# VOLTAGE REGULATOR WITH ON/OFF SWITCH

## FEATURES

- **High Voltage Precision at ± 2.4%**
- **Active High On/Off Control**
- **Very Low Dropout Voltage 80 mV at 30 mA**
- **Very Low Noise**
- **Very Small SOT-23L or SOT-89-5 Surface Mount Packages**
- **Internal Thermal Shutdown**
- **Short Circuit Protection**

## APPLICATIONS

- **Battery Powered Systems**
- **Cellular Telephones**
- **Pagers**
- **Personal Communications Equipment**
- **Portable Instrumentation**
- **Portable Consumer Equipment**
- **Radio Control Systems**
- **Toys**
- **Low Voltage Systems**

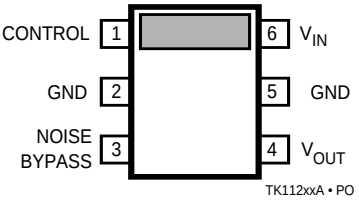
## DESCRIPTION

The TK112xxA is a low dropout linear regulator with a built-in electronic switch. The internal switch can be controlled by TTL or CMOS logic levels. The device is in the ON state when the control pin is pulled to a logic high level. An external capacitor can be connected to the noise bypass pin to lower the output noise level to 30 μVrms.

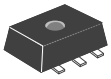
An internal PNP pass transistor is used to achieve a low dropout voltage of 70 mV (typ.) at 30 mA load current. The TK112xxA has a very low quiescent current of 180 μA at no load and 1 mA with a 30 mA load. The standby current is typically 100 nA. The internal thermal shutdown circuitry limits the junction temperature to below 150 °C. The load current is internally monitored and the device will shutdown in the presence of a short circuit or overcurrent condition at the output.

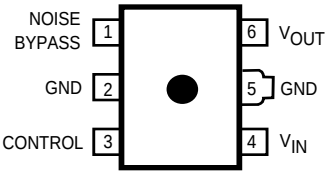
The TK112xxA is available in either 6 pin SOT-23L or 5 pin SOT-89-5 surface mount packages.

**TK112XXA**

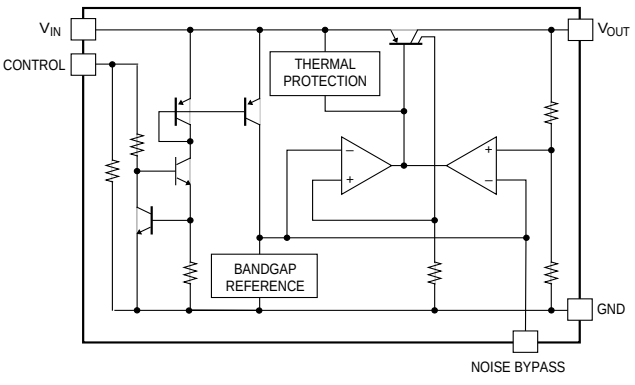



TK112xxA • PO






**BLOCK DIAGRAM**




## ORDERING INFORMATION

TK112 □□A □ □□

Voltage Code

Tape/Reel Code

Package Code

| VOLTAGE CODE | | PACKAGE CODE | TAPE/REEL CODE |
|---|---|---|---|
| 20 = 2.0 V* | 35 = 3.5 V* | M: SOT-23L | BX : Bulk/Bag |
| 21 = 2.1 V | 36 = 3.6 V | U: SOT-89-5 | TL : Tape Left (SOT-23L) |
| 22 = 2.22 V* | 38 = 3.8 V | | TB : Tape Bottom (SOT-89-5) |
| 25 = 2.5 V* | 40 = 4.0 V* | | |
| 28 = 2.8 V* | 42 = 4.2 V | | |
| 29 = 2.9 V | 45 = 4.5 V* | | |
| 30 = 3.0 V* | 48 = 4.8 V* | | |
| 31 = 3.1 V* | 49 = 4.9 V | | |
| 33 = 3.3 V* | 50 = 5.0 V* | | |
| | 55 = 5.5 V | | |

* Indicates voltage is available in a SOT-89-5 package.

## ABSOLUTE MAXIMUM RATINGS

Supply Voltage ..... 16 V
Power Dissipation SOT-23L (Note 1) ..... 400 mW
Power Dissipation SOT-89-5 (Note 2) ..... 800 mW
Storage Temperature Range ..... -55 to +150 °C
Operating Temperature Range .....-30 to +80 °C
Lead Soldering Temp. (3 sec.) ..... 230 °C
Junction Temperature ..... 150 °C

## TK11220A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.0 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 1.92 | 2.00 | 2.08 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 1.7 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3 V → 8 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 3) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.2 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: Power dissipation is 400 mW when mounted as recommended. Derate at 3.2 mW/°C for $T_A$ > 25 °C.
Note 2: Power dissipation is 800 mW when mounted as recommended. Derate at 6.4 mW/°C for $T_A$ > 25 °C.
Note 3: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11221A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.1 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.02 | 2.10 | 2.18 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 1.8 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.1 V → 8.1 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 3.5 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.2 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11222A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.22 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.14 | 2.22 | 2.3 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 1.92 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.22 V → 8.22 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 3.72 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11225A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.5 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.42 | 2.50 | 2.58 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 2.2 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.5 V → 8.5 V (Note 1) | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.0 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11228A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.8 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.72 | 2.80 | 2.88 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 2.5 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.8 V → 8.8 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.3 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11229A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 3.9 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.82 | 2.90 | 2.98 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 2.6 V | | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.9 V → 8.9 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.4 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11230A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.0 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 2.92 | 3.00 | 3.08 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 2.7 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 4 V → 9 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.5 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11231A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.1 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.02 | 3.10 | 3.18 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 2.8 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 4.1 V → 9.1 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.6 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11233A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.3 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.22 | 3.30 | 3.38 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 4.3 V → 9.3 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 4.8 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11235A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.5 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.42 | 3.50 | 3.58 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3.2 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 4.5 V → 9.5 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 5 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.05 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11236A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.6 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.51 | 3.60 | 369 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3.3 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 3.6 V → 9.6 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 5.3 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11238A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 4.8 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.71 | 3.80 | 3.89 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3.5 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 4.8 V → 9.8 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 5.3 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 30 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11240A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 5.0 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 3.90 | 4.00 | 4.10 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3.7 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 5 V → 10 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 5.5 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 40 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11242A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 5.2 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 4.10 | 4.20 | 4.30 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 3.9 V | | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 5.2 V → 10.2 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 5.7 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 40 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11245A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 5.5 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 4.39 | 4.50 | 4.61 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 4.2 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 5 V → 10 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 6 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 40 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11248A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 5.8 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 4.68 | 4.80 | 4.92 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 4.5 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 5.8 V → 10.8 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 6.3 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.1 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 40 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11249A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 5.9 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 4.78 | 4.90 | 5.02 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 4.6 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 5.9 V → 10.9 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 6.4 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.2 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 40 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11250A ELECTRICAL CHARACTERISTICS

Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 6.0 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 4.88 | 5.00 | 5.12 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 4.7 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 6 V → 11 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 6.5 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.2 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 50 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TK11255A ELECTRICAL CHARACTERISTICS

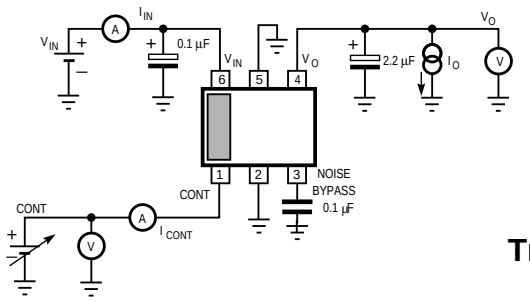
Test conditions: $T_A$ = 25 °C, $V_{IN}$ = 6.5 V, $C_P$ = 0.1 µF, unless otherwise specified.

| SYMBOL | PARAMETER | TEST CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| $I_{IN}$ | Quiescent Current | $I_O$ = 0 mA, Except $I_{CONT}$ | | 170 | 350 | µA |
| $I_{STBY}$ | Standby Current | $V_{IN}$ = 8 V, at output off | | | 0.1 | µA |
| $V_O$ | Output Voltage | $I_O$ = 30 mA | 5.36 | 5.5 | 5.63 | V |
| $V_{DROP}$ | Dropout Voltage | $I_O$ = 60 mA | | 0.16 | 0.26 | V |
| | | $I_O$ = 150 mA | | 0.29 | 0.4 | V |
| $I_O$ | Output Current | $V_{OUT}$ = 5.2 V | 180 | 240 | | mA |
| $I_{OR}$ | Recommended Output Current | | | | 150 | mA |
| Line Reg | Line Regulation | $V_{IN}$ = 6.5 V → 11.5 V | | 3.0 | 20 | mV |
| Load Reg | Load Regulation | $I_O$ = 5 mA → 60 mA (Note 1) | | 10 | 50 | mV |
| | | $I_O$ = 5 mA → 100 mA | | 20 | 100 | mV |
| | | $I_O$ = 5 mA → 150 mA | | 30 | 160 | mV |
| RR | Ripple Rejection | 100 mV(rms), $I_O$ = 10 mA | | 55 | | dB |
| $\Delta V_O/\Delta T_A$ | Output Voltage Temperature Dependency | $V_{IN}$ = 7 V, $I_O$ = 10 mA<br>-20 °C ≤ $T_A$ ≤ + 75 °C | | 0.2 | | mV/ °C |
| $V_{NO}$ | Output Noise Voltage | 10 Hz < f < 80 kHz,<br>$I_O$ = 30 mA | | 50 | | µV(rms) |
| $V_{REF}$ | Noise Bypass Terminal Voltage | | | 1.25 | | V |
| **Control Terminal Specification** | | | | | | |
| $I_{CONT}$ | Control Current | Output on, $V_{CONT}$ = 1.8 V | | 12 | 30 | µA |
| $V_{CONT}$ | Control Voltage | Output on | 1.8 | | | V |
| | | Output off | | | 0.6 | V |
| $t_r$ | Output Rise Time | $I_O$ = 30 mA,<br>$V_{CONT}$ = 0 V → 1.8 V | | 0.3 | | ms |

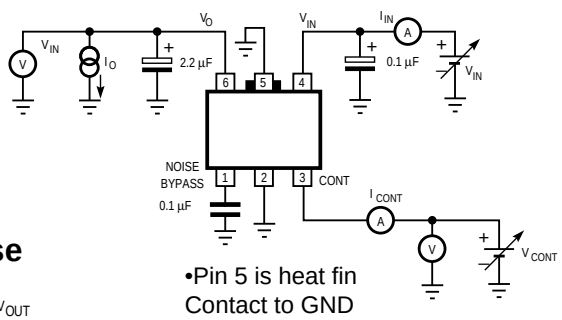
Note 1: This is a pulse measurement where $T_J$ is constant. The output change due to temperature is not included.

## TEST CIRCUITS

### SOT-23L

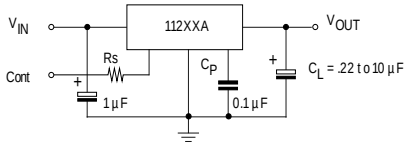



### SOT-89-5




•Pin 5 is heat fin
Contact to GND

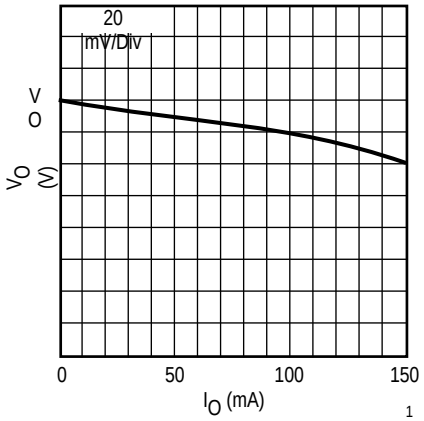
### Transient Response




## TYPICAL PERFORMANCE CHARACTERISTICS

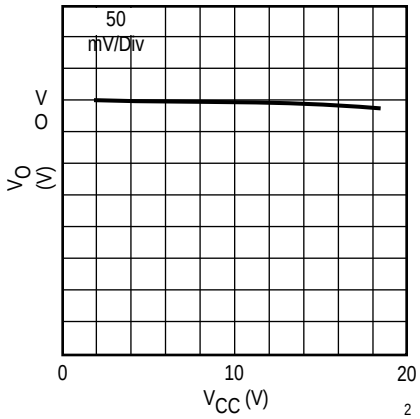
$T_A$ = 25 °C unless otherwise specified

**LOAD REGULATION**



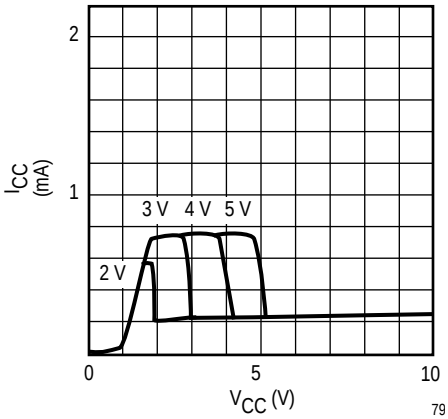

1

**LINE REGULATION**



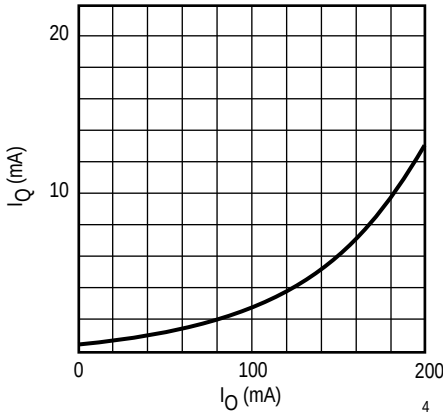

2

**SUPPLY VOLTAGE vs. INPUT CURRENT (NO LOAD)**



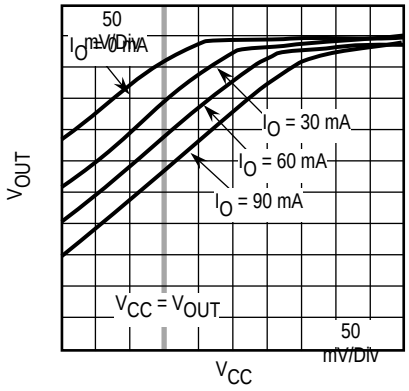

79

**QUIESCENT CURRENT vs. LOAD CURRENT**



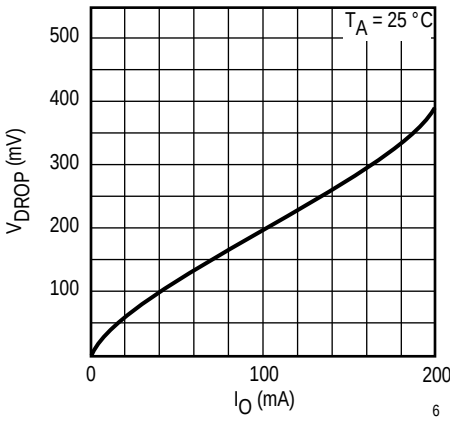

4

**OUTPUT VOLTAGE vs. INPUT VOLTAGE**




5

**DROPOUT VOLTAGE vs. LOAD CURRENT**

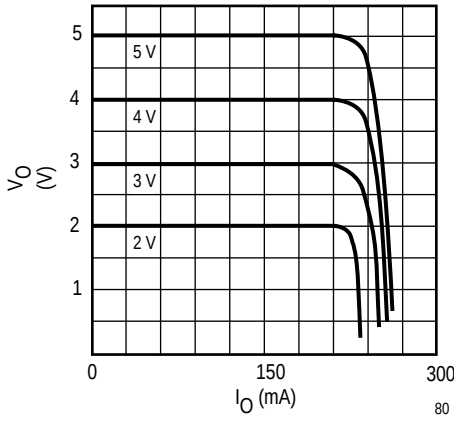



6

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

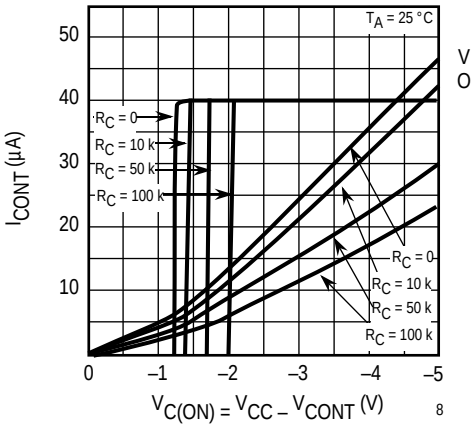
$T_A$ = 25 °C unless otherwise specified

**SHORT CURRENT vs. OUTPUT VOLTAGE**



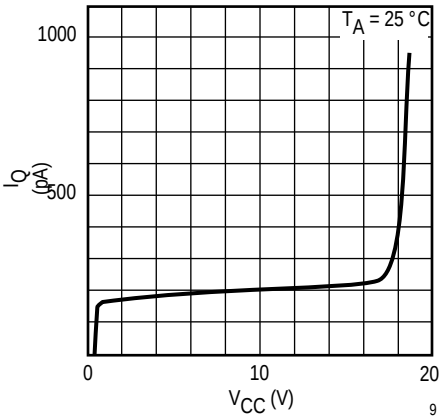

80

**CONTROL CURRENT vs. CONTROL VOLTAGE**



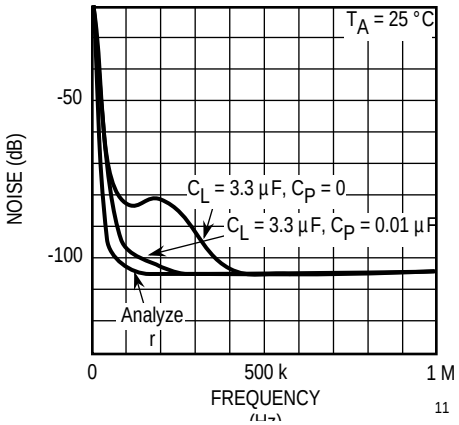

8

**QUIESCENT CURRENT vs. INPUT VOLTAGE (OFF)**



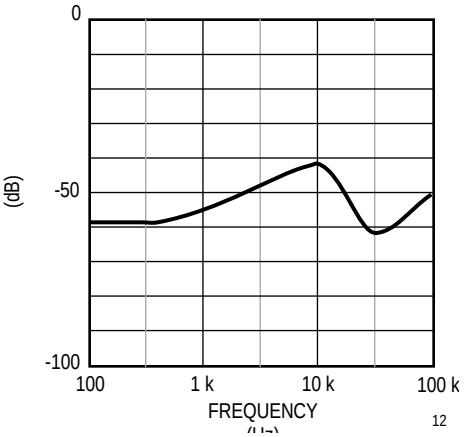

9

**NOISE LEVEL vs. FREQUENCY**



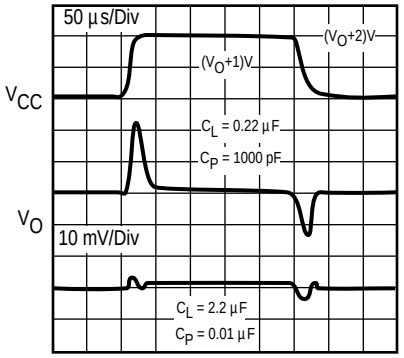

11

**RIPPLE REJECTION vs. FREQUENCY**



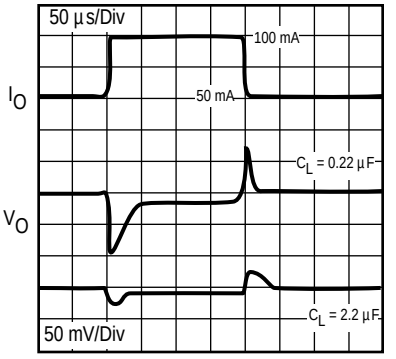

12

**LINE TRANSIENT RESPONSE**



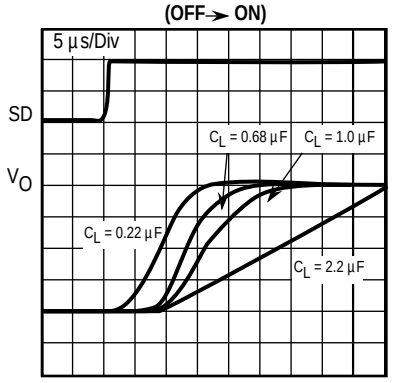

13

**LOAD TRANSIENT RESPONSE**



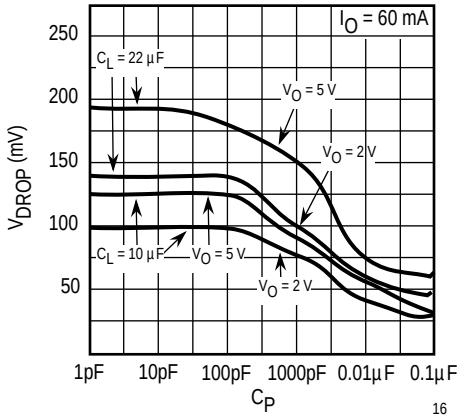

14

**OUTPUT VOLTAGE RESPONSE (OFF→ ON)**




15

**NOISE LEVEL vs. BYPASS CAPACITOR**

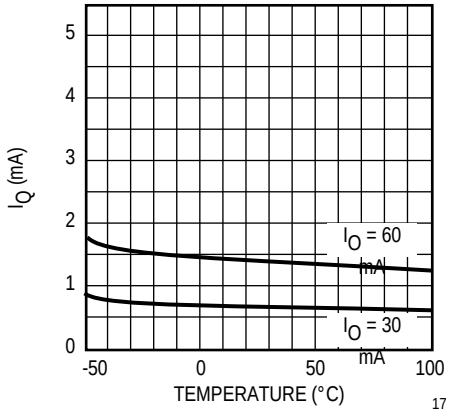



16

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

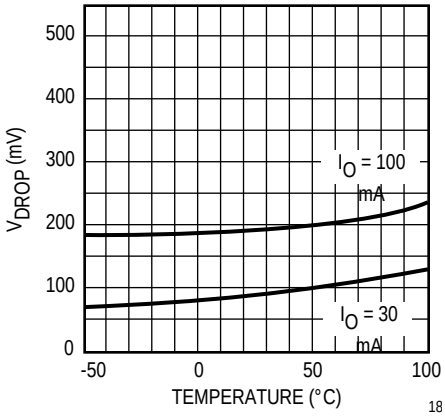
$T_A$ = 25 °C unless otherwise specified

**QUIESCENT CURRENT vs. TEMPERATURE**



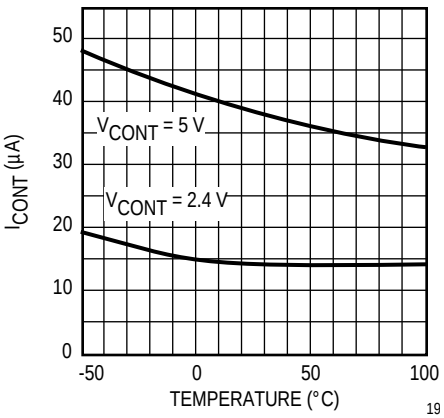

17

**DROPOUT VOLTAGE vs. TEMPERATURE**



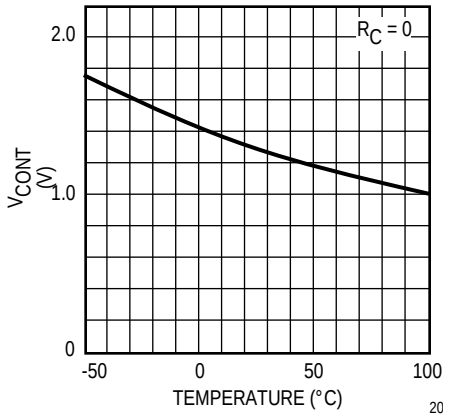

18

**CONTROL CURRENT vs. TEMPERATURE**



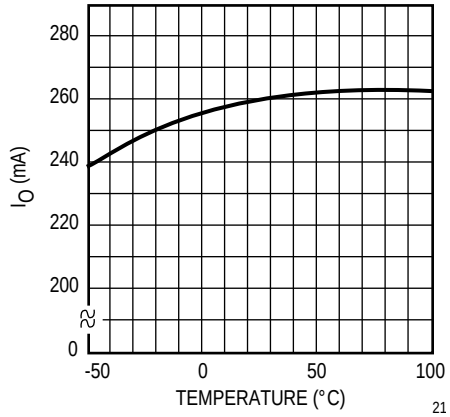

19

**CONTROL VOLTAGE THRESHOLD vs. TEMPERATURE**



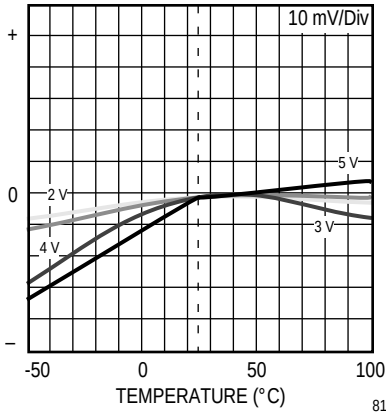

20

**OUTPUT CURRENT vs. TEMPERATURE**




21

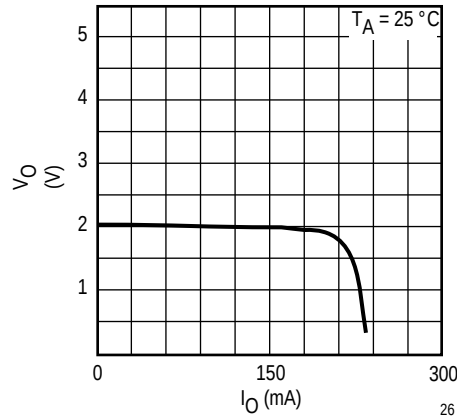
**OUTPUT VOLTAGE VARIATION**




81

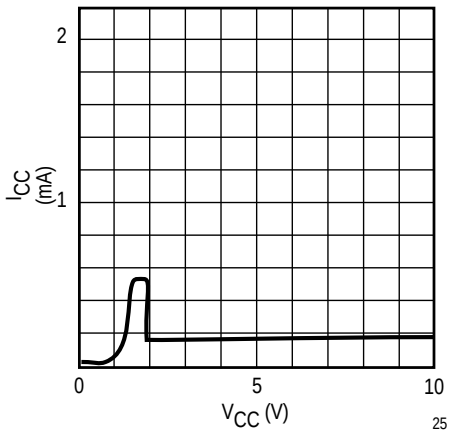
**TK11220A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



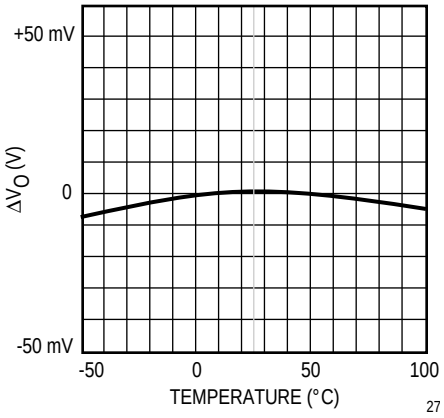

26

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




25

**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**



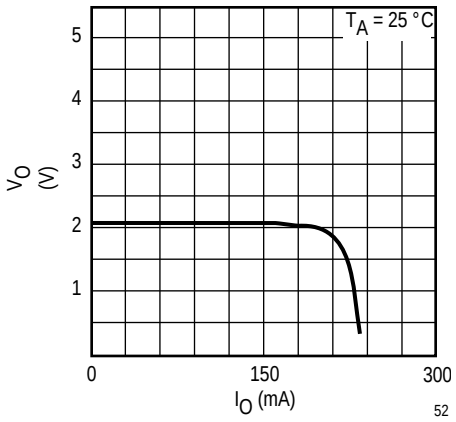

27

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

$T_A$ = 25 °C unless otherwise specified

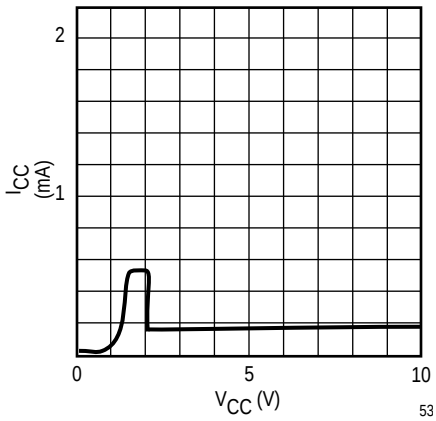
**TK11221A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



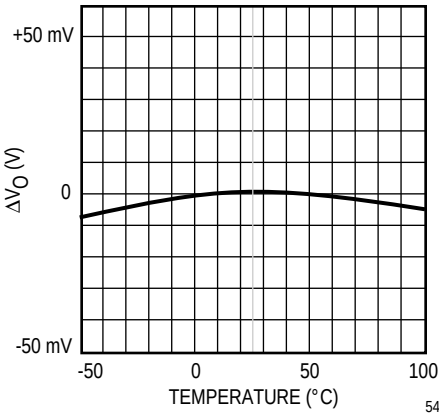

52

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




53

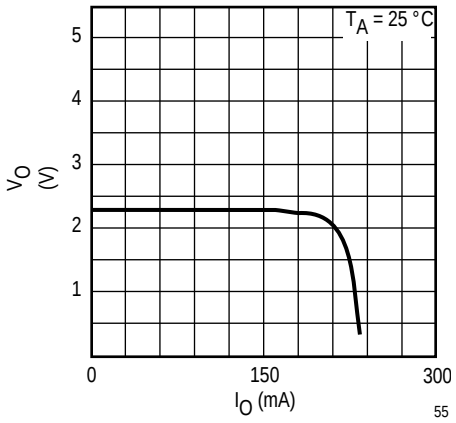
**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**




54

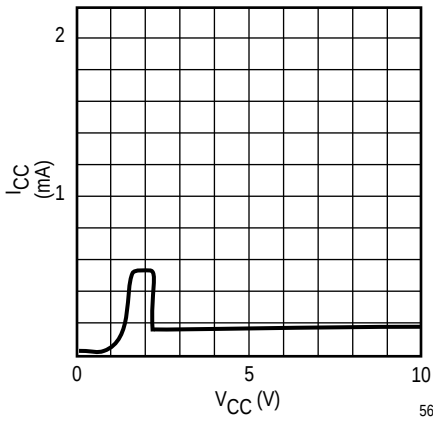
**TK11222A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



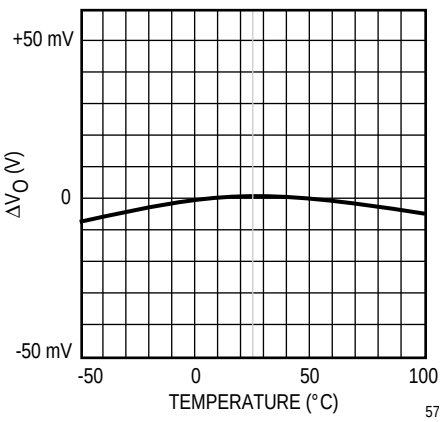

55

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




56

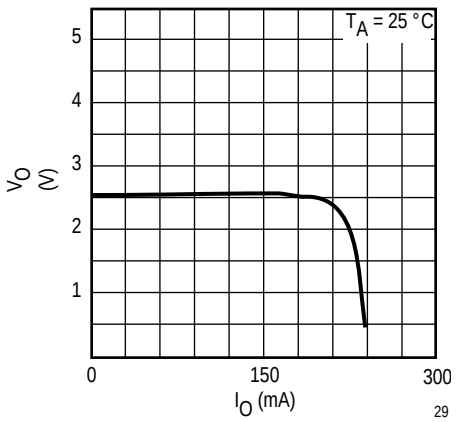
**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**




57

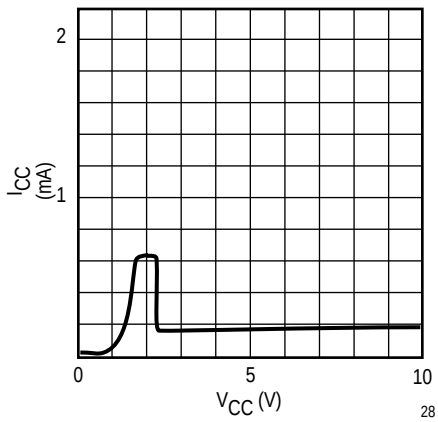
**TK11225A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



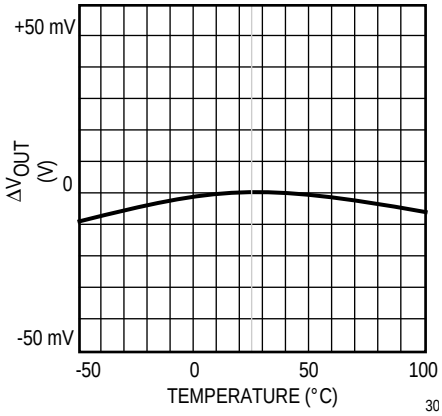

29

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




28

**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**



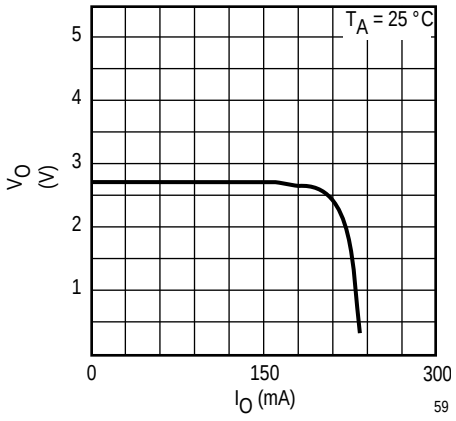

30

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

**TK11228A**

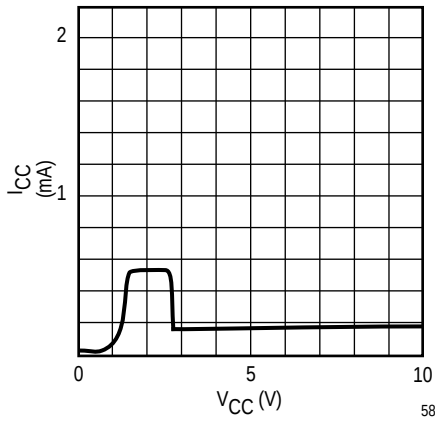
$T_A$ = 25 °C unless otherwise specified

**OUTPUT VOLTAGE vs. LOAD CURRENT**



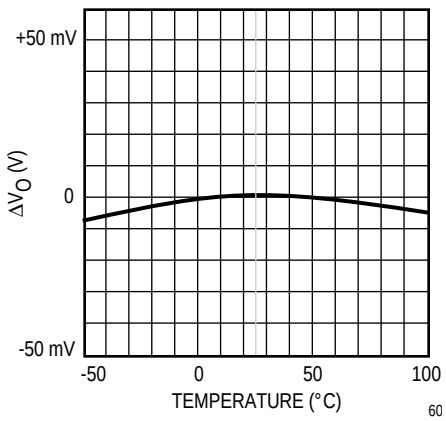

59

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




58

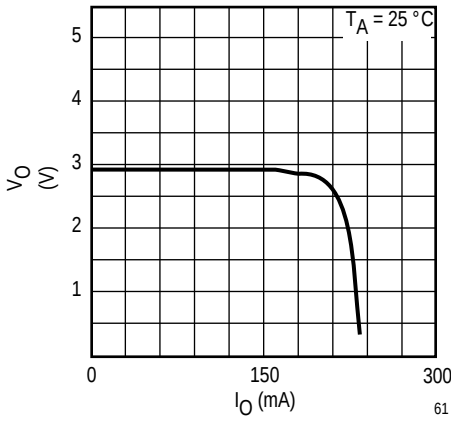
**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**




60

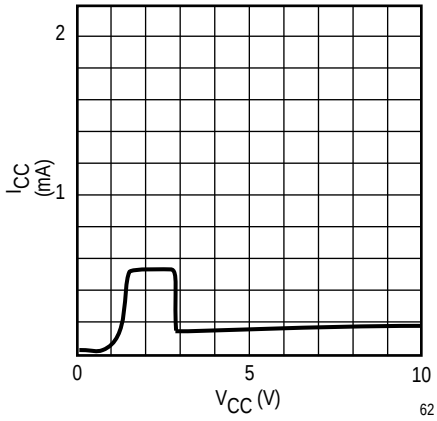
**TK11229A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



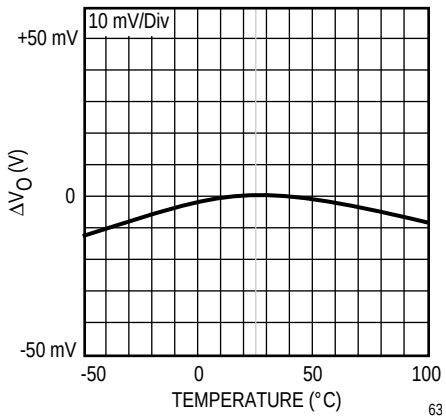

61

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




62

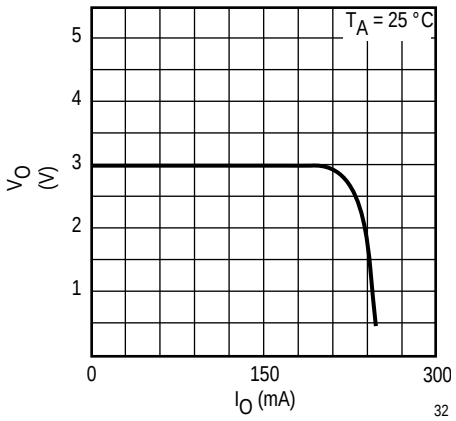
**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**




63

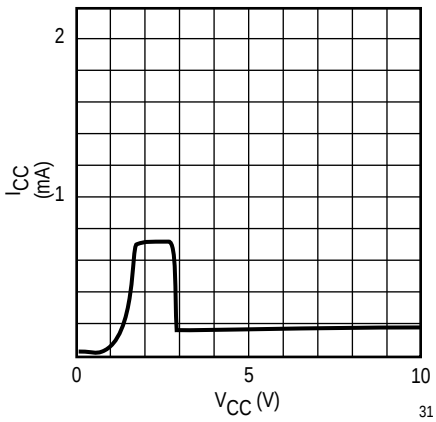
**TK11230A**

**OUTPUT VOLTAGE vs. LOAD CURRENT**



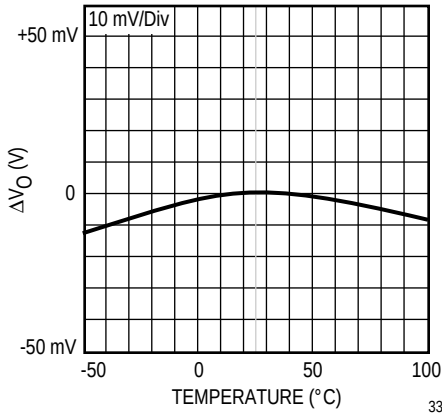

32

**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




31

**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**



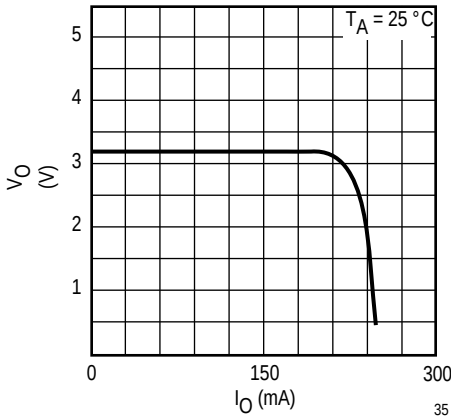

33

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

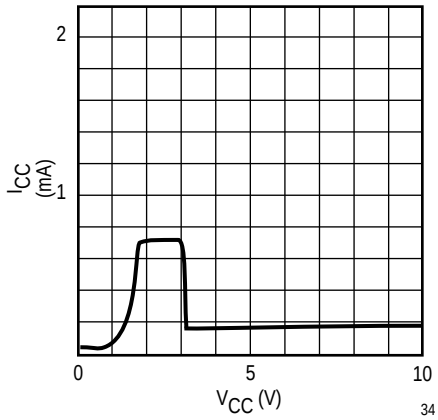
$T_A$ = 25 °C unless otherwise specified

**TK11231A**

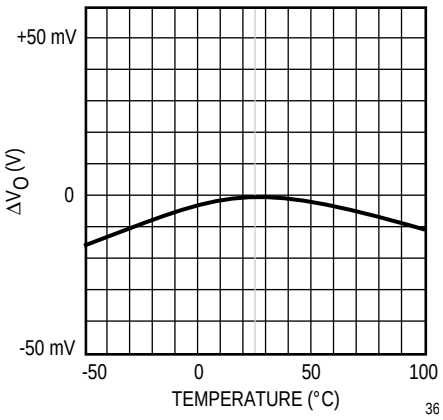
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

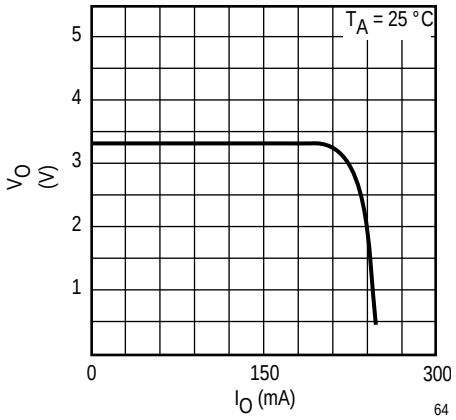



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

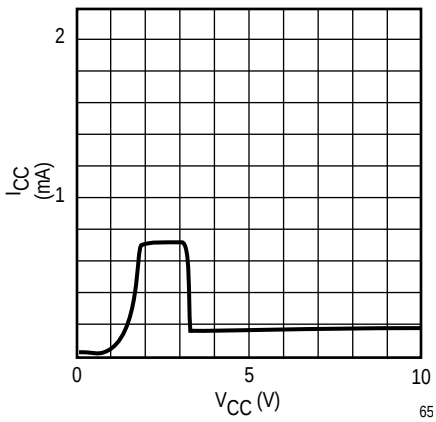



**TK11233A**

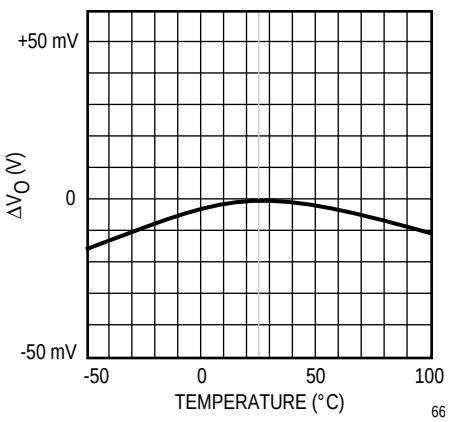
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

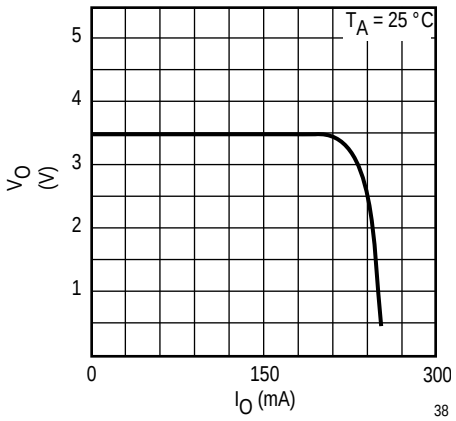



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

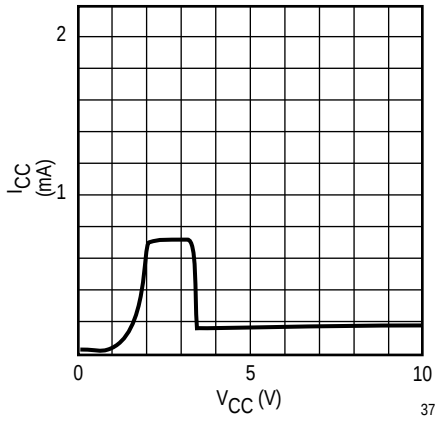



**TK11235A**

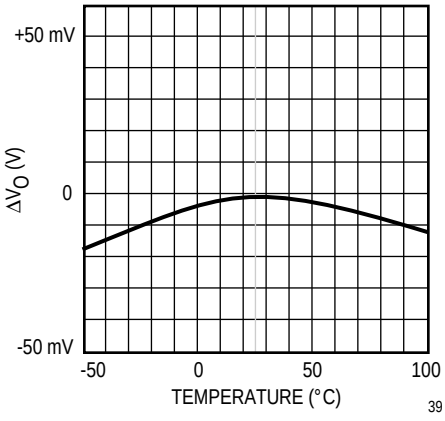
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

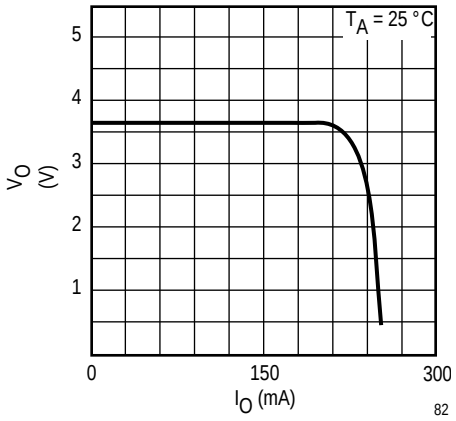


## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

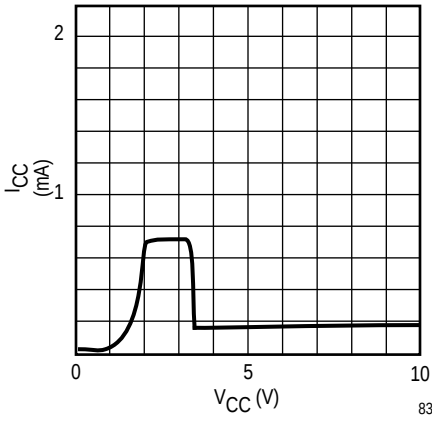
**TK11236A**

$T_A$ = 25 °C unless otherwise specified

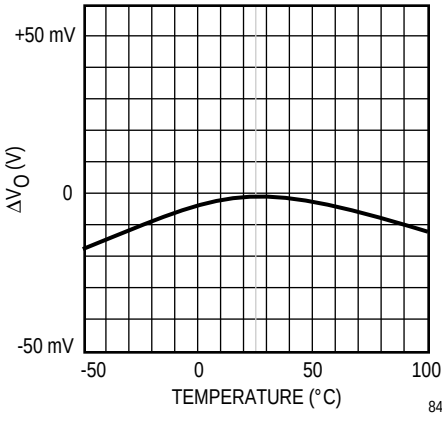
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

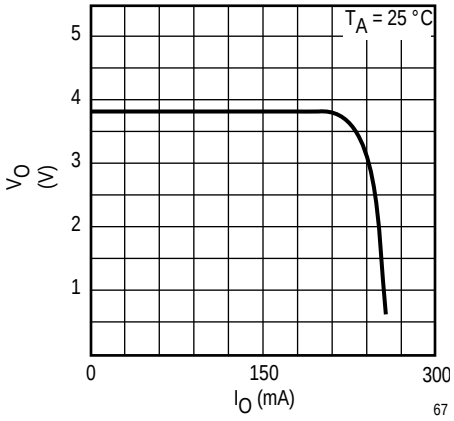



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

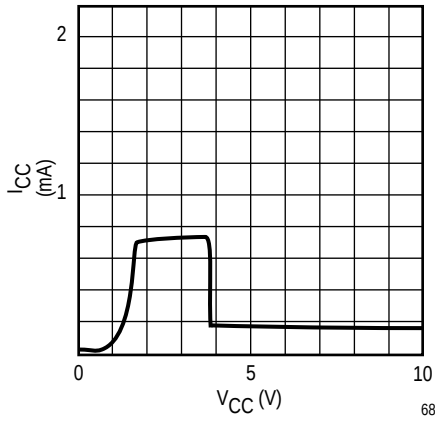



**TK11238A**

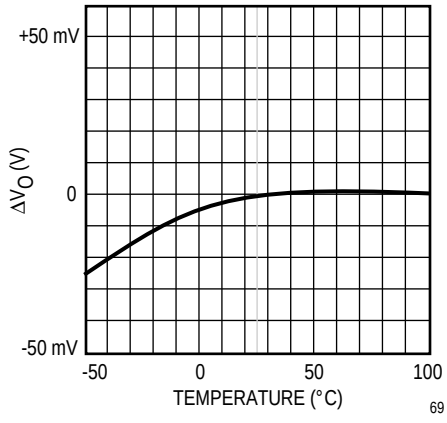
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

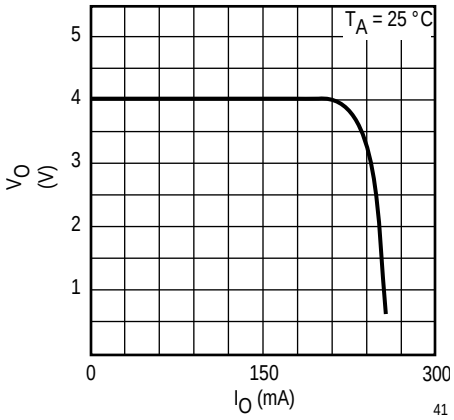



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

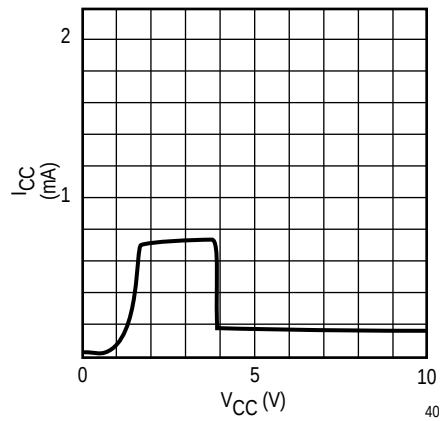



**TK11240A**

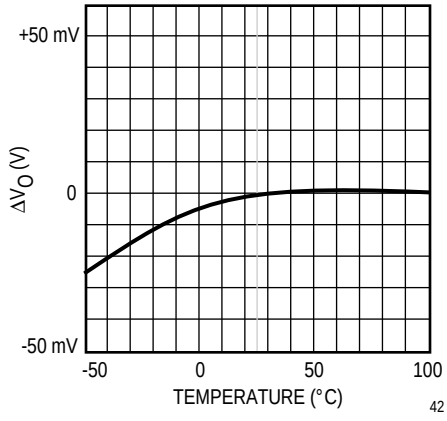
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

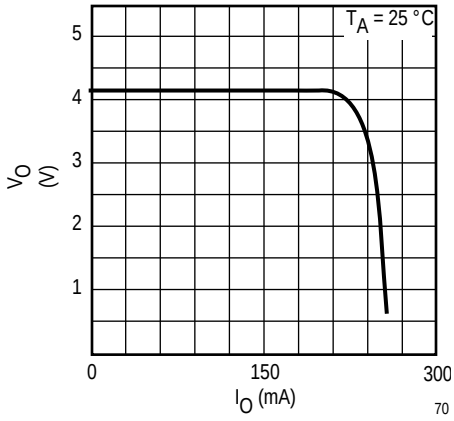


## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

$T_A$ = 25 °C unless otherwise specified

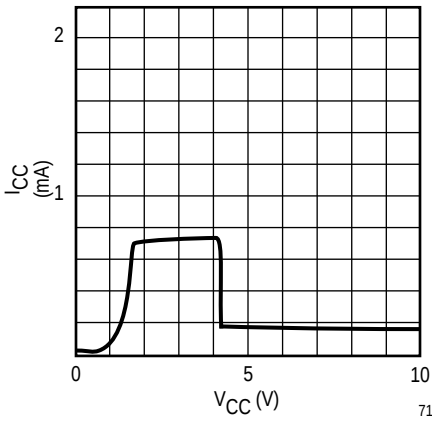
**TK11242A**

OUTPUT VOLTAGE vs. LOAD CURRENT



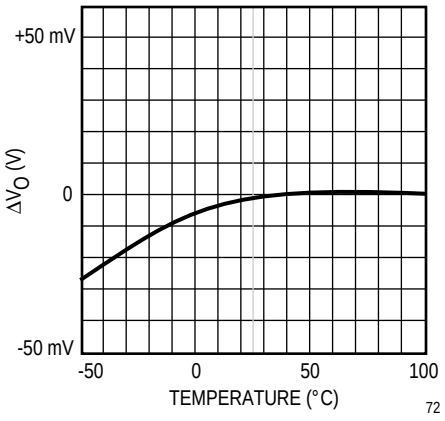

70

INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)




71

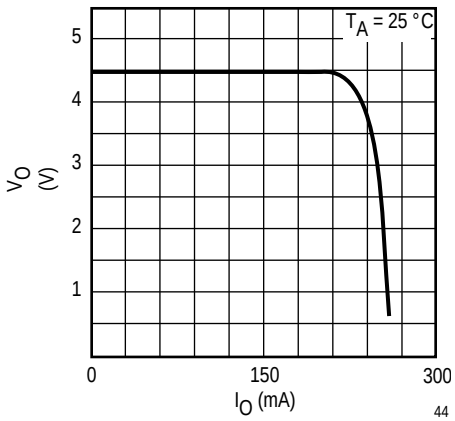
OUTPUT VOLTAGE CHANGE vs. TEMPERATURE




72

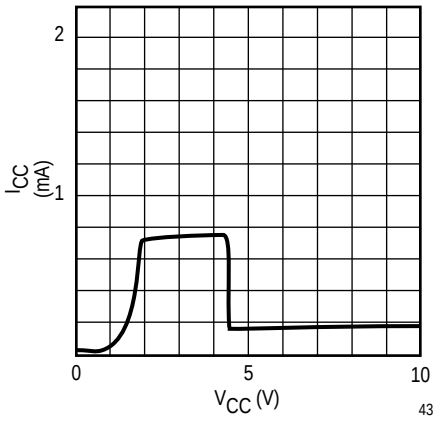
**TK11245A**

OUTPUT VOLTAGE vs. LOAD CURRENT



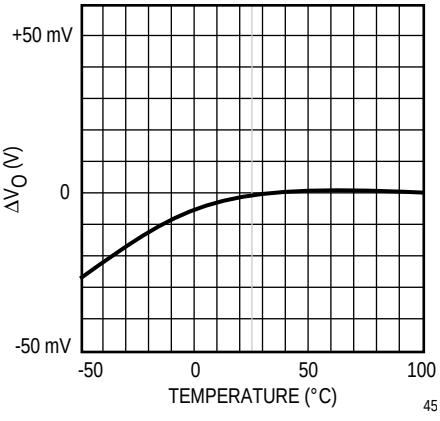

44

INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)




43

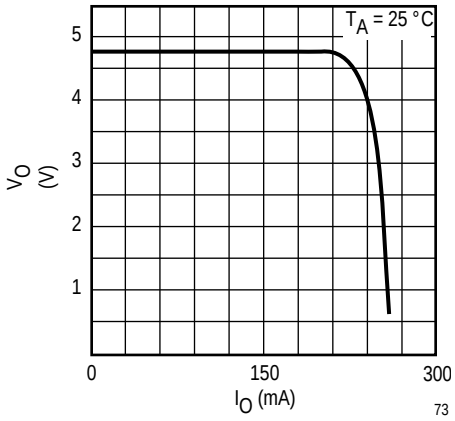
OUTPUT VOLTAGE CHANGE vs. TEMPERATURE




45

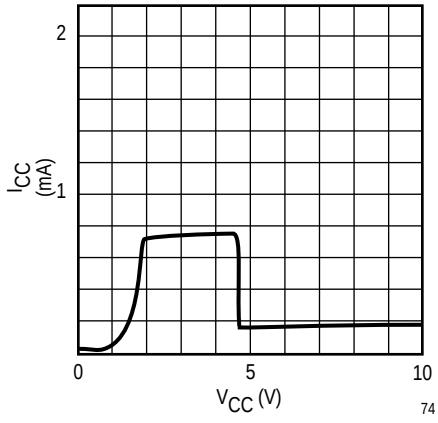
**TK11248A**

OUTPUT VOLTAGE vs. LOAD CURRENT



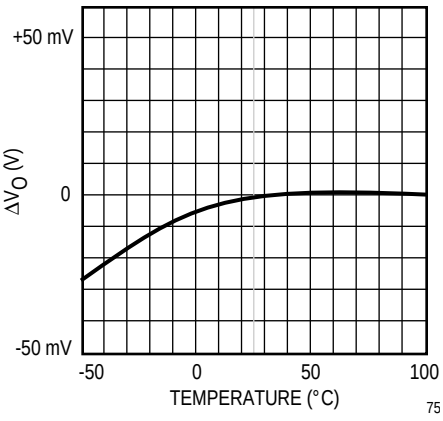

73

INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)




74

OUTPUT VOLTAGE CHANGE vs. TEMPERATURE



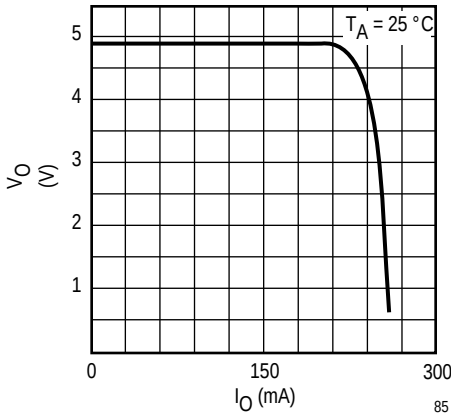

75

## TYPICAL PERFORMANCE CHARACTERISTICS (CONT.)

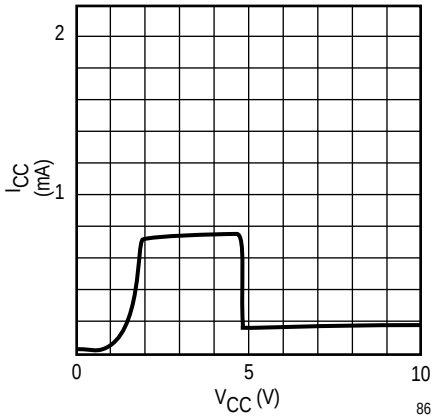
**TK11249A**

$T_A$ = 25 °C unless otherwise specified

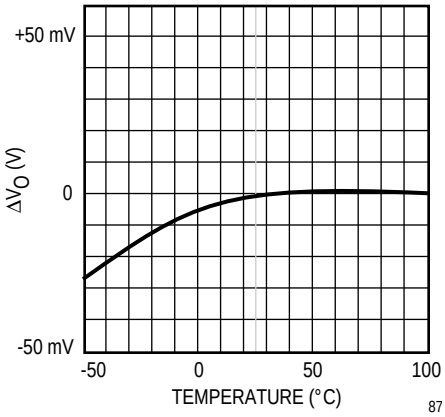
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

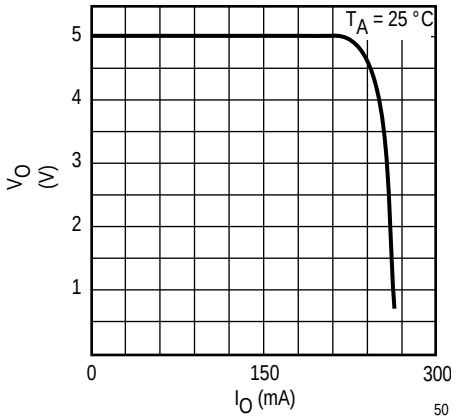



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

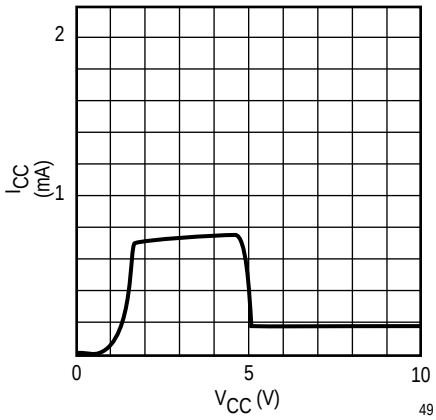



**TK11250A**

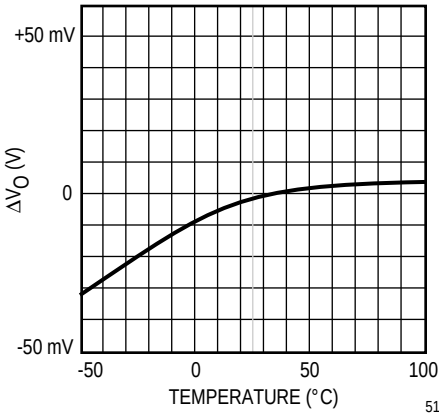
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**

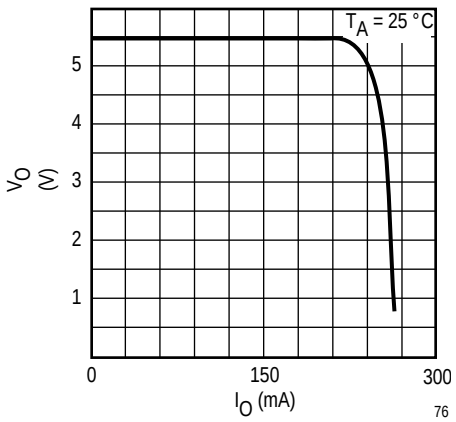



**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**

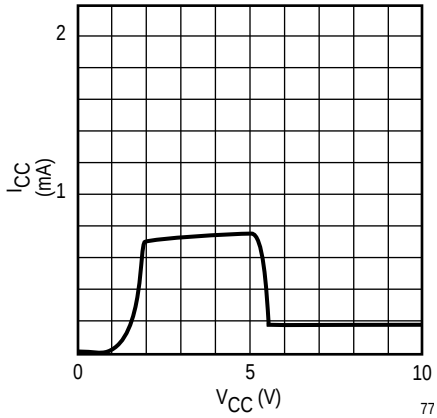



**TK11255A**

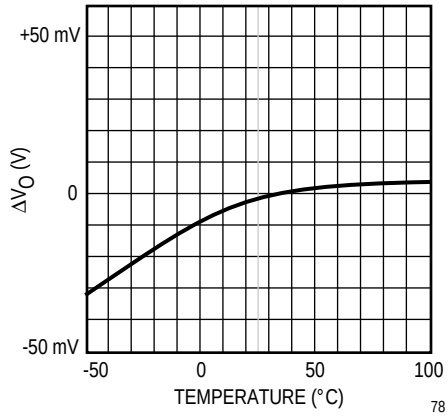
**OUTPUT VOLTAGE vs. LOAD CURRENT**




**INPUT CURRENT vs. INPUT VOLTAGE (NO LOAD)**




**OUTPUT VOLTAGE CHANGE vs. TEMPERATURE**



## DEFINITION AND EXPLANATION OF TECHNICAL TERMS

### LINE REGULATION (LINE REG)

Line regulation is the relationship between change in output voltage due to a change in input voltage.

### LOAD REGULATION (LOAD REG)

Load regulation is the relationship between change in output voltage due to a change in load current.

### DROP OUT VOLTAGE ($V_{DROP}$)

This is a measure of how well the regulator performs as the input voltage decreases. The smaller the number, the further the input voltage can decrease before regulation problems occur. Nominal output voltage is first measured when $V_{IN} = V_{OUT} + 1$ at a chosen load current. When the output voltage has dropped 100 mV from the nominal, $V_{IN} - V_{OUT}$ is the dropout voltage. This voltage is affected by load current and junction temperature.

### OUTPUT NOISE VOLTAGE

This is the effective AC voltage that occurs on the output voltage under the condition where the input noise is low and with a given load, filter capacitor, and frequency range.

### THERMAL PROTECTION

This is an internal feature which turns the regulator off when the junction temperature rises above 150 °C. After the regulator turns off, the temperature drops and the regulator output turns back on. Under certain conditions, the output waveform may appear to be an oscillation as the output turns off and on and back again in succession.

### PACKAGE POWER DISSIPATION ($P_D$)

This is the power dissipation level at which the thermal sensor is activated. The IC contains an internal thermal sensor which monitors the junction temperature. When the junction temperature exceeds the monitor threshold of 150 °C, the IC is shutdown. The junction temperature rises as the difference between the input power ($V_{IN}$ X $I_{IN}$) and the output power ($V_{OUT}$ X $I_{OUT}$) increases. The rate of temperature rise is greatly affected by the mounting pad configuration on the PCB, the board material, and the ambient temperature. When the IC mounting has good thermal conductivity, the junction temperature will be low even if the power dissipation is great. When mounted on the recommended mounting pad, the power dissipation of the SOT-23L is increased to 400 mW. For operation at ambient temperatures over 25 °C, the power dissipation of the SOT-23L device should be derated at 3.2 mW/°C. The power dissipation of the SOT-89-5 package is 800 mW when mounted as recommended. Derate the power dissipation at 6.4 mW/°C for operation above 25 °C. To determine the power dissipation for shutdown when mounted, attach the device on the actual PCB and deliberately increase the output current (or raise the input voltage) until the thermal protection circuit is activated. Calculate the power dissipation of the device by subtracting the output power from the input power. These measurements should allow for the ambient temperature of the PCB. The value obtained from PD/(150 °C - $T_A$) is the derating factor. The PCB mounting pad should provide maximum thermal conductivity in order to maintain low device temperatures. As a general rule, the lower the temperature, the better the reliability of the device. The Thermal resistance when mounted is expressed as follows:

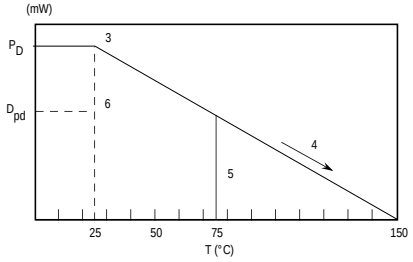
$$T_J = \theta_{JA} \text{ X } P_D + T_A$$

For Toko ICs, the internal limit for junction temperature is 150 °C. If the ambient temperature, $T_A$ is 25 °C, then:

$$150\ °C = \theta_{JA} \text{ X } P_D + 25\ °C$$
$$\theta_{JA} \text{ X } P_D = 125\ °C$$
$$\theta_{JA} = 125\ °C / P_D$$

$P_D$ is the value when the thermal sensor is activated. A simple way to determine PD is to calculate $V_{IN}$ X $I_{IN}$ when the output side is shorted. Input current gradually falls as temperature rises. You should use the value when thermal equilibrium is reached.

The range of currents usable can also be found from the graph below.




Procedure:

1.) Find $P_D$
2.) $P_{D1}$ is taken to be $P_D$ X (≈0.8 ~ 0.9)
3.) Plot $P_{D1}$ against 25 °C
4.) Connect $P_{D1}$ to the point corresponding to the 150 °C with a straight line.

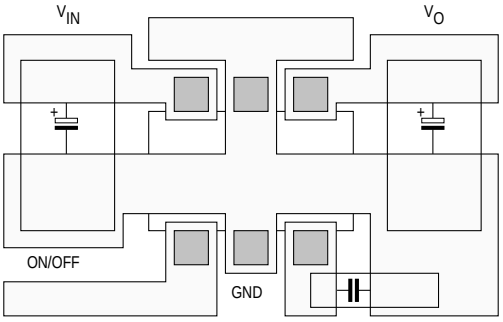
## DEFINITION AND EXPLANATION OF TECHNICAL TERMS (CONT.)

5.) In design, take a vertical line from the maximum operating temperature (e.g. 75 °C) to the derating curve.

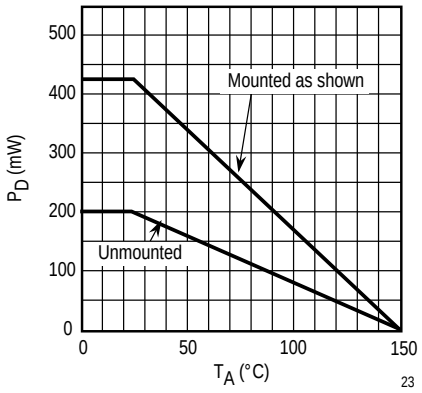
6.) Read off the value of $P_D$ against the point at which the vertical line intersects the derating curve. This is taken as the maximum power dissipation, $D_{PD}$.

The maximum operating current is:

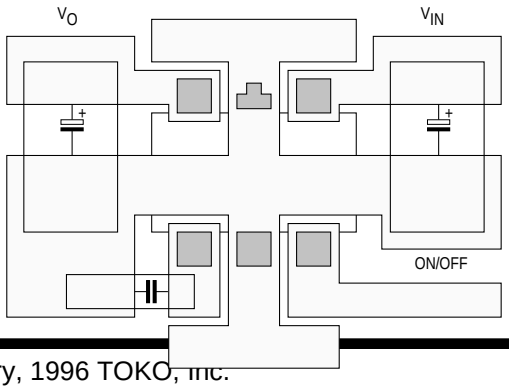
$$I_{OUT} = (D_{PD}/(V_{IN(MAX)} - V_{OUT}).$$



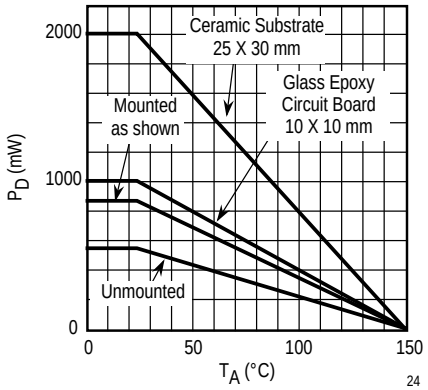

SOT-23L Board Layout




SOT-23L Power Dissipation Curve




SOT-89-5 Board Layout




SOT-89-5 Power Dissipation Curve

Copper pattern should be as large as possible. Power dissipation is 400 mW for SOT-23L and 800 mV for SOT-89-5. A low ESR capacitor is recommended. For low temperature operation, select a capacitor with a low ESR at the lowest operating temperature to prevent oscillation, degradation of ripple rejection and increase in noise. The minimum recommended capacitance is 2.2 µF.

**INPUT/OUTPUT DECOUPLING CAPACITOR CONSIDERATIONS**

Voltage regulators require input and output decoupling capacitors. The required value of these capacitors vary with application. Capacitors made by different manufacturers can have different characteristics, particularly with regard to high frequencies and equivalent resistance (ESR) over temperature. The type of capacitor is also important. For example, a 4.7 µF aluminum electrolytic may be required for a certain application. If a tantalum capacitor is used, a lower value of 2.2 µF would be adequate. It is important to consider the temperature characteristics of the decoupling capacitors. While Toko regulators are designed to operate as low as -40 °C, many capacitors will not operate properly at this temperature. The capacitance of aluminum electrolytic capacitors may decrease to 0 at low temperatures. This may cause oscillation on the output of the regulator since some capacitance is required to guarantee stability. Thus, it is important to consider the characteristics of the capacitor over temperature when selection decoupling capacitors. The ESR is another important parameter. The ESR will increase with temperature but low ESR capacitors are often larger and more costly. In general, Tantalum capacitors offer lower ESR than aluminum electrolytic, but new low ESR aluminum electrolytic

## DEFINITION AND EXPLANATION OF TECHNICAL TERMS (CONT.)

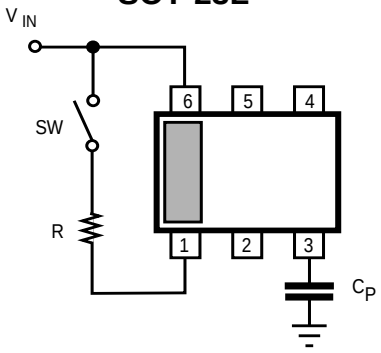
capacitors are now available from several manufacturers. Usually a bench test is sufficient to determine the minimum capacitance required for a particular application. After taking thermal characteristics and tolerance into account, the minimum capacitance value should be approximately two times this value. The recommended minimum capacitance for the TK112xxA is 2.2 μF. Please note that linear regulators with a low dropout voltage have high internal loop gains which requires care in guarding against oscillation caused by insufficient decoupling capacitance. The use of high quality decoupling capacitors suited for your application will guarantee proper operation of the circuit.

### NOISE BYPASS CAPACITOR SECTION

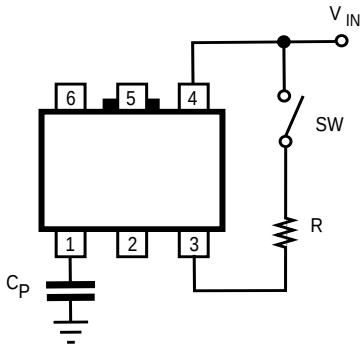
The noise bypass capacitor ($C_P$) should be connected as close as possible to pin 3 and ground. The recommended value for $C_P$ is 0.01 μF. The noise bypass terminal has a high impedance and care should be taken if the noise bypass capacitor is not used. This terminal is susceptible to external noise and oscillation can occur when $C_P$ is not used and the solder pad for this pin is made too large.

## CONTROL FUNCTION

**SOT-23L**

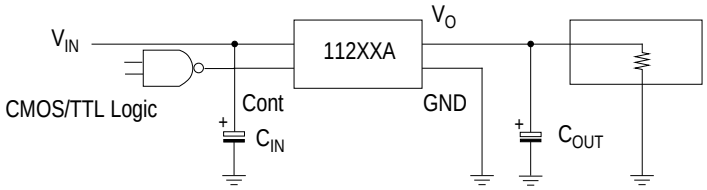



**SOT-89-5**



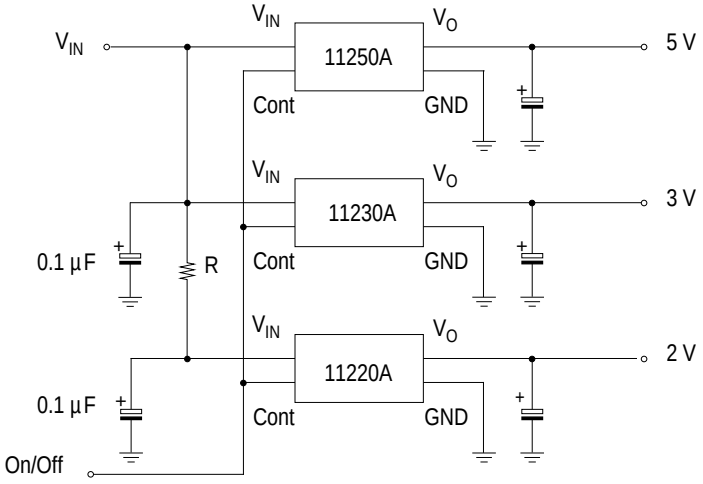

If the control function is not used, connect the control terminal to a logic high level or $V_{IN.}$ This will allow the regulator to be on. The regulator will be on when the control terminal voltage is greater than 1.8 V. The seris resistor, $R_S$, should be less than 300 kΩ. The control current will decrease as $R_S$, increases. The control threshold voltage will also change.

## MICROPROCESSOR/LOGIC CONTROL




The Input and Control current in the off mode are less than 200 pA.

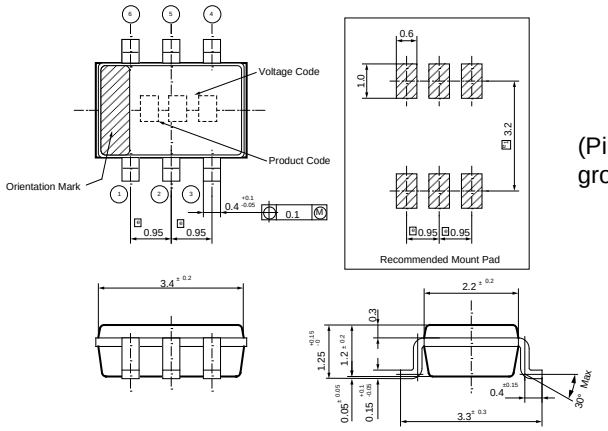
## PARALLEL CONNECTION FOR ON/OFF CONTROL




To reduce IC power dissipation, connect a resistor, $R_S$, in series with $V_{IN}$ for the lower output voltage devices. This will prevent thermal shutdown due to excessive power dissipation.

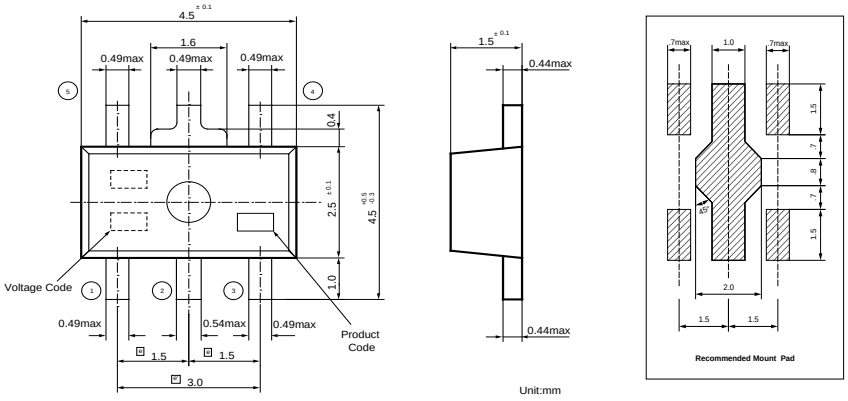
# PACKAGE OUTLINE

## SOT-23L




(Pin 2 and pin 5 should be grounded for heat dissipation)

## SOT-89-5




### Marking Information

| | |
|---|---|
| Product Code | P |
| Voltage Code | |
| TK11220A | 20 |
| TK11221A | 21 |
| TK11222A | 22 |
| TK11225A | 25 |
| TK11228A | 28 |
| TK11229A | 29 |
| TK11230A | 30 |
| TK11231A | 31 |
| TK11233A | 33 |
| TK11235A | 35 |
| TK11236A | 36 |
| TK11238A | 38 |
| TK11240A | 40 |
| TK11242A | 42 |
| TK11245A | 45 |
| TK11248A | 48 |
| TK11249A | 49 |
| TK11250A | 50 |
| TK11255A | 55 |

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