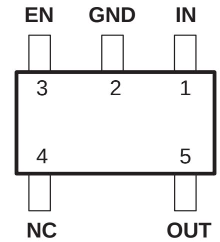
- **50-mA Low-Dropout Regulator**
- **Fixed Output Voltage Options: 5 V, 3.8 V, 3.3 V, 3.2 V, and 3 V**
- **Dropout Typically 120 mV at 50 mA**
- **Thermal Protection**
- **Less Than 1 μA Quiescent Current in Shutdown**
- **–40°C to 125°C Operating Junction Temperature Range**
- **5-Pin SOT-23 Package**
- **ESD Protection Verified to 1.5 kV Human Body Model (HBM) per MIL-STD-883C**

**DBV PACKAGE**
**(TOP VIEW)**




NC – No internal connection

## description

The TPS760xx is a 50mA, low dropout (LDO) voltage regulator designed specifically for battery-powered applications. A proprietary BiCMOS fabrication process allows the TPS760xx to provide outstanding performance in all specifications critical to battery-powered operation.

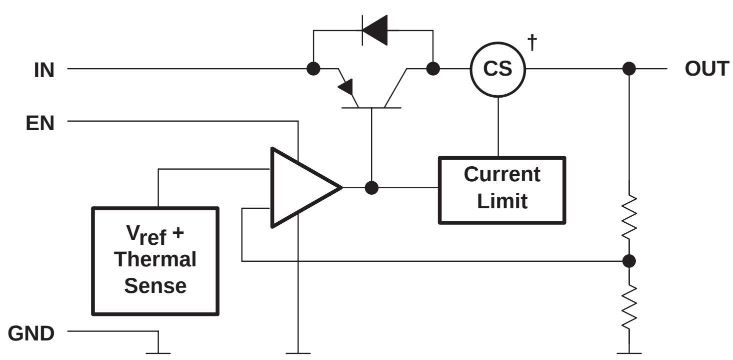
The TPS760xx is available in a space-saving SOT–23 package and operates over a junction temperature range of –40°C to 125°C.

**AVAILABLE OPTIONS**

| $T_J$ | VOLTAGE | PACKAGE | PART NUMBER | SYMBOL |
|---|---|---|---|---|
| –40°C to 125°C | 3 V | SOT-23 | TPS76030DBVR | PAGI |
| | 3.2 V | | TPS76032DBVR | PAOI |
| | 3.3 V | | TPS76033DBVR | PAHI |
| | 3.8 V | | TPS76038DBVR | PAJI |
| | 5 V | | TPS76050DBVR | PANI |

NOTE: The DBV package is available taped and reeled only.

## functional block diagram




† Current sense

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

## Terminal Functions

| TERMINAL NAME | TERMINAL NO. | I/O | DESCRIPTION |
|---|---|---|---|
| IN | 1 | I | Input voltage |
| GND | 2 | | Ground |
| EN | 3 | I | Enable input |
| NC | 4 | | No connection |
| OUT | 5 | O | Regulated output voltage |

## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input voltage range, $V_I$‡ . . . . . . . . . . –0.3 V to 16 V
Voltage range at EN . . . . . . . . . . –0.3 V to $V_I$ + 0.3 V
Peak output current . . . . . . . . . . internally limited
Continuous total dissipation . . . . . . . . . . See dissipation table
Operating junction temperature range, $T_J$ . . . . . . . . . . –40°C to 150°C
Storage temperature range, $T_{stg}$ . . . . . . . . . . –65°C to 150°C
ESD rating, HBM . . . . . . . . . . 1.5 kV

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
‡ All voltages are with respect to device GND pin.

**DISSIPATION RATING TABLE**

| | PACKAGE | $T_A \leq 25°C$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25°C$ | $T_A = 70°C$ POWER RATING | $T_A = 85°C$ POWER RATING |
|---|---|---|---|---|---|
| Recommended | DBV | 350 mW | 3.5 mW/°C | 192 mW | 140 mW |
| Maximum | DBV | 437 mW | 3.5 mW/°C | 280 mW | 227 mW |

## recommended operating conditions

| | | MIN | NOM | MAX | UNIT |
|---|---|---|---|---|---|
| Input voltage, $V_I$ | TPS76030 | 3.2 | | 16 | V |
| | TPS76032 | 3.4 | | 16 | V |
| | TPS76033 | 3.5 | | 16 | V |
| | TPS76038 | 4 | | 16 | V |
| | TPS76050 | 5.2 | | 16 | V |
| Continuous output current, $I_O$ | | 0 | | 50 | mA |
| Operating junction temperature, $T_J$ | | –40 | | 125 | °C |

## electrical characteristics over recommended operating free-air temperature range, $V_I = V_{O(nom)} + 1$ V, $I_O$ = 1 mA, EN = $V_I$, $C_o$ = 2.2 µF (unless otherwise noted)

| PARAMETER | | | TEST CONDITIONS | | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|---|---|
| $V_O$ | Output voltage | TPS76030 | $T_J$ = 25°C | | 2.96 | 3 | 3.04 | V |
| | | | $T_J$ = 25°C, | 1 mA < $I_O$ < 50 mA | 2.92 | | 3.04 | V |
| | | | 1 mA < $I_O$ < 50 mA | | 2.91 | | 3.07 | V |
| | | TPS76032 | $T_J$ = 25°C | | 3.16 | 3.2 | 3.24 | V |
| | | | $T_J$ = 25°C, | 1 mA < $I_O$ < 50 mA | 3.13 | | 3.24 | V |
| | | | 1 mA < $I_O$ < 50 mA | | 3.1 | | 3.3 | V |
| | | TPS76033 | $T_J$ = 25°C | | 3.26 | 3.3 | 3.34 | V |
| | | | $T_J$ = 25°C, | 1 mA < $I_O$ < 50 mA | 3.23 | | 3.34 | V |
| | | | 1 mA < $I_O$ < 50 mA | | 3.2 | | 3.4 | V |
| | | TPS76038 | $T_J$ = 25°C | | 3.76 | 3.8 | 3.84 | V |
| | | | $T_J$ = 25°C, | 1 mA < $I_O$ < 50 mA | 3.73 | | 3.84 | V |
| | | | 1 mA < $I_O$ < 50 mA | | 3.7 | | 3.9 | V |
| | | TPS76050 | $T_J$ = 25°C | | 4.95 | 5 | 5.05 | V |
| | | | $T_J$ = 25°C, | 1 mA < $I_O$ < 50 mA | 4.91 | | 5.05 | V |
| | | | 1 mA < $I_O$ < 50 mA | | 4.89 | | 5.1 | V |
| $I_{I(standby)}$ | Standby current | | EN = 0 V | | | | 1 | µA |
| | Quiescent current (GND current) | | $I_O$ = 0 mA, $T_J$ = 25°C | | | 90 | 115 | µA |
| | | | $I_O$ = 0 mA | | | | 130 | |
| | | | $I_O$ = 1 mA, $T_J$ = 25°C | | | 100 | 130 | |
| | | | $I_O$ = 1 mA | | | | 170 | |
| | | | $I_O$ = 10 mA, $T_J$ = 25°C | | | 190 | 215 | |
| | | | $I_O$ = 10 mA | | | | 460 | |
| | | | $I_O$ = 50 mA, $T_J$ = 25°C | | | 850 | 1100 | |
| | | | $I_O$ = 50 mA | | | | 1200 | |
| | Input regulation | TPS76030 | 4 V < $V_I$ < 16, | $I_O$ = 1 mA | | 3 | 10 | mV |
| | | TPS76032 | 4.2 V < $V_I$ < 16, | $I_O$ = 1 mA | | 3 | 10 | |
| | | TPS76033 | 4.3 V < $V_I$ < 16, | $I_O$ = 1 mA | | 3 | 10 | |
| | | TPS76038 | 4.8 V < $V_I$ < 16, | $I_O$ = 1 mA | | 3 | 10 | |
| | | TPS76050 | 6 V < $V_I$ < 16, | $I_O$ = 1 mA | | 3 | 10 | |
| $V_n$ | Output noise voltage | | BW = 300 Hz to 50 kHz, $C_o$ = 10 µF, $T_J$ = 25°C | | | 190 | | µVrms |
| | Ripple rejection | | f = 1 kHz, $C_o$ = 10 µF, $T_J$ = 25°C | | | 63 | | dB |
| | Dropout voltage | | $I_O$ = 0 mA, $T_J$ = 25°C | | | 1 | 3 | mV |
| | | | $I_O$ = 0 mA | | | | 5 | |
| | | | $I_O$ = 1 mA, $T_J$ = 25°C | | | 7 | 10 | |
| | | | $I_O$ = 1 mA | | | | 15 | |
| | | | $I_O$ = 10 mA, $T_J$ = 25°C | | | 40 | 60 | |
| | | | $I_O$ = 10 mA | | | | 90 | |
| | | | $I_O$ = 50 mA, $T_J$ = 25°C | | | 120 | 150 | |
| | | | $I_O$ = 50 mA | | | | 180 | |
| | Peak output current/current limit | | $T_J$ = 25°C | | 100 | 125 | | mA |

## electrical characteristics over recommended operating free-air temperature range, $V_I = V_{O(nom)} + 1$ V, $I_O = 1$ mA, EN = $V_I$, $C_o = 1$ µF (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| | High level enable input | | 2 | | | V |
| | Low level enable input | | | | 0.8 | V |
| $I_I$ | Input current (EN) | EN = 0 V | –1 | 0 | 1 | µA |
| | | EN = $V_I$ | | 2.5 | 5 | µA |

## TYPICAL CHARACTERISTICS

### Table of Graphs

| | | | FIGURE |
|---|---|---|---|
| $V_O$ | Output voltage | vs Output current | 1, 2, 3 |
| | | vs Free-air temperature | 4, 5, 6 |
| | Ground current | vs Free-air temperature | 7, 8, 9 |
| | Output noise | vs Frequency | 10 |
| $Z_o$ | Output impedance | vs Frequency | 11 |
| $V_{DO}$ | Dropout voltage | vs Free-air temperature | 12 |
| | Line transient response | | 13, 15 |
| | Load transient response | | 14, 16 |

## TYPICAL CHARACTERISTICS

**TPS76030**
**OUTPUT VOLTAGE**
**vs**
**OUTPUT CURRENT**

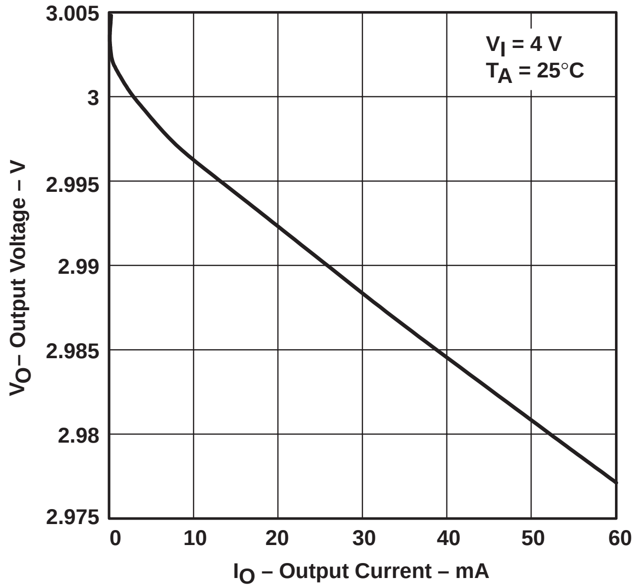



**Figure 1**

**TPS76033**
**OUTPUT VOLTAGE**
**vs**
**OUTPUT CURRENT**

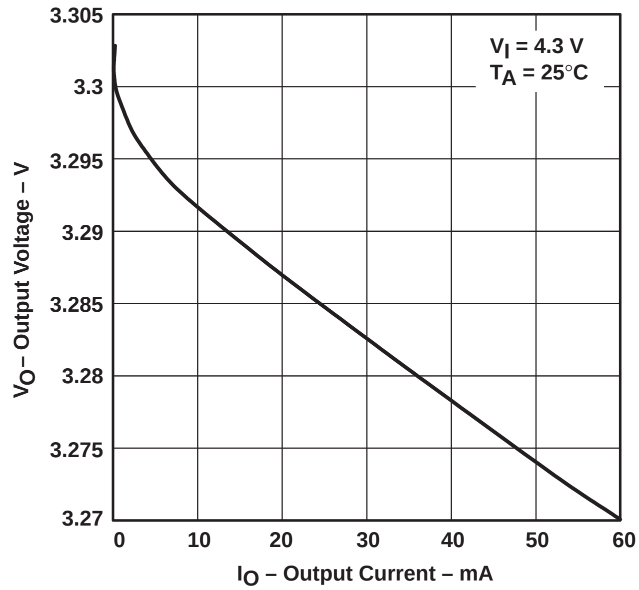



**Figure 2**

**TPS76050**
**OUTPUT VOLTAGE**
**vs**
**OUTPUT CURRENT**

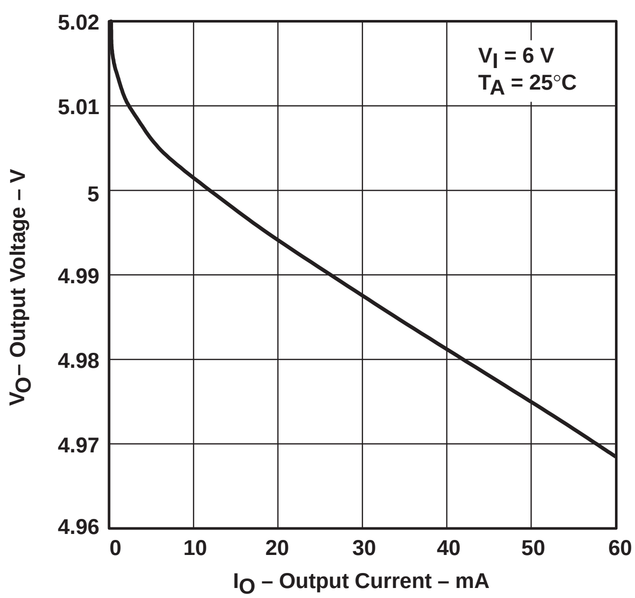



**Figure 3**

**TPS76030**
**OUTPUT VOLTAGE**
**vs**
**FREE-AIR TEMPERATURE**

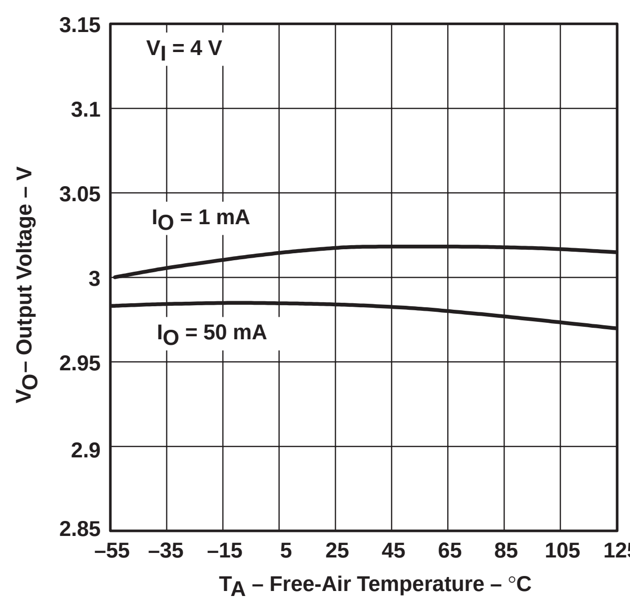



**Figure 4**

## TYPICAL CHARACTERISTICS

**TPS76033**
**OUTPUT VOLTAGE**
**vs**
**FREE-AIR TEMPERATURE**

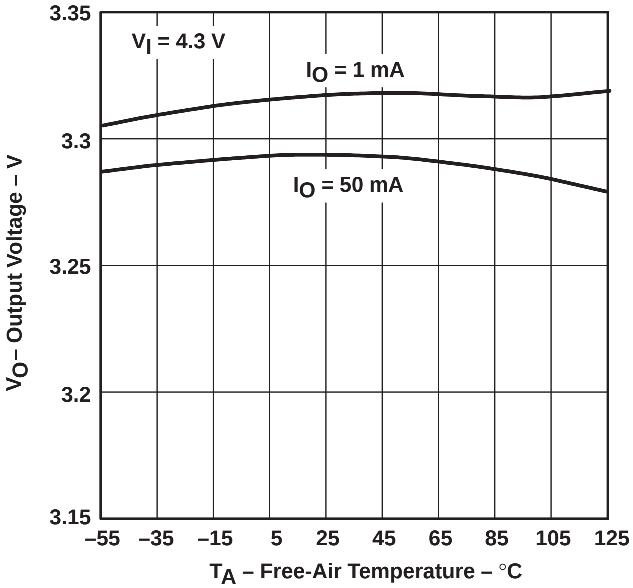



**Figure 5**

**TPS76050**
**OUTPUT VOLTAGE**
**vs**
**FREE-AIR TEMPERATURE**

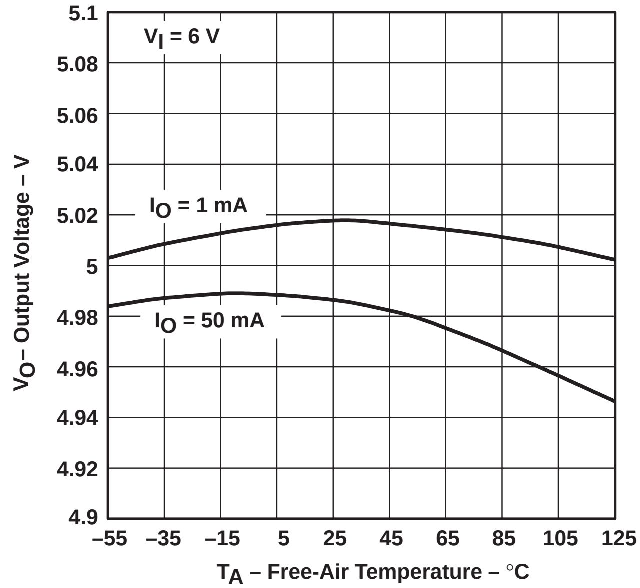



**Figure 6**

**TPS76030**
**GROUND CURRENT**
**vs**
**FREE-AIR TEMPERATURE**

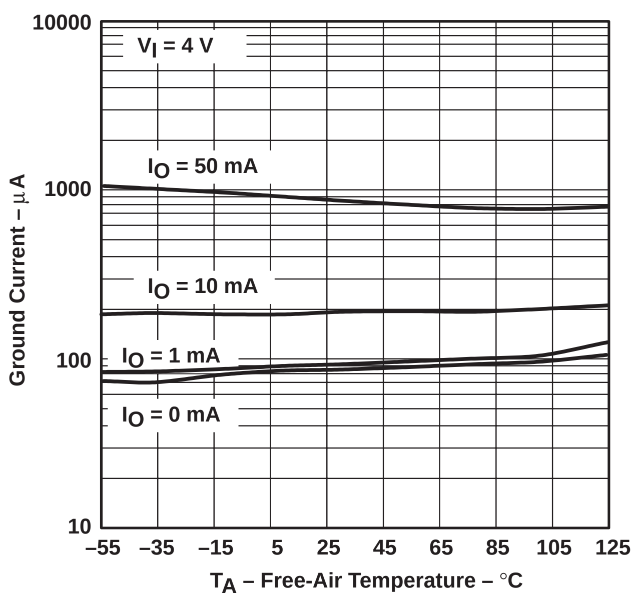



**Figure 7**

**TPS76033**
**GROUND CURRENT**
**vs**
**FREE-AIR TEMPERATURE**

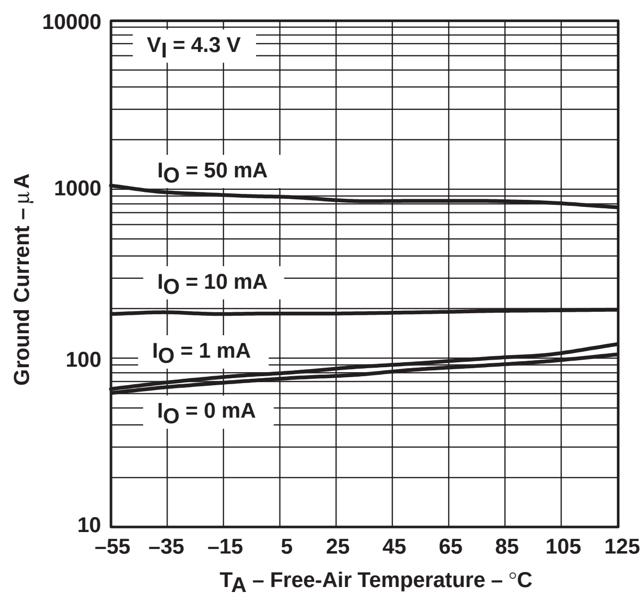



**Figure 8**

## TYPICAL CHARACTERISTICS

TPS76050
GROUND CURRENT
vs
FREE-AIR TEMPERATURE

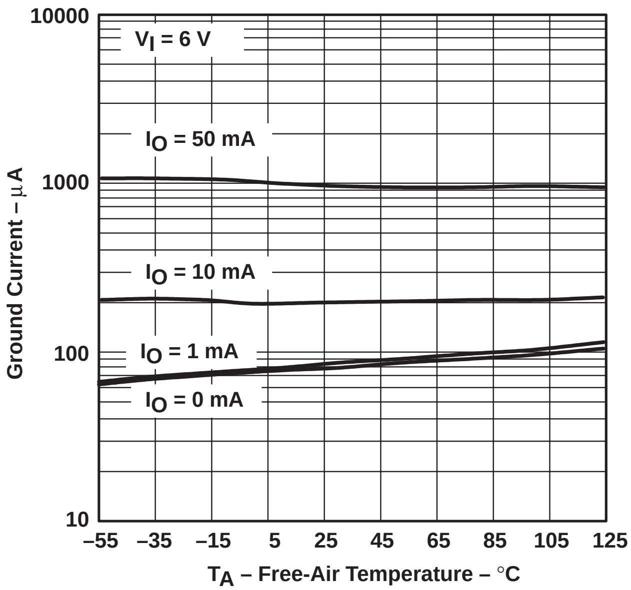



Figure 9

OUTPUT NOISE
vs
FREQUENCY

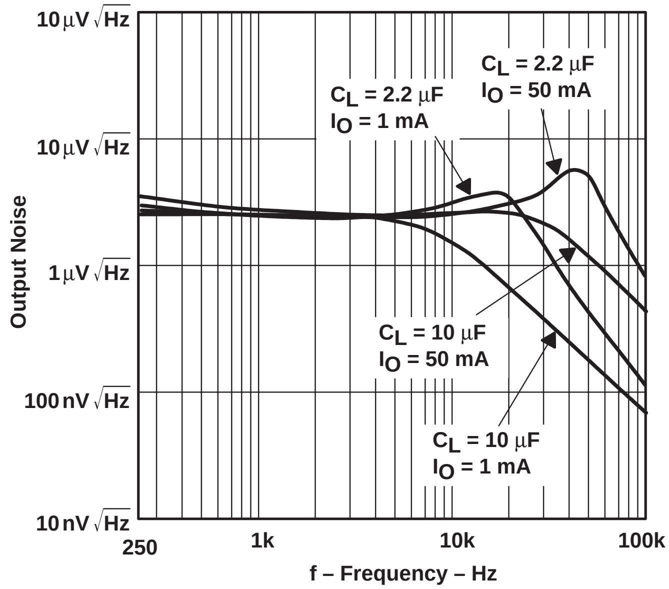



Figure 10

OUTPUT IMPEDANCE
vs
FREQUENCY

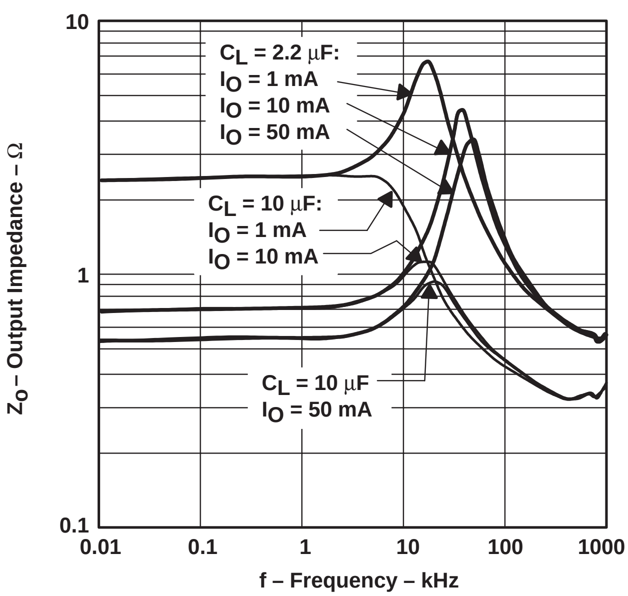



Figure 11

TPS76030
DROPOUT VOLTAGE
vs
FREE-AIR TEMPERATURE

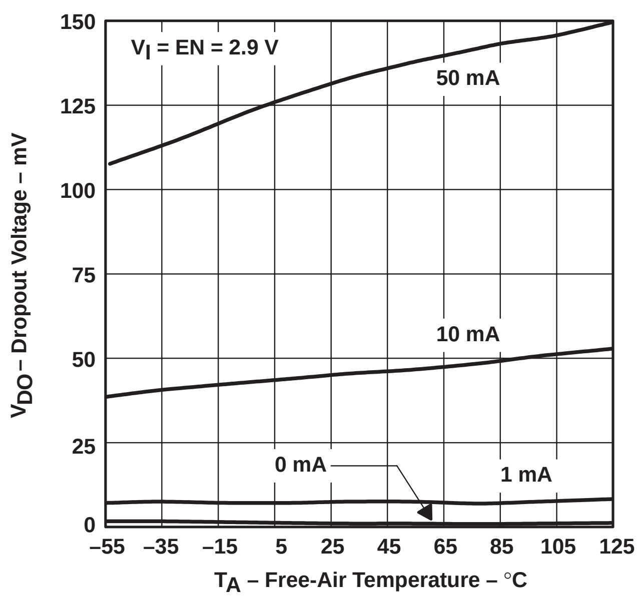



Figure 12

## TYPICAL CHARACTERISTICS

**TPS76033**
**LINE TRANSIENT RESPONSE**

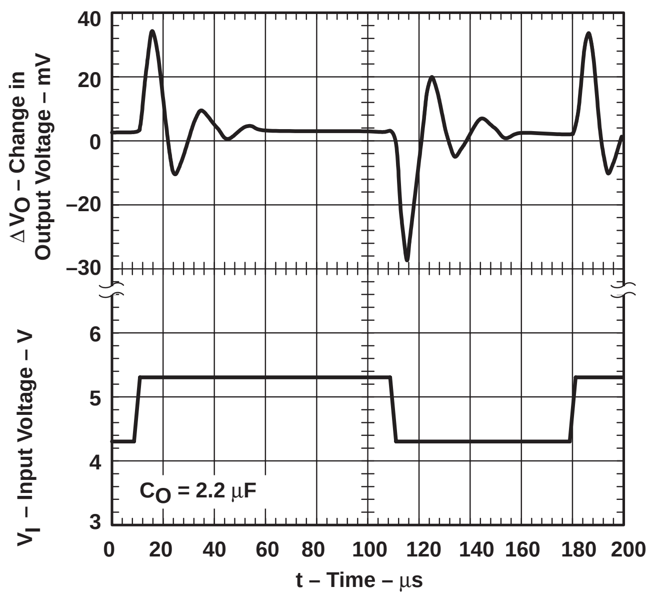



Figure 13

**TPS76033**
**LOAD TRANSIENT RESPONSE**

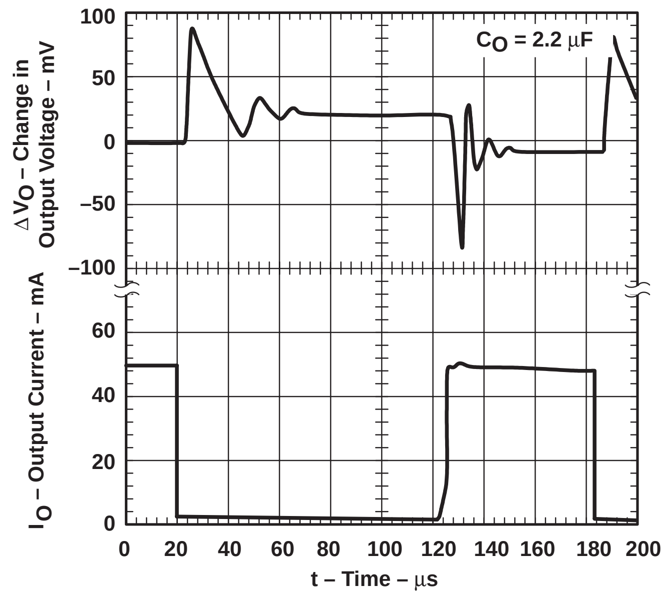



Figure 14

**TPS76050**
**LINE TRANSIENT RESPONSE**

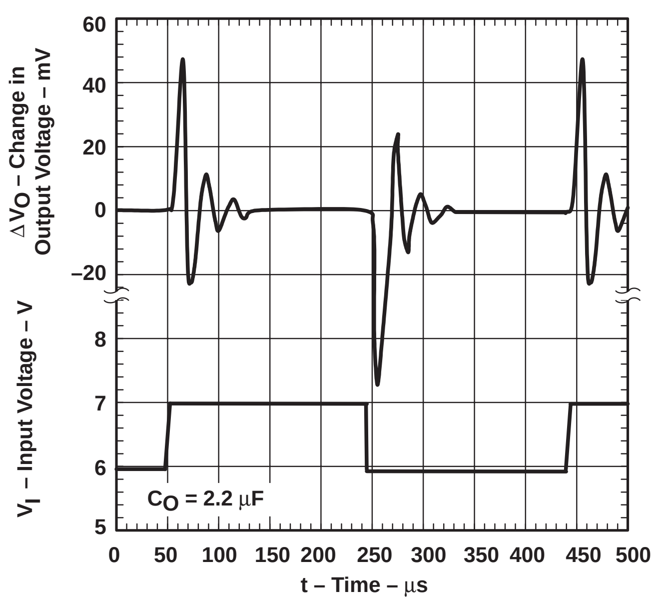



Figure 15

**TPS76050**
**LOAD TRANSIENT RESPONSE**

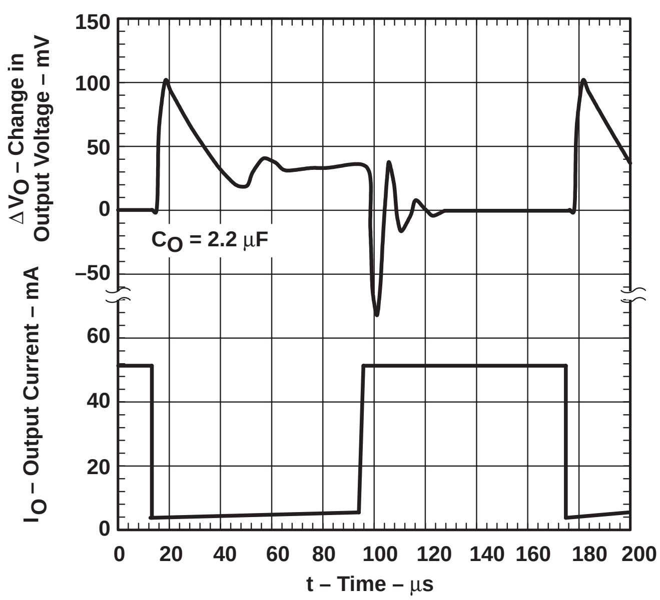



Figure 16

## APPLICATION INFORMATION

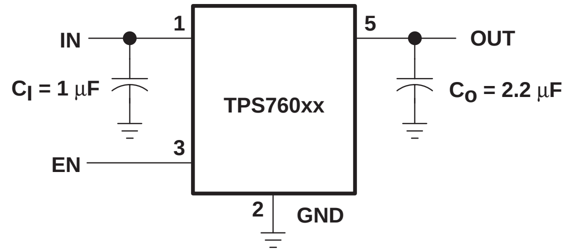



**Figure 17. TPS760xx Typical Application**

### over current protection

The over current protection circuit forces the TPS760xx into a constant current output mode when the load is excessive or the output is shorted to ground. Normal operation resumes when the fault condition is removed. An overload or short circuit may also activate the over temperature protection if the fault condition persists.

### over temperature protection

The thermal protection system shuts the TPS760xx down when the junction temperature exceeds 160°C. The device recovers and operates normally when the temperature drops below 150°C.

### input capacitor

A 0.047 μF or larger ceramic decoupling capacitor with short leads connected between IN and GND is recommended. The decoupling capacitor may be omitted if there is a 1 μF or larger electrolytic capacitor connected between IN and GND and located reasonably close to the TPS760xx. However, the small ceramic device is desirable even when the larger capacitor is present, if there is a lot of high frequency noise present in the system.

### output capacitor

Like all low dropout regulators, the TPS760xx requires an output capacitor connected between OUT and GND to stabilize the internal control loop. The minimum recommended capacitance value is 2.2 μF and the ESR (equivalent series resistance) must be between 0.1 Ω and 20 Ω. Capacitor values of 2.5-μF or larger are acceptable, provided the ESR is less than 20 Ω. Solid tantalum electrolytic, aluminum electrolytic, and multilayer ceramic capacitors are all suitable, provided they meet the requirements described above. Most of the commercially available 2.2-μF surface-mount solid-tantalum capacitors, including devices from Sprague, Kemet, and Nichicon, meet the ESR requirements stated above. Multilayer ceramic capacitors should have minimum values of 2.5 μF over the full operating temperature range of the equipment.

### enable (EN)

A logic zero on the enable input shuts the TPS760xx off and reduces the supply current to less than 1 μA. Pulling the enable input high causes normal operation to resume. If the enable feature is not used, EN should be connected to IN to keep the regulator on all of the time. The EN input must not be left floating.

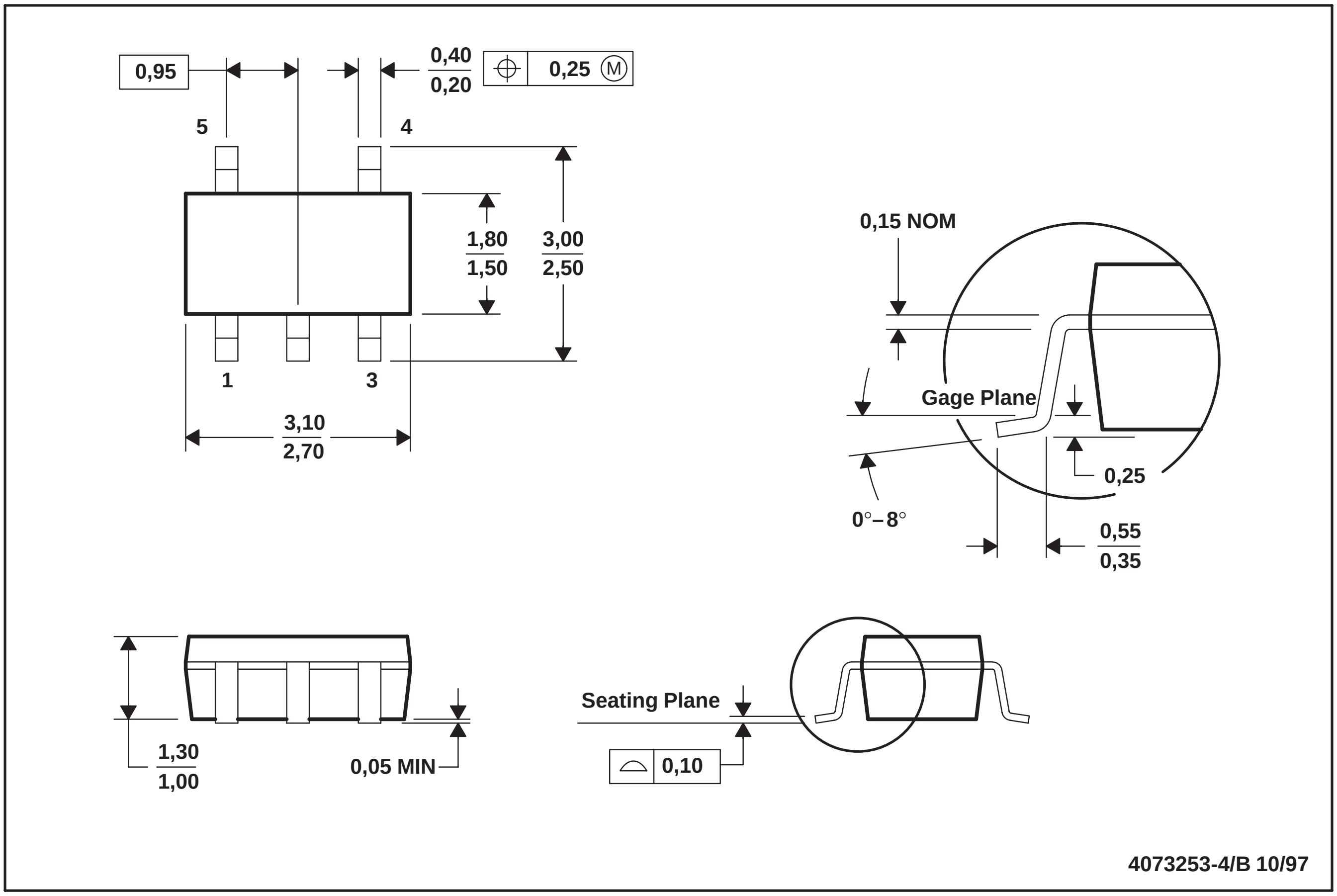
## APPLICATION INFORMATION

### reverse current path

The power transistor used in the TPS760xx has an inherent diode connected between IN and OUT as shown in the functional block diagram. This diode conducts current from the OUT terminal to the IN terminal whenever IN is lower than OUT by a diode drop. This condition does not damage the TPS760xx, provided the current is limited to 100mA.

## MECHANICAL DATA

**DBV (R-PDSO-G5)** **PLASTIC SMALL-OUTLINE PACKAGE**




NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions include mold flash or protrusion.