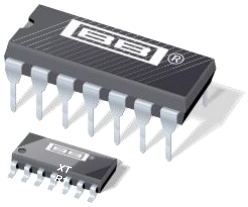
BURR - BROWN®



# XTR105

databook/XTR105.html

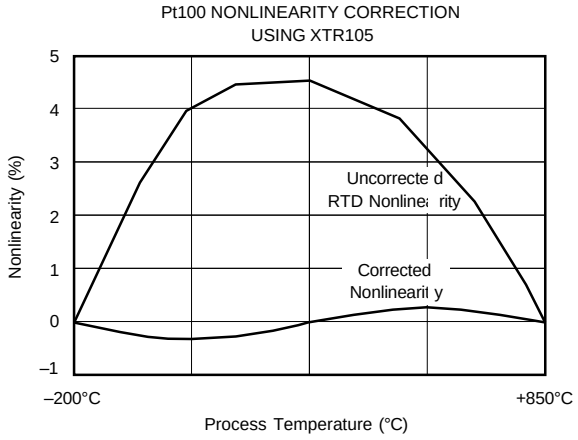
# 4-20mA CURRENT TRANSMITTER with Sensor Excitation and Linearization

## FEATURES

- LOW UNADJUSTED ERROR
- TWO PRECISION CURRENT SOURCES 800μA EACH
- RTD OR BRIDGE EXCITATION
- LINEARIZATION
- TWO OR THREE-WIRE RTD OPERATION
- LOW OFFSET DRIFT: 0.4μV/°C
- LOW OUTPUT CURRENT NOISE: 30nAp-p
- HIGH PSR: 110dB min
- HIGH CMR: 86dB min
- WIDE SUPPLY RANGE: 7.5V TO 36V
- 14-PIN DIP AND SO-14 SOIC PACKAGES

## APPLICATIONS

- INDUSTRIAL PROCESS CONTROL
- FACTORY AUTOMATION
- SCADA REMOTE DATA ACQUISITION
- REMOTE TEMPERATURE AND PRESSURE TRANSDUCERS



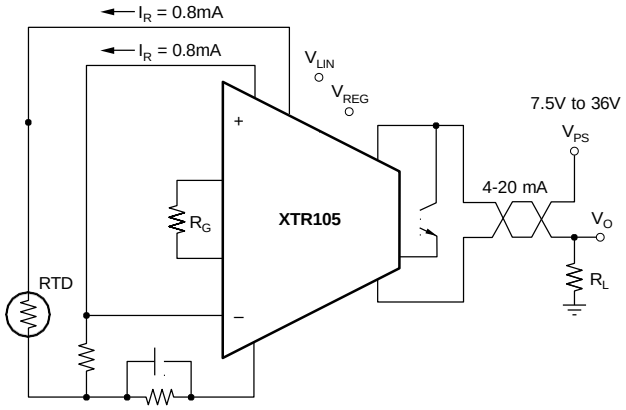

## DESCRIPTION

The XTR105 is a monolithic 4-20mA, two-wire current transmitter with two precision current sources. It provides complete current excitation for Platinum RTD temperature sensors and bridges, instrumentation amplifier, and current output circuitry on a single integrated circuit.

Versatile linearization circuitry provides a 2nd-order correction to the RTD, typically achieving a 40:1 improvement in linearity.

Instrumentation amplifier gain can be configured for a wide range of temperature or pressure measurements. Total unadjusted error of the complete current transmitter is low enough to permit use without adjustment in many applications. This includes zero output current drift, span drift and nonlinearity. The XTR105 operates on loop power supply voltages down to 7.5V.

The XTR105 is available in 14-pin plastic DIP and SO-14 surface-mount packages and is specified for the –40°C to +85°C industrial temperature range.

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# SPECIFICATIONS

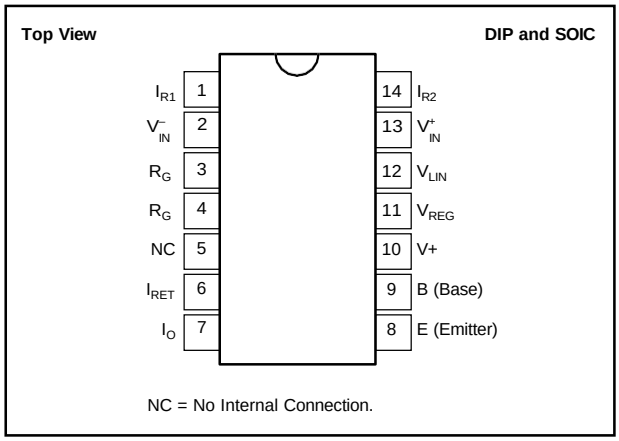
At $T_A$ = +25°C, V+ = 24V, and TIP29C external transistor, unless otherwise noted.

| PARAMETER | CONDITIONS | XTR105P, U | | | XTR105PA, UA | | | UNITS |
|---|---|---|---|---|---|---|---|---|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| **OUTPUT** | | | | | | | | |
| Output Current Equation | | | $I_O = V_{IN} \bullet (40/R_G) + 4mA$, $V_{IN}$ in Volts, $R_G$ in Ω | | | | | A |
| Output Current, Specified Range | | 4 | | 20 | ✻ | | ✻ | mA |
| Over-Scale Limit | | 24 | 27 | 30 | ✻ | ✻ | ✻ | mA |
| Under-Scale Limit | $I_{REG}$ = 0V | 1.8 | 2.2 | 2.6 | ✻ | ✻ | ✻ | mA |
| **ZERO OUTPUT**(1) | $V_{IN}$ = 0V, $R_G = \infty$ | | 4 | | | ✻ | | mA |
| Initial Error | | | ±5 | ±25 | | ✻ | ±50 | µA |
| vs Temperature | | | ±0.07 | ±0.5 | | ✻ | ±0.9 | µA/°C |
| vs Supply Voltage, V+ | V+ = 7.5V to 36V | | 0.04 | 0.2 | | ✻ | ✻ | µA/V |
| vs Common-Mode Voltage | $V_{CM}$ = 1.25V to 3.5V(2) | | 0.02 | | | ✻ | | µA/V |
| vs $V_{REG}$ Output Current | | | 0.3 | | | ✻ | | µA/mA |
| Noise: 0.1Hz to 10Hz | | | 0.03 | | | ✻ | | µAp-p |
| **SPAN** | | | | | | | | |
| Span Equation (Transconductance) | | | $S = 40/R_G$ | | | ✻ | | A/V |
| Initial Error (3) | Full Scale ($V_{IN}$) = 50mV | | ±0.05 | ±0.2 | | ✻ | ±0.4 | % |
| vs Temperature(3) | | | ±3 | ±25 | | ✻ | ✻ | ppm/°C |
| Nonlinearity: Ideal Input(4) | Full Scale ($V_{IN}$) = 50mV | | 0.003 | 0.01 | | ✻ | ✻ | % |
| **INPUT**(5) | | | | | | | | |
| Offset Voltage | $V_{CM}$ = 2V | | ±50 | ±100 | | ✻ | ±250 | µV |
| vs Temperature | | | ±0.4 | ±1.5 | | ✻ | ±3 | µV/°C |
| vs Supply Voltage, V+ | V+ = 7.5V to 36V | | ±0.3 | ±3 | | ✻ | ✻ | µV/V |
| vs Common-Mode Voltage, RTI (CMRR) | $V_{CM}$ = 1.25V to 3.5V(2) | | ±10 | ±50 | | ✻ | ±100 | µV/V |
| Common-Mode Input Range(2) | | 1.25 | | 3.5 | ✻ | | ✻ | V |
| Input Bias Current | | | 5 | 25 | | ✻ | 50 | nA |
| vs Temperature | | | 20 | | | ✻ | | pA/°C |
| Input Offset Current | | | ±0.2 | ±3 | | ✻ | ±10 | nA |
| vs Temperature | | | 5 | | | ✻ | | pA/°C |
| Impedance: Differential | | | 0.1 \|\| 1 | | | ✻ | | GΩ \|\| pF |
| Common-Mode | | | 5 \|\| 10 | | | ✻ | | GΩ \|\| pF |
| Noise: 0.1Hz to 10Hz | | | 0.6 | | | ✻ | | µVp-p |
| **CURRENT SOURCES** | $V_O$ = 2V(6) | | | | | | | |
| Current | | | 800 | | | ✻ | | µA |
| Accuracy | | | ±0.05 | ±0.2 | | ✻ | ±0.4 | % |
| vs Temperature | | | ±15 | ±35 | | ✻ | ±75 | ppm/°C |
| vs Power Supply, V+ | V+ = 7.5V to 36V | | ±10 | ±25 | | ✻ | ✻ | ppm/V |
| Matching | | | ±0.02 | ±0.1 | | ✻ | ±0.2 | % |
| vs Temperature | | | ±3 | ±15 | | ✻ | ±30 | ppm/°C |
| vs Power Supply, V+ | V+ = 7.5V to 36V | | 1 | 10 | | ✻ | ✻ | ppm/V |
| Compliance Voltage, Positive | | (V+) –3 | (V+) –2.5 | | ✻ | ✻ | | V |
| Negative(2) | | 0 | –0.2 | | ✻ | ✻ | | V |
| Output Impedance | | | 150 | | | ✻ | | MΩ |
| Noise: 0.1Hz to 10Hz | | | 0.003 | | | ✻ | | µAp-p |
| **$V_{REG}$**(2) | | | 5.1 | | | ✻ | | V |
| Accuracy | | | ±0.02 | ±0.1 | | ✻ | ✻ | V |
| vs Temperature | | | ±0.2 | | | ✻ | | mV/°C |
| vs Supply Voltage, V+ | | | 1 | | | ✻ | | mV/V |
| Output Current | | | ±1 | | | ✻ | | mA |
| Output Impedance | | | 75 | | | ✻ | | Ω |
| **LINEARIZATION** | | | | | | | | |
| $R_{LIN}$ (internal) | | | 1 | | | ✻ | | kΩ |
| Accuracy | | | ±0.2 | ±0.5 | | ✻ | ±1 | % |
| vs Temperature | | | ±25 | ±100 | | ✻ | ✻ | ppm/°C |
| **POWER SUPPLY** | | | | | | | | |
| Specified | | | +24 | | | ✻ | | V |
| Voltage Range | | +7.5 | | +36 | ✻ | | ✻ | V |
| **TEMPERATURE RANGE** | | | | | | | | |
| Specification, $T_{MIN}$ to $T_{MAX}$ | | –40 | | +85 | ✻ | | ✻ | °C |
| Operating | | –55 | | +125 | ✻ | | ✻ | °C |
| Storage | | –55 | | +125 | ✻ | | ✻ | °C |
| Thermal Resistance, $\theta_{JA}$ | | | | | | | | |
| 14-Pin DIP | | | 80 | | | ✻ | | °C/W |
| SO-14 Surface-Mount | | | 100 | | | ✻ | | °C/W |

✻Specification same as XTR105P, XTR105U.

NOTES: (1) Describes accuracy of the 4mA low-scale offset current. Does not include input amplifier effects. Can be trimmed to zero. (2) Voltage measured with respect to $I_{RET}$ pin. (3) Does not include initial error or TCR of gain-setting resistor, $R_G$. (4) Increasing the full-scale input range improves nonlinearity. (5) Does not include Zero Output initial error. (6) Current source output voltage with respect to $I_{RET}$ pin.

## PIN CONFIGURATION




NC = No Internal Connection.

## PACKAGE/ORDERING INFORMATION

| PRODUCT | PACKAGE | PACKAGE DRAWING NUMBER[1] | TEMPERATURE RANGE |
|---|---|---|---|
| XTR105PA | 14-Pin Plastic DIP | 010 | –40°C to +85°C |
| XTR105P | 14-Pin Plastic DIP | 010 | –40°C to +85°C |
| XTR105UA | SO-14 Surface Mount | 235 | –40°C to +85°C |
| XTR105U | SO-14 Surface Mount | 235 | –40°C to +85°C |

NOTE: (1) For detailed drawing and dimension table, please see end of data sheet, or Appendix C of Burr-Brown IC Data Book.

## ABSOLUTE MAXIMUM RATINGS[1]

| | |
|---|---|
| Power Supply, V+ (referenced to $I_O$ pin) | V |
| Input Voltage, $V_{IN}^+$, $V_{IN}^-$ (referenced to $I_O$ pin) | 0V to V+ |
| Storage Temperature Range | 55°C to +125°C |
| Lead Temperature (soldering, 10s) | +300°C |
| Output Current Limit | Continuous |
| Junction Temperature | +165°C |

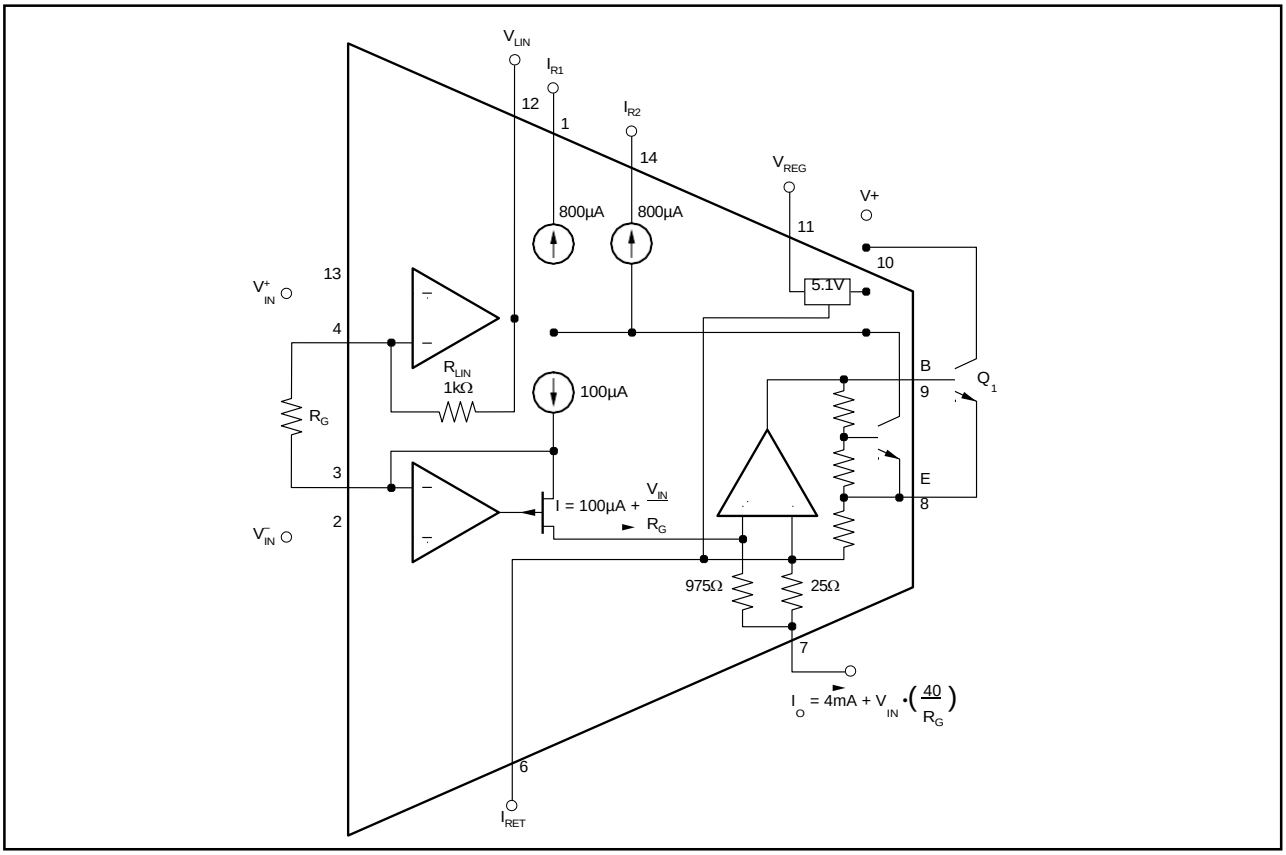
NOTE: (1) Stresses above these ratings may cause permanent damage.

## ELECTROSTATIC DISCHARGE SENSITIVITY

This integrated circuit can be damaged by ESD. Burr-Brown recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

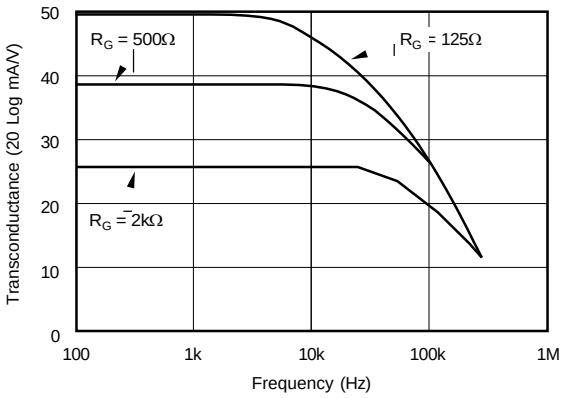
## FUNCTIONAL BLOCK DIAGRAM



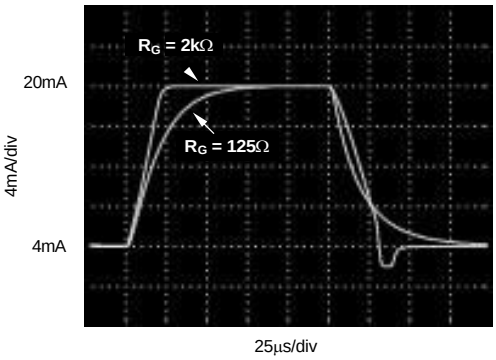
# TYPICAL PERFORMANCE CURVES

At $T_A$ = +25°C, V+ = 24V, unless otherwise noted.

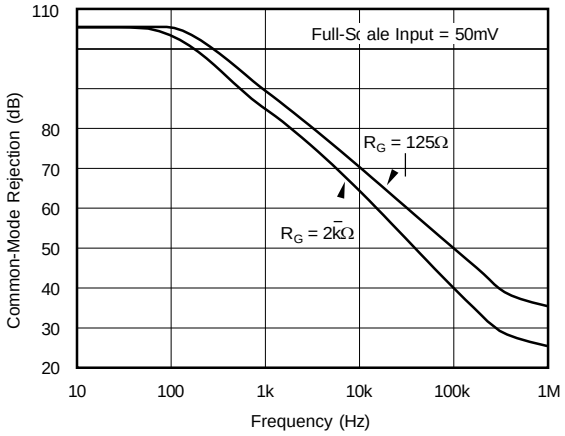
TRANSCONDUCTANCE vs FREQUENCY



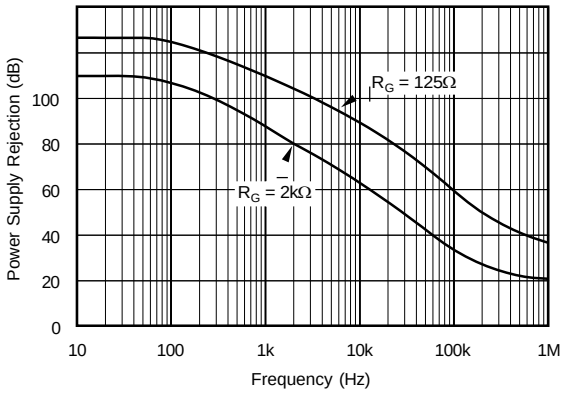

STEP RESPONSE



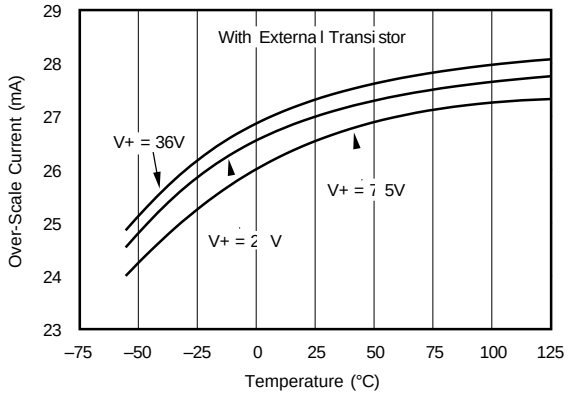

COMMON-MODE REJECTION vs FREQUENCY



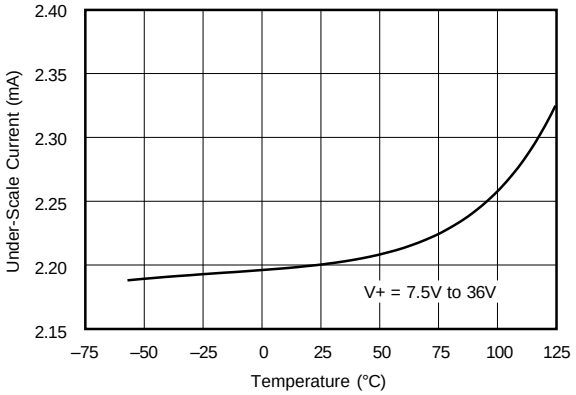

POWER-SUPPLY REJECTION vs FREQUENCY




OVER-SCALE CURRENT vs TEMPERATURE



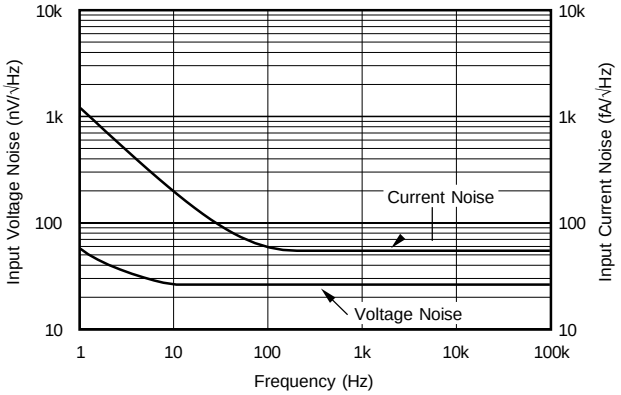

UNDER-SCALE CURRENT vs TEMPERATURE



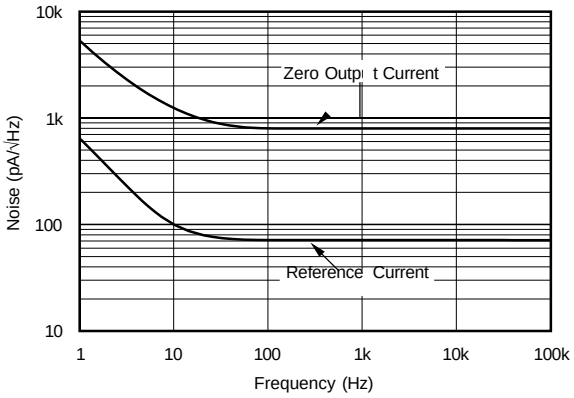
# TYPICAL PERFORMANCE CURVES (CONT)

At $T_A$ = +25°C, V+ = 24V, unless otherwise noted.

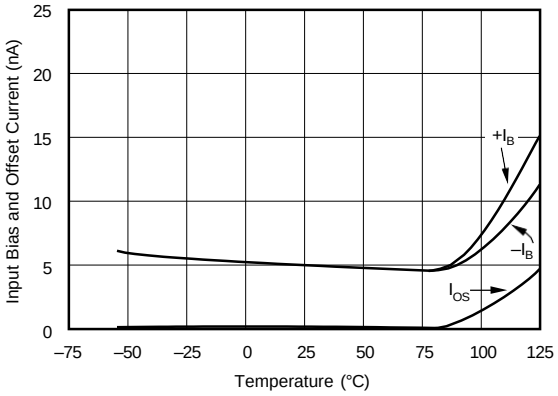
INPUT VOLTAGE AND CURRENT NOISE DENSITY vs FREQUENCY



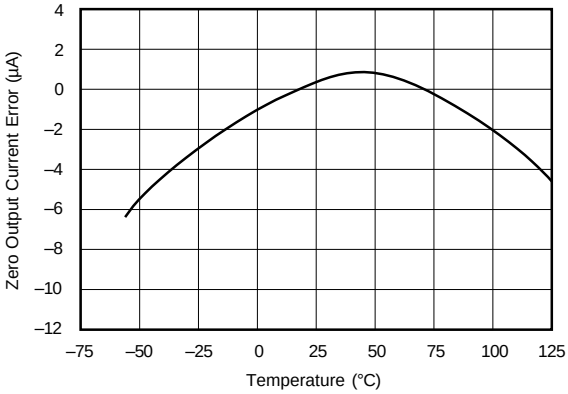

ZERO OUTPUT AND REFERENCE CURRENT NOISE vs FREQUENCY



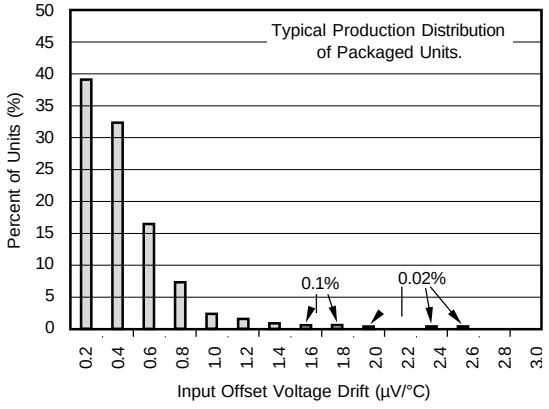

INPUT BIAS AND OFFSET CURRENT vs TEMPERATURE



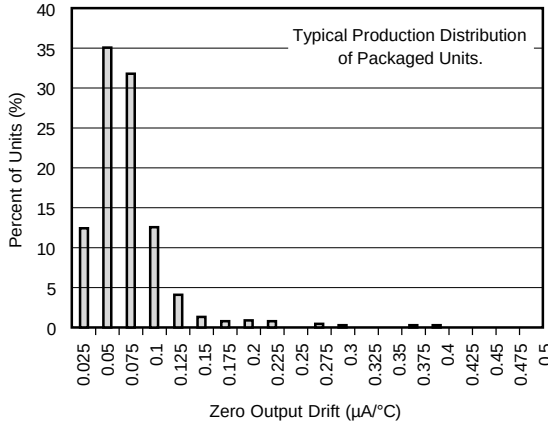

ZERO OUTPUT CURRENT ERROR vs TEMPERATURE




INPUT OFFSET VOLTAGE DRIFT PRODUCTION DISTRIBUTION



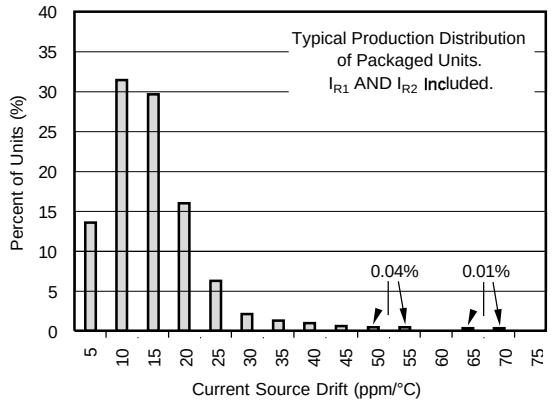

ZERO OUTPUT DRIFT PRODUCTION DISTRIBUTION



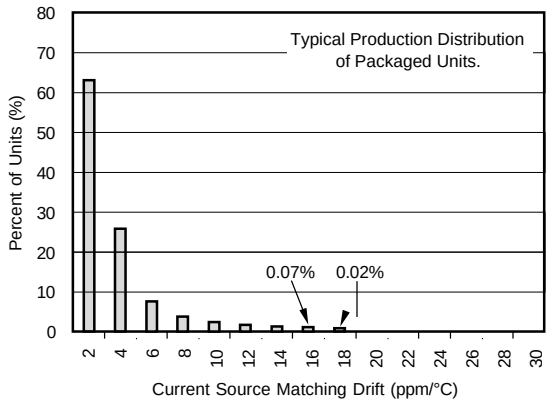
# TYPICAL PERFORMANCE CURVES (CONT)

At $T_A$ = +25°C, V+ = 24V, unless otherwise noted.

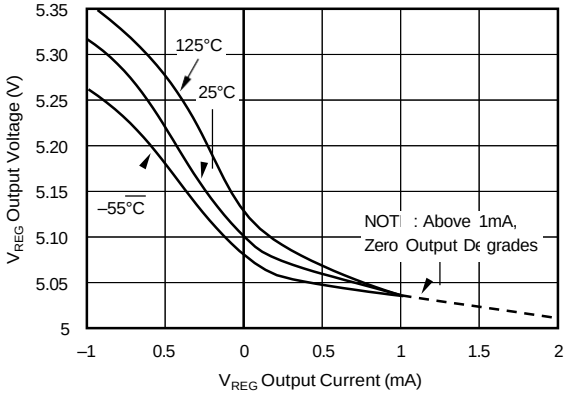
CURRENT SOURCE DRIFT
PRODUCTION DISTRIBUTION




CURRENT SOURCE MATCHING
DRIFT PRODUCTION DISTRIBUTION




$V_{REG}$ OUTPUT VOLTAGE vs $V_{REG}$ OUTPUT CURRENT




REFERENCE CURRENT ERROR
vs TEMPERATURE