage vs. $V_{SENSE}$




$V_{OUT}$ vs. Ambient Temperature




$V_{OUT}$ vs. Ambient Temperature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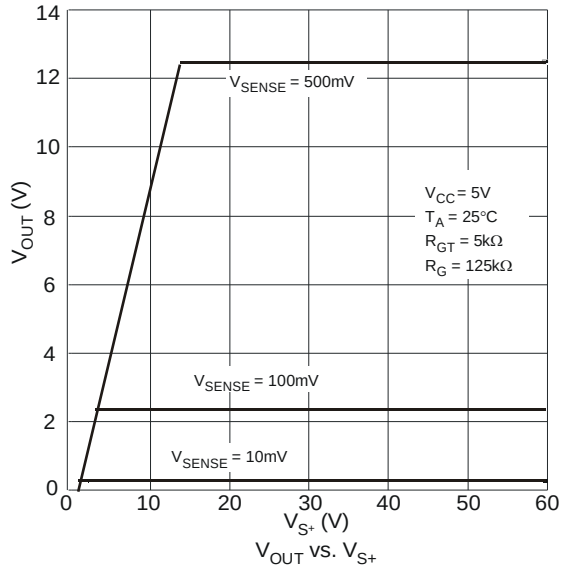
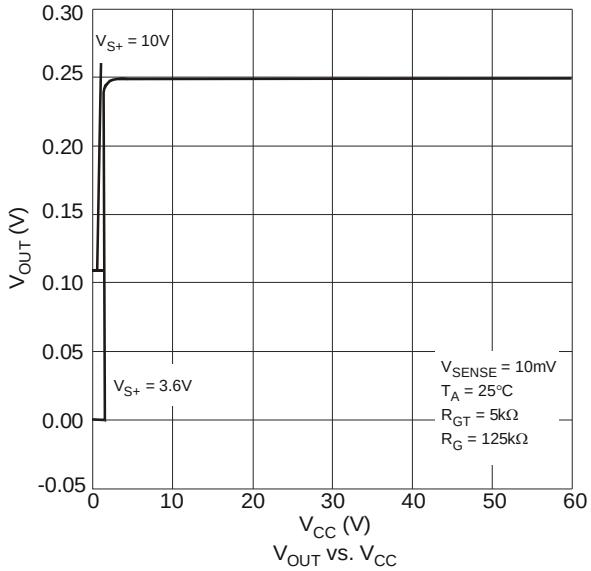
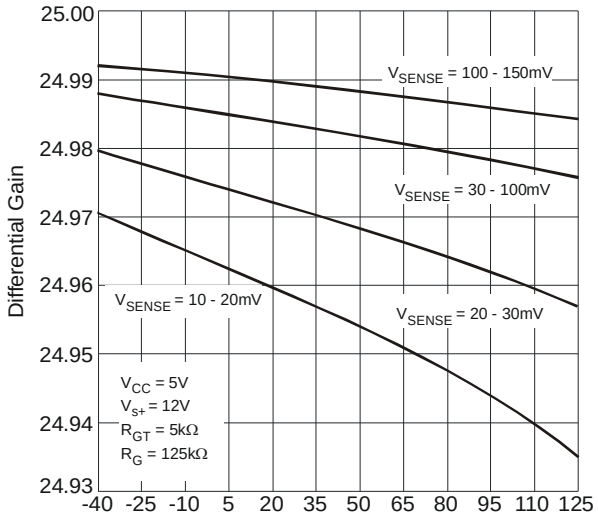
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ, $T_A$ = 25°C



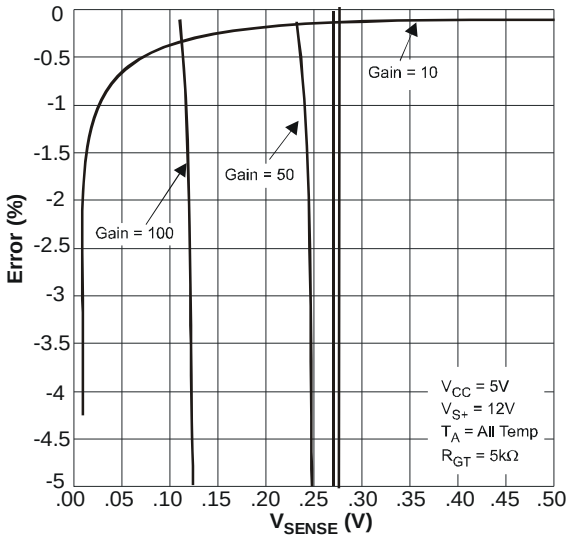

$V_{OUT}$ vs. $V_{S+}$



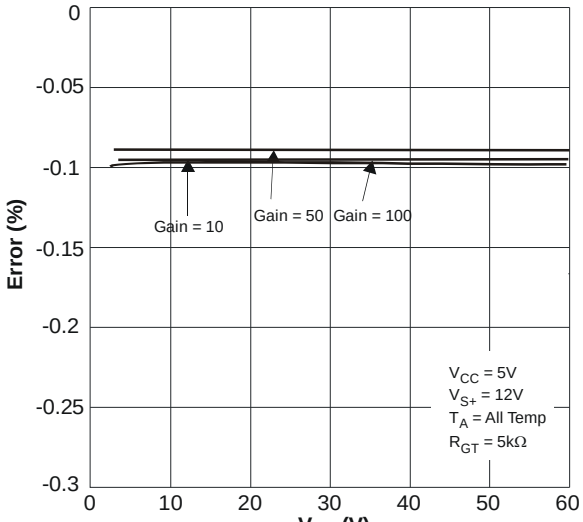

$V_{OUT}$ vs. $V_{CC}$



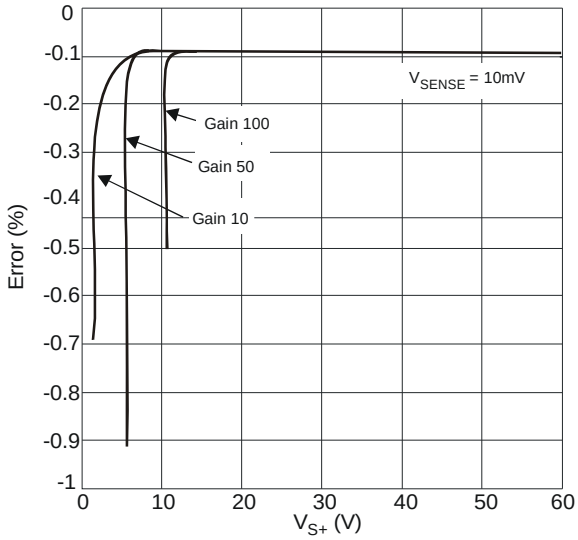

Differential Gain vs. Temperature




**Error vs. $V_{SENSE}$**




**Error vs. $V_{CC}$**




Error vs. $V_{S+}$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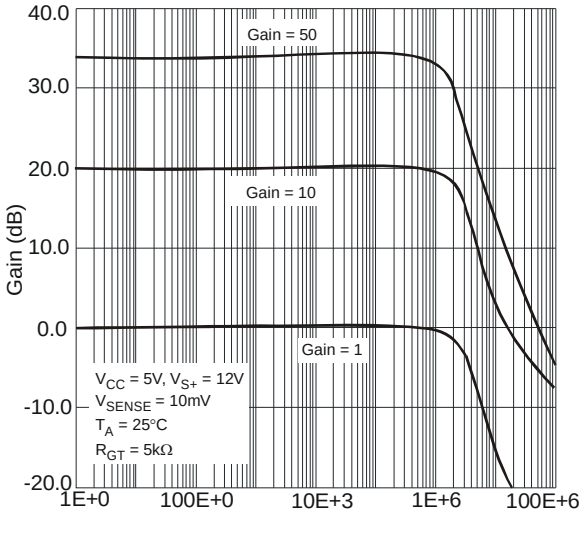
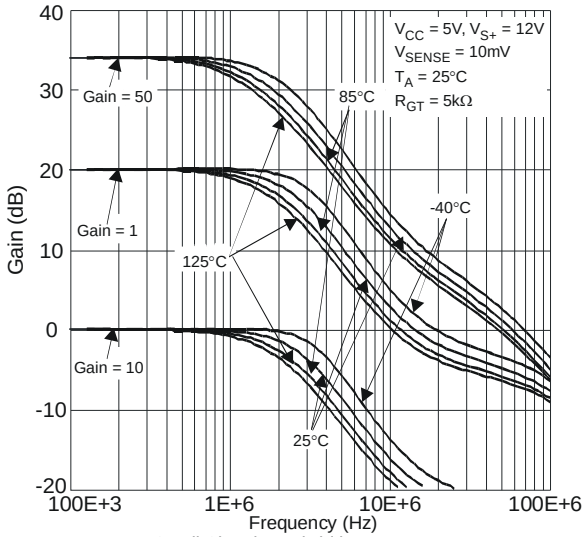
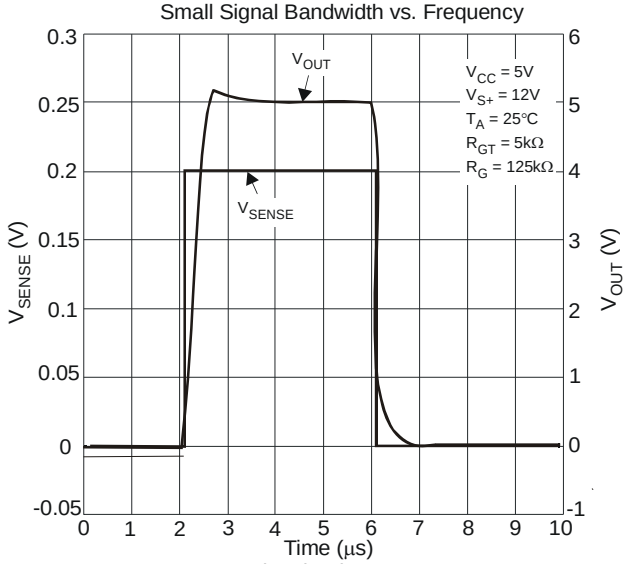
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ , $T_A$ = 25°C



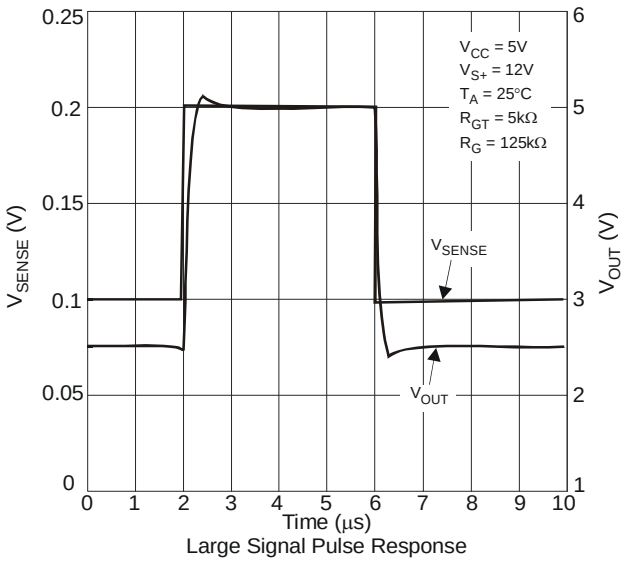

Small Signal Bandwidth vs. Frequency



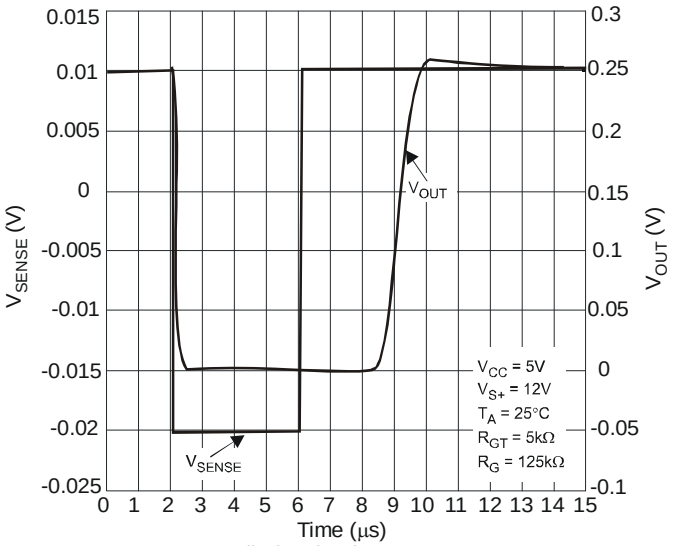

Small Signal Bandwidth vs. Frequency



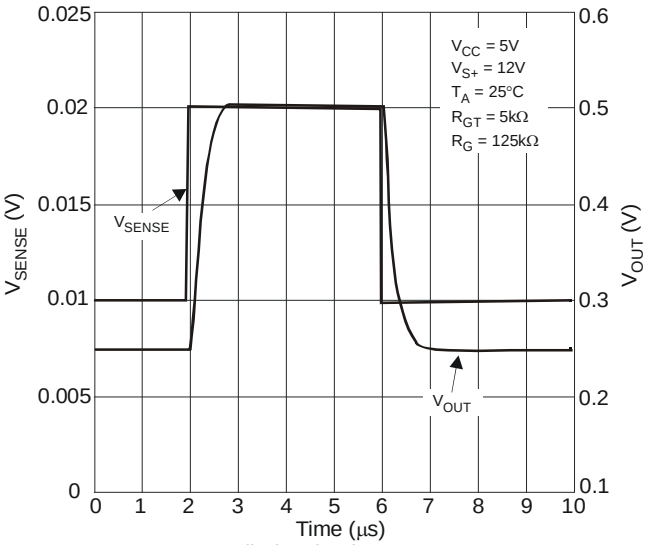

Large Signal Pulse Response




Large Signal Pulse Response




Small Signal Pulse Response




Small Signal Pulse Response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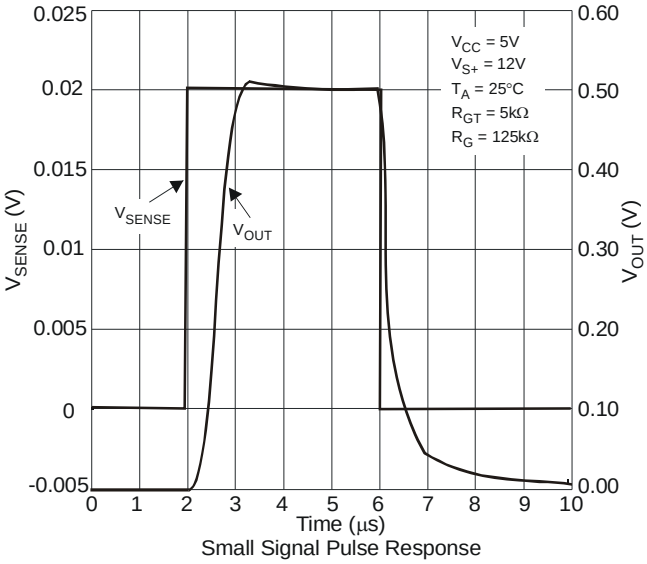
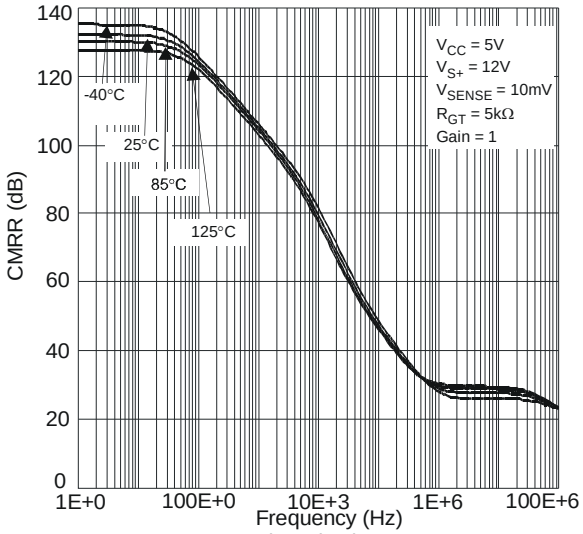
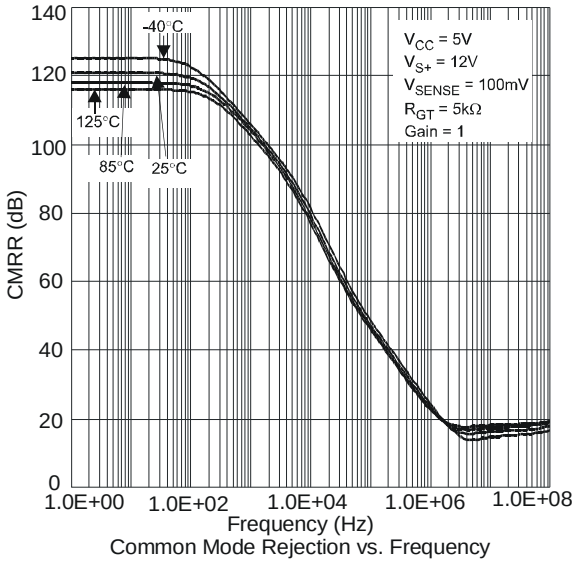
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ , $T_A$ = 25°C



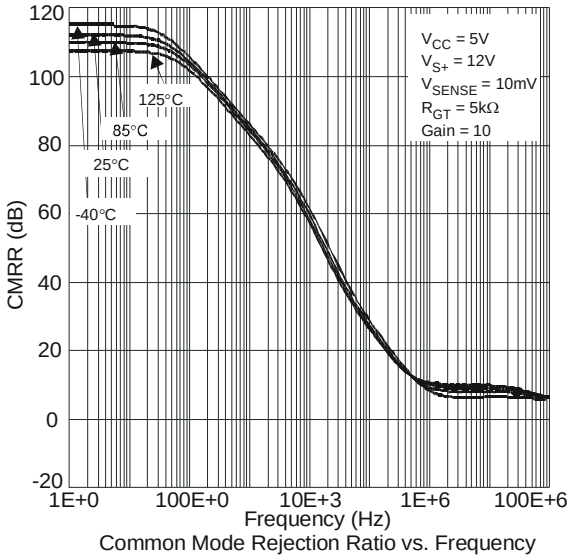
Small Signal Pulse Response



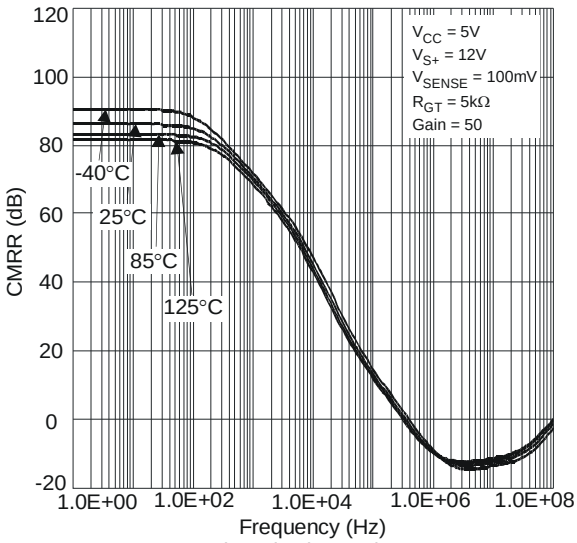
Common Mode Rejection vs. Frequency



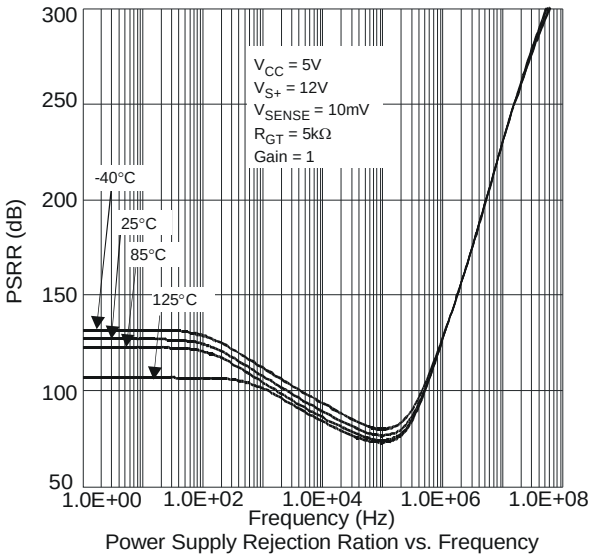
Common Mode Rejection vs. Frequency



Common Mode Rejection Ratio vs. Frequency



Common Mode Rejection Ratio vs. Frequency



Power Supply Rejection Ration vs. Frequency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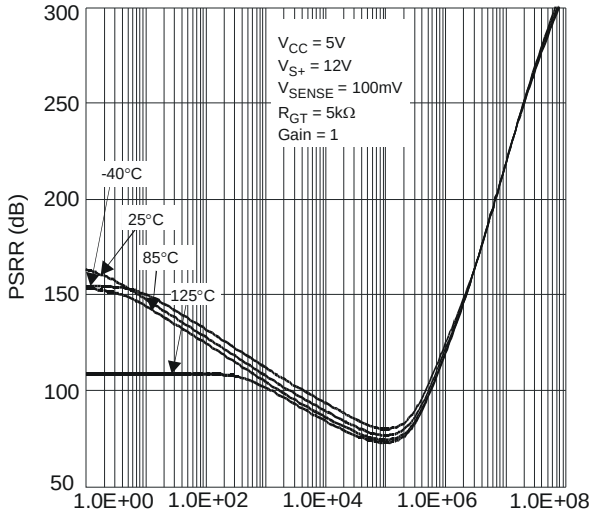
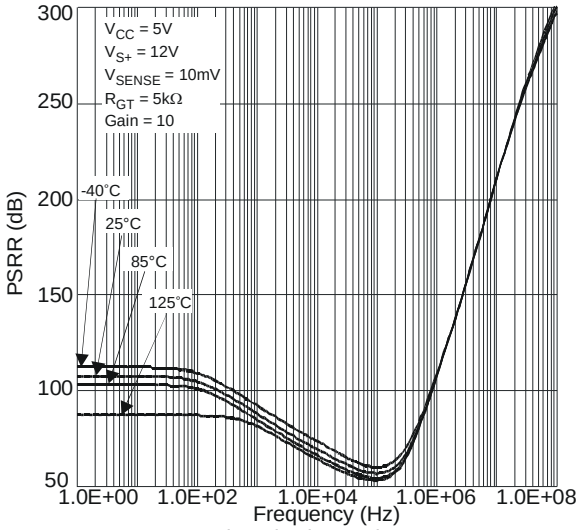
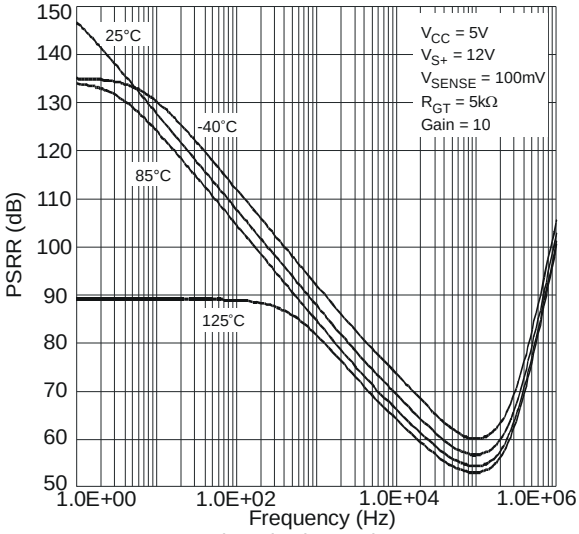
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ , $T_A$ = 25°C



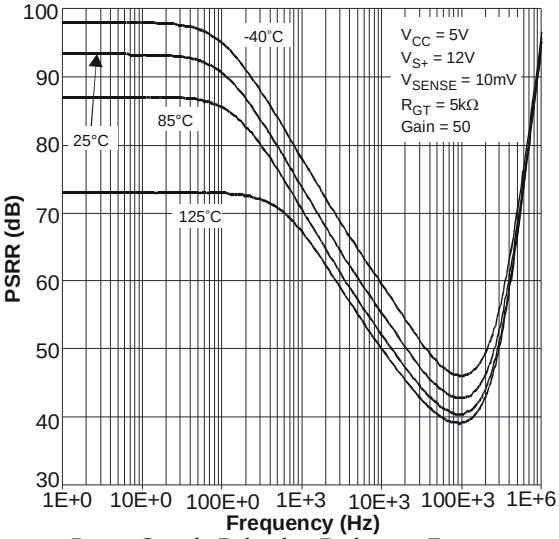

Power Supply Rejection Ration vs. Frequency



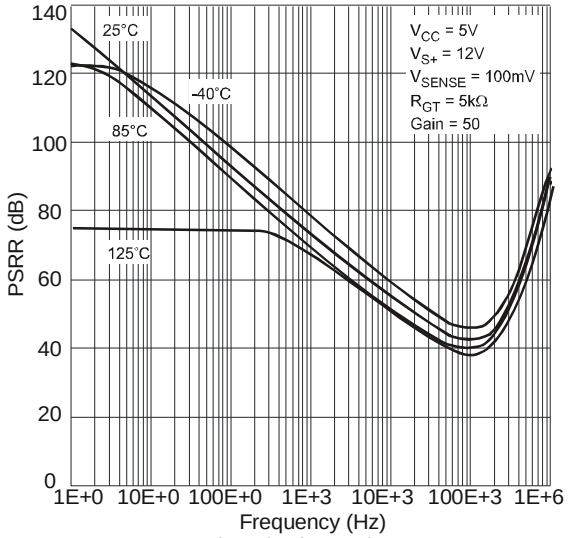

Power Supply Rejection Ration vs. Frequency



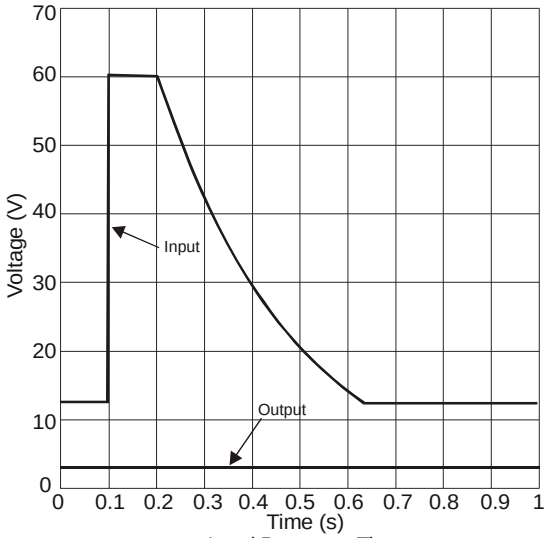

Power Supply Rejection Ration vs. Frequency




**Power Supply Rejection Ration vs. Frequency**




Power Supply Rejection Ratio vs. Frequency




Load Dump vs. Time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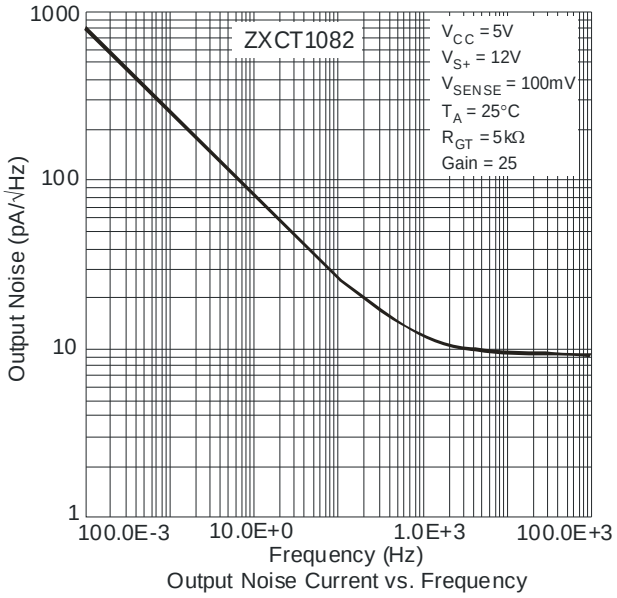
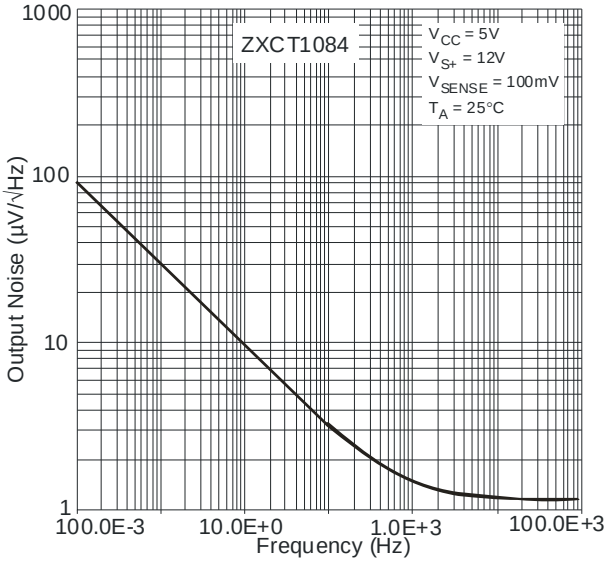
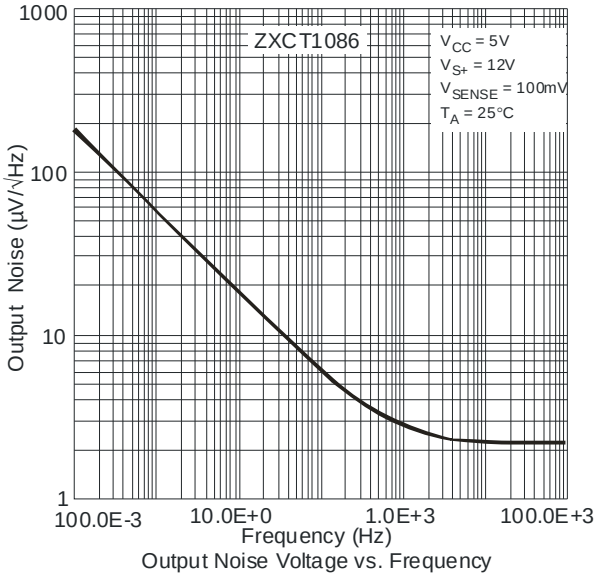
## Typical Characteristics (cont.) $V_{S+}$ = 12V, $V_{CC}$ = 5V $V_{SENSE}$ = 100mV, $R_{GT}$ = 5kΩ, $R_G$ = 125kΩ , $T_A$ = 25°C




Output Noise Current vs. Frequency




Output Noise Voltage vs. Frequency




Output Noise Voltage vs. Frequency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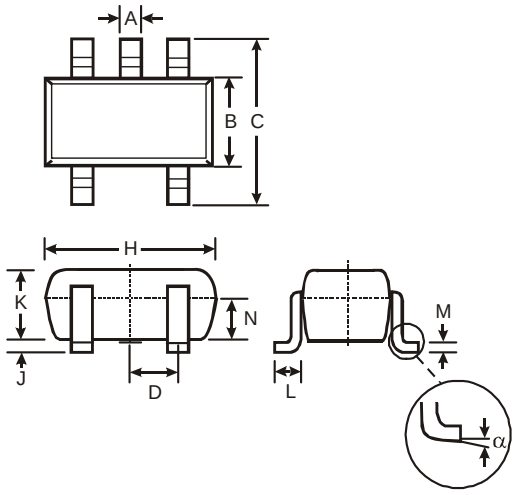
## Ordering Information

| Part Number | AEC-Q100 | Pack | Part mark | Reel Size | Tape width | Quantity per reel |
|---|---|---|---|---|---|---|
| ZXCT1082E5TA | Grade 1 | SOT25 | 1082 | 7”, 180mm | 8mm | 3000 |
| ZXCT1083E5TA | Grade 1 | SOT25 | 1083 | 7”, 180mm | 8mm | 3000 |
| ZXCT1084E5TA | Grade 1 | SOT25 | 1084 | 7”, 180mm | 8mm | 3000 |
| ZXCT1085E5TA | Grade 1 | SOT25 | 1085 | 7”, 180mm | 8mm | 3000 |
| ZXCT1086E5TA | Grade 1 | SOT25 | 1086 | 7”, 180mm | 8mm | 3000 |
| ZXCT1087E5TA | Grade 1 | SOT25 | 1087 | 7”, 180mm | 8mm | 3000 |

## Package Outline Dimensions

### SOT25




| SOT25 | | | |
|---|---|---|---|
| **Dim** | **Min** | **Max** | **Typ** |
| **A** | 0.35 | 0.50 | 0.38 |
| **B** | 1.50 | 1.70 | 1.60 |
| **C** | 2.70 | 3.00 | 2.80 |
| **D** | — | — | 0.95 |
| **H** | 2.90 | 3.10 | 3.00 |
| **J** | 0.013 | 0.10 | 0.05 |
| **K** | 1.00 | 1.30 | 1.10 |
| **L** | 0.35 | 0.55 | 0.40 |
| **M** | 0.10 | 0.20 | 0.15 |
| **N** | 0.70 | 0.80 | 0.75 |
| **α** | 0° | 8° | — |
| **All Dimensions in mm** | | | |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