



THE DATASHEET OF TPS1101D



TPS1101, TPS1101Y SINGLE P-CHANNEL ENHANCEMENT-MODE MOSFETS

SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

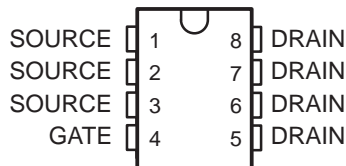
- Low $r_{DS(on)}$. . . 0.09 Ω Typ at $V_{GS} = -10$ V
- 3 V Compatible
- Requires No External V_{CC}
- TTL and CMOS Compatible Inputs
- $V_{GS(th)} = -1.5$ V Max
- Available in Ultrathin TSSOP Package (PW)
- ESD Protection Up to 2 kV per MIL-STD-883C, Method 3015

description

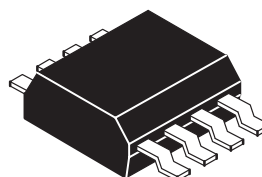
The TPS1101 is a single, low- $r_{DS(on)}$, P-channel, enhancement-mode MOSFET. The device has been optimized for 3-V or 5-V power distribution in battery-powered systems by means of the Texas Instruments LinBiCMOS™ process. With a maximum $V_{GS(th)}$ of -1.5 V and an I_{DSS} of only 0.5 μ A, the TPS1101 is the ideal high-side switch for low-voltage, portable battery-management systems where maximizing battery life is a primary concern. The low $r_{DS(on)}$ and excellent ac characteristics (rise time 5.5 ns typical) of the TPS1101 make it the logical choice for low-voltage switching applications such as power switches for pulse-width-modulated (PWM) controllers or motor/bridge drivers.

The ultrathin thin shrink small-outline package or TSSOP (PW) version fits in height-restricted places where other P-channel MOSFETs cannot. The size advantage is especially important where board height restrictions do not allow for a small-outline integrated circuit (SOIC) package. Such applications include notebook computers, personal digital assistants (PDAs), cellular telephones, and PCMCIA cards. For existing designs, the D-packaged version has a pinout common with other P-channel MOSFETs in SOIC packages.

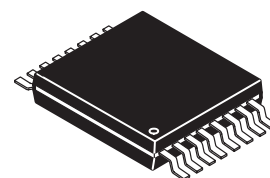
D PACKAGE
(TOP VIEW)



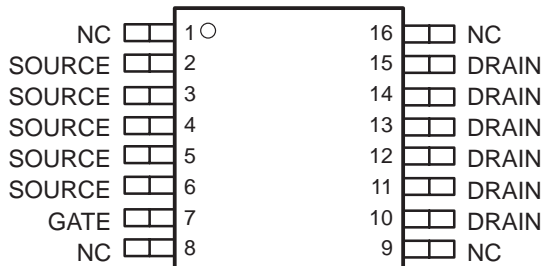
D PACKAGE



PW PACKAGE



PW PACKAGE
(TOP VIEW)



NC – No internal connection

AVAILABLE OPTIONS

| T _J | PACKAGED DEVICES† | | CHIP FORM (Y) |
|----------------|-------------------|-------------|---------------|
| | SMALL OUTLINE (D) | TSSOP (PW) | |
| -40°C to 150°C | TPS1101D | TPS1101PWLE | TPS1101Y |

† The D package is available taped and reeled. Add an R suffix to device type (e.g., TPS1101DR). The PW package is only available left-end taped and reeled (indicated by the LE suffix on the device type; e.g., TPS1101PWLE). The chip form is tested at 25°C.



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 **TEXAS
INSTRUMENTS**

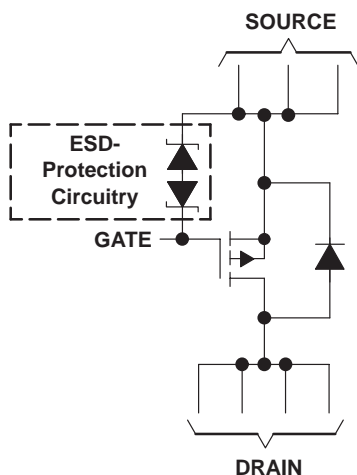
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SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

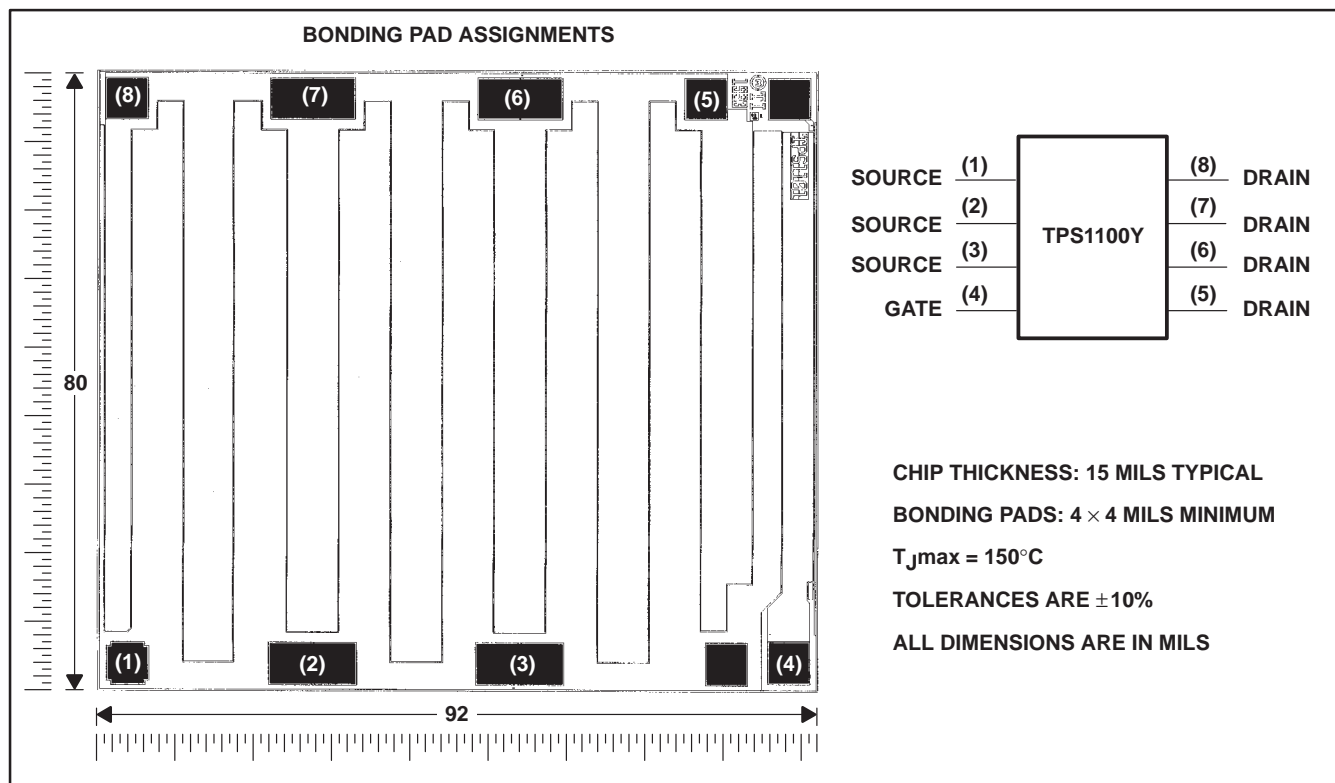
schematic



NOTE A: For all applications, all source terminals should be connected and all drain terminals should be connected.

TPS1101Y chip information

This chip, when properly assembled, displays characteristics similar to the TPS1101. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. The chips may be mounted with conductive epoxy or a gold-silicon preform.



TPS1101, TPS1101Y

SINGLE P-CHANNEL ENHANCEMENT-MODE MOSFETS

SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

absolute maximum ratings over operating free-air temperature (unless otherwise noted)[†]

| | | | | UNIT | |
|---|--------------------------|---------------------------|---------------------------|------------|------------------|
| Drain-to-source voltage, V_{DS} | | | | - 15 | V |
| Gate-to-source voltage, V_{GS} | | | | 2 or - 15 | V |
| Continuous drain current ($T_J = 150^\circ\text{C}$), $I_{D\ddagger}$ | $V_{GS} = -2.7\text{ V}$ | D package | $T_A = 25^\circ\text{C}$ | ± 0.62 | A |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.39 | |
| | | PW package | $T_A = 25^\circ\text{C}$ | ± 0.61 | |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.38 | |
| | $V_{GS} = -3\text{ V}$ | D package | $T_A = 25^\circ\text{C}$ | ± 0.88 | |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.47 | |
| | | PW package | $T_A = 25^\circ\text{C}$ | ± 0.86 | |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.45 | |
| | $V_{GS} = -4.5\text{ V}$ | D package | $T_A = 25^\circ\text{C}$ | ± 1.52 | |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.71 | |
| | | PW package | $T_A = 25^\circ\text{C}$ | ± 1.44 | |
| | | | $T_A = 125^\circ\text{C}$ | ± 0.67 | |
| $V_{GS} = -10\text{ V}$ | D package | $T_A = 25^\circ\text{C}$ | ± 2.30 | | |
| | | $T_A = 125^\circ\text{C}$ | ± 1.04 | | |
| | PW package | $T_A = 25^\circ\text{C}$ | ± 2.18 | | |
| | | $T_A = 125^\circ\text{C}$ | ± 0.98 | | |
| Pulsed drain current, $I_{D\ddagger}$ | | | $T_A = 25^\circ\text{C}$ | ± 10 | A |
| Continuous source current (diode conduction), I_S | | | $T_A = 25^\circ\text{C}$ | - 1.1 | A |
| Storage temperature range, T_{stg} | | | | -55 to 150 | $^\circ\text{C}$ |
| Operating junction temperature range, T_J | | | | -40 to 150 | $^\circ\text{C}$ |
| Operating free-air temperature range, T_A | | | | -40 to 125 | $^\circ\text{C}$ |
| Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds | | | | 260 | $^\circ\text{C}$ |

[†] 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.

[‡] Maximum values are calculated using a derating factor based on $R_{\theta JA} = 158^\circ\text{C}/\text{W}$ for the D package and $R_{\theta JA} = 176^\circ\text{C}/\text{W}$ for the PW package. These devices are mounted on an FR4 board with no special thermal considerations.

DISSIPATION RATING TABLE

| PACKAGE | $T_A \leq 25^\circ\text{C}$ 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 | $T_A = 125^\circ\text{C}$ POWER RATING |
|---------|---|--|--|--|---|
| D | 791 mW | 6.33 mW/ $^\circ\text{C}$ | 506 mW | 411 mW | 158 mW |
| PW | 710 mW | 5.68 mW/ $^\circ\text{C}$ | 454 mW | 369 mW | 142 mW |

[‡] Maximum values are calculated using a derating factor based on $R_{\theta JA} = 158^\circ\text{C}/\text{W}$ for the D package and $R_{\theta JA} = 176^\circ\text{C}/\text{W}$ for the PW package. These devices are mounted on an FR4 board with no special thermal considerations.

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SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

electrical characteristics at $T_J = 25^\circ\text{C}$ (unless otherwise noted)

static

| PARAMETER | TEST CONDITIONS | TPS1101 | | | TPS1101Y | | | UNIT |
|---|---|---------------------------|-------|------|----------|-----|-----|---------------|
| | | MIN | TYP | MAX | MIN | TYP | MAX | |
| $V_{GS(th)}$ Gate-to-source threshold voltage | $V_{DS} = V_{GS}$, $I_D = -250 \mu\text{A}$ | -1 | -1.25 | -1.5 | -1.25 | | | V |
| V_{SD} Source-to-drain voltage (diode-forward voltage) [†] | $I_S = -1 \text{ A}$, $V_{GS} = 0 \text{ V}$ | -1.04 | | | -1.04 | | | V |
| I_{GSS} Reverse gate current, drain short circuited to source | $V_{DS} = 0 \text{ V}$, $V_{GS} = -12 \text{ V}$ | ±100 | | | | | | nA |
| I_{DSS} Zero-gate-voltage drain current | $V_{DS} = -12 \text{ V}$, $V_{GS} = 0 \text{ V}$ | $T_J = 25^\circ\text{C}$ | | -0.5 | | | | μA |
| | | $T_J = 125^\circ\text{C}$ | | -10 | | | | |
| $r_{DS(on)}$ Static drain-to-source on-state resistance [†] | $V_{GS} = -10 \text{ V}$ | $I_D = -2.5 \text{ A}$ | | 90 | | 90 | | m Ω |
| | $V_{GS} = -4.5 \text{ V}$ | $I_D = -1.5 \text{ A}$ | | 134 | 190 | 134 | | |
| | $V_{GS} = -3 \text{ V}$ | $I_D = -0.5 \text{ A}$ | | 198 | 310 | 198 | | |
| | $V_{GS} = -2.7 \text{ V}$ | | | 232 | 400 | 232 | | |
| g_{fs} Forward transconductance [†] | $V_{DS} = -10 \text{ V}$, $I_D = -2 \text{ A}$ | 4.3 | | | 4.3 | | | S |

[†] Pulse test: pulse duration $\leq 300 \mu\text{s}$, duty cycle $\leq 2\%$

dynamic

| PARAMETER | TEST CONDITIONS | TPS1101, TPS1101Y | | | UNIT |
|--|---|---|-----|-----|------|
| | | MIN | TYP | MAX | |
| Q_g Total gate charge | $V_{DS} = -10 \text{ V}$, $V_{GS} = -10 \text{ V}$, $I_D = -1 \text{ A}$ | 11.25 | | | nC |
| Q_{gs} Gate-to-source charge | | 1.5 | | | |
| Q_{gd} Gate-to-drain charge | | 2.6 | | | |
| $t_{d(on)}$ Turn-on delay time | $V_{DD} = -10 \text{ V}$, $R_L = 10 \Omega$, $I_D = -1 \text{ A}$, $R_G = 6 \Omega$, See Figures 1 and 2 | 6.5 | | | ns |
| $t_{d(off)}$ Turn-off delay time | | 19 | | | ns |
| t_r Rise time | | 5.5 | | | ns |
| t_f Fall time | | 13 | | | |
| $t_{rr(SD)}$ Source-to-drain reverse recovery time | | $I_F = 5.3 \text{ A}$, $di/dt = 100 \text{ A}/\mu\text{s}$ | 16 | | |

PARAMETER MEASUREMENT INFORMATION

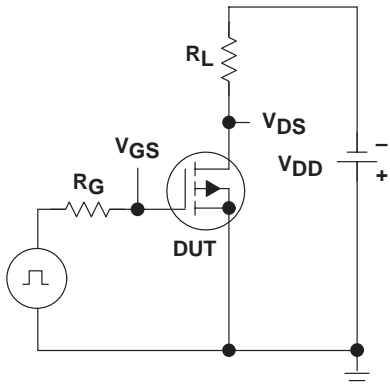


Figure 1. Switching-Time Test Circuit

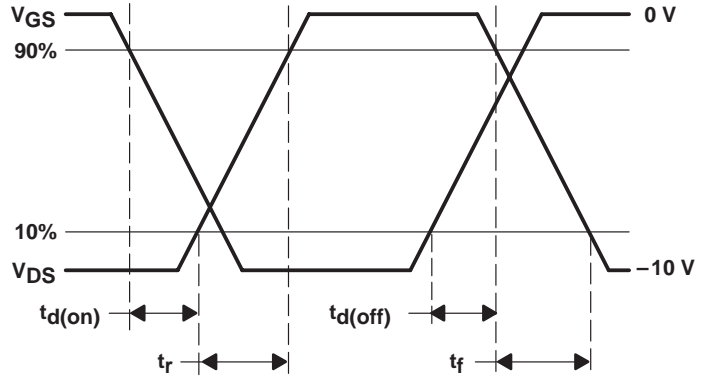


Figure 2. Switching-Time Waveforms

TYPICAL CHARACTERISTICS

Table of Graphs

| | | FIGURE |
|---|----------------------------|--------|
| Drain current | vs Drain-to-source voltage | 3 |
| Drain current | vs Gate-to-source voltage | 4 |
| Static drain-to-source on-state resistance | vs Drain current | 5 |
| Capacitance | vs Drain-to-source voltage | 6 |
| Static drain-to-source on-state resistance (normalized) | vs Junction temperature | 7 |
| Source-to-drain diode current | vs Source-to-drain voltage | 8 |
| Static drain-to-source on-state resistance | vs Gate-to-source voltage | 9 |
| Gate-to-source threshold voltage | vs Junction temperature | 10 |
| Gate-to-source voltage | vs Gate charge | 11 |

TPS1101, TPS1101Y SINGLE P-CHANNEL ENHANCEMENT-MODE MOSFETS

SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

TYPICAL CHARACTERISTICS

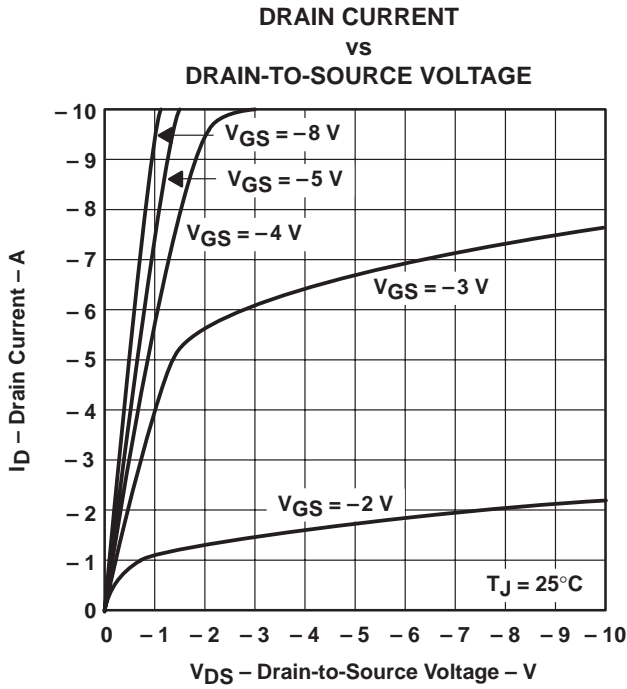


Figure 3

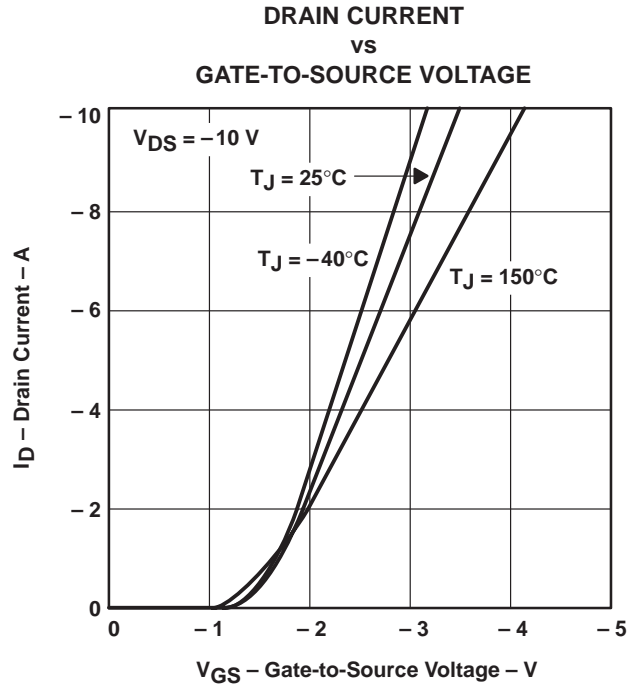


Figure 4

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE vs DRAIN CURRENT

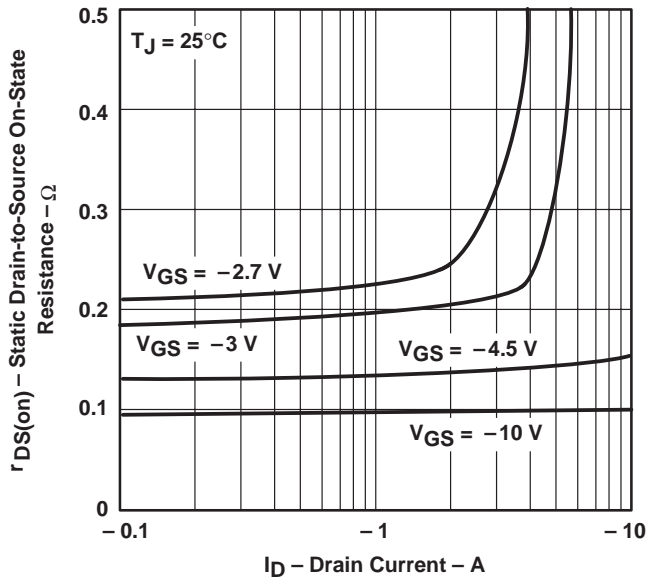
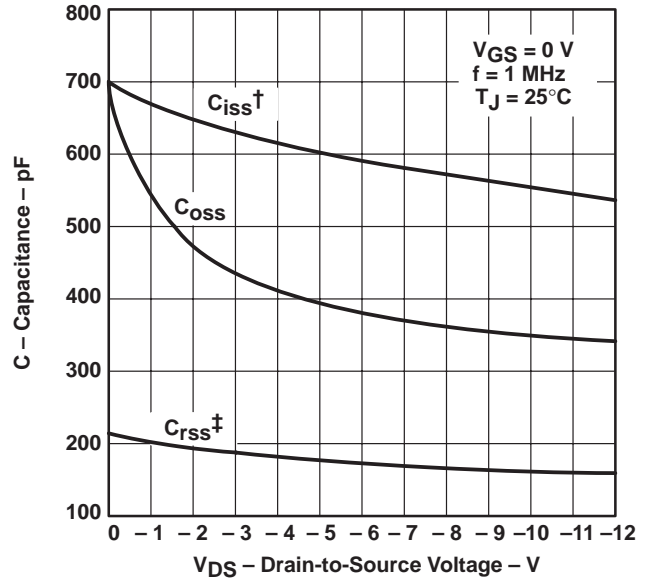


Figure 5

CAPACITANCE† vs DRAIN-TO-SOURCE VOLTAGE



$$† C_{iss} = C_{gs} + C_{gd}, C_{ds(\text{shorted})}$$

$$‡ C_{rss} = C_{gd}, C_{oss} = C_{ds} + \frac{C_{gs} C_{gd}}{C_{gs} + C_{gd}} \approx C_{ds} + C_{gd}$$

Figure 6



TYPICAL CHARACTERISTICS

STATIC DRAIN-TO-SOURCE
ON-STATE RESISTANCE (NORMALIZED)
vs
JUNCTION TEMPERATURE

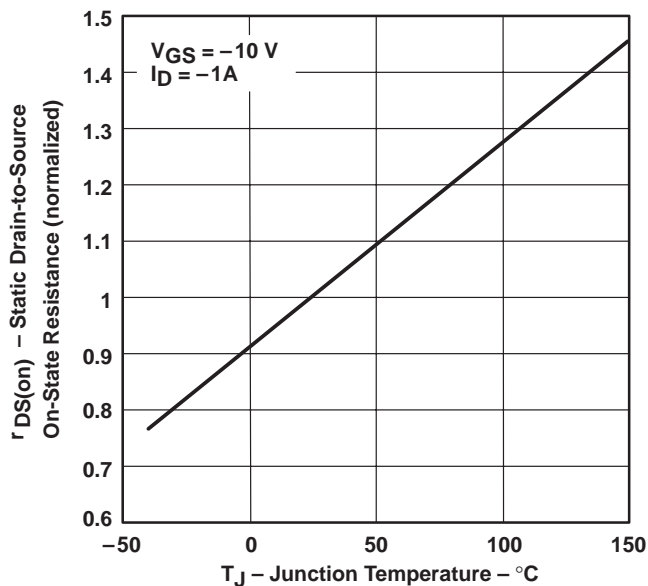


Figure 7

SOURCE-TO-DRAIN DIODE CURRENT
vs
SOURCE-TO-DRAIN VOLTAGE

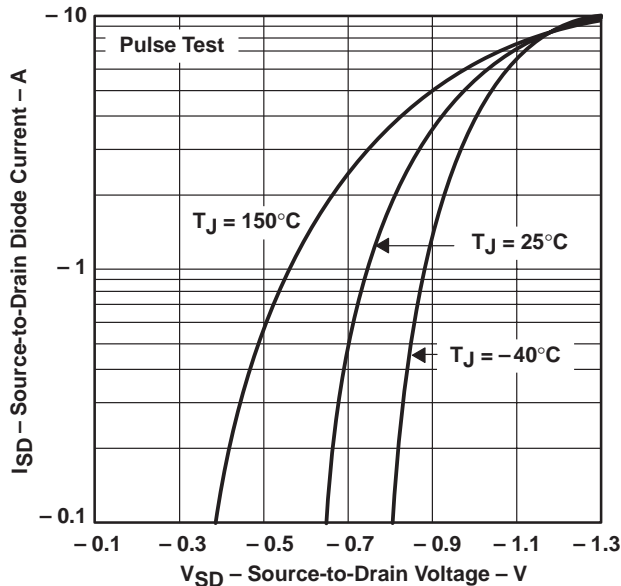


Figure 8

STATIC DRAIN-TO-SOURCE ON-STATE RESISTANCE
vs
GATE-TO-SOURCE VOLTAGE

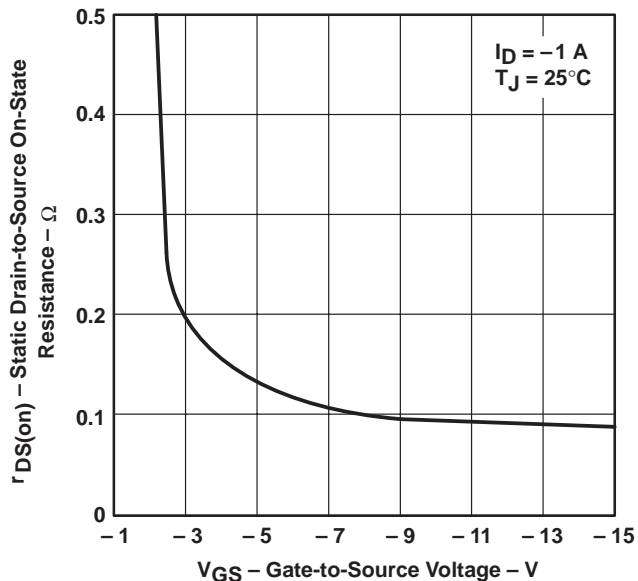


Figure 9

GATE-TO-SOURCE THRESHOLD VOLTAGE
vs
JUNCTION TEMPERATURE

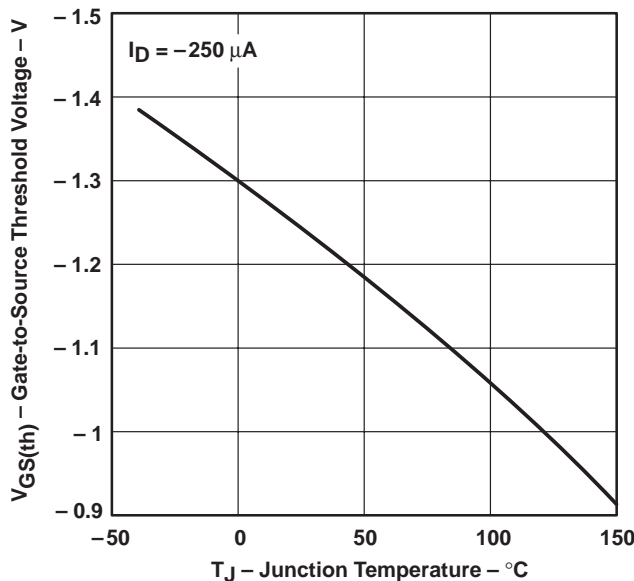


Figure 10

TPS1101, TPS1101Y SINGLE P-CHANNEL ENHANCEMENT-MODE MOSFETS

SLVS079C – DECEMBER 1993 – REVISED AUGUST 1995

TYPICAL CHARACTERISTICS

GATE-TO-SOURCE VOLTAGE
vs
GATE CHARGE

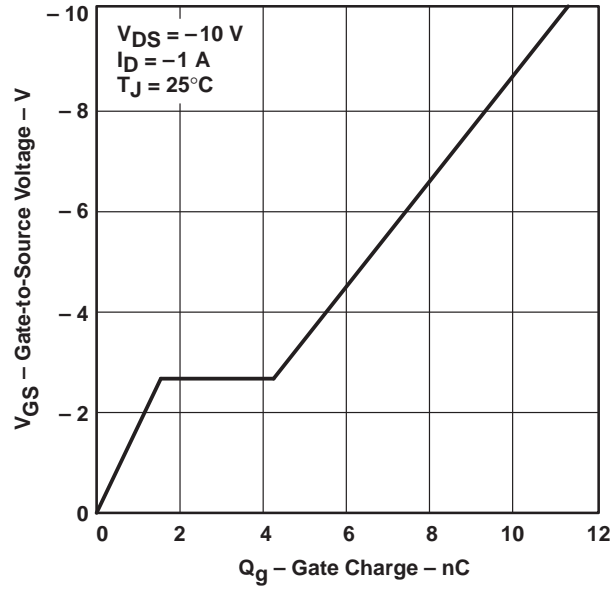
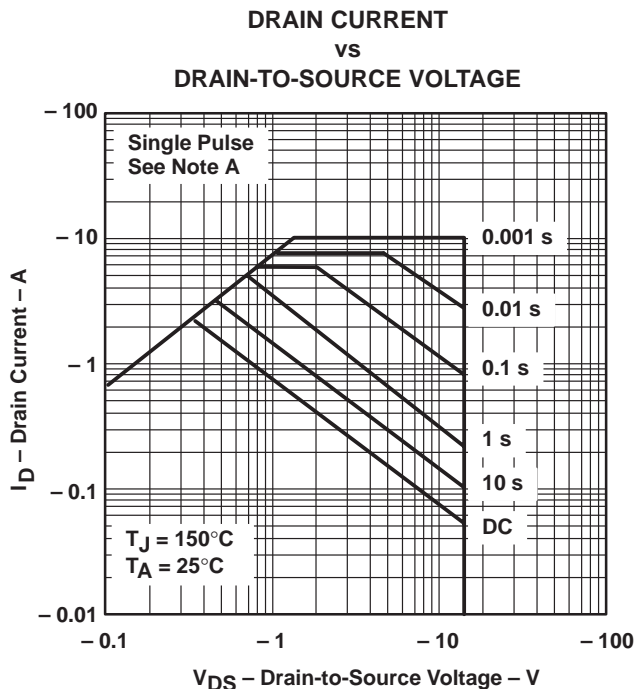


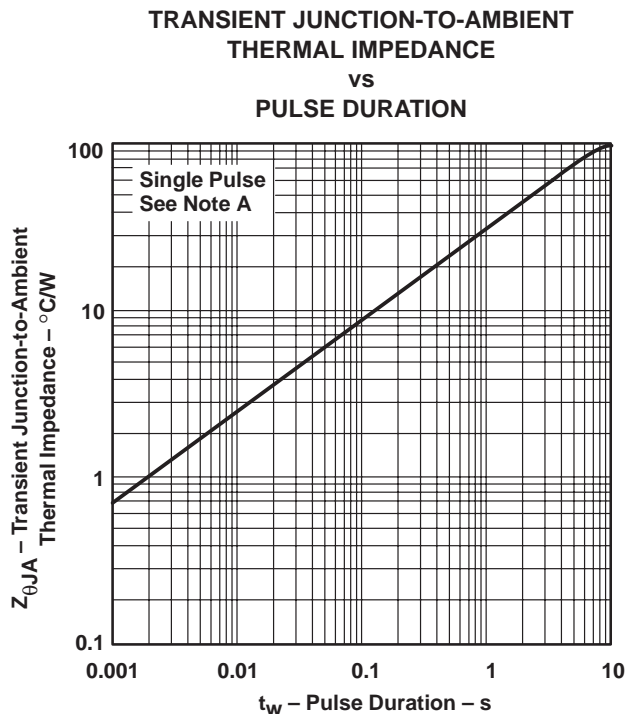
Figure 11

THERMAL INFORMATION



NOTE A: Values are for the D package and are FR4-board-mounted only.

Figure 12



NOTE A: Values are for the D package and are FR4-board-mounted only.

Figure 13

APPLICATION INFORMATION

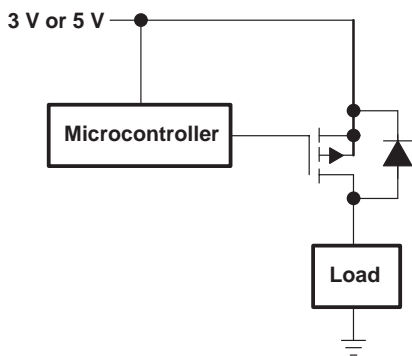


Figure 14. Notebook Load Management

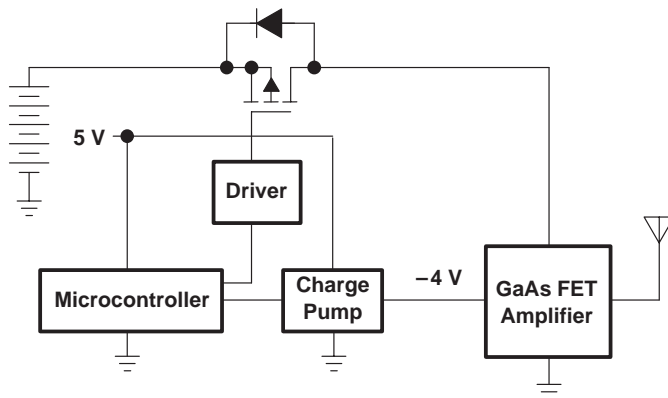


Figure 15. Cellular Phone Output Drive

PACKAGING INFORMATION

| Orderable Device | Status (1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan (2) | Lead/Ball Finish (6) | MSL Peak Temp (3) | Op Temp (°C) | Device Marking (4/5) | Samples |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS1101D | ACTIVE | SOIC | D | 8 | 75 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | 1101 | Samples |
| TPS1101DR | ACTIVE | SOIC | D | 8 | 2500 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | 1101 | Samples |
| TPS1101PWR | ACTIVE | TSSOP | PW | 16 | 2000 | Green (RoHS & no Sb/Br) | CU NIPDAU | Level-1-260C-UNLIM | | PS1101 | 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.

OBSELETE: 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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish 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 |
|------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS1101DR | SOIC | D | 8 | 2500 | 330.0 | 12.4 | 6.4 | 5.2 | 2.1 | 8.0 | 12.0 | Q1 |
| TPS1101PWR | TSSOP | PW | 16 | 2000 | 330.0 | 12.4 | 6.9 | 5.6 | 1.6 | 8.0 | 12.0 | Q1 |

TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

| Device | Package Type | Package Drawing | Pins | SPQ | Length (mm) | Width (mm) | Height (mm) |
|------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS1101DR | SOIC | D | 8 | 2500 | 340.5 | 338.1 | 20.6 |
| TPS1101PWR | TSSOP | PW | 16 | 2000 | 367.0 | 367.0 | 35.0 |

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