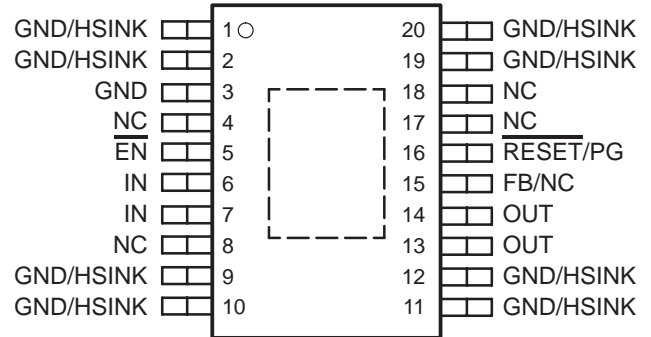


- Open Drain Power-On Reset With 200 ms Delay (TPS777xx)
- Open Drain Power Good (TPS778xx)
- 750-mA Low-Dropout Voltage Regulator
- Available in 1.5-V, 1.8-V, 2.5-V, 3.3-V Fixed Output and Adjustable Versions
- Dropout Voltage to 260 mV (Typ) at 750 mA (TPS77x33)
- Ultralow 85 μA Typical Quiescent Current
- Fast Transient Response
- 2% Tolerance Over Specified Conditions for Fixed-Output Versions
- 8-Pin SOIC and 20-Pin TSSOP PowerPAD™ (PWP) Package
- Thermal Shutdown Protection

description

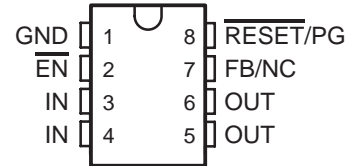
TPS777xx and TPS778xx are designed to have a fast transient response and be stable with a 10 μF low ESR capacitor. This combination provides high performance at a reasonable cost.

PWP PACKAGE
(TOP VIEW)

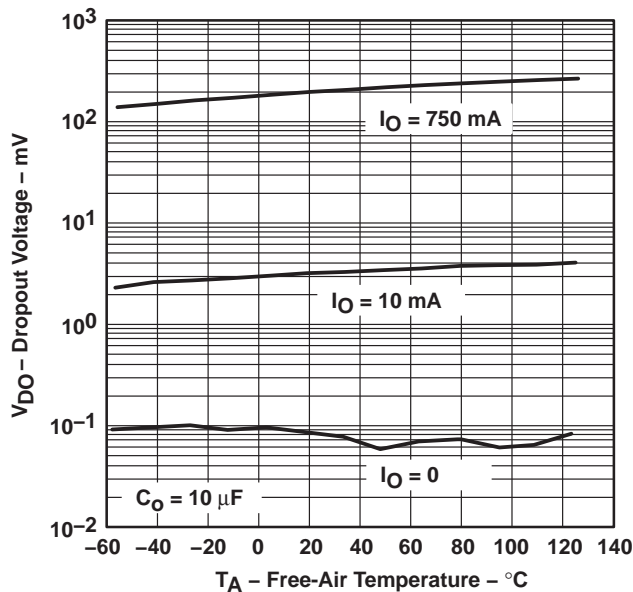


NC – No internal connection

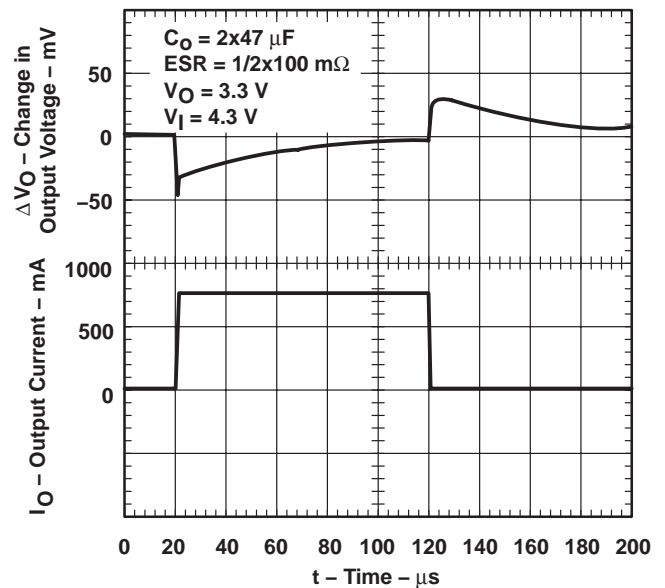
D PACKAGE
(TOP VIEW)



TPS77x33
DROPOUT VOLTAGE
vs
FREE-AIR TEMPERATURE



TPS77x33
LOAD TRANSIENT RESPONSE



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description (continued)

Because the PMOS device behaves as a low-value resistor, the dropout voltage is very low (typically 260 mV at an output current of 750 mA for the TPS77x33) and is directly proportional to the output current. Additionally, since the PMOS pass element is a voltage-driven device, the quiescent current is very low and independent of output loading (typically 85 μA over the full range of output current, 0 mA to 750 mA). These two key specifications yield a significant improvement in operating life for battery-powered systems. This LDO family also features a sleep mode; applying a TTL high signal to $\overline{\text{EN}}$ (enable) shuts down the regulator, reducing the quiescent current to 1 μA at $T_J = 25^\circ\text{C}$.

The $\overline{\text{RESET}}$ output of the TPS777xx initiates a reset in microcomputer and microprocessor systems in the event of an undervoltage condition. An internal comparator in the TPS777xx monitors the output voltage of the regulator to detect an undervoltage condition on the regulated output voltage.

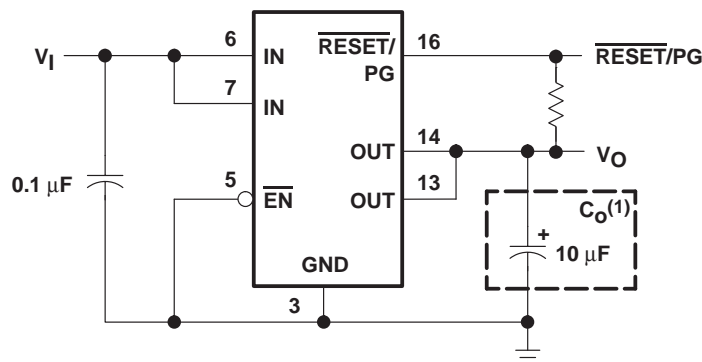
Power good (PG) of the TPS778xx is an active high output, which can be used to implement a power-on reset or a low-battery indicator.

The TPS777xx and TPS778xx are offered in 1.5-V, 1.8-V, 2.5-V, and 3.3-V fixed-voltage versions and in an adjustable version (programmable over the range of 1.5 V to 5.5 V for the TPS77701 option and 1.2 V to 5.5 V for the TPS77801 option). Output voltage tolerance is specified as a maximum of 2% over line, load, and temperature ranges. The TPS777xx and TPS778xx families are available in 8-pin SOIC and 20-pin PWP packages.

AVAILABLE OPTIONS

| T_J | OUTPUT VOLTAGE (V) | PACKAGED DEVICES | | | |
|----------------|------------------------------|------------------|-------------|-----------|-----------|
| | TYP | TSSOP (PWP) | | SOIC (D) | |
| -40°C to 125°C | 3.3 | TPS77733PWP | TPS77833PWP | TPS77733D | TPS77833D |
| | 2.5 | TPS77725PWP | TPS77825PWP | TPS77725D | TPS77825D |
| | 1.8 | TPS77718PWP | TPS77818PWP | TPS77718D | TPS77818D |
| | 1.5 | TPS77715PWP | TPS77815PWP | TPS77715D | TPS77815D |
| | Adjustable 1.5 V to 5.5 V | TPS77701PWP | — | TPS77701D | — |
| | Adjustable 1.2 V to 5.5 V | — | TPS77801PWP | — | TPS77801D |

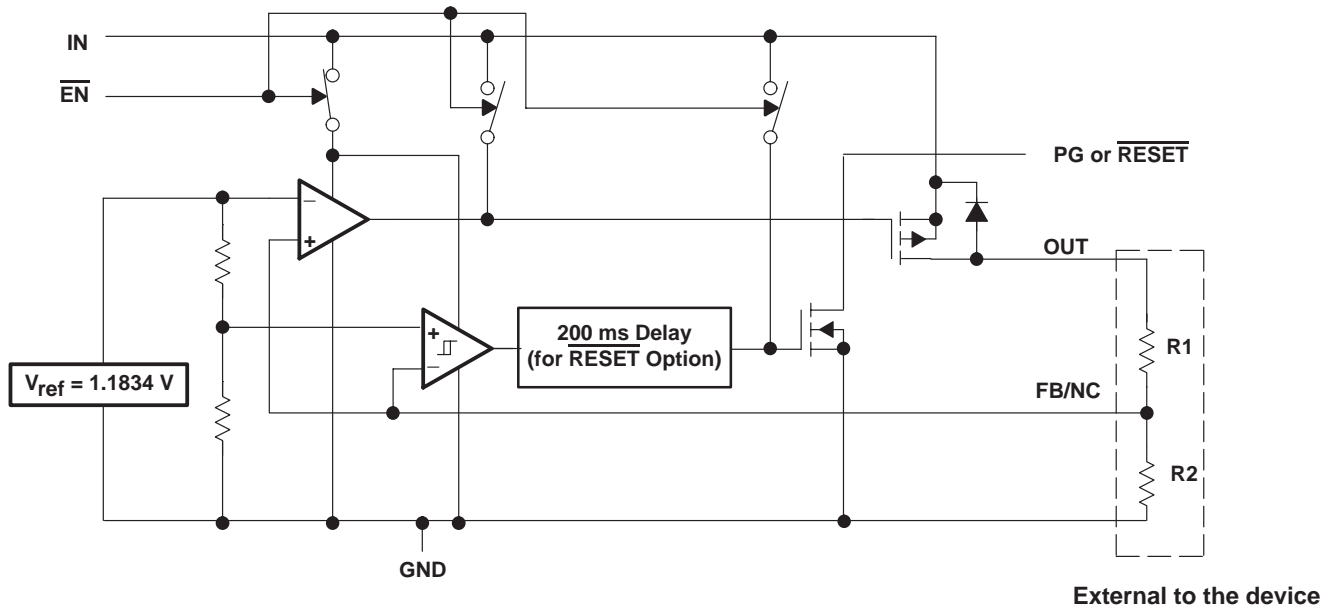
The TPS77x01 is programmable using an external resistor divider (see application information). The D and PWP packages are available taped and reeled. Add an R suffix to the device type (e.g., TPS77701DR).



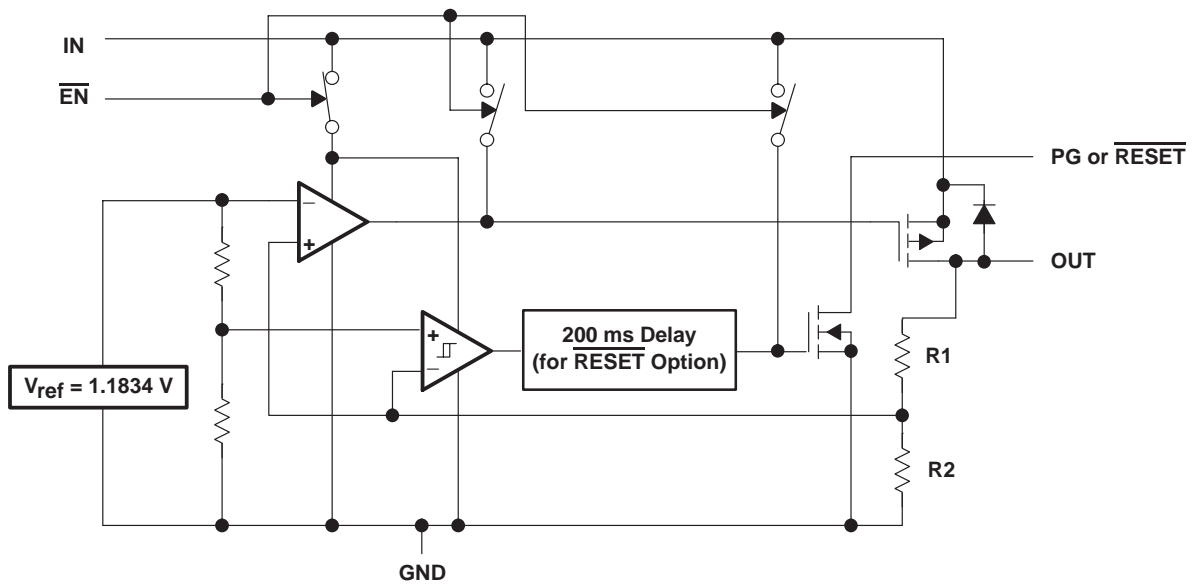
(1) See application information section for capacitor selection details.

Figure 1. Typical Application Configuration for Fixed Output Options

functional block diagram—adjustable version



functional block diagram—fixed-voltage version



TPS77701, TPS77715, TPS77718, TPS77725, TPS77733 with $\overline{\text{RESET}}$ OUTPUT
TPS77801, TPS77815, TPS77818, TPS77825, TPS77833 with PG OUTPUT
FAST-TRANSIENT-RESPONSE 750-mA LOW-DROPOUT LINEAR REGULATORS



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Terminal Functions

SOIC Package (TPS777xx)

| TERMINAL NAME | NO. | I/O | DESCRIPTION |
|---------------------------|------|-----|---|
| $\overline{\text{EN}}$ | 2 | I | Enable input |
| FB/NC | 7 | I | Feedback input voltage for adjustable device (no connect for fixed options) |
| GND | 1 | | Regulator ground |
| IN | 3, 4 | I | Input voltage |
| OUT | 5, 6 | O | Regulated output voltage |
| $\overline{\text{RESET}}$ | 8 | O | $\overline{\text{RESET}}$ output |

TSSOP Package (TPS777xx)

| TERMINAL NAME | NO. | I/O | DESCRIPTION |
|---------------------------|-----------------------------|-----|---|
| $\overline{\text{EN}}$ | 5 | I | Enable input |
| FB/NC | 15 | I | Feedback input voltage for adjustable device (no connect for fixed options) |
| GND | 3 | | Regulator ground |
| GND/HSINK | 1, 2, 9, 10, 11, 12, 19, 20 | | Ground/heatsink |
| IN | 6, 7 | I | Input |
| NC | 4, 8, 17, 18 | | No connect |
| OUT | 13, 14 | O | Regulated output voltage |
| $\overline{\text{RESET}}$ | 16 | O | $\overline{\text{RESET}}$ output |

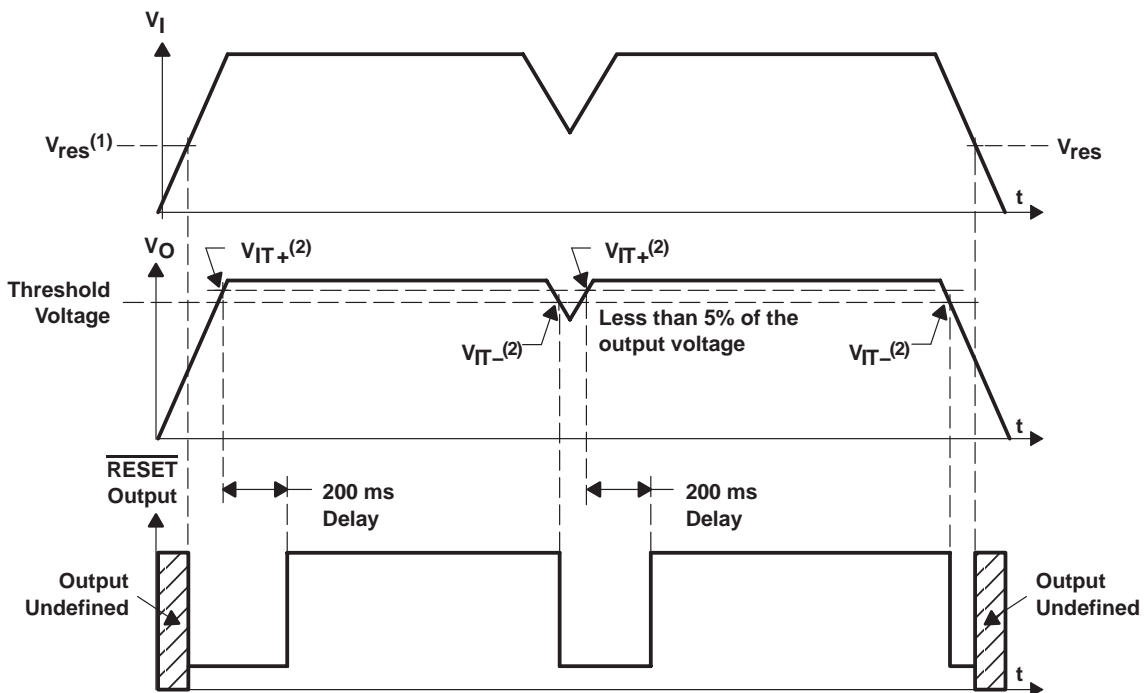
SOIC Package (TPS778xx)

| TERMINAL NAME | NO. | I/O | DESCRIPTION |
|------------------------|------|-----|---|
| $\overline{\text{EN}}$ | 2 | I | Enable input |
| FB/NC | 7 | I | Feedback input voltage for adjustable device (no connect for fixed options) |
| GND | 1 | | Regulator ground |
| IN | 3, 4 | I | Input voltage |
| OUT | 5, 6 | O | Regulated output voltage |
| PG | 8 | O | PG output |

TSSOP Package (TPS778xx)

| TERMINAL NAME | NO. | I/O | DESCRIPTION |
|------------------------|-----------------------------|-----|---|
| $\overline{\text{EN}}$ | 5 | I | Enable input |
| FB/NC | 15 | I | Feedback input voltage for adjustable device (no connect for fixed options) |
| GND | 3 | | Regulator ground |
| GND/HSINK | 1, 2, 9, 10, 11, 12, 19, 20 | | Ground/heatsink |
| IN | 6, 7 | I | Input |
| NC | 4, 8, 17, 18 | | No connect |
| OUT | 13, 14 | O | Regulated output voltage |
| PG | 16 | O | PG output |

TPS777xx $\overline{\text{RESET}}$ timing diagram



(1) V_{res} is the minimum input voltage for a valid $\overline{\text{RESET}}$. The symbol V_{res} is not currently listed within EIA or JEDEC standards for semiconductor symbology.

(2) V_{IT-} – Trip voltage is typically 5% lower than the output voltage ($95\%V_O$). V_{IT-} to V_{IT+} is the hysteresis voltage.

TPS77701, TPS77715, TPS77718, TPS77725, TPS77733 with RESET OUTPUT
TPS77801, TPS77815, TPS77818, TPS77825, TPS77833 with PG OUTPUT
FAST-TRANSIENT-RESPONSE 750-mA LOW-DROPOUT LINEAR REGULATORS



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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)(1)

| | |
|---|-------------------------------|
| Input voltage range ⁽²⁾ , V_I | -0.3 V to 13.5 V |
| Voltage range at EN | -0.3 V to 16.5 V |
| Maximum RESET voltage (TPS777xx) | 16.5 V |
| Maximum PG voltage (TPS778xx) | 16.5 V |
| Peak output current | Internally limited |
| Output voltage, V_O (OUT, FB) | 7 V |
| Continuous total power dissipation | See dissipation rating tables |
| Operating junction temperature range, T_J | -40°C to 125°C |
| Storage temperature range, T_{stg} | -65°C to 150°C |
| ESD rating, HBM | 2 kV |

- (1) 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.
- (2) All voltage values are with respect to network terminal ground.

DISSIPATION RATING TABLE 1 – FREE-AIR TEMPERATURES

| PACKAGE | AIR FLOW (CFM) | $T_A < 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING |
|---------|----------------|--|---|--|--|
| D | 0 | 568 mW | 5.68 mW/°C | 312 mW | 227 mW |
| | 250 | 904 mW | 9.04 mW/°C | 497 mW | 361 mW |

DISSIPATION RATING TABLE 2 – FREE-AIR TEMPERATURES

| PACKAGE | AIR FLOW (CFM) | $T_A < 25^\circ\text{C}$ POWER RATING | DERATING FACTOR ABOVE $T_A = 25^\circ\text{C}$ | $T_A = 70^\circ\text{C}$ POWER RATING | $T_A = 85^\circ\text{C}$ POWER RATING |
|---------|----------------|--|---|--|--|
| PWP§ | 0 | 2.9 W | 23.5 mW/°C | 1.9 W | 1.5 W |
| | 300 | 4.3 W | 34.6 mW/°C | 2.8 W | 2.2 W |
| PWP¶ | 0 | 3 W | 23.8 mW/°C | 1.9 W | 1.5 W |
| | 300 | 7.2 W | 57.9 mW/°C | 4.6 W | 3.8 W |

- (1) This parameter is measured with the recommended copper heat sink pattern on a 1-layer PCB, 5 in × 5 in PCB, 1 oz. copper, 2 in × 2 in coverage (4 in²).
- (2) This parameter is measured with the recommended copper heat sink pattern on a 8-layer PCB, 1.5 in × 2 in PCB, 1 oz. copper with layers 1, 2, 4, 5, 7, and 8 at 5% coverage (0.9 in²) and layers 3 and 6 at 100% coverage (6 in²). For more information, refer to TI technical brief SLMA002.

recommended operating conditions

| | | MIN | MAX | UNIT |
|---------------------------------------|----------|-----|-----|------|
| Input voltage, V_I ⁽¹⁾ | | 2.7 | 10 | V |
| Output voltage range, V_O | TPS77701 | 1.5 | 5.5 | V |
| | TPS77801 | 1.2 | 5.5 | |
| Operating junction temperature, T_J | | -40 | 125 | °C |

(1) Minimum $V_{IN} = V_{OUT} + V_{DO}$ or 2.7V, whichever is greater.

electrical characteristics over recommended operating temperature range ($T_J = -40^\circ\text{C}$ to 125°C), $V_I = V_{O(\text{typ})} + 1\text{ V}$, $I_O = 1\text{ mA}$, $\overline{\text{EN}} = 0\text{ V}$, $C_O = 10\text{ }\mu\text{F}$ (unless otherwise noted)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|--|------------|------------|-----|------------------|
| Output voltage (10 μA to 750 mA load) | TPS77701 | $1.5\text{ V} \leq V_O \leq 5.5\text{ V}$, $T_J = 25^\circ\text{C}$ | V_O | | | V |
| | | $1.5\text{ V} \leq V_O \leq 5.5\text{ V}$, | 0.98 V_O | 1.02 V_O | | |
| | TPS77801 | $1.2\text{ V} \leq V_O \leq 5.5\text{ V}$, $T_J = 25^\circ\text{C}$ | V_O | | | |
| | | $1.2\text{ V} \leq V_O \leq 5.5\text{ V}$, | 0.98 V_O | 1.02 V_O | | |
| | TPS77x15 | $T_J = 25^\circ\text{C}$, $2.7\text{ V} < V_{IN} < 10\text{ V}$ | 1.5 | | | |
| | | $T_J = -40^\circ\text{C}$ to 125°C , $2.7\text{ V} < V_{IN} < 10\text{ V}$ | 1.470 | 1.530 | | |
| | TPS77x18 | $T_J = 25^\circ\text{C}$, $2.8\text{ V} < V_{IN} < 10\text{ V}$ | 1.8 | | | |
| | | $T_J = -40^\circ\text{C}$ to 125°C , $2.8\text{ V} < V_{IN} < 10\text{ V}$ | 1.764 | 1.836 | | |
| | TPS77x25 | $T_J = 25^\circ\text{C}$, $3.5\text{ V} < V_{IN} < 10\text{ V}$ | 2.5 | | | |
| | | $T_J = -40^\circ\text{C}$ to 125°C , $3.5\text{ V} < V_{IN} < 10\text{ V}$ | 2.450 | 2.550 | | |
| | TPS77x33 | $T_J = 25^\circ\text{C}$, $4.3\text{ V} < V_{IN} < 10\text{ V}$ | 3.3 | | | |
| | | $T_J = -40^\circ\text{C}$ to 125°C , $4.3\text{ V} < V_{IN} < 10\text{ V}$ | 3.234 | 3.366 | | |
| Quiescent current (GND current) | | $10\text{ }\mu\text{A} < I_O < 750\text{ mA}$, $T_J = 25^\circ\text{C}$ | 85 | | | μA |
| | | $I_O = 750\text{ mA}$ | 125 | | | |
| Output voltage line regulation ($\Delta V_O/V_O$) | | $V_O + 1\text{ V} < V_I \leq 10\text{ V}$, $T_J = 25^\circ\text{C}$ | 0.01 | | | %/V |
| Load regulation | | | 3 | | | mV |
| Output noise voltage (TPS77x18) | | BW = 200 Hz to 100 kHz, $C_O = 10\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$, $I_C = 750\text{ }\mu\text{A}$ | 54 | | | μVrms |
| Output current limit | | $V_O = 0\text{ V}$ | 1.2 | 1.7 | 2 | A |
| Thermal shutdown junction temperature | | | 150 | | | $^\circ\text{C}$ |
| Standby current | | $\overline{\text{EN}} = V_I$, $T_J = 25^\circ\text{C}$, $2.7\text{ V} < V_I < 10\text{ V}$ | 1 | | | μA |
| | | $\overline{\text{EN}} = V_I$, $2.7\text{ V} < V_I < 10\text{ V}$ | 10 | | | μA |
| FB input current | TPS77x01 | FB = 1.5 V | 2 | | | nA |
| High level enable input voltage | | | 1.7 | | | V |
| Low level enable input voltage | | | 0.9 | | | V |
| Power supply ripple rejection | | $f = 1\text{ KHz}$, $C_O = 10\text{ }\mu\text{F}$, $T_J = 25^\circ\text{C}$ | 60 | | | dB |
| Reset (TPS77xx) | Minimum input voltage for valid $\overline{\text{RESET}}$ | $I_O(\text{RESET}) = 300\text{ }\mu\text{A}$ | 1.1 | | | V |
| | Trip threshold voltage | V_O decreasing | 92 | 98 | | % V_O |
| | Hysteresis voltage | Measured at V_O | 0.5 | | | % V_O |
| | Output low voltage | $V_I = 2.7\text{ V}$, $I_O(\text{RESET}) = 1\text{ mA}$ | 0.15 | 0.4 | | V |
| | Leakage current | $V(\text{RESET}) = 5\text{ V}$ | 1 | | | μA |
| | RESET time-out delay | | 200 | | | ms |

TPS77701, TPS77715, TPS77718, TPS77725, TPS77733 with RESET OUTPUT
TPS77801, TPS77815, TPS77818, TPS77825, TPS77833 with PG OUTPUT
FAST-TRANSIENT-RESPONSE 750-mA LOW-DROPOUT LINEAR REGULATORS



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electrical characteristics over recommended operating temperature range ($T_J = -40^{\circ}\text{C}$ to 125°C), $V_I = V_{O(\text{typ})} + 1\text{ V}$, $I_O = 1\text{ mA}$, $\overline{\text{EN}} = 0\text{ V}$, $C_O = 10\text{ }\mu\text{F}$ (unless otherwise noted) (continued)

| PARAMETER | | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|--|------------------------------------|---|-----|------|-----|---------------|
| PG (TPS778xx) | Minimum input voltage for valid PG | $I_{O(\text{PG})} = 300\text{ }\mu\text{A}$ | | 1.1 | | V |
| | Trip threshold voltage | V_O decreasing | 92 | | 98 | $\%V_O$ |
| | Hysteresis voltage | Measured at V_O | | 0.5 | | $\%V_O$ |
| | Output low voltage | $V_I = 2.7\text{ V}$, $I_{O(\text{PG})} = 1\text{ mA}$ | | 0.15 | 0.4 | V |
| | Leakage current | $V(\text{PG}) = 5\text{ V}$ | | | 1 | μA |
| Input current ($\overline{\text{EN}}$) | | $\overline{\text{EN}} = 0\text{ V}$ | -1 | 0 | 1 | μA |
| | | $\overline{\text{EN}} = V_I$ | -1 | | 1 | |
| Dropout voltage (1) | TPS77733 | $I_O = 750\text{ mA}$, $T_J = 25^{\circ}\text{C}$ | | 260 | | mV |
| | | $I_O = 750\text{ mA}$, | | | 427 | |
| | TPS77833 | $I_O = 750\text{ mA}$, $T_J = 25^{\circ}\text{C}$ | | 260 | | |
| | | $I_O = 750\text{ mA}$, | | | 427 | |

(1) IN voltage equals $V_{O(\text{typ})} - 100\text{ mV}$; TPS77x01 output voltage set to 3.3 V nominal with external resistor divider. TPS77x15, TPS77x18, and TPS77x25 dropout voltage limited by input voltage range limitations (i.e., TPS77x33 input voltage needs to drop to 3.2 V for purpose of this test).

TYPICAL CHARACTERISTICS

Table of Graphs

| | | | FIGURE |
|----------|------------------------------------|-------------------------|---------|
| V_O | Output voltage | vs Output current | 2, 3, 4 |
| | | vs Free-air temperature | 5, 6, 7 |
| | Ground current | vs Free-air temperature | 8 |
| | Power supply ripple rejection | vs Frequency | 9 |
| | Output spectral noise density | vs Frequency | 10 |
| Z_O | Output impedance | vs Frequency | 11 |
| V_{DO} | Dropout voltage | vs Input voltage | 12 |
| | | vs Free-air temperature | 13 |
| | Input voltage (min) | vs Output voltage | 14 |
| | Line transient response | | 15, 17 |
| | Load transient response | | 16, 18 |
| V_O | Output voltage | vs Time | 19 |
| | Equivalent series resistance (ESR) | vs Output current | 21 – 24 |

TYPICAL CHARACTERISTICS

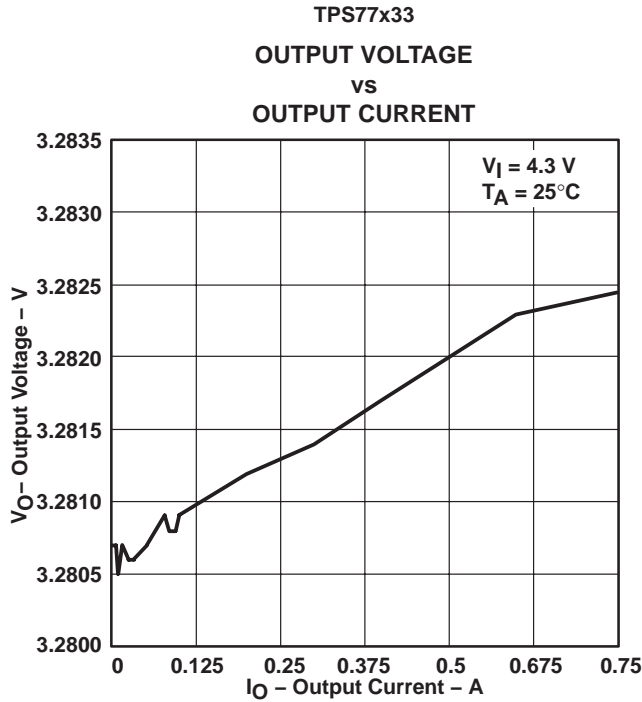


Figure 2

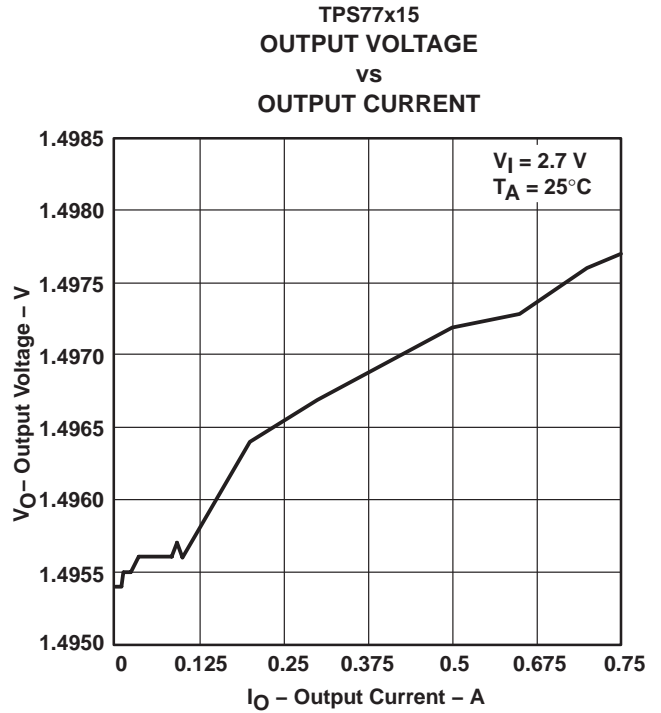


Figure 3

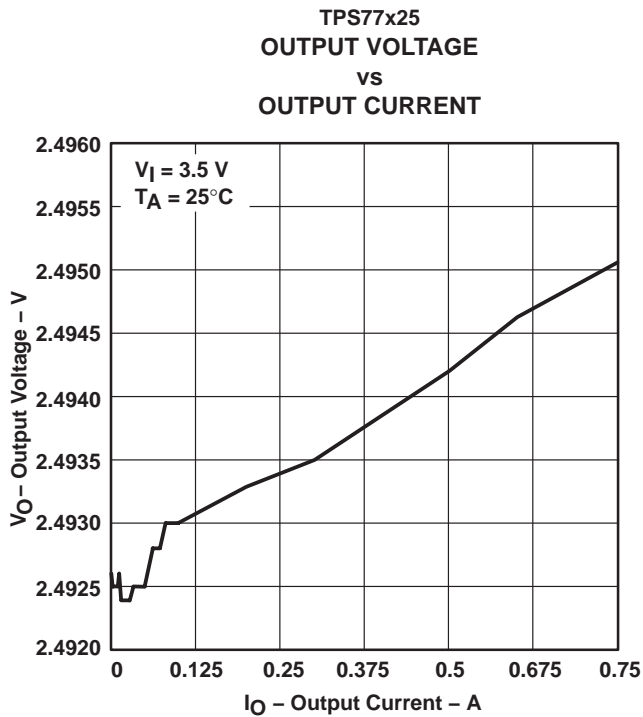


Figure 4

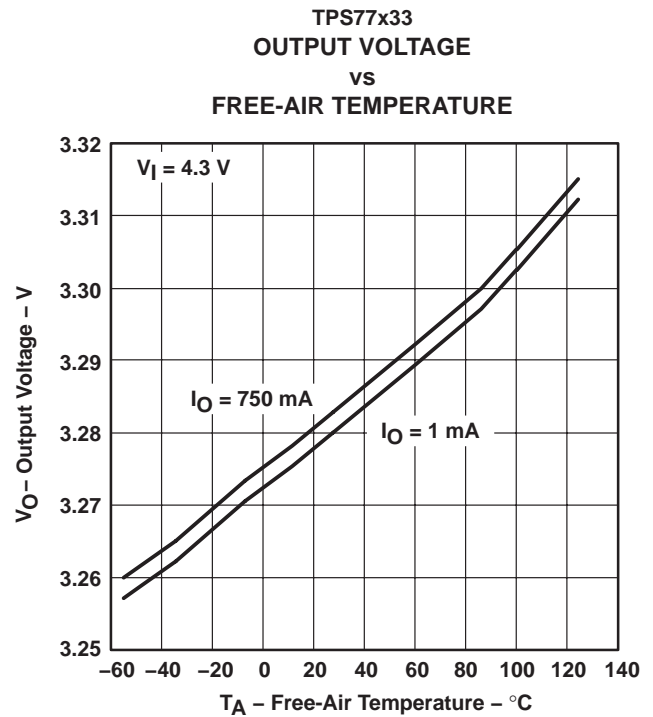


Figure 5

TYPICAL CHARACTERISTICS

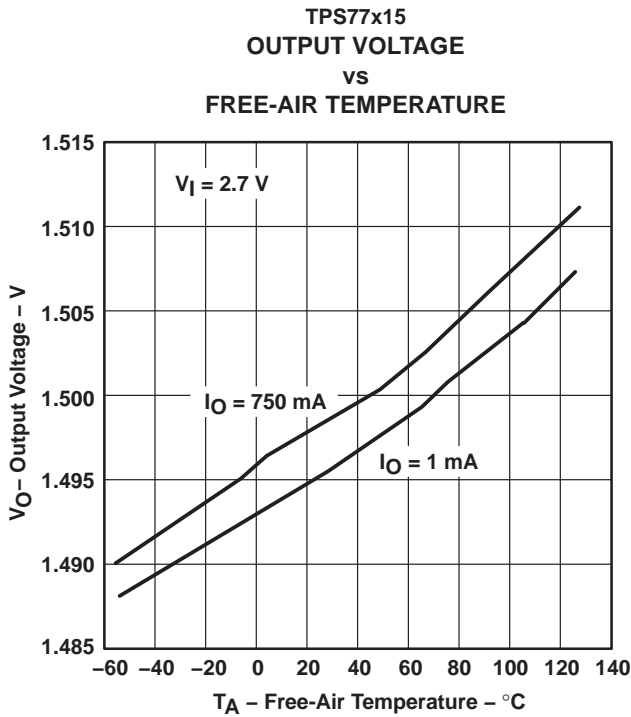


Figure 6

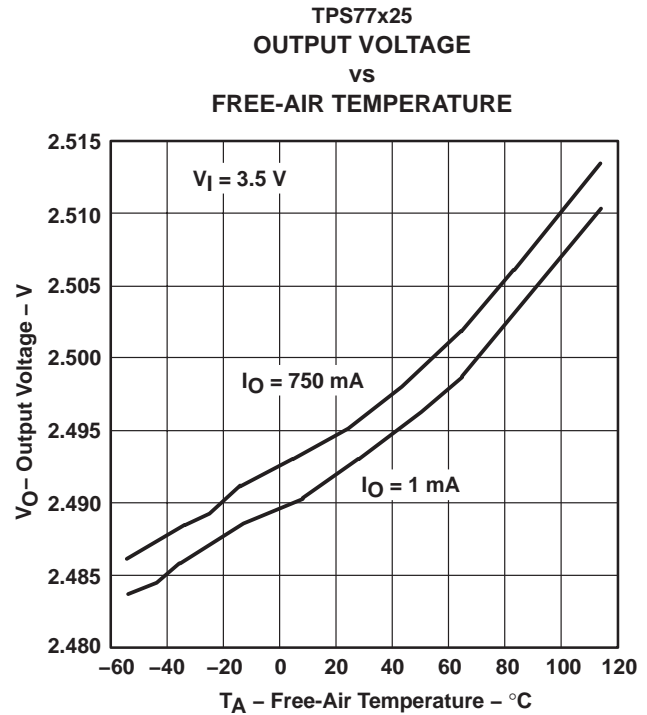


Figure 7

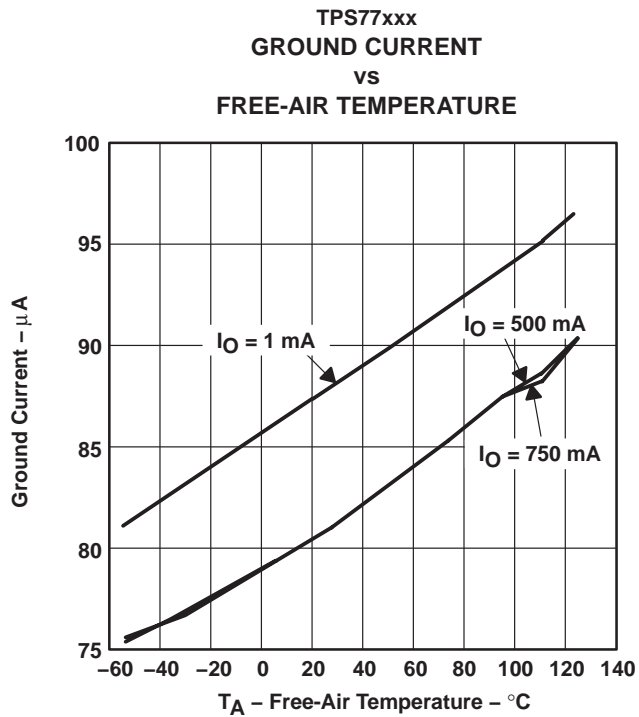


Figure 8

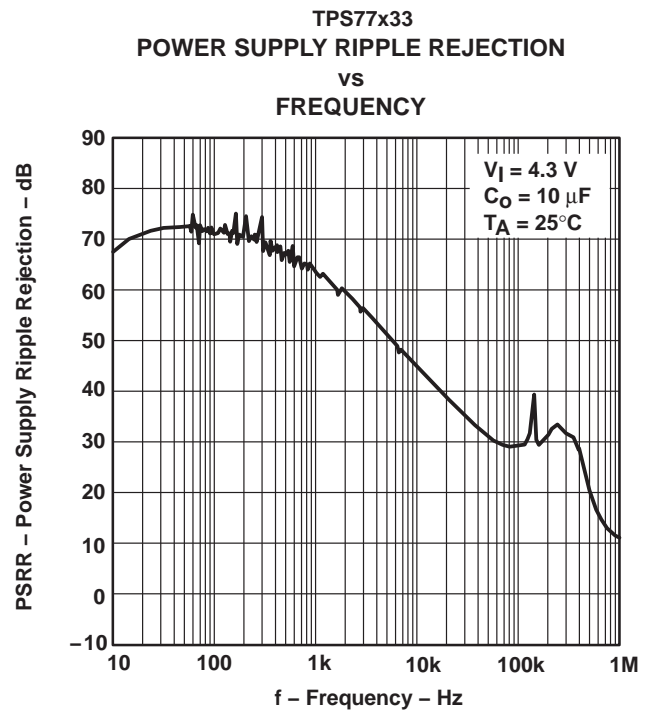


Figure 9

TYPICAL CHARACTERISTICS

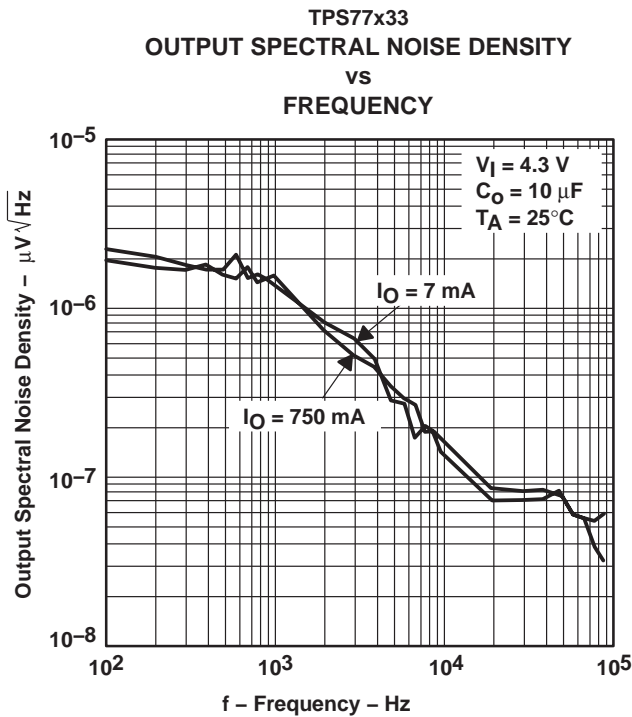


Figure 10

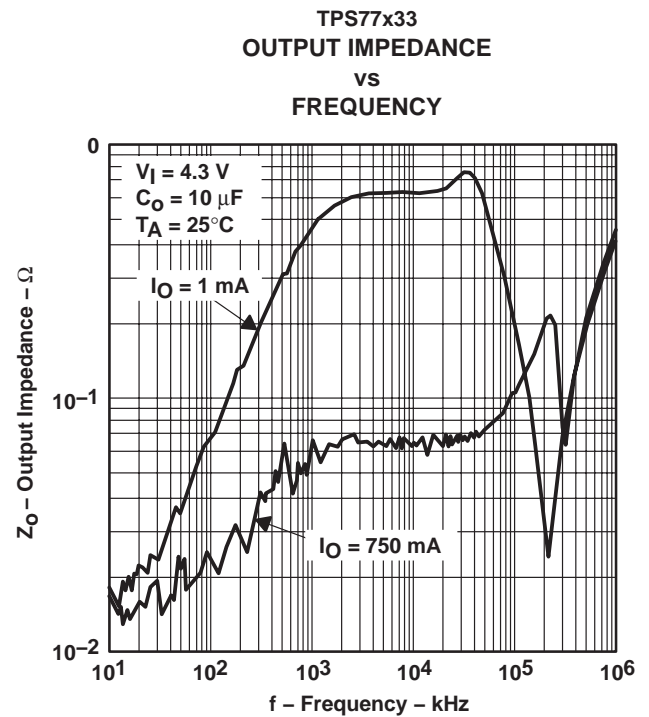


Figure 11

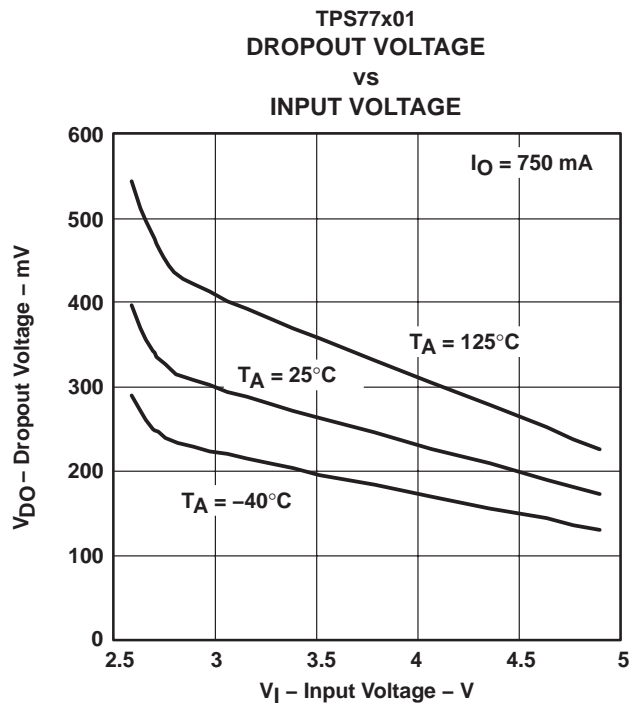


Figure 12

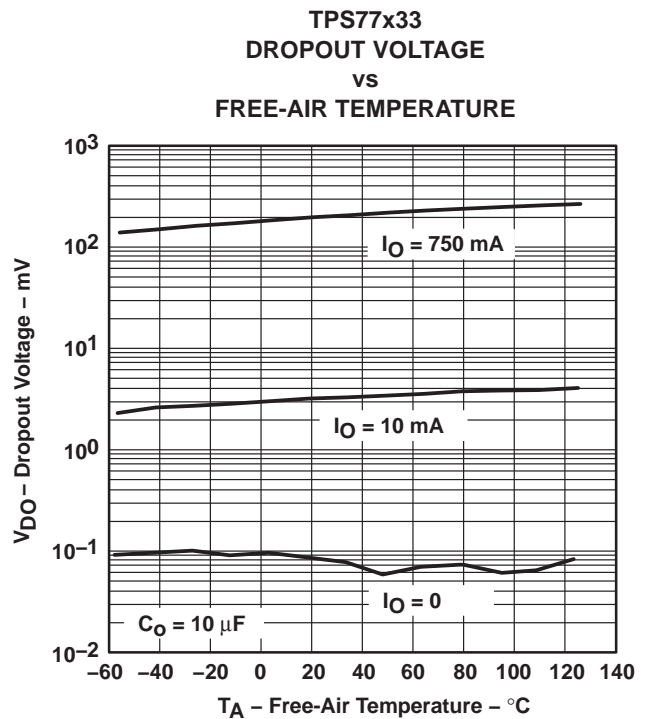
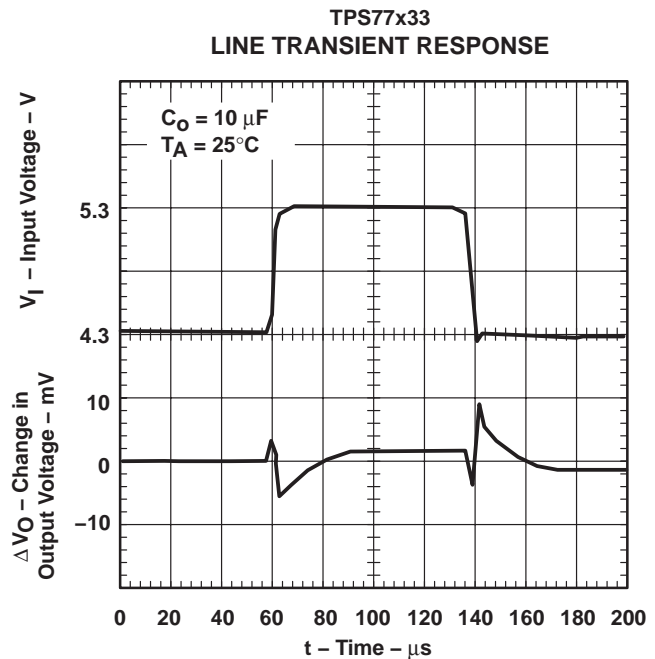
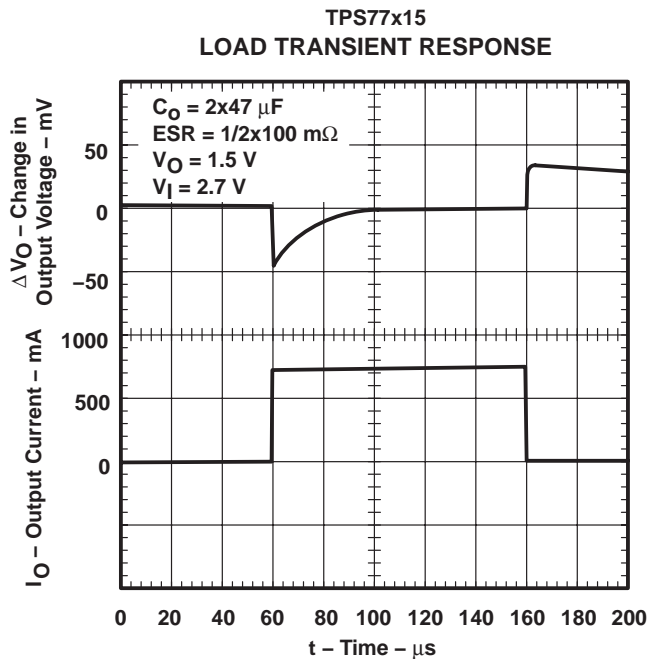
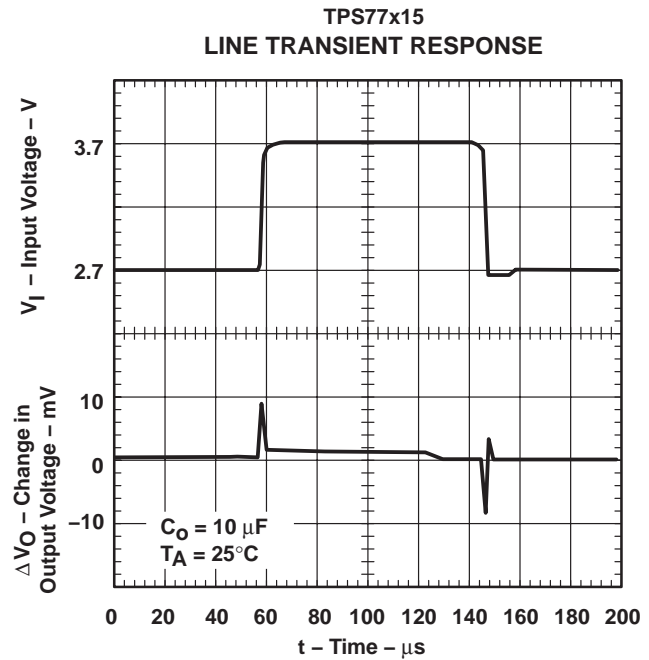
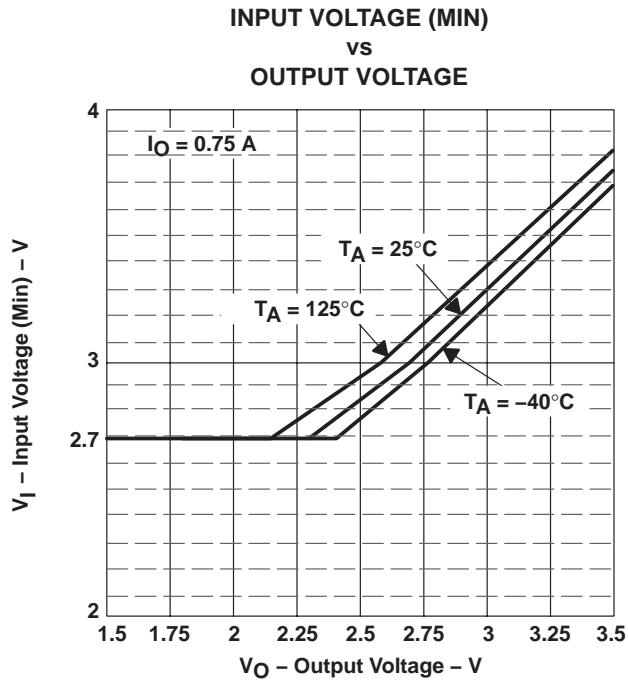


Figure 13

TYPICAL CHARACTERISTICS



TYPICAL CHARACTERISTICS

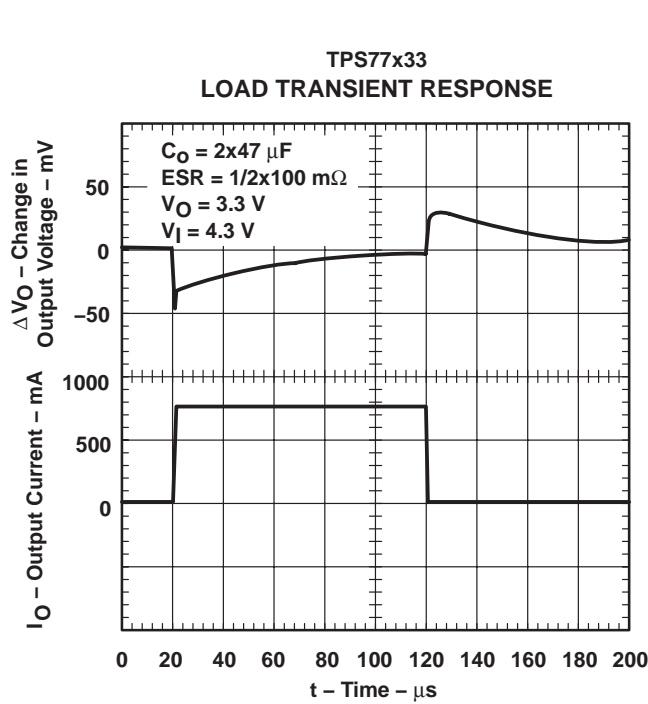


Figure 18

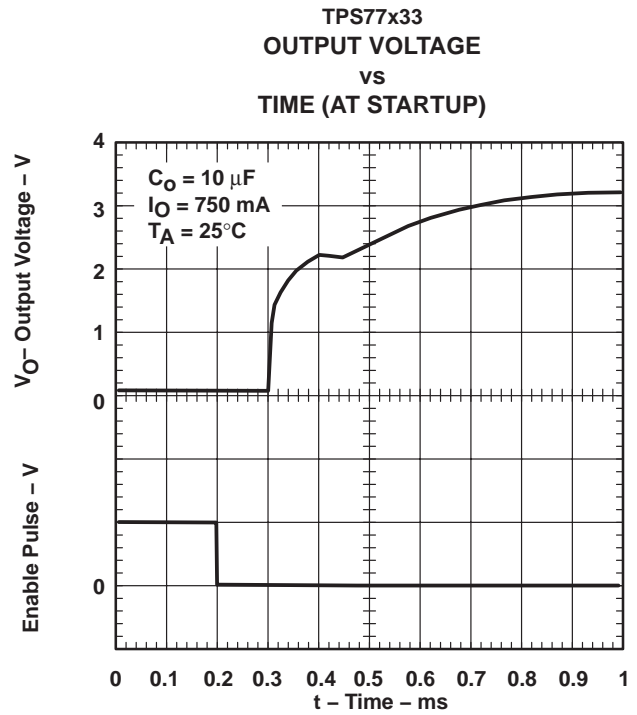


Figure 19

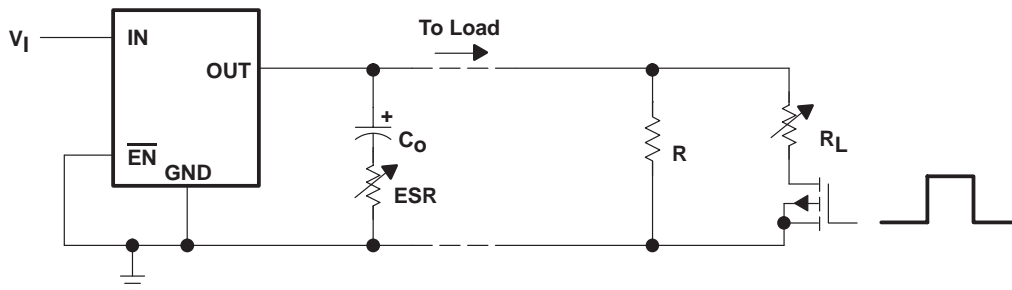


Figure 20. Test Circuit for Typical Regions of Stability (Figures 21 through 24) (Fixed Output Options)

TYPICAL CHARACTERISTICS

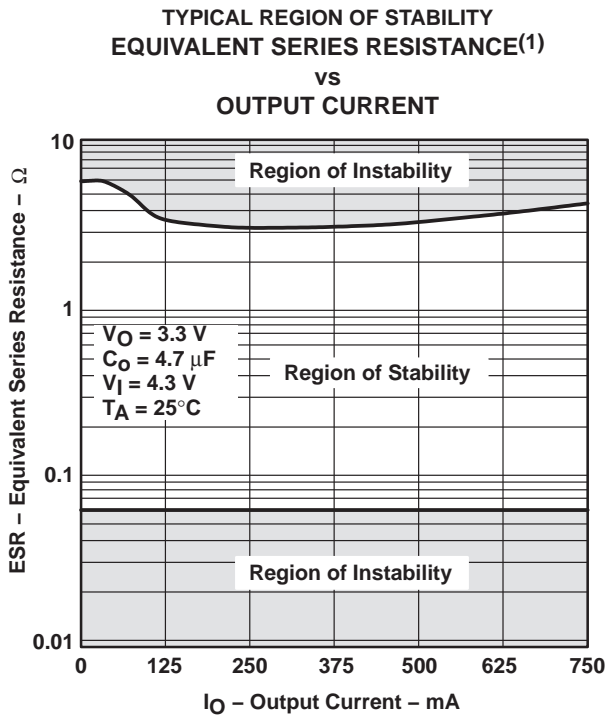


Figure 21

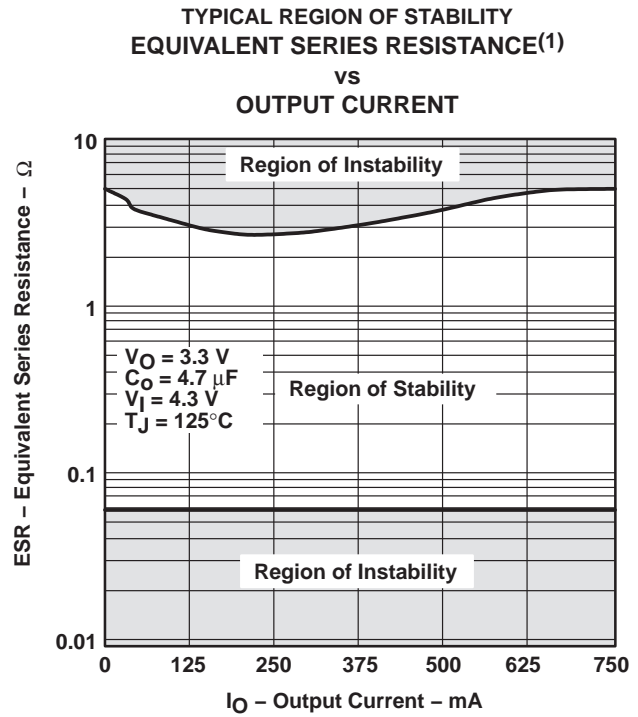


Figure 22

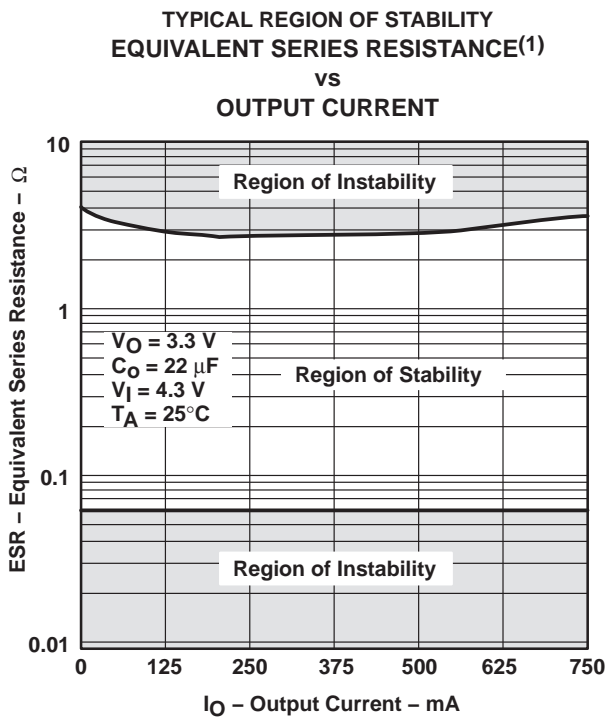


Figure 23

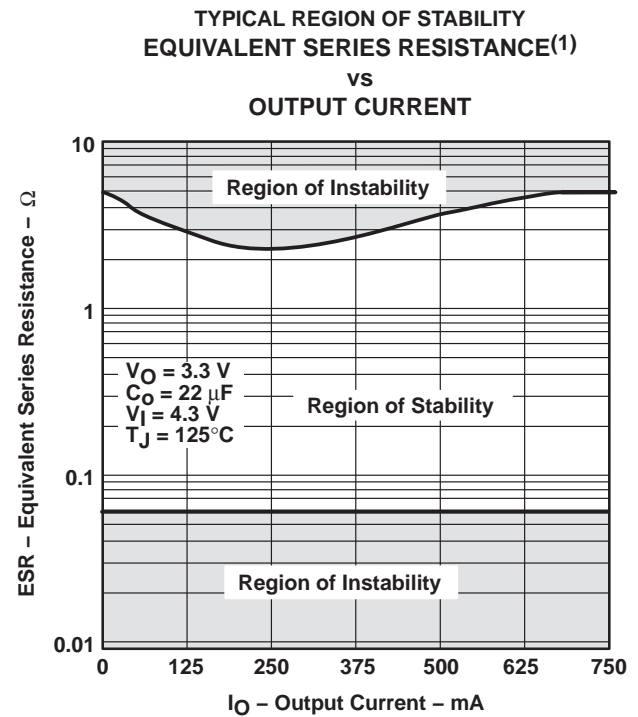


Figure 24

(1) Equivalent series resistance (ESR) refers to the total series resistance, including the ESR of the capacitor, any series resistance added externally, and PWB trace resistance to C_O .

APPLICATION INFORMATION

The TPS777xx and TPS778xx families include four fixed-output voltage regulators (1.5 V, 1.8 V, 2.5 V, and 3.3 V), and an adjustable regulator, the TPS77x01 (adjustable from 1.5 V to 5.5 V for TPS77701 option and 1.2 V to 5.5 V for TPS77801 option).

device operation

The TPS777xx and TPS778xx feature very low quiescent current, which remains virtually constant even with varying loads. Conventional LDO regulators use a pnp pass element, the base current of which is directly proportional to the load current through the regulator ($I_B = I_C/\beta$). The TPS777xx and TPS778xx use a PMOS transistor to pass current; because the gate of the PMOS is voltage driven, operating current is low and invariable over the full load range.

Another pitfall associated with the pnp-pass element is its tendency to saturate when the device goes into dropout. The resulting drop in β forces an increase in I_B to maintain the load. During power up, this translates to large start-up currents. Systems with limited supply current may fail to start up. In battery-powered systems, it means rapid battery discharge when the voltage decays below the minimum required for regulation. The TPS777xx and TPS778xx quiescent currents remain low even when the regulator drops out, eliminating both problems.

The TPS777xx and TPS778xx families also feature a shutdown mode that places the output in the high-impedance state (essentially equal to the feedback-divider resistance) and reduces quiescent current to 2 μA . If the shutdown feature is not used, $\overline{\text{EN}}$ should be tied to ground.

minimum load requirements

The TPS777xx and TPS778xx families are stable even at zero load; no minimum load is required for operation.

FB—pin connection (adjustable version only)

The FB pin is an input pin to sense the output voltage and close the loop for the adjustable option. The output voltage is sensed through a resistor divider network to close the loop as it is shown in Figure 26. Normally, this connection should be as short as possible; however, the connection can be made near a critical circuit to improve performance at that point. Internally, FB connects to a high-impedance wide-bandwidth amplifier and noise pickup feeds through to the regulator output. Routing the FB connection to minimize/avoid noise pickup is essential.

external capacitor requirements

An input capacitor is not usually required; however, a ceramic bypass capacitor (0.047 μF or larger) improves load transient response and noise rejection if the TPS777xx or TPS778xx are located more than a few inches from the power supply. A higher-capacitance electrolytic capacitor may be necessary if large (hundreds of milliamps) load transients with fast rise times are anticipated.

Like all low dropout regulators, the TPS777xx and TPS778xx require an output capacitor connected between OUT and GND to stabilize the internal control loop. The minimum recommended capacitance value is 10 μF and the ESR (equivalent series resistance) must be between 50 m Ω and 1.5 Ω . Capacitor values 10 μF or larger are acceptable, provided the ESR is less than 1.5 Ω . Solid tantalum electrolytic, aluminum electrolytic, and multilayer ceramic capacitors are all suitable, provided they meet the requirements described previously.

APPLICATION INFORMATION

external capacitor requirements (continued)

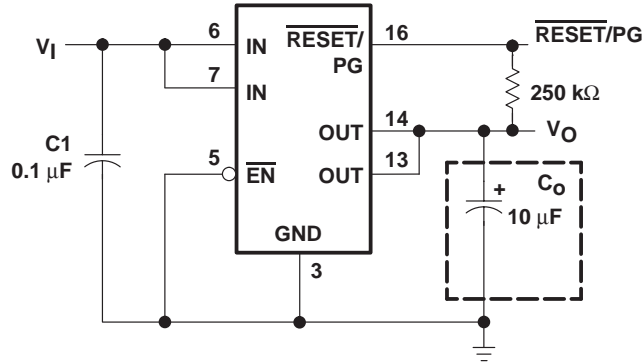


Figure 25. Typical Application Circuit (Fixed Versions)

programming the TPS77x01 adjustable LDO regulator

The output voltage of the TPS77x01 adjustable regulator is programmed using an external resistor divider as shown in Figure 26. The output voltage is calculated using:

$$V_O = V_{ref} \times \left(1 + \frac{R1}{R2}\right) \tag{1}$$

Where:

$V_{ref} = 1.1834 \text{ V typ}$ (the internal reference voltage)

Resistors R1 and R2 should be chosen for approximately 10-μA divider current. Lower value resistors can be used but offer no inherent advantage and waste more power. Higher values should be avoided as leakage currents at FB increase the output voltage error. The recommended design procedure is to choose $R2 = 110 \text{ k}\Omega$ to set the divider current at approximately 10 μA and then calculate R1 using:

$$R1 = \left(\frac{V_O}{V_{ref}} - 1\right) \times R2 \tag{2}$$

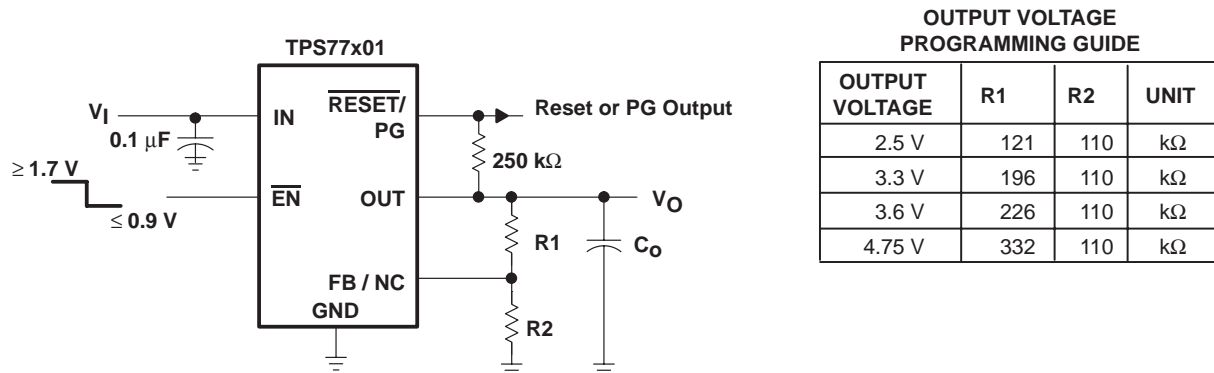


Figure 26. TPS77x01 Adjustable LDO Regulator Programming

APPLICATION INFORMATION

reset indicator

The TPS777xx features a $\overline{\text{RESET}}$ output that can be used to monitor the status of the regulator. The internal comparator monitors the output voltage: when the output drops to between 92% and 98% of its nominal regulated value, the $\overline{\text{RESET}}$ output transistor turns on, taking the signal low. The open-drain output requires a pullup resistor. If not used, it can be left floating. $\overline{\text{RESET}}$ can be used to drive power-on reset circuitry or as a low-battery indicator. $\overline{\text{RESET}}$ does not assert itself when the regulated output voltage falls outside the specified 2% tolerance, but instead reports an output voltage low relative to its nominal regulated value (refer to timing diagram for start-up sequence).

power-good indicator

The TPS778xx features a power-good (PG) output that can be used to monitor the status of the regulator. The internal comparator monitors the output voltage: when the output drops to between 92% and 98% of its nominal regulated value, the PG output transistor turns on, taking the signal low. The open-drain output requires a pullup resistor. If not used, it can be left floating. PG can be used to drive power-on reset circuitry or used as a low-battery indicator.

regulator protection

The TPS777xx and TPS778xx PMOS-pass transistors have a built-in back diode that conducts reverse currents when the input voltage drops below the output voltage (e.g., during power down). Current is conducted from the output to the input and is not internally limited. When extended reverse voltage is anticipated, external limiting may be appropriate.

The TPS777xx and TPS778xx also feature internal current limiting and thermal protection. During normal operation, the TPS777xx and TPS778xx limit output current to approximately 1.7 A. When current limiting engages, the output voltage scales back linearly until the overcurrent condition ends. While current limiting is designed to prevent gross device failure, care should be taken not to exceed the power dissipation ratings of the package. If the temperature of the device exceeds 150°C(typ), thermal-protection circuitry shuts it down. Once the device has cooled below 130°C(typ), regulator operation resumes.

APPLICATION INFORMATION

POWER DISSIPATION AND JUNCTION TEMPERATURE

Specified regulator operation is assured to a junction temperature of 125°C; the maximum junction temperature should be restricted to 125°C under normal operating conditions. This restriction limits the power dissipation the regulator can handle in any given application. To ensure the junction temperature is within acceptable limits, calculate the maximum allowable dissipation, $P_{D(max)}$, and the actual dissipation, P_D , which must be less than or equal to $P_{D(max)}$.

The maximum-power-dissipation limit is determined using the following equation:

$$P_{D(max)} = \frac{T_{Jmax} - T_A}{R_{\theta JA}}$$

Where:

T_{Jmax} is the maximum allowable junction temperature.

$R_{\theta JA}$ is the thermal resistance junction-to-ambient for the package, and is calculated as

$$\frac{1}{\text{derating factor}} \quad \text{from the dissipation rating tables.}$$

T_A is the ambient temperature.

The regulator dissipation is calculated using:

$$P_D = (V_I - V_O) \times I_O$$

Power dissipation resulting from quiescent current is negligible. Excessive power dissipation will trigger the thermal protection circuit.

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS77701D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77701 | Samples |
| TPS77701DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77701 | Samples |
| TPS77701PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77701 | Samples |
| TPS77701PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77701 | Samples |
| TPS77715D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77715 | Samples |
| TPS77715DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77715 | Samples |
| TPS77715PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77715 | Samples |
| TPS77715PWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77715 | Samples |
| TPS77718D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77718 | Samples |
| TPS77718DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77718 | Samples |
| TPS77718DRG4 | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77718 | Samples |
| TPS77718PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77718 | Samples |
| TPS77718PWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77718 | Samples |
| TPS77718PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77718 | Samples |
| TPS77725D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77725 | Samples |
| TPS77725PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77725 | Samples |
| TPS77725PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77725 | Samples |
| TPS77725PWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77725 | Samples |
| TPS77733D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77733 | Samples |
| TPS77733DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77733 | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS77733PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77733 | Samples |
| TPS77733PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77733 | Samples |
| TPS77801D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77801 | Samples |
| TPS77801DG4 | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77801 | Samples |
| TPS77801DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77801 | Samples |
| TPS77801PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77801 | Samples |
| TPS77801PWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77801 | Samples |
| TPS77801PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77801 | Samples |
| TPS77801PWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77801 | Samples |
| TPS77815D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77815 | Samples |
| TPS77815DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77815 | Samples |
| TPS77815PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77815 | Samples |
| TPS77815PWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77815 | Samples |
| TPS77815PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77815 | Samples |
| TPS77818D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77818 | Samples |
| TPS77818PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77818 | Samples |
| TPS77818PWPG4 | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77818 | Samples |
| TPS77818PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77818 | Samples |
| TPS77818PWPRG4 | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77818 | Samples |
| TPS77825D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77825 | Samples |
| TPS77825DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77825 | Samples |

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead finish/ Ball material (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS77825PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77825 | Samples |
| TPS77825PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77825 | Samples |
| TPS77833D | ACTIVE | SOIC | D | 8 | 75 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77833 | Samples |
| TPS77833DR | ACTIVE | SOIC | D | 8 | 2500 | RoHS & Green | NIPDAU | Level-1-260C-UNLIM | -40 to 125 | 77833 | Samples |
| TPS77833PWP | ACTIVE | HTSSOP | PWP | 20 | 70 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77833 | Samples |
| TPS77833PWPR | ACTIVE | HTSSOP | PWP | 20 | 2000 | RoHS & Green | NIPDAU | Level-2-260C-1 YEAR | -40 to 125 | PT77833 | Samples |

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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TAPE AND REEL INFORMATION



QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Reel Diameter (mm) | Reel Width W1 (mm) | A0 (mm) | B0 (mm) | K0 (mm) | P1 (mm) | W (mm) | Pin1 Quadrant |
|--------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS77701DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77701PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77715DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77718DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77718PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77725PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77733DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77733PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77801DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77801PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77815DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77815PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77818PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77825DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77825PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |
| TPS77833DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS77833PWPR | HTSSOP | PWP | 20 | 2000 | 330.0 | 16.4 | 6.95 | 7.1 | 1.6 | 8.0 | 16.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|--------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS77701DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77701PWPR | HTSSOP | PWP | 20 | 2000 | 853.0 | 449.0 | 35.0 |
| TPS77715DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77718DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77718PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77725PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77733DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77733PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77801DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77801PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77815DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77815PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77818PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77825DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77825PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |
| TPS77833DR | SOIC | D | 8 | 2500 | 350.0 | 350.0 | 43.0 |
| TPS77833PWPR | HTSSOP | PWP | 20 | 2000 | 350.0 | 350.0 | 43.0 |

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